



CITY OF CHANDLER, ARIZONA

PECOS SURFACE WATER TREATMENT PLANT ADMINISTRATION BUILDING HVAC AND WATER QUALITY LAB RENOVATION

CITY PROJECT NO. WA2106.401

CONSTRUCTION SERVICES AGREEMENT (CONSTRUCTION MANAGER AT RISK)

**Kimberly Moon, P.E.
CIP City Engineer**

CITY OF CHANDLER, ARIZONA

**PECOS SURFACE WATER TREATMENT PLANT ADMINISTRATION
BUILDING HVAC AND WATER QUALITY LAB RENOVATION
CITY PROJECT NO.: WA2106.401**

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**CONSTRUCTION MANAGER AT RISK
CONSTRUCTION SERVICES AGREEMENT
PROJECT NO.: WA2106.401**

This Agreement (the "AGREEMENT") is made and entered into on the ____ day of _____, 2023, ("Effective Date") by and between City of Chandler, an Arizona municipal corporation, hereinafter called "City" and **Caliente Construction, Inc.** the "Construction Manager at Risk" or "CM@Risk" designated below (City and CM@Risk may individually be referred to as "Party" and collectively referred to as "Parties").

City and CM@Risk agree as follows:

ARTICLE 1 - PARTICIPANTS AND PROJECT

CITY: CIP City Engineer: Kimberly Moon, P.E.
Public Works & Utilities Department
P.O. Box 4008, Mail Stop 407 Chandler, AZ 85244-4008
Phone: 480-782-3349 Email: kimberly.moon@chandleraz.gov

CITY: Construction Project Manager: Jason Garcia
Public Works & Utilities Department
P.O. Box 4008, Mail Stop 407 Chandler, AZ 85244-4008
Phone: 480-782-3453 Email: jason.garcia@chandleraz.gov

CM@RISK: Legal Company Name: Caliente Construction, Inc.
Mailing Address: 485 W. Vaughn St., Tempe AZ 85283
Physical Address: 485 W. Vaughn St., Tempe AZ 85283
Arizona Roc No.: 091625; 098769; 164561
Federal Tax Id No.: 86-0697201
State Where Organized: Arizona
Business Organization: corporation
Statutory Agent Name: Registered Agent Solutions
Statutory Agent Mailing Address: 300 W. Clarendon Ave Ste 240 Phoenix AZ 85013
Statutory Agent Physical Address: _____

CM@Risk's Authorized Project Representative:

Name: Lorraine Bergman
Title: President
Phone: 602-625-1434
Email: lbergman@calienteconstruction.com

PROJECT DESCRIPTION:

This project is for the renovation of the admin building at the Pecos Surface Water Treatment Plant facility which includes new HVAC system, water quality laboratory remodel, and SCADA room build out located at 1475 E Pecos Rd, Chandler, AZ 85286. The HVAC scope is to include demo of the existing mechanical equipment including boiler, chiller, AHU and ductwork for the building HVAC system, new ducts, rewiring and sealing of existing ducts to remain, new HVAC mechanical equipment for the building, dedicated HVAC system for the laboratory space including new roof top units, outside mechanical yard to house the chiller with CMU walls, and new CRAC unit system for the server room. The remodeled lab is to include demo of the existing space, new casework, plumbing, mechanical, gas lines, electrical, fume hoods, offices, and workspaces. Additional improvements to include new steel staircase to provide roof access from the outside, SCADA room on the first floor which will include new partition walls, electrical, and mechanical and other associated improvements for the project.

PROJECT LOCATION:

1475 East Pecos Road, Chandler, AZ 85286

ARTICLE 2 - AGREEMENT DOCUMENTS

2.1 AGREEMENT DOCUMENTS

The Agreement between City and CM@Risk will consist of the following Agreement Documents:

1. This Construction Services Agreement and all of its Exhibits, including Project Plans and Technical Specifications.
2. General Conditions and General Conditions Appendices, incorporated by reference.
3. Project Specific Special Provisions as set forth in **Exhibit A**, incorporated by reference.
4. Accepted GMP/Price Proposal as set forth in **Exhibit D**, incorporated by reference.

2.2 In the event of any inconsistency, conflict, or ambiguity between or among the Agreement Documents, the Agreement Documents will take precedence as described in Section 14.1.4 of the General Conditions.

2.3 DEFINITIONS

The definitions in Sections 2 and 15 of the General Conditions apply to all the Agreement Documents, including this Agreement.

ARTICLE 3 - PRE-CONSTRUCTION SERVICES

Although CM@Risk has performed Pre-Construction Services pursuant to a separate Agreement between City and CM@Risk, the completion, quality and accuracy of those services and the deliverables provided by City thereunder directly impact CM@Risk's performance of its obligations under this Agreement. Therefore, all of CM@Risk's obligations, duties, and warranties in relation to Pre-Construction Services and deliverables survive completion of the Pre-Construction Services Agreement and are incorporated herein. Any breach of any of CM@Risk's duties, obligations, or warranties under the Pre-Construction Services Agreement will likewise be considered a breach of this Agreement.

ARTICLE 4 - CONSTRUCTION SERVICES

4.1 GENERAL

4.1.1 CM@Risk agrees at its own cost and expense, to do all work necessary and required to fully, timely and properly complete the construction of the Project in strict accordance with the Agreement Documents in a good and workmanlike manner, free and clear of all claims, liens, and charges whatsoever, in the manner and under the conditions specified, and within the schedule, stated in attached **Exhibit A**.

- 4.1.2 CM@Risk must provide all of the labor and materials, and perform the Work in accordance with Section 4 of the General Conditions. Some, but not all, of the major components of the Construction Services and the corresponding subsections of Section 4 of the General Conditions are set forth below.
- 4.1.3 This is an Agreement for complete construction services in accordance with the Construction Manager at Risk method of delivery of construction services. CM@RISK has participated in the design process and been an active member of the Project Design Team and is fully aware of any issues and constraints involved in this Construction Project.
- 4.1.4 CM@RISK is the CITY's fiduciary responsible for undertaking all necessary action contemplated under the Agreement documents to construct the Project and ensure timely and quality completion of the Project at a cost within the Guaranteed Maximum Price (GMP).
- 4.1.5 At all times relevant to this Agreement and performance of the Work, the CM@Risk must fully comply with all Laws, Regulations, or Legal Requirements applicable to City, the Project and the Agreement, including, without limitation, those set forth on attached **Exhibit A**.
- 4.1.6 CM@Risk must perform the Work under this Agreement using only those firms, team members and individuals designated by CM@Risk consistent with the Statement of Qualifications dated July 19, 2022, the GMP Proposal, or otherwise approved by City pursuant to the General Conditions. No other entities or individuals may be used without prior approval of the Project Manager
- 4.1.7 CM@Risk will comply with all terms and conditions of the General Conditions.
- 4.1.8 In the event of a conflict between this Agreement and the General Conditions or an exhibit hereto or appendix thereto, the terms of this Agreement will control.
- 4.1.9 Ownership of Work Product. Notwithstanding anything to the contrary in this Agreement, all Work Product prepared or otherwise created in connection with the performance of this Agreement, including the Work, are to be and remain the property of City. For purposes of this provision, "Work Product" will include all designs, drawings, plans, specifications, ideas, renderings and other information or matter, in whatever form created (e.g., electronic or printed) and in all media now known or hereinafter created. All Work Product will be considered Work Made for Hire as defined in the United States Copyright Act 17 U.S.C. § 101 (Copyright Act). If for any reason, any such Work is found not to be a Work Made for Hire, CM@Risk hereby transfers and assigns ownership of the copyright in such Work to City. The rights in this Section are exclusive to City in perpetuity.

4.2 CM@RISK'S PRE-AGREEMENT AND PRE-WORK DELIVERABLES

4.2.1 The CM@Risk must provide the Deliverables in accordance with Section 4.2 of the General Conditions.

4.3 PRE-CONSTRUCTION CONFERENCE

Refer to Section 4.3 of the General Conditions.

4.4 PERFORMANCE OF THE WORK (INCLUDING FIELD MEASUREMENTS, SUBCONTRACTORS, AND SUPPLIERS)

Refer to Section 4.4 of the General Conditions.

4.5 CONTROL OF THE PROJECT SITE

Refer to Section 4.5 of the General Conditions.

4.6 PROJECT SAFETY

Refer to Section 4.6 of the General Conditions.

4.7 MATERIALS QUALITY, SUBSTITUTIONS AND SHOP DRAWINGS

Refer to Section 4.7 of the General Conditions.

4.8 PROJECT RECORD DOCUMENTS

Refer to Section 4.8 of the General Conditions.

4.9 WARRANTY AND CORRECTION OF DEFECTIVE WORK

Refer to Section 4.9 of the General Conditions.

ARTICLE 5 - CITY RESPONSIBILITIES

5.1 City will have the responsibilities, and provide the information specified in, and subject to the conditions set forth in, Section 5 of the General Conditions.

ARTICLE 6 - AGREEMENT TIME

6.1 GENERAL

6.1.1 The Agreement Duration is **517** Calendar Days.

6.1.2 The Agreement Time will start with the Notice to Proceed (NTP) and end with Final Acceptance, as set forth in Article 6.4 below. The Notice to Proceed cannot be issued until approval and acceptance by City of the GMP or Fixed Price.

6.1.3 The Agreement Time will be as set forth in the Project Schedule. CM@Risk agrees that it will commence performance of the Work and complete the Project through Final Acceptance within the Agreement Time.

6.1.4 Time is of the essence of this Agreement for the Project, and for each phase and designated Milestone thereof.

6.2 PROJECT SCHEDULE

6.2.1 The Project Schedule approved as part of the GMP Proposal and incorporated herein as part of the attached **Exhibit D** must be updated and maintained throughout CM@Risk's performance under this Agreement in accordance with Section 6.2 of the General Conditions.

6.2.2 Failure on the part of CM@Risk to adhere to the approved Project Schedule will be deemed a material breach and sufficient grounds for termination of this Agreement by City.

6.2.3 Work must be completed to meet the following milestones after the Notice to Proceed:

<u>Milestone</u>	<u>Time</u>	<u>Liquidated damages for delay</u>
1. [REDACTED]	within [REDACTED] days	\$ [REDACTED] per calendar day

6.3 SUBSTANTIAL COMPLETION

Substantial Completion must be achieved no later than the Substantial Completion Date set forth in the Project Schedule. Substantial Completion will be determined in accordance with Section 6.3 of the General Conditions.

6.4 FINAL ACCEPTANCE

6.4.1 Final Acceptance will be obtained within the time period set forth in the Project Schedule.

6.4.2 Final Acceptance will be issued pursuant to Section 6.5 of the General Conditions.

6.5 LIQUIDATED DAMAGES

6.5.1 Substantial Completion Liquidated Damages. CM@Risk acknowledges and agrees that if CM@Risk fails to obtain Substantial Completion of the Work within the Agreement Time, City will sustain extensive damages and serious loss as a result of such failure. The exact amount of such damages will be extremely difficult to ascertain. Therefore, City and CM@Risk agree that if CM@Risk fails to achieve Substantial Completion of the Work within the Agreement Time, City will be entitled to retain or recover from CM@Risk, as

liquidated damages and not as a penalty, the sum per calendar day as indicated in MAG § 108.9.

6.5.2 Final Acceptance Liquidated Damages. For the same reasons set forth in Article 6.5.1 above, City and CM@Risk further agree that if CM@Risk fails to achieve Final Acceptance of the Work within the Agreement Time, City will be entitled to retain or recover from CM@Risk, as liquidated damages and not as a penalty, the sum per calendar day as indicated in MAG § 108.9 commencing from the actual date of Substantial Completion or Final Acceptance as required under the Agreement.

6.5.3 MAG Liquidated Damages. If no liquidated damages are specified in Articles 6.5.1 or 6.5.2 above, then the liquidated damages provisions in MAG § 108.9 will apply.

6.5.4 City may deduct liquidated damages described in this Article 6.5 from any unpaid amounts then or thereafter due CM@Risk under this Agreement. Any liquidated damages not so deducted from any unpaid amounts due CM@Risk will be payable to City at the demand of City, together with interest from the date of the demand at the highest lawful rate of interest payable by CM@Risk.

6.6 **MUTUAL WAIVER OF CONSEQUENTIAL DAMAGES ONLY**

6.6.1 CM@Risk and City waive claims against each other for consequential damages arising out of or relating to this Agreement. This mutual waiver includes:

6.6.1.1 Damages incurred by City for rental expenses, for losses of use, income, profit, financing, business and reputation, and for loss of management or employee productivity or of the services of such persons; and

6.6.1.2 Damages incurred by CM@Risk for principal office expenses including the compensation of personnel stationed there, for losses of financing, business and reputation, and for loss of profit except anticipated profit arising directly from the Work.

6.6.2 This mutual waiver is applicable, without limitation, to all consequential damages due to either Party's termination of this Agreement. Nothing contained in this Article 6.6 will be deemed to preclude an award of liquidated damages, when applicable, in accordance with Article 6.5 above.

6.6.3 Nothing herein will be deemed to constitute a waiver of any other remedy available to City in the event of CM@Risk's default under this Agreement prior to full performance of the Work including, as applicable, specific performance or completion of the Work on behalf of CM@Risk, the cost and expense of which will be offset against any monies then or thereafter due to CM@Risk (if any) and otherwise immediately reimbursed to City by CM@Risk.

ARTICLE 7 - AGREEMENT PRICE

7.1 AGREEMENT PRICE

- 7.1.1 In exchange for CM@Risk's full, timely, and acceptable performances and construction of the Work under this Agreement, and subject to all of the terms of this Agreement, City will pay CM@Risk the "Agreement Price," which:

The sum of the CM@Risk's Fee and reimbursable Cost of the Work, as defined in Section 15 of the General Conditions, which the CM@Risk guarantees will not exceed the GMP set forth in **Exhibit D** in the amount of **\$1,319,649**. Costs which would cause the GMP to be exceeded must be paid by CM@Risk without reimbursement from City.

- 7.1.2 The Agreement Price is all-inclusive and specifically includes all fees, cost, insurance and bond premiums, allowances, construction contingency, owner's contingency, and taxes of any type necessary to fully, properly and timely perform and construct Work.

7.2 CHANGES TO AGREEMENT PRICE

Shall be determined under Section 9 of the General Conditions.

ARTICLE 8 - FORCED LABOR OF ETHNIC UYGHURS PROHIBITED

- 8.1 **FORCED LABOR OF ETHNIC UYGHURS PROHIBITED.** By entering into this Agreement, Contractor certifies and agrees Contractor does not currently use and will not use for the term of this Agreement: (i) the forced labor of ethnic Uyghurs in the People's Republic of China; or (ii) any goods or services produced by the forced labor of ethnic Uyghurs in the People's Republic of China; or (iii) any contractors, subcontractors or suppliers that use the forced labor or any goods or services produced by the forced labor of ethnic Uyghurs in the People's Republic of China.

SIGNATURE PAGE TO FOLLOW

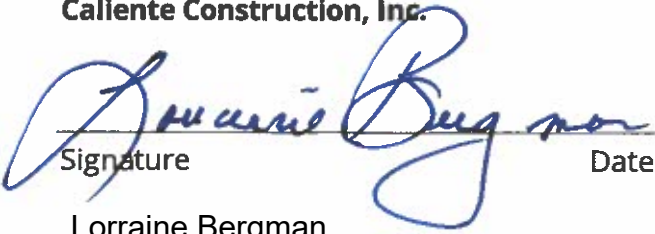
IN WITNESS WHEREOF, the Parties hereto have executed this Agreement through their duly authorized representatives and bind their respective entities as of the effective date.

"CITY" CITY OF CHANDLER

"CM@Risk"

Caliente Construction, Inc.

MAYOR


Signature

2/23/23
Date

RECOMMENDED BY:

Lorraine Bergman

Print Name

President/CEO

Title

lbergman@calienteconstruction.com

Signer Email Address



Kimberly Moon, P.E.
CIP City Engineer

APPROVED AS TO FORM:

City Attorney 

ATTEST:

City Clerk

Seal

EXHIBIT A

PROJECT SPECIFIC SPECIAL PROVISIONS

4.2.7 Aerial Construction Photography

General Conditions Section 4 Subsections 4.2.7.1 & 4.2.7.2 are not applicable to this project.

4.2.8 Government Approvals and Permits

General Conditions Section 4 Subsection 4.2.8.1, City permit fees will be paid internally by the City and all other fees will be the responsibility of the Contractor.

Subletting of Agreement

Contractor must perform, with his own organization, work amounting to not less than 50 percent of the total Agreement cost.

Failure to submit Subcontractor's List Form, demonstrating self-performance not less than 50 percent of the total Agreement cost, will cause the bid to be deemed non-responsive.

Contractors should contact the Arizona Registrar of Contractors for information on license requirements.

EXHIBIT B

GENERAL CONDITIONS



GENERAL CONDITIONS

Approved date: July 20, 2022

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Appendix 2 – Cost Reduction Incentive Proposals for Design Bid Build Agreements

Appendix 3 – Contractor's Affidavit Regarding Settlement of Claims

Appendix 4 – Forms of Performance Bond

Appendix 5 – Forms of Payment Bond

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Appendix 8 – Construction Sign Detail

Appendix 9 – Cost of the Work (Applicable solely to Construction Manager at Risk and Job Order Contracting)

Appendix 10 Landscape Establishment Period

SECTION 1 - SCOPE OF THESE GENERAL CONDITIONS

These General Conditions encompass provisions that apply, and are incorporated into all construction Agreements entered into by the City of Chandler, unless otherwise specifically excluded in the executed Agreement.

SECTION 2 - GENERAL DEFINITIONS

Allowance: A specific amount for a specific item of Work, if any, that City agrees has not been sufficiently designed, detailed, or selected (including design changes from 90% to 100% as authorized by and at the discretion of the City) at the time the Agreement Price is agreed to for Contractor to provide a definitive price.

Alternate Systems Evaluations or Alternative Analysis: Alternatives for design, means and methods or other scope considerations that are evaluated using value analysis principles and have the potential to reduce construction costs while still delivering a quality and functional Project that meets City requirements.

Change Order: A written instrument issued after execution of the Agreement Documents signed by City and Contractor, stating their agreement upon all of the following: the addition, deletion or revision in the scope of services or deliverables; the amount of the adjustment to the Agreement Price, the extent of the adjustment to the Agreement Time, or modifications of other agreement terms. The Agreement Price and the Agreement Time may be changed only by Change Order.

Consultant: Person or firm that provides professional services.

City (Owner or OWNER): City of Chandler, a municipal corporation, with whom Contractor has entered into the Agreement and for whom the Work or Services are to be provided pursuant to the Agreement(s).

Contingent Bid Items: This is a minor bid item which is likely, but not certain, to occur during the course of work. If the Engineer determines that this work is required, the Contractor will accomplish the work and payment will be made based on the contingent unit bid price included in the proposal. Since the quantity listed in the proposal is primarily for bid comparison, the amount of work required by the Engineer may vary materially from this.

Agreement: The written agreement executed between City and Contractor, including all of the Agreement Documents.

Agreement Documents: The documents which together form the Agreement between City and Contractor, as identified in Article 2 of the Agreement, or are otherwise incorporated into the Agreement, including the Agreement, the exhibits thereto, these General Conditions, any Notice to Proceed, and any Job Order (if applicable), the Plans and Specifications, Project Schedule, written and properly executed Change Orders, MAG Specifications and City's amendments thereto, and any other documents so designated in the Agreement.

Agreement Price: The agreed-upon price to be paid to Contractor for full, timely, and acceptable completion of the Work or Services under the terms of the Agreement.

Agreement Time(s): The number of calendar days or the dates related to the applicable phase, Substantial Completion, or Final Acceptance as stated in Agreement Documents. Agreement Time starts

with the Notice to Proceed (NTP) and ends with Final Acceptance. The Agreement Time is set forth in the Agreement and is based upon the Project Schedule agreed to by City in writing.

Contractor: The person or business association with whom City has entered into an agreement for construction related Work or Services in relation to the Project at issue.

Contractor Payment Request: The form that is accepted by City and used by Contractor in requesting progress payments or final payment and which must include such supporting documentation as is required by the Agreement Documents or City.

Construction Budget: The City's budget for construction of the Project.

Construction Documents: The Plans, Specifications, and Drawings prepared and issued by the Design Professional and approved by City for construction, meaning the documents are sealed by the Design Professional (as required), acceptable for permitting and incorporated into the Agreement by this reference. All amendments and modifications to the Construction Documents must be approved in writing by City prior to incorporation into the Agreement.

Cost of the Work: The term Cost of the Work will mean costs necessarily incurred by Contractor in the proper performance of the Work. Such costs will be at rates not higher than the standard paid at the place of the Project except with prior consent of City.

Critical Path Method (CPM): A scheduling technique which identifies the logical sequence of the activities occurring in a Construction Project, the anticipated time required to complete each activity in the Project, and the activities that must be completed on schedule to finish the Project within the anticipated time. Typically, activities are arranged in a network that shows both activities and their dependencies. CPM is also used as a management technique which enables contracting parties to predict when activities may occur so that resources can be effectively used and limitations can be identified.

Critical Path: Critical Path is the sequence of project network activities which add up to the longest overall duration. Once established in the Project Schedule, the Critical Path for the Project must not be changed without prior written approval of City.

Day: Calendar day(s) unless otherwise specifically stated in the Agreement Documents.

Design Professional: The qualified, licensed person, firm or corporation who furnishes design and construction administration services required under the Agreement Documents. These services may include, but are not limited to: development of Construction Drawings and Documents, review of Contractor Submittal(s), review of and response to Requests for Information, approval and certification of progress payment applications, construction administration, and construction agreement close out.

Differing Site Conditions: Concealed or latent physical conditions or subsurface conditions at the Site that, (i) materially differ from the conditions indicated in the Agreement Documents, or (ii) are of an unusual nature, differing materially from the conditions ordinarily encountered and generally recognized as inherent in the Work at the general area of the Site. Caliche, rock, hard-digging or sandy/silty soil encountered on a project is not considered a "Differing Site Condition."

Drawings (Plans): Documents, which visually represent the scope, extent and character of the Work to be furnished and performed by Contractor during the construction phase and which have been prepared

or approved by the Design Professional and City. These documents include Drawings that have reached a sufficient state of completion and released by Design Professional solely for the purposes of review and use in performing constructability or bid-ability reviews by Contractor and in preparing cost estimates (e.g. Master Planning and Programming, Schematic Design, Design Development, and Construction Drawings), but *“not for construction.”* Shop Drawings are not Drawings as so defined.

Final Acceptance: The City's acceptance of the facility or project from the Contractor after all Work is completed, tested, and inspected in accordance with the Agreement requirements. Final Acceptance results in a Letter of Acceptance (LOA).

Fixed Price: A fixed price or amount for an Agreement Price, Scope of Work, materials, or other item under an Agreement, Change Order, or other agreement, which City agrees, in writing, to pay instead of the actual cost.

Float: The number of Days by which an activity can be delayed without lengthening the Critical Path and extending the Agreement Time. Unless otherwise expressly agreed in writing, all Float belongs to City.

Laws, Regulations, or Legal Requirements: Any and all applicable laws, rules, regulations, ordinances, codes and orders applicable to the Project of any and all governmental bodies, agencies, authorities and courts having jurisdiction and any applicable provisions of the Development Agreement for the Project (if any), including, without limitation, those provisions relating to the design and construction of the Project.

Line Item: The individual elements of Work identified on a bid or other schedule and associated with a price or a unit price and quantity particular to that individual element of the Work. Also refers to individual items of work within the Schedule of Values.

Liquidated Damages: Designated damages for the City to collect as compensation upon a specific breach (example: late delivery).

Long-Lead Item: Long-lead item refers to the equipment, product, or system that is identified at the earliest stage of a project to have a delivery time long enough to affect directly the Critical Path/the overall lead time of the project.

MAG: The Maricopa Association of Governments.

MAG Specifications: The most current version of the Uniform Standard Specifications for Public Works Construction published by MAG.

MAG Standard Details: The most current version of the Uniform Standard Details as published by MAG.

Minor change: A change in the Work having no impact on cost or time or the City-approved design intent, as determined by City.

Notice to Proceed (NTP): A written notice given by City to Contractor fixing the date on which Contractor will start to perform Contractor's obligations under the Agreement.

Project: The Project specified in the Agreement (including a Job Order).

Project Manager: The Project Manager designated in Article 1 of the Agreement, or any successor thereto

designated by City. The Project Manager has the authority to act on behalf of City, as delineated and limited by the Agreement Documents and applicable law. And City will communicate with Contractor through the Project Manager. However, the Project Manager has no authority to bind City or City Council in contravention of any City code, State or Federal statute or regulation, or these General Conditions.

Project Schedule: The schedule for the completion of the Project agreed to and required by City.

Project Specific Conditions: Additional conditions which apply to the specific Project and Scope of Work which are set forth in Exhibit D of the Agreement.

Project Team: The Project Team consisting of the Design Professional, Contractor, Project Manager, and such others as City may designate.

Punch List: The list initially prepared by Contractor pursuant to the Agreement Documents, reviewed and supplemented by the Project Manager (and at the sole option of the Project Manager, the Design Professional) and approved by City containing items of incomplete work not impacting Substantial Completion, if allowed for under the Agreement, and to be completed or corrected by Contractor after Substantial Completion and before Final Acceptance in accordance with the Agreement Documents.

Quality Assurance (QA) Testing: Testing performed to verify the accuracy and applicability of the QC testing results and to ascertain that the materials installed meet the specified levels of quality in accordance with the Agreement Documents.

Quality Control (QC) Testing: Testing performed to assure that the materials installed comply with the requirements in the Agreement Documents.

Requests for Information (RFIs): Formal written request from Contractor to City or Design Professional for the Project seeking clarification or additional information needed for Contractor to properly complete the Work or Services under the Agreement. City may require RFI's to be submitted on a specific form or in a specified format.

Schedule of Values (SOV): The specified document prepared by Contractor, and approved and accepted by City, which divides the Agreement Price into pay items, such that the sum of all pay items equals the Agreement Price for the construction phase Work, or for any portion of the Work having a separate specified Agreement Price.

Scope of Work: The scope of work agreed to or required by City and incorporated into the Agreement as Exhibit A.

Shop Drawings: All drawings, diagrams, schedules and other data specifically prepared for the Work by Contractor or a Subcontractor, Sub-subcontractor, manufacturer, supplier or distributor to illustrate some portion of the Work.

Site: The land or premises on which the Project is located.

Specifications: The part(s) of the Agreement Documents for the construction phase consisting of written technical descriptions of materials, equipment, construction systems, standards and workmanship as applied to the Work and certain administrative details applicable thereto. Where specified, the Project must be constructed using the current Uniform Standard Specifications and Details for Public Works

Construction as furnished by the Maricopa Association of Governments, as amended by City.

Subconsultant: A person, firm or corporation having an Agreement with Consultant/Contractor to furnish services required as its independent professional associate or consultant with respect to the Project.

Subcontractor: An individual or firm having a direct Agreement with Contractor or any other individual or firm having an Agreement with the aforesaid contractors at any tier, who undertakes to perform a part of pre-construction services or construction phase Work at the Site for which Contractor is responsible. Subcontractors must be selected through the Subcontractor selection process described in the Agreement Documents, if any.

Substantial Completion: The date when the City determines that the Work (or separable units of Phases as provided in the Agreement Documents) is essentially and satisfactorily complete in accordance with the Agreement Documents such that the Project is ready for use by the City for its intended purpose, opening to the general public, full occupancy or use by City (including, without limitation, all separate units, or rooms, facilities, access, income-generating areas, and all areas serving the general public, as applicable, must be ready for full operation without material inconvenience or discomfort), including, to the extent applicable to the Work, the following: all materials, equipment, systems, controls, features, facilities, accessories, and similar elements are installed in the proper manner and in operating condition, inspected, and approved; surfaces have been painted; masonry and concrete cleaned with any sealer or other finish applied; utilities and systems connected and functioning; site work complete; permanent heating, ventilation, air conditioning, vertical transportation, and other systems properly operating with proper controls; lighting and electrical systems installed, operable and controlled; paving completed, signage installed, and other work as applicable, has been performed to a similar state of essential and satisfactory completion.

Supplier: A manufacturer, fabricator, distributor, or vendor having a direct Agreement with Contractor or with any Subcontractor to furnish materials or equipment to be incorporated in the construction phase Work by Contractor or any Subcontractor.

Total Float: Number of Days by which pre-construction services or construction phase Work or any part of the same may be delayed without necessarily extending a pertinent Agreement Time or schedule milestone in the Project Schedule.

Work: The entire completion of construction or the various separately identifiable parts thereof, required to be furnished during the construction phase. Work includes and is the result of performing or furnishing labor and furnishing and incorporating materials, resources and equipment into the construction, and performing or furnishing services and documents as required by the Agreement Documents for the construction phase.

Writing: Typing, printing, photography and other modes of representing or reproducing words in a visible form, including email, and expressions.

SECTION 3 - STANDARD SPECIFICATIONS AND DETAILS

- 3.1 City operates under the latest revision of the MAG Specifications and MAG Standard Details as amended by City. City's current amendment to the MAG Specifications, part of the City's Unified Development Manual, may be found and downloaded from City's website at <http://www.chandleraz.gov>.

- 3.2 Copies of the MAG Specifications and MAG Standard Details are available at the Maricopa Association of Governments office, 302 N. 1st Avenue, Suite 300, Phoenix, Arizona. They may also be downloaded from their website at: <http://www.azmag.gov/Newsroom/Publications>
- 3.3 The MAG Specifications and Standard Details and City's amendments thereto are incorporated into the Agreement by this reference.

SECTION 4 - CONTRACTOR'S RESPONSIBILITIES FOR CONSTRUCTION SERVICES

4.1 GENERAL

- 4.1.1 Contractor must construct the Work in accordance with the Agreement Documents and as outlined in Exhibit A of the Agreement to the satisfaction of City, exercising the degree of professional care, skill, diligence, quality and judgment that a professional construction manager engaged, experienced and specializing in the construction management of construction and facilities of similar scope, function, size, quality, complexity and detail in urban areas throughout the United States comparable to Chandler, Arizona would exercise at such time, under similar conditions. Contractor must, at all times, perform the Work in conformance with sound and generally accepted engineering principles and construction management and construction contracting practices.
- 4.1.2 If Contractor observes errors, discrepancies or omissions in the Agreement Documents, Contractor must promptly notify the Design Professional and City and request clarification. If Contractor, with the exercise of reasonable care, should have recognized such error, inconsistency, omission, or difference and fails to report it to City, and if Contractor proceeds with the Work affected by such observed errors, discrepancies or omissions, without receiving such clarifications, Contractor does so at its own risk and will be liable to City for damages resulting from proceeding without clarification.
- 4.1.3 Project Team and agents of each of them, testing agencies and governmental agencies with jurisdictional interests will be provided access to the Work at reasonable times for their observation, inspection, and testing. Contractor must provide proper and safe conditions for such access.
- 4.1.4 Contractor must comply with, and require all Subcontractors to comply with, the Arizona Contractors' license laws, including all requirements with respect to being duly registered and licensed.
- 4.1.5 Contractor must ensure that all employees performing any Work for which Contractor is responsible have a legal right to live and work in the United States. In addition, all compensation of any such employee must meet all applicable requirements of the Fair Labor Standards Act (FLSA) and Federal Minimum Wage laws.
- 4.1.6 Contractor must comply with the Immigration Reform and Control Act of 1986 (IRCA). Contractor understands and acknowledges the applicability of the IRCA activities. Contractor agrees to comply with the IRCA while performing their work and to permit City inspection of Contractor personnel records to verify such compliance.
- 4.1.7 Pursuant to MAG Specifications §§ 107.4, Contractor must report immediately any discovery of archeological ruins or artifacts. Excavation must stop immediately so that City can decide on the pertinent steps to follow such discovery.

- 4.1.8 All property owners that may be affected by the proposed construction activities must be notified of the scope, duration of the construction activities and possible interference with their day-to-day activities by Contractor prior to start of construction. In addition, individual residential or commercial interferences, such as driveway restrictions, water outages, and all other Work adjacent to residence/business, require 48-hour notification in advance of specific adjoining Work. Notification may be through door hangers or other procedures approved by the City.
- 4.1.9 Access must be maintained to adjacent properties at all times during construction. Where property has more than one point of access, no more than one access will be restricted or closed at any one time. Access to adjacent private driveways will be maintained during all non-working hours.
- 4.1.10 Contractor must furnish and erect construction signs in accordance with Project Specifications. The signs must be professionally prepared and subject to approval by City, must be maintained by Contractor for the duration of the project, and must be removed by Contractor during the final project clean up.
- 4.1.11 The number of signs required, the size, shape, installation requirements and information to be included for construction signs is established on the detail sheet, provided, however, signs must be a minimum of 4 foot by 8 foot and must be installed so that the bottom of the sign is at least 4 foot above grade. No direct payment will be made for furnishing and erecting construction signs. The cost thereof must be included in other items for which direct payment is made. Sign locations will be determined by City.
- 4.1.12 All required construction signs must be installed by Contractor within 7 Days of Notice to Proceed.
- 4.1.13 The Work to be accomplished under these Agreement Documents has been designed for City by a Design Professional retained by City for this purpose. It is understood that normal construction Administration for the purpose of interpretation of the Agreement Documents is provided by City. Should any services of the Design Professional be required to assist in the corrections of errors or omissions by Contractor, or services of the Design Professional be required because of changes in structure or equipment where Contractor has requested approval of substitute methods or material, or any other items detailed herein below, those services will be provided by the Design Professional at the standard hourly rates previously negotiated with City and must be paid for by the Contractor.
- 4.1.14 Contractor must reimburse City for costs incurred by the Design Professional for additional services to the Project through no fault of City or the Design Professional including, but not limited to, the following conditions:
- a. Additional Site visits, investigations, inspections, design work or reports by the Design Professional which are required due to damages to existing facilities or completed Work caused by the Contractor in his performance, Contractor's negligence, or Contractor's Work which is rejected as defective or as failing to conform to the Agreement Documents;
 - b. Design Professional construction phase services rendered on the project during the time the project remains incomplete after the Agreement date of final completion will be charged to Contractor at a rate previously negotiated City; and

- c. All retesting required due to the failure of Contractor's Work to meet the requirements of the Agreement Documents will be at Contractor's expense. All standby and travel time by the City's testing lab, the Design Professional or City due to Contractor's inability to be prepared for testing at the agreed upon time will be at the Contractor's expense.

4.1.15 City may withhold from any payment otherwise due to Contractor any amounts necessary to pay the Design Professional for such additional services as provided herein above.

4.1.16 Contractor will not be required to bear additional costs incurred by City due to errors by the Design Professional.

4.2 **CONTRACTOR'S PRE-AGREEMENT AND PRE-WORK DELIVERABLES**

4.2.1 Prior to award of the Agreement, Contractor must execute Agreement and deliver to City. Failure to do so may delay Agreement award. Contractor must also provide to City its Contractor's License classification and number and its Federal Tax I.D. number.

4.2.2 Before beginning any Work under the Agreement, Agreement must be fully executed by City.

4.2.3 After Agreement award, City will issue to Contractor an award letter. At that time Contractor must deliver to City such bonds and certificates of insurance with endorsements in such amounts (and other evidence of insurance requested by City) required under Section 11 of these General Conditions, and as the Agreement requires.

4.2.4 As evidence of Workmen's Compensation Insurance, Contractor must, upon request, provide a letter of certification from the Industrial Commission of Arizona that Contractor is insured by the State Compensation Fund or is an authorized self-insurer or a certificate of insurance issued by an insurance company authorized by the Insurance Department of Arizona to write Workmen's Compensation and Occupational Disease Insurance in the State of Arizona.

4.2.5 Within 10 Days of the date of the executed Agreement letter issued by City, Contractor must submit to City for review and acceptance the following items:

4.2.5.1 Comprehensive construction Project Schedule including a Critical Path Method (CPM) diagram schedule as described in Section 6.2. Project Schedule must be in Microsoft Project standard file format. Within 10 Days of receipt of City's comments, Contractor must make all required corrections, adjustments, and additions to complete the Project Schedule and resubmit to City for review.

4.2.5.2 Preliminary schedule of submittals and Shop Drawings. Within 10 Days of receipt of City's comments, Contractor must submit the corrected and completed schedule of Shop Drawings submissions for approval. Contractor's schedule of Shop Drawings and sample submittals will be acceptable to City if it provides a workable arrangement for reviewing and processing the required submittals.

4.2.5.3 Schedule of Values in a form specified by City reflecting the subcontracts and other categories that will be used to submit Pay Applications for the Work. The total amount of the Schedule of Values must not be greater than the Agreement Price. The Schedule of Values will be reviewed at the Pre-Construction Conference and revised by Contractor within 10 Days after Pre-Construction Conference in response to comments and questions from

City. Once accepted by City in writing, the Schedule of Values for the Project must not be changed without the prior written approval of City.

4.2.6 Video Recording Requirement. Prior to performing any Work, Contractor must document the existing conditions of the Site, all other areas where Work will occur and all adjacent areas that may be impacted by the Work via digital video format. Contractor must video record and index all areas, features, buildings and other public and private improvements that could potentially be impacted by the Work. Video recording must be coordinated with City. When video recording private property, Contractor must also coordinate the video recording with the private property owner, if possible. Contractor must provide City with a copy of said digital video format prior to performing any Work.

4.2.7 Aerial Drone Construction Photography.

4.2.7.1 If Agreement duration is greater than 90 calendar days, Contractor must engage a professional unmanned aerial vehicle (UAV) aerial pilot to photograph the Site prior to construction mobilization, at three-month intervals during construction, and following final inspection. Drone camera specifications must meet the following minimum requirements:

- a. 1-inch CMOS
- b. Pixels: 20M
- c. FOV 84 8.8 mm/24 mm (35 mm format equivalent) f/2.8-f/11 auto focus at 1 m-
- d. For photographing: 16.9 Aspect Ratio: 5472x3078
- e. For video shooting: MP4/MOV/H.264
- f. FHD: 1920x1080 120p @100Mbps
- g. File format: High Definition (HD) JPEG for digital photos and HD MPEG 4 for digital video.
- h. All metadata to be recorded including GPS data and preserved with photographs provided.

Interval	JPEG
3 month intervals	At an altitude (AGL) between 70-90 ft.
3 month intervals	Images to be taken every 50-100 ft. to be determined based on project scope.

4.2.7.2 Drone photos to be taken in sequential geographical order and then organized and provided in the same manner unless otherwise specified.

4.2.7.3 Photos to be provided digitally via an online file share service and/or by a USB drive to contractor.

4.2.7.4 Drone pilots to obey ALL local (city, county, state) UAV regulations as well as FAA UAV guidelines including, but not limited to, conducting all flights during daylight hours, not exceeding maximum altitude ceilings (depending on area), not flying over people, yielding to other aircraft.

4.2.7.5 Drone pilots must fly drone within visual line of sight (VSOL) and have visual spotter when needed. Drone pilots only to operate in favorable weather conditions when minimum visibility is 3 miles or greater.

4.2.7.6 Drone pilots to conduct a preflight checklist and visually inspect the entire flight path prior to flying to ensure a safe flight.

4.2.7.7 **Airspace Authorizations.** Operations in Class G airspace are allowed without air traffic control (ATC) permission. Operations in Class B, C, D and E airspace need ATC authorization. Drone pilots to schedule each flight in advance and based on airspace if required will notify nearby airports/control towers, etc.

4.2.8 **Government Approvals and Permits.**

4.2.8.1 Contractor must obtain all necessary permits for the Work and pay all applicable fees, unless otherwise noted on the Plans and in the Specifications. City permit fees will be paid internally by City. For bidding purposes, an allowance for all permit fees is included in the bid schedule under the item "allowance for permit fees." The Contractor will be paid for the actual cost of the permit fees upon submitting a receipt showing the fee Contractor has paid. Excluded from the above allowance are items such as all costs incurred by the Contractor in securing the permit except for the actual permit fee established by the agency, cost for all shutdowns or outages, cost for pole bracing, cost of permits for construction water, cost of construction water, cost for any additional insurance requirements, cost for any licenses, and other similar type costs. Contractor is specifically notified of the need to obtain the necessary environmental permits or file the necessary environmental and regulatory permit notices.

4.2.8.2 Copies of all permits and the associated notices must be provided to City prior to starting the permitted activity.

4.3 **PRE-CONSTRUCTION CONFERENCE**

4.3.1 Prior to the commencement of any Work, City will schedule a Pre-Construction Conference.

4.3.2 The purpose of this Conference is to establish a working relationship between Contractor, the utility firms, and various City agencies. The agenda will include critical elements of the Work schedule, submittal schedule, cost breakdown of major lump sum items, Payment Requests and processing, coordination with the involved utility firms, and emergency telephone numbers for all representatives involved in the course of construction.

4.3.3 Minimum attendance by Contractor at any mandatory meeting with City must be (1) Contractor's Representative, who is authorized to execute and sign documents on behalf of the firm, (2) Contractor's on-site Superintendent, and (3) Contractor's Safety Office, or other employee responsible for safety.

4.4 **PERFORMANCE OF THE WORK (INCLUDING FIELD MEASUREMENTS, SUBCONTRACTORS, AND SUPPLIERS)**

4.4.1 Unless otherwise provided in the Agreement Documents to be the responsibility of City or a separate Contractor, Contractor must provide through itself or Subcontractors the necessary supervision, labor, inspection, testing, start-up, material, equipment, machinery, temporary utilities and other temporary facilities to permit Contractor to complete the Work consistent with the Agreement Documents.

4.4.2 Contractor must perform all construction activities efficiently and with the requisite expertise, skill and competence to satisfy the requirements of the Agreement Documents. Contractor must at all times exercise complete and exclusive control over the means, methods, safety, sequences and techniques of construction.

4.4.3 Contractor's Superintendent must be present at the Site at all times that material Work

under this Agreement is taking place. Contractor's Superintendent or designee must be present at the Site at all times any other Work under this Agreement is taking place. Superintendent must not be replaced without written notice to City. Whenever the Superintendent is not present at a particular part of the Work where the City or Design Professional may desire to inform the Contractor relative to interpretation of the Drawings and Specifications or to disapproval or rejection of materials or Work performed, the City or Design Professional may provide such information in writing to the foreman or other worker in charge of the particular part of the Work in reference to which the information is given. Information so given will be as binding as if given to the Superintendent.

4.4.4 All elements of the Work must be under the direct supervision of a foreman or his designated representative on the Site who must have the authority to take actions required to properly carry out that particular element of the Work.

4.4.5 Working Hours. Except in connection with the safety or protection of persons or the Work or property at the Site or adjacent thereto, and except as otherwise indicated, all Work at the Site must be performed during regular working hours, and Contractor will not permit overtime work or the performance of Work on Saturday, Sunday or any legal holiday without City's written consent given after prior written notice to City. If it will become absolutely necessary to perform Work at night or on Saturdays, Sundays or legal holidays, the City must be informed at least 24 hours in advance of the beginning of performance of such Work. Only such Work will be done at night as can be done satisfactorily as determined by the City. Good lighting and all other necessary facilities for carrying out and inspecting the Work must be provided and maintained at all points where such Work is being done. Further, unless such non-normal work hours are performed at City's request or required by the Agreement Documents, Contractor must pay to City all additional costs incurred by City by reason of such non-normal working hours. Expenses incurred by City for overtime compensation must be reimbursed by Contractor as follows: (i) City staff at the rate set forth in current City Fee Schedule as published on City website, (ii) Design Professional and staff at the standard hourly rates previously negotiated with City, and (iii) all others at actual cost plus ten percent administrative overhead. Such costs may be deducted by City from any payments due to Contractor. Provided, however, if overtime work or work during other than normal hours is at the request of City and not due to Contractor delay, City will pay the cost of City overtime expenses.

4.4.6 Where the Agreement Documents require that a particular product be installed or applied by an applicator approved by the manufacturer, it is Contractor's responsibility to ensure the Subcontractor employed for such work is approved by the manufacturer. All materials and equipment must be stored, applied, installed, connected, erected, used, cleaned and conditioned in accordance with the instructions of the applicable manufacturer, fabricator, supplier or distributor, except as otherwise provided in the Agreement Documents; but no provisions of any such instructions will be effective to impose on City or Design Professional responsibility for the means, methods, techniques, sequences or procedures of construction or for safety precautions incident thereto.

4.4.7 Before starting the Work, Contractor must carefully study and compare the various Plans, Drawings, other Agreement Documents, and Specifications relative to that portion of the Work, as well as the information furnished by City, must take field measurements of any existing conditions related to that portion of the Work and must observe any conditions at the Site affecting it. The exactness of grades, elevations, dimensions, or locations given on any Drawings, or the Work installed by other contractors, is not guaranteed by City.

- 4.4.8 Before ordering materials or doing Work, Contractor and each Subcontractor must verify measurements at the Site and will be responsible for the correctness of such measurements. No extra charge or compensation will be allowed because of differences between actual dimensions and the dimensions indicated on the Agreement Documents, including the Drawings.
- 4.4.9 Ground Level Construction Photography.
- 4.4.9.1 The Contractor must furnish progress photographs of the project. The photographer selected by the Contractor must be approved by the City and must be either a commercial photographer or an individual experienced and equipped for such photography.
- 4.4.9.2 The Contractor must deliver to City all photographs taken during that period with each application for payment. If the current photographs do not accompany the application, the application will not be reviewed and will be returned to the Contractor as incomplete.
- 4.4.9.3 Photographs must be identified by use of typewritten labels affixed to the back of the photograph. The label must provide a description of the view, the direction from which the photograph was taken, the name of the project, City's project number, the name of Contractor and the date of the photography. The stationing must also be included for all pipeline installations.
- 4.4.9.4 Photographs must be taken during the construction period and must be of aesthetic composition and depict the progress of the Work from the beginning of construction through and including the finished product. City may vary the specified frequency so that significant progress or changes can be recorded on the photographs.
- 4.4.10 Underground Facilities.
- 4.4.10.1 The existence and number of facilities as shown on the Plans are estimated from information furnished by the particular utility. Contractor is responsible for field verification and location of all utilities prior to the start of construction. No field work will be allowed to start until Contractor has contacted Arizona 811 and all affected utilities have been located. In addition, Contractor must expose and physically locate all potentially conflicting utilities prior to construction. The actual locations of the utilities must be compared to locations shown on the Plans and any required changes in alignment and grade must be made at the time of construction in consultation with Project Manager. It is generally recognized and Contractor should anticipate that information from Arizona 811 or information from utility companies during project design, frequently fails to disclose all underground facilities. The fact that more utility lines or other underground facilities are located in the Project Site than shown on the Project Plans does not constitute an "unforeseen Condition" and such undisclosed underground facilities do not differ materially from the conditions which Contractor should expect. The provisions of Sections 105.4, 105.6, 107.11 and 109.8.1 of the MAG Uniform Standard Specifications for Public Works Construction apply and are incorporated herein by this reference.
- 4.4.10.2 Contractor is responsible for all coordination with utility companies. The provisions of Sections 105.4, 105.6, 107.11 and 109.8.1 of the MAG Uniform Standard Specifications for Public Works Construction strictly apply and no additional compensation will be paid to Contractor for delays due to utility work on the project.
- 4.4.11 Relocation of Existing Water Meters. When a service line has been extended and a line

setter installed in a meter box, City forces will re-install meter. No compression fittings will be utilized.

4.4.12 Water Turn-On or Turn-Off.

4.4.12.1 Contractor must coordinate all water line turn-ons and turn-offs through the City. Application must be made to the Municipal Utility Division and Contractor must pay the established charges. The City will close existing valves, but will not guarantee a bone-dry Shutdown.

4.4.12.2 Contractor must notify all customers affected by the turn-off not less than 48 hours in advance. Notification must be in writing, must give the reason for the turn-off and must give the estimated time and duration that water service will be interrupted. Contractor is also notified that water turn-off will not be permitted on the Day before and after Thanksgiving Day and Christmas Day.

4.4.12.3 No direct payment will be made to Contractor for turn-ons or turn-offs. Costs associated therewith will be included in other items for which direct payment is made.

4.4.13 Tests and Inspections.

4.4.13.1 Contractor must give City timely (at a minimum, twenty-four hours) notice of readiness of the Work for all required inspections, tests or approvals. Contractor must give timely notice to City in advance of backfilling or otherwise covering any part of the Work so that city representative may, if desired, observe such part of the Work before it is concealed. Whenever Contractor varies the normal period during which Work or any portion of it is carried on each Day, Contractor must give timely notice to City so that city representative may, if desired, be present to observe the Work in progress. If Contractor fails to give such timely notice, any Work done in the absence of city representative will be subject to rejection. If Contractor gives such notice to City, but then is not ready for such inspections, tests, approvals or observations at the time so noticed, Contractor must reimburse City for all costs incurred by the attendance of city representatives.

4.4.13.2 If any law, ordinance, rule, regulation, code, or orders of any public body having jurisdiction requires any Work (or part thereof) to be inspected, tested or approved, Contractor (unless another party is specified in the Agreement Documents) must assume full responsibility therefor, pay all costs in connection therewith and furnish City the required certificates of inspection, testing, or approval. Contractor must also be responsible for and must pay all costs in connection with any inspection or testing required by the Specifications in connection with City's acceptance of a manufacturer, fabricator, supplier or distributor of materials or equipment proposed to be incorporated in the Work, or of materials or equipment submitted for approval prior to Contractor's purchase thereof for incorporation in the Work. The cost of all other inspections, tests and approvals required by the Agreement Documents will be paid by City (unless otherwise specified).

4.4.13.3 All inspections, tests or approvals other than those required by law, ordinance, rule, regulation, code or order of any public body having jurisdiction must be performed by organizations acceptable to City and by the Design Professional if so specified.

4.4.13.4 Neither observations by City, the Design Professional nor inspections, tests or approvals by others will relieve Contractor from their obligations to perform the Work in accordance with the Agreement Documents.

- 4.4.14 Uncovering Work. If any Work that is to be observed, inspected, tested or approved is covered without written concurrence of City, it must, if requested by City be uncovered for observation. Unless Contractor has given City timely notice of Contractor's intention to cover such Work and City has not acted with reasonable promptness in response to such notice, Contractor must furnish all necessary labor, material and bear all the expenses of such uncovering, exposure, observation, inspection and testing and of satisfactory reconstruction, including compensation for additional professional services, and an appropriate deductive Change Order will be issued.
- 4.4.15 In all cases of interconnection of its Work with existing or other Work, Contractor must verify at the Site all dimensions relating to such existing or other Work. Any errors due to Contractor's failure to so verify all such grades, elevations, locations or dimensions must be promptly rectified by Contractor without any increase in the Agreement Price. Any design errors or omissions noted by Contractor during this review must be reported promptly to City.
- 4.4.16 Contractor must establish and maintain all construction grades, lines, levels, and benchmarks, and will be responsible for accuracy and protection of same. This Work must be performed or supervised by a licensed civil engineer or surveyor in the State of Arizona.
- 4.4.17 Contractor must photograph all buried piping of greater than four (4) inches in diameter prior to backfill.
- 4.4.18 Contractor is responsible for the proper performance of the work of Subcontractors and any acts and omissions in connection with such performance. Nothing in the Agreement Documents is intended or deemed to create any legal or contractual relationship between City and any Subcontractor or Sub-Subcontractor, including but not limited to any third-party beneficiary rights.
- 4.4.19 Contractor must coordinate the activities of all Subcontractors. Contractor must coordinate performance of the Work with City's Public Works & Utilities Department and other departments or agencies within City. The Design Professional and other contractors or parties involved in the Project. If City performs other work on the Project or at the Site with separate contractors under City's control, Contractor agrees to cooperate and coordinate its activities with those of such separate contractors so that the Project can be completed in an orderly and coordinated manner without unreasonable disruption.
- 4.4.20 Contractor will not substitute or change any Subcontractor or Supplier without the prior written approval of City. Any substitute or replacement Subcontractor or Supplier must be required to meet the same qualifications and selection criteria and process as the original Subcontractor or Supplier. If a Subcontract/Supplier selection plan has been approved by City, Contractor will follow that plan unless otherwise approved by City in writing.
- 4.4.21 Contractor must not change or replace any members of its Project team, including Contractor's Representative, Project Manager, or Superintendent, without an explanation for the change being given to City, and receiving prior written approval of the change from City, which approval will not be unreasonably withheld.
- 4.4.22 Subcontractors whose scope of work has a value greater than 15% of the total Agreement Price are required to furnish performance and payment bonds to Contractor, unless

otherwise approved in writing by City.

- 4.4.23 Contractor must comply with MAG Specification § 108.2 (E) unless otherwise specified in Agreement Documents.

4.5 **CONTROL OF THE PROJECT SITE**

- 4.5.1 Throughout all phases of construction, including suspension of Work, Contractor must keep the Site reasonably free from debris, trash and construction wastes to permit Contractor to perform its construction services efficiently, safely and without interfering with the use of adjacent land areas. Prior to Final Acceptance of the Work, or a portion of the Work, Contractor must remove all debris, trash, construction wastes, materials, equipment, machinery and tools arising from the Work or applicable portions thereof to permit City to occupy the Project or a portion of the Project for its intended use.
- 4.5.2 Contractor must take whatever steps, procedures or means necessary to prevent dust nuisance due to construction operations. The dust control measures must be maintained at all times to the satisfaction of City and in accordance with the requirements of the Maricopa County Bureau of Air Pollution Control Rules and Regulations.
- 4.5.3 Contractor must maintain Americans with Disabilities Act (ADA) and American National Standards Institute (ANSI) accessibility requirements during construction activities, including without limitation compliance with the 2010 regulations governing implementation of the ADA to the extent applicable. ADA and ANSI accessibility requirements must include, but not be limited to, parking, building access, areas of refuge, and emergency exit paths of travel. Contractor is responsible for the coordination of all Work to minimize disruption to residents and the public.
- 4.5.4 Only materials and equipment used directly in the Work will be brought to and stored on the Site by Contractor. When equipment is no longer required for Work, it must be removed promptly from the Site. Protection of construction materials and equipment stored at the Site from weather, theft, damage and all other adversity is solely the responsibility of the Contractor.
- 4.5.5 Contractor agrees all persons working on the Site must act at all times in the best interest of the Project and will comply with all applicable rules and regulations reasonably set forth by City related to the Site. Notwithstanding the foregoing or anything in this Agreement to the contrary, City may remove from the Site any individual who City deems in their reasonable discretion to be creating a disturbance or causing any problem on the Site.
- 4.5.6 Contractor will be responsible to City for the acts and omissions of Contractor's employees, Subcontractors and their agents and employees, and any other person performing any of the Work under an Agreement with Contractor, or claiming by, through or under Contractor, for all damages, losses, costs and expenses resulting from such acts or omissions.
- 4.5.7 City may conduct criminal, drive history, and all other requested background checks of Contractor and Subcontractor personnel performing Work or who have access to City's information, data, or facilities in accordance with City's current background check policies, or the provisions of the Project Specific Conditions. Any officer, employee or agent that fails to background check must be replaced immediately.
- 4.5.8 City will have a final authority, based upon security reasons: (i) to determine when

security clearance of Contractor's and Subcontractor's personnel is required; (ii) to determine the nature of the security clearance, up to and including fingerprinting personnel; and (iii) to determine whether or not any individual or entity may provide Services or perform Work under the Agreement.

- 4.5.9 If City objects to any personnel for any reasonable cause, then Contractor must, upon notice from City, remove such individual from the Project.

4.6 **PROJECT SAFETY**

- 4.6.1 The Project and all Work performed in relation thereto is governed by applicable provisions of the federal laws, including but not limited to, the latest amendments of the following:

- a. Williams-Steiger Occupational Safety & Health Act of 1970, Public Law, 91-596.
- b. Part 1910 and Part 1926 – Occupational Safety and Health Standards, Chapter XVII of Title 29, Code of Federal Regulations.
- c. Part 1518 – Safety and Health Regulations for Construction, Chapter XIII of Title 29, Code of Federal Regulations.

- 4.6.2 Contractor is responsible for safety of the job Site for employees of Contractor as well as for members of the general public and others who may drive or walk through or be at the Site.

- 4.6.3 Contractor recognizes the importance of performing the Work in a safe manner so as to prevent damage, injury or loss to: (i) all individuals at the Site, whether working or visiting; (ii) the Work, including materials and equipment incorporated into the Work and stored On-Site or Off-Site; and (iii) all other property at the Site or adjacent thereto, including trees, shrubs, lawns, walks, pavements, roadways, structures and utilities not designated for removal, relocation or replacement in the course of construction; and (iv) the owners or tenants of adjacent property and their patrons, employees and invitees.

- 4.6.4 Contractor assumes responsibility for implementing and monitoring all safety precautions and programs related to the performance of the Work.

- 4.6.5 Contractor must provide a "competent person" as required by O.S.H.A regulations. The "competent person" must be identified at the Pre-Construction Conference with City advised in writing of any changes.

- 4.6.6 The "competent person" must make routine daily inspections of the Site and must hold weekly safety meetings with Contractor's personnel, Subcontractors and others as applicable.

- 4.6.7 Contractor and Subcontractors must comply with all legal and regulatory requirements relating to safety, as well as any City specific safety requirements set forth in the Agreement Documents, provided that such City-specific requirements do not violate any applicable legal and regulatory requirements.

- 4.6.8 Contractor will immediately report in writing any safety-related injury, loss, damage or accident arising from the Work to Project Manager and, to the extent mandated by Legal Requirements, to all government or quasi-government authorities having jurisdiction over safety-related matters involving the Project or the Work.

- 4.6.9 Contractor's responsibility for safety under this Section is not intended in any way to relieve Subcontractors and Sub-Subcontractors of their own contractual and legal obligations and responsibility for (i) complying with all Legal Requirements, including those related to health and safety matters, and (ii) taking all necessary measures to implement and monitor all safety precautions and programs to guard against injury, losses, damages or accidents resulting from their performance of the Work.
- 4.6.10 As between City and Contractor, Contractor is responsible to City for any and all the safety issues relating to the Work on the Project. Contractor must administer and manage the safety program. This will include, but not necessarily be limited to review of the safety programs of each Subcontractor. Contractor must monitor the establishment and execution of compliance with all applicable regulatory and advisory agency construction safety standards. Contractor's responsibility for review, monitoring, and coordination of the Subcontractor's safety programs will not extend to direct control over execution of the Subcontractors' safety programs. Notwithstanding Contractor's safety obligations to City, it is agreed and understood that each individual Subcontractor will remain controlling employer responsible for the safety programs and precautions applicable to its own work and the activities of other's work in areas designated to be controlled by such Subcontractor for purposes of workers compensation insurance coverage.
- 4.6.11 Nothing in this agreement will relieve Contractor of his responsibility to maintain traffic, structures, etc., as noted on the Plans, Specifications, and Project Specific Conditions. Contractor is responsible to provide all necessary shoring, bracing and trench support as is necessary to maintain traffic structures, etc., as stipulated in the Plans, Specifications, and Special Provisions. If the stability of adjoining building, walls, roadways, etc., is endangered by Contractor's excavation, shoring, bracing, or under pinning must be provided as necessary to ensure project safety. Cost for shoring, bracing, underpinning, and trench support will be included in the appropriate items listed in the Agreement Price, and no additional payment will be made for this work.
- 4.7 **MATERIALS QUALITY, SUBSTITUTIONS, AND SHOP DRAWINGS**
- 4.7.1 **Quality Control and Quality Assurance Testing.**
- 4.7.1.1 All construction materials to be used or incorporated in the Project are subject to inspection, Quality Control & Quality Assurance Testing, and approval or rejection by City. Any material rejected by City must be removed immediately and replaced in an acceptable manner to City at no additional cost to City. When QC/QA tests indicate noncompliance with the Agreement Documents, retesting must be performed by the same testing laboratory that performed the tests that indicated noncompliance.
- 4.7.1.2 The Contractor must establish, provide, and maintain an effective Quality Control Testing Program (QCTP). The Contractor must develop his own program or procure the services of a consultant. In either case, the party performing the tests must be currently certified by the National Bureau of Standards in the National Voluntary Laboratory Accreditation Program (NVLAP) for construction services or the AASHTO Accreditation Plan (AAP) for Soils, Asphalt and Concrete. The Contractor must provide all support necessary to perform QC and QA testing and sampling (i.e. shoring for testing trench backfill, backhoes, motor graders, loaders, etc. to facilitate testing and sampling). The City will perform the QA testing.
- 4.7.1.3 The Contractor must submit a written QCTP to the City as a required submittal. The Contractor must not begin Work until the Quality Control Program has been reviewed and

- accepted by the City. Resumes of all personnel that will be associated directly or indirectly with the QCTP must be included.
- 4.7.1.4 The QCTP must include, but not be limited to, on-site/field and laboratory testing of all material delivered to the Site and any existing materials or conditions pertinent to the project.
- 4.7.1.5 All testing must be under the direction of a Professional Engineer registered in the State of Arizona, knowledgeable in Materials Testing. All "Test Report" forms must be stamped by said Engineer.
- 4.7.1.6 The written QCTP will set forth the responsibilities of the engineer, project manager, supervisory personnel and each technician assigned to this project. Substitutions or replacement of personnel must require prior written approval by the City. All personnel must be proficient within their assigned duties and possess certification(s) commensurate with their position and responsibilities. The minimum certification(s) for each technician must be NICET Level II, Arizona Technical Testing Institute, American Concrete Institute, or other nationally recognized program applicable to the project and approved by the City of Chandler. The written QCTP must include a description of the required field and construction materials laboratory tests, including required frequencies that meet the minimums established herein.
- 4.7.1.7 The Contractor must establish a system to record and report all material test results. The daily test reports must include, but not be limited to:
- a. Test designation;
 - b. Date of test;
 - c. Name of tester;
 - d. Location of test/sample (station and offset);
 - e. Product suppliers and product codes (as applicable);
 - f. Depth/elevation of test/sample;
 - g. Test result;
 - h. Control requirement(s);
 - i. Cause of rejection (if applicable);
 - j. Results of retests (if applicable); and
 - k. Remedial action (if applicable).
- 4.7.1.8 The Contractor must submit test results to the designated City representative.
- 4.7.1.9 The Contractor must also submit a weekly report to the City summarizing the testing and construction activities completed by emailing the report to the email addresses noted above. All weekly reports must be submitted simultaneously to the Contractor and the City of Chandler. The report must include individual summary sheets for each utility line, structure, and portion of the pavement section. Cores must be numbered sequentially throughout the Project. Re-cores must reference the original core by number and must contain the averaged values for thickness and density. Total pavement thickness must be reported. Vertical location of tests for underground utilities must indicate the depth of the

excavation at the location of the test (i.e., cut to flow line [if applicable], depth to bottom or top of pipe, etc.). Density tests must be numbered sequentially. If the minimum number of tests has not been performed per the written QCTP, this must be stated in the weekly summary report with an explanation of the circumstances.

- 4.7.1.10 The City will maintain a copy of the Project test results and weekly reports in the Project file. In cases where quality control activities do not comply with the Agreement provisions, the City may:
- a. Order the Contractor to replace ineffective or unqualified quality control personnel.
 - b. Order the Contractor to stop operations until appropriate corrective action is taken.
- 4.7.1.11 Although minimum testing requirements are specified herein, the Contractor bears full responsibility for the quality of the materials and their installation and may elect to perform additional testing beyond the requirements set forth herein to ensure compliance.
- 4.7.1.12 The Quality Control requirements contained in this Section are in addition to and separate from Quality Assurance Testing, which will be performed by the City of Chandler or its representative. If the Quality Assurance test results are not in agreement with the Quality Control test results, the Contractor will have the option to retain a third party consultant for referee tests. The third party consultant must meet the same requirements as the consultant performing the Quality Control Testing. The results of the third party will be binding. All cost incurred by the referee testing will be the Contractor's expense. If the Contractor elects not to retain a third party for referee testing, the City of Chandler test results will prevail.
- 4.7.1.13 Except as otherwise noted within this Section, Work or materials required by this Section are non-pay items. Per MAG Section 101, a non-pay item is an item of Work for which no separate payment will be made, the cost of which is to be included as an incidental cost for associated item(s) included on the Bid Schedule or Schedule of Values.
- 4.7.2 Trade Names and Substitutions.
- 4.7.2.1 Substitutions prior to bid will only be considered if in compliance with Arizona Revised Statute § 34-104.
- 4.7.2.2 Contractor, if requested by City, must submit Samples or any additional information that may be necessary to evaluate the acceptability of the substitution.
- 4.7.2.3 City will make the final decision and will notify Contractor in writing as to whether the substitution has been accepted or rejected.
- 4.7.2.4 If City does not respond within 15 working days, Contractor must continue to perform the Work in accordance with the Agreement Documents and the substitution will be considered rejected.
- 4.7.3 Shop Drawings.
- 4.7.3.1 Contractor must prepare and submit Shop Drawings which show details of all Work to insure proper installation of the Work using those materials and equipment specified under the approved Plans and Specifications.

- 4.7.3.2 Contractor must submit a schedule of Shop Drawing submissions, which avoids bulk submissions to the extent reasonably possible, with the Project Schedule for City approval. The schedule of Shop Drawing submissions must include all of the items for which Shop Drawings are required by the Agreement Documents, including the Specifications. Unless otherwise noted, Shop Drawings will not be required for items specified or detailed in the Uniform Standard Specifications and Details or the Technical Specifications.
- 4.7.3.3 Shop Drawings must be numbered consecutively for each Specification section and must accurately and distinctly present the following:
- a. All working and erection dimensions.
 - b. Arrangements and sectional views.
 - c. Necessary details, including complete information for making connections between work under this Agreement and work under other Agreements.
 - d. Kinds of materials and finishes.
 - e. Parts list and description thereof.
- 4.7.3.4 Each Drawing or page must include:
- a. Project Name, City of Chandler Project Number and descriptions.
 - b. Submittal date and space for revision dates.
 - c. Identification of equipment, product or material.
 - d. Name of Contractor and Subcontractor.
 - e. Name of Supplier and Manufacturer.
 - f. Relation to adjacent structure of material.
 - g. Physical dimensions clearly identified.
 - h. ASTM and Federal Specifications references.
 - i. Identification of and justification for deviations from the Agreement Documents.
 - j. Contractor's stamp, initialed or signed, dated and certifying the review of submittal, certification of field measurements and compliance with Agreement.
 - k. Location at which the equipment or materials are to be installed.
- 4.7.3.5 Location will mean both physical location and location relative to other connected or attached material. City will return unchecked any submittal, which does not contain complete data on the Work and full information on related matters.
- 4.7.3.6 Stock or standard drawings will not be accepted for review unless full identification and supplementary information is shown thereon in ink or typewritten form.
- 4.7.3.7 Contractor must schedule, prepare and submit all Shop Drawings in accordance with a timetable that will allow its suppliers and manufacturers sufficient time to fabricate, manufacture, inspect, test and deliver their respective products to the project Site in a timely manner so as to not delay the complete performance of the Work.

- 4.7.3.8 If the Shop Drawings show departures from the Agreement requirements, Contractor must make specific mention thereof in the Letter of Transmittal; otherwise review of such submittals by City will not constitute review of the departure. Review of the Drawings will constitute review of the specific subject matter for which the Drawings were submitted and not of any other structure, material, equipment, or apparatus shown on the Drawings.
- 4.7.3.9 The review of Shop Drawings will be general and will not relieve Contractor of responsibility for the accuracy of such Drawings, nor for the proper fitting and construction of the Work, nor for the furnishing of materials or Work required by the Agreement. No construction called for by Shop Drawings will be initiated until such Drawings have been reviewed and approved by City.
- 4.7.3.10 The procedure in seeking review of the Shop Drawings will be as follows:
- a. Contractor must submit complete sets of Shop Drawings and other descriptive data as specified in this Section.
 - b. After Contractor's submittal or resubmittal of Shop Drawings, if Contractor has submitted Shop Drawings in accordance with the City-approved submittal schedule, or upon resubmission, City will be provided with three (3) calendar weeks for review. Should City require additional review time above and beyond the three (3) calendar weeks, Contractor may ask for a time extension or monetary compensation, if they can present valid, factual evidence that actual damages were incurred by Contractor. City will determine the amount of the time extension or the monetary compensation to be awarded Contractor, if any, in accordance with City's Policy Statement for Calculating Delays and Damages, Appendix 1.
- 4.7.3.11 Contractor will be responsible for all extra costs incurred by City caused by Contractor's failure to comply with the procedure outline above.
- 4.7.4 Long Lead Time Items. Contractor must submit Shop Drawings, as required by the Engineer, on all long lead items to be furnished and installed as part of the project within 10 Days after the date of the executed Agreement letter issued by City. In addition, Contractor must order all long lead items to be furnished and installed as part of this Project within 3 Days after receiving approved Shop Drawings. For all long lead times for which Shop Drawings are not required, Contractor must order said long lead items within 15 Days after the date of the executed Agreement letter issued by City. Within 2 Days after ordering long lead items, Contractor must supply copies of all purchase orders, along with an accurate delivery schedule from the supplier.
- 4.7.5 Construction Water. If Contractor uses water from City's water system for construction water, Contractor must obtain a fire hydrant meter from City of Chandler Utility Services (480-782-2280) and all construction water must be obtained through the hydrant meter. Contractor must pay all fees related to the hydrant meter and all water bills for construction water. All cost for meters and construction water will be included in the Agreement Price.
- 4.8 **PROJECT RECORD DOCUMENTS**
- 4.8.1 During the construction period, Contractor must maintain at the jobsite a full-size set of prints of the Construction Document Drawings and Shop Drawings for Project Record Document purposes.

- 4.8.2 Contractor must mark these Drawings to indicate the actual installation where the installation varies from the original Construction Documents. Contractor must give particular attention to information on elements that will be concealed, which would be difficult to identify or measure and record later. Items required to be marked include but are not limited to:
- a. Dimensional changes to the Drawings.
 - b. Revisions to details shown on Drawings.
 - c. Locations and depths of underground utilities.
 - d. Revisions to routing of piping and conduits.
 - e. Actual equipment locations.
 - f. Changes made by Change Order or Addendum.
 - g. Details not on original Agreement Drawings.
- 4.8.3 Contractor must mark completely and accurately Project Record Drawing sets of Construction Documents.
- 4.8.4 Contractor must mark Project Record Drawings sets with red erasable colored pencil.
- 4.8.5 Contractor must note Request for Information (RFI) Numbers and Change Order numbers, etc., as required to identify the source of the change to the Construction Documents.
- 4.8.6 Contractor must submit Project Record Drawing sets and Shop Drawings to City or its representative for review and comment.
- 4.8.7 Upon receipt of the reviewed Project Record Drawings from City, Contractor must correct any deficiencies and omissions to the Drawings and submit the final original of the Project Record Drawings to City prior to Final Payment.
- 4.8.8 Project Manager will review the Project Record Drawings monthly prior to the date established for the Payment Request and will be the sole judge of acceptance of these Drawings.
- 4.9 **WARRANTY AND CORRECTION OF DEFECTIVE WORK**
- 4.9.1 Contractor warrants to City that the construction, including all materials and equipment furnished as part of the Work, will be new unless otherwise specified in the Agreement Documents, of good quality, and free of defects in materials and workmanship. Contractor's warranty obligation excludes defects caused by abuse, alterations, or unreasonable failure to maintain the construction by persons other than Contractor, subcontractors, or others under Contractor's control. Nothing in this warranty will limit any manufacturer's warranty which provides City with greater warranty rights than set forth herein or in the Agreement. Contractor will provide City with all manufacturers' warranties and operation and maintenance manuals upon substantial completion of the Work. Contractor's warranty must be for one (1) year, in accordance with MAG Specification § 108.8, and will commence for all portions of the Work upon Final Acceptance of the entire Work as determined by City under the Agreement. All statutory or other warranties, express or implied, related to latent defects will remain in force and are not limited by this provision.
- 4.9.2 City May Stop the Work. If the Work is defective, or Contractor fails to supply sufficient skilled workmen or suitable materials or equipment, City may order Contractor to stop the

Work without cost to City, or any portion thereof, until the cause for such order has been eliminated; however, this right of City to stop the Work will not give rise to any duty on the part of City to exercise this right for the benefit of Contractor or any other party.

4.9.3 Correction or Removal of Defective Work.

4.9.3.1 If required by City, Contractor must promptly, without cost to City and as specified by City, either correct any defective Work, whether or not fabricated, installed or completed, or, if the Work has been rejected by City, remove it from the Site and replace it with non-defective Work. Contractor must correct any Work which may be displaced in correcting, removing or replacing defective Work. No compensation will be allowed Contractor for such removal, replacement or remedial Work. Contractor must reimburse City for costs incurred by City due to such correction or removal including but not limited to additional expenses for inspection, testing or observation and for repeated reviews by the City or Design Professional.

4.9.3.2 Upon failure on the part of the Contractor to comply within a reasonably prompt time with any written order of City to correct or remove defective Work, City has authority to cause nonconforming materials or rejected Work to be remedied, removed, or replaced at the Contractor's expense and to deduct the costs from any moneys due or to become due the Contractor.

4.9.4 City May Correct Defective Work. If Contractor fails within a reasonable time after written notice of City to proceed to correct defective Work or to remove and replace rejected Work as required by City or if Contractor fails to perform the Work in accordance with the Agreement Documents (including any requirements of the progress schedule), City may, after 7 Days' written notice to Contractor, correct and remedy any such deficiency. To the extent necessary to complete corrective and remedial action, City may exclude Contractor from all or part of the Work, and suspend Contractor's services related thereto, take possession of Contractor's tools, appliances, construction equipment and machinery at the Site and incorporate in the Work all materials and equipment stored at the Site or for which City has paid Contractor, but which are stored elsewhere. Contractor must allow City, city representatives, agents and employees such access to the Site as may be necessary to enable City to exercise City's rights under this Section. All direct and indirect costs of City in exercising such rights will be charged against Contractor in an amount verified by City representative, and a Change Order will be issued incorporating the necessary revisions in the Agreement Documents and a reduction in the Agreement Price. Such direct and indirect costs will include, in particular but without limitation, compensation for additional professional services required and all costs of repair and replacement of Work or others destroyed or damaged by correction, removal or replacement of Contractor's defective Work. Contractor will not be allowed an extension of the Agreement Time because of any delay in Contractor's performance of the Work attributable to the exercise by City or City's rights hereunder.

4.9.5 Correction or Removal of Unauthorized Work.

4.9.5.1 Any Work done beyond the lines and grades shown on the Drawings or established by the Design Professional or any changes in, additions to, or deductions from the Work done without written authority will be considered as unauthorized and will not be paid for. Work so done may be ordered remedied, removed, or replaced at the Contractor's expense.

4.9.5.2 Upon failure on the part of the Contractor to comply promptly with any order of the City,

City will have authority to cause unauthorized Work to be remedied, removed, or replaced at the Contractor's expense and to deduct the costs from any moneys due or to become due the Contractor.

4.9.6 Correction Period - One Year Guarantee.

4.9.6.1 If, within one year after the date of Final Acceptance, or such longer period of time as may be prescribed by law or by the terms of any applicable special guarantee required by the Agreement Documents, or by any specific provision of the Agreement Documents, any Work is found to be defective, Contractor must promptly, without cost to City and in accordance with City's written instructions, either correct such defective Work, or, if it has been rejected by City, remove it from the Site and replace it with non-defective Work. If Contractor does not promptly comply with the terms of such instructions, or in an emergency where delay would cause serious risk of loss or damage, City may have the defective Work corrected or the rejected Work removed and replaced, and all direct and indirect costs of such removal and replacement, including compensation for additional professional services, must be paid by Contractor. Such action by the City will not relieve the Contractor of the guarantees required by this Section or elsewhere in the Agreement Documents.

4.9.6.2 If, in the opinion of the City, defective Work creates a dangerous condition or requires immediate correction or attention to prevent further loss to the City or to prevent interruption of operation of the City, the City will attempt to give the notice required by this Section. If the Contractor cannot be contacted or does not comply with the City's request for correction within a reasonable time as determined by the City, the City may, notwithstanding the provisions of this Section, proceed to make such correction or provide such attention; and the costs of such correction or attention will be charged against the Contractor. Such action by the City will not relieve the Contractor of the guarantees required by this Section or elsewhere in the Agreement Documents.

4.9.6.3 This Section does not in any way limit the guarantee on any items for which a longer guarantee is specified or on any items for which a manufacturer or supplier gives a guarantee for a longer period. The Contractor agrees to act as co-guarantor with such manufacturer or supplier and must furnish the City all appropriate guarantee or warranty certificates upon completion of the Project. No guarantee period, whether provided for in this Section or elsewhere, will in any way limit the liability of Contractor or their sureties or insurers under the indemnity or insurance provisions of these General Conditions and the Project Specific Special Conditions.

4.9.7 Acceptance of Defective Work.

4.9.7.1 If, instead of requiring correction or removal and replacement of defective Work, City may accept Work when in the best interest of the City to do so with appropriate monetary credit from Contractor. If any such acceptance occurs prior to final payment, a Change Order will be issued incorporating the necessary revisions in the Agreement Documents, including appropriate reduction in the Agreement Price; or, if the acceptance occurs after final payment, an appropriate amount must be paid by Contractor to City.

4.9.7.2 Alternatively, City may require Contractor to furnish at Contractor's expense, a special performance guarantee or other surety prior to acceptance of defective work.

4.9.8 The Warranty period begins on the Final Acceptance date noted in the Certificate of Completion, irrespective of early completion by some Subcontractors of their work.

- 4.9.9 Contractor's warranty obligation must be in accordance with MAG Specifications.
- 4.9.10 Nothing in the warranties contained in the Agreement Documents are intended to limit any manufacturer's warranty which provides City with greater warranty rights than set forth in this Section or the Agreement Documents. Contractor must provide City with all manufacturers' warranties prior to Substantial Completion, if applicable, or Final Acceptance.
- 4.9.11 Contractor agrees that it will be responsible to manage and administer the correction of any Work that is not in conformance with the Agreement Documents during the warranty periods set forth in this Section, or during any longer periods to the extent required by the Agreement Documents. A progress payment, or partial or entire use or occupancy of the Project by City, will not constitute acceptance of Work not in accordance with the Agreement Documents.
- 4.9.12 When notified of a warranty issue, Contractor must respond in writing within 48-hours and must perform warranty Work as soon as material for said repairs are available (as judged solely by City), and in any event Contractor must, take immediate steps to commence and complete correction of nonconforming Work no later than the time period set forth in City's written notification in accordance with the Agreement Documents. This includes the correction, removal or replacement of the nonconforming Work and any damage caused to other parts of the Work affected by the nonconforming Work. If defects develop which are determined by City to be an emergency, City will notify Contractor, via the most expeditious means regarding the nature and condition of the defects. In turn, Contractor must immediately dispatch necessary forces to correct the defect or the emergency condition in accordance with Agreement Documents.
- 4.9.13 The time periods referenced in this Section apply only to Contractor's obligation to correct nonconforming Work and is not intended to constitute a period of limitations for any other rights or remedies that City may have regarding Contractor's other obligations under the Agreement Documents.
- 4.9.14 Without limiting the foregoing or anything in these General Conditions or the Agreement to the contrary, Contractor must obtain and provide to City all warranties for any portion of the Project offered by the manufacturer, installer or provider thereof. City and the user of the facility will have the right to the full value and benefit of all such warranties. Contractor must ensure all such warranties are fully transferrable to facilitate the full value of this Section.
- 4.9.15 Contractor's warranty excludes damages or defects caused by abuse, alterations to the Work not executed by or through Contractor, improper or insufficient maintenance, improper operation, or normal wear and tear and normal usage.
- 4.9.16 In the event of any noncompliance with this entire Section 4, City may require Contractor to stop or suspend the Work in whole or in part.

SECTION 5 - CITY RESPONSIBILITIES

5.1 CITY PROJECT MANAGER AND INSPECTORS

- 5.1.1 Project Manager is responsible for providing City-supplied information and approvals in a timely manner to assist Contractor to fulfill its obligations under the Agreement Documents.

- 5.1.2 Project Manager will also provide Contractor with prompt notice when it observes any failure on the part of Contractor to fulfill its contractual obligations, including any default or defect in the Project or non-conformance with the Drawings and Specifications.
- 5.1.3 City may utilize Field Inspectors to assist Project Manager during construction in observing performance of Contractor. City's use of Inspectors is for the purpose of assisting Project Manager.
- 5.1.4 The Inspectors are authorized to inspect all Work and materials furnished. Such inspections may extend to all or part of the Work and to preparation, fabrication or manufacture of the materials to be used. The Inspectors have the authority to issue instructions contrary to the Construction Documents if approved and coordinated with the directions of Project Manager.
- 5.1.5 The Inspectors have the authority to reject work or materials until any questions at issue can be decided by Project Manager.
- 5.1.6 The use of Inspectors by City will not make City responsible for or give City control over construction means, methods, techniques, sequences or procedures or for safety precautions or programs or responsibility for Contractor's failure to perform the Work in accordance with Agreement Documents. The Inspectors are not authorized to direct any of Contractor's activities, employees or Subcontractors.

5.2 **DESIGN PROFESSIONAL SERVICES**

City may contract separately with one or more Design Professionals to provide construction administration of the Project. The Design Professional's Agreement, as well as other firms hired by City may be furnished to Contractor. Contractor does not have the right to limit or restrict or reject any Agreement modifications that are mutually acceptable to City and Design Professional.

5.3 **CITY'S SEPARATE CONTRACTORS**

City is responsible for all work performed on the Project or at the Site by separate contractors retained by City. City will contractually require its separate contractors to reasonably cooperate with, and reasonably coordinate their activities so as not to interfere with Contractor in order to enable Contractor to timely complete the Work consistent with the Agreement Documents. Contractor must immediately notify the Project manager, and address the matter in the next monthly status report, if any activities of such separate contractors are expected to interfere, or are interfering, with Contractor and such interference will or could result in any delay in Contractor's performance of the Work.

5.4 **PERMIT REVIEW AND INSPECTIONS**

- 5.4.1 If requested by Contractor, Project Manager will provide assistance and guidance in obtaining necessary reviews, permits and inspections.
- 5.4.2 The regulating agencies of City, such as Development and Sustainability, Fire and Planning Departments, enforce legal requirements. The enforcement activities of City are independent and separate from this Agreement.

5.5 **PLANS AND SPECIFICATIONS TO THE CONTRACTOR**

Contractor will be provided up to five copies of the Agreement Documents as are reasonably necessary for the execution of the Work. Additional copies will be furnished,

upon request, at the cost of reproduction.

SECTION 6 - AGREEMENT TIME

6.1 AGREEMENT TIME

- 6.1.1 The Agreement Time will start with the Notice to Proceed ("NTP") and end with Final Acceptance.
- 6.1.2 Beginning on the date of the NTP, Contractor must begin to fulfill Contractor's obligations under the Agreement. Contractor's obligations include providing City and other agencies with any submittals required by the Project Specific Special Provisions, including but not limited to, an approved Project Schedule, Traffic Control Plans, and a Stormwater Pollution Prevention Plan. Contractor must submit all such required submittals before any physical construction work commences on the Site. NTP does not authorize construction work until all agreement insurance, bonds, and schedules are submitted to and accepted by the City.
- 6.1.3 The Agreement Time will be as set forth in the Project Schedule. Contractor agrees that it will commence performance of the Work and complete the Project through both Substantial Completion and Final Acceptance within the Agreement Time.
- 6.1.4 Time is of the essence of this Agreement, for the Project, for the Work, and for each phase and designated Milestone thereof.
- 6.1.5 Failure of Contractor to perform any covenant or condition contained in the Agreement Documents within the time periods specified herein, will constitute a material breach of this Agreement entitling City to terminate the Agreement unless Contractor applies for and receives an extension of time, in accordance with the procedures set forth in the Agreement Documents.
- 6.1.6 Failure of City to insist upon the performance of any covenant or condition within the time periods specified herein, will not constitute a waiver of Contractor's duty to perform every other covenant or condition within the designated periods, unless a specific waiver is granted in writing for each such covenant or condition.
- 6.1.7 City's agreement to waive a specific time provision or to extend the time for performance will not constitute a waiver of any other time provisions contained in the Agreement Documents. Failure of Contractor to complete performance promptly within the additional time authorized in the waiver or extension of time agreement constitutes a material breach of this Agreement entitling City to all the remedies set forth herein or provided by law.

6.2 PROJECT SCHEDULE

- 6.2.1 The Project Schedule must be in Microsoft Project standard file format, must be updated and maintained throughout the Agreement Time, and must contain the following:
 - 6.2.1.1 Detailed representation of all activities for the project, both on-site construction and major procurement. All significant activities together with the resource loading requirements for each and all items appearing on the schedule of values or bid schedule for progress payments must be shown on the Project Schedule or in attached transmittal letter as described in Section 6.2.8.

- 6.2.1.2 Dependencies between activities must be indicated so that it may establish as to the effect the progress of any one activity would have on other activities and on the Schedule.
- 6.2.1.3 Activities for submission, review, and approval of all required submittals.
- 6.2.1.4 An amount of time will be established prior to the final completion date for “punch list and cleanup”. No other activities will be scheduled during this period. Punch list and cleanup must be shown on the Project Schedule and must be entirely completed prior to the expiration of the Agreement Time.
- 6.2.2 Within 10 Days of receipt of City’s comments, Contractor must make all required corrections, adjustments, and additions to complete the Project Schedule and resubmit to City for review. City’s review of and response to the Project Schedule is for the purpose of: (1) City planning and staffing for the Project as may be required from time to time; (2) ensuring Contractor’s general conformance with the scheduling requirements of the Agreement Documents and completion of the Project within the Agreement Time; and (3) monitoring and evaluating the construction status for purposes of approving monthly progress payments. Acceptance of a submitted schedule by City should in no way be construed as an affirmation or admission that the schedule is reasonable or workable by Contractor. The responsibility for completing the Work on the Project within the Agreement Time remains the obligation of Contractor. City’s review does not relieve Contractor from compliance with the requirements of the Agreement Documents or be construed as relieving Contractor of its complete and exclusive control over the means, methods, sequences and techniques for executing the work.
- 6.2.3 The Project Schedule must show milestones, including milestones for City-furnished information, and must include activities for City-furnished material and construction by other contractors when those activities are interrelated with Contractor activities.
- 6.2.4 The Project Schedule must be revised as required by conditions and progress of the Work, but such revisions do not relieve Contractor of its obligations to complete the Work within the Agreement Time, as adjusted in accordance with the Agreement Documents. No modification to the Agreement Documents or the Agreement Time will be effective unless approved in advance by City.
- 6.2.5 For all items of materials and equipment that are critical or may require long lead times to acquire, the Project Schedule must show dates for submission, review and approval of submittals, ordering, and delivery.
- 6.2.6 An updated Project Schedule must be submitted monthly to City as part of the Payment Request. The monthly submittal must include one full size plot of the entire schedule and one electronic copy containing the schedule in Microsoft Project standard file format. In addition, Contractor must, upon request by City, provide a copy of all submitted schedule data in electronic format which must be clearly labeled with the Project description, scheduling program name and version number, and schedule print/data date.
- 6.2.7 Contractor must provide City with a monthly status report with each Project Schedule detailing the progress of the Work, including: (i) if the Work is proceeding according to schedule, (ii) any discrepancies, conflicts, or ambiguities found to exist in the Agreement Documents that require resolution, and (iii) other information detailing items that require resolution so as not to jeopardize the ability to complete the Work in the Agreement Time.

- 6.2.8 With each Project Schedule submittal, Contractor must include a transmittal letter including the following:
- a. Description of problem tasks, referenced to field instructions or requests for information (RFI's), as appropriate.
 - b. Current and anticipated delays including:
 - (i) Cause of the delay.
 - (ii) Corrective action and schedule adjustments to correct the delay.
 - (iii) Known or potential impacts and their delay on other activities, milestones, and their impact on the Substantial Completion and Final Acceptance dates.
 - (iv) Changes in construction sequence.
 - c. Pending items and status thereof including but not limited to:
 - (i) Time Extension requests;
 - (ii) Substantial Completion date status;
 - (iii) Final Acceptance date status.
 - d. If ahead of schedule, the number of calendar Days ahead.
 - e. If behind schedule, the number of calendar Days behind.
 - f. Other Project or scheduling concerns.
- 6.2.9 Critical Path Method (CPM).
- 6.2.9.1 Unless otherwise specified in the Agreement, the Project Schedule must include a Critical Path Method (CPM) diagram schedule showing the sequence of activities, the interdependence of each activity and identifies the Critical Path.
- 6.2.9.2 The CPM diagram schedule must be in calendar Days and indicate duration, earliest and latest start and finish dates for all activities, and total Float Times for all activities except critical activities. The CPM diagram must be presented in a time scaled graphical format for the Project as a whole.
- 6.2.9.3 The CPM diagram schedule must indicate all relationships between activities.
- 6.2.9.4 The activities making the Project Schedule must contain sufficient detail to assure that adequate planning has been done for proper execution of the Work and such that it provides an appropriate basis for monitoring and evaluation the progress of the Work. Individual activities must not exceed 30 Days in length, in most cases.
- 6.2.9.5 The CPM diagram schedule must be based upon activities, which coincide with the Schedule of Values.
- 6.2.9.6 The CPM diagram schedule must show all submittals associated with each work activity and the review time for each submittal.
- 6.2.10 Float Time.
- 6.2.10.1 The total Float Time within the overall schedule is for the exclusive use of City, but City may approve Contractor's use of Float as needed to meet Agreement Milestones and

the Project completion date.

- 6.2.10.2 Contractor will not be allowed to sequence, hide, or reallocate Float Time through such strategies, as extending activity duration estimates to consume available Float, using preferential logic, or using extensive crew/resource sequencing, etc. No time extensions will be granted nor delay damages paid until a delay occurs which extends the Work beyond the Agreement Time.
- 6.2.11 City-Caused Delays. City-caused delays on the Project, if any, may be offset by City-caused time savings (i.e., Critical Path submittals returned in less time than allowed by the Agreement, approval of substitution requests and credit changes which result in savings of time to Contractor, etc.) In such an event, Contractor will not be entitled to receive a time extension or delay damages until all City-caused time savings are exceeded and the Agreement Time is also exceeded.
- 6.2.12 Rain-Related Delays. Contractor is required, in preparing the Project Schedule to take into account all relevant weather conditions, including normal rainfall and distribution. No additional compensation will be given for any rain-related delays or impacts on the Work or the Project Schedule. No time extension will be granted in the Project Schedule unless the rainfall during the construction of Work is unusually severe, was not reasonably anticipated, and the total rainfall was significantly in excess of the normal rainfall for the Project Site location. Normal rainfall for the Project will be determined from the 10-year average rainfall for the Site as measured by the National Oceanic and Atmospheric Administration or comparable source of reliable information for rainfall in Chandler, Arizona. In addition, the excessive rainfall must have actually impacted Work activities on the Critical Path and caused delay beyond any remaining Float at the time of the rain-caused delay. The burden of documenting normal rainfall, the excessive rainfall and the impact on Critical Path activities is on Contractor. All other provisions in the Agreement Documents relating to claims, including without limitation notice requirements, apply to any claim by Contractor for a rain delay.
- 6.2.13 City's "Policy Statement for Calculating Delays and Damages," Appendix 1 to these General Conditions, will apply to all claims of delay and delay damages.
- 6.2.14 Force Majeure. If Contractor is delayed or prevented from the performance of any Work required under this Agreement by reason of acts of God or other causes beyond the control and without fault of Contractor (financial inability excepted), performance of that Work will be excused, but only for the period of the delay. The time for performance of the Work will be extended for a period equivalent to the period of delay. In addition, the parties agree if Contractor's delayed or suspended performance directly arises out of or directly results from the COVID-19 pandemic, Contractor's delayed or suspended performance may be excused as set forth in this clause. Provided, however; Contractor must give the City written notice within 30 days of the occurrence of the event giving rise to COVID-19 pandemic related delayed or suspended performance. For COVID-19 pandemic related delay or suspended performance, the parties must agree in writing to the length of the excused delay or suspended performance. Further, Contractor must obtain the City's written approval to use any allowance established as part of the project for delays and costs related to the COVID-19 pandemic.

6.3 **SUBSTANTIAL COMPLETION**

- 6.3.1 When Contractor considers that the Work, phase or a portion thereof, which City agrees in

writing to accept separately, is substantially complete, City will prepare and submit to Contractor a comprehensive Punch List of items to be completed or corrected prior to Final Acceptance and Final Payment. Failure to include an item on such Punch List does not alter the responsibility of Contractor to complete all Work in accordance with the Agreement Documents.

6.3.2 Upon receipt of Contractor's Punch List, Project Manager will make an inspection to determine whether the Work or designated portion thereof is substantially complete. Project Manager may, at Project Manager's sole option, be assisted in such inspection by the Design Professional for the Project. If the inspection by the Project Manager discloses any item, whether or not included on Contractor's Punch List, which is not sufficiently completed in accordance with the Agreement Documents so that City can occupy or utilize the Work, phase or designated portion thereof for its intended use, Contractor must, before issuance of the Certificate of Substantial Completion, complete or correct such item upon notification by Project Manager. In such case, Contractor must then submit a request for another inspection by Project Manager to determine Substantial Completion.

6.3.3 Certificate of Substantial Completion.

6.3.3.1 The Project Manager will not issue a Certificate of Substantial Completion unless and until the Work (or separable units or Phases as provided in the Agreement Documents) is essentially and satisfactorily complete in accordance with the Agreement Documents, such that the Project is ready for use by City for its intended purpose, opening to the general public, full occupancy or use by City (including, without limitation, all separate units, or rooms, facilities, access, income-generating areas, and all areas serving the general public, as applicable, must be ready for full-operation without material inconvenience or discomfort), including, to the extent applicable to the Work, the following: all materials, equipment, systems, controls, features, facilities, accessories and similar elements are installed in the proper manner and in operating condition, inspected and approved; surfaces have been painted; masonry and concrete cleaned with any sealer or other finish applied; utilities and systems connected and functioning; site work complete; permanent heating, ventilation, air condition, vertical transportation and other systems properly operating with proper controls; lighting and electrical systems installed, operable and controlled; paving completed, signage installed, and other Work as applicable, has been performed to a similar state of essential and satisfactory completion. A minor amount of Work, as determined by and at the discretion of the Project Manager, such as installation of minor accessories or items, a minor amount of painting, minor replacement of defective work, minor adjustment of controls or sound systems, or completion or correction of minor exterior work that cannot be completed as a result of weather conditions, will not delay determination of Substantial Completion. If prior written approval is obtained from City for purposes of Substantial Completion, specified areas of the entire Work or Project may be individually certified as Substantially Complete. In no event will Substantial Completion be deemed to have occurred unless and until: (i) a temporary certificate of occupancy has been issued by the appropriate Governmental Authorities (as applicable) and (ii) all terms and Work required under this Agreement have been fulfilled by Contractor and same will have also been approved and accepted by City, subject only to the Punch List items.

6.3.3.2 If requested by City, Contractor must complete and turn-over to City the Project on a phased basis. Each phase will have a separate inspection by the Project Manager, a Punch List generated, and then an inspection by City with final approval and acceptance only after the

Project Manager's Punch List.

6.4 **PARTIAL UTILIZATION**

6.4.1 City at City's option may use and occupy any substantially completed parts of the Work which has specifically been identified in the Agreement Documents, or which City, the Design Professional and Contractor agree constitutes a separately functioning and usable part of the Work that can be used by City for its intended purpose, without significant interference with Contractor's performance of the remainder of the Work, provided, however, if the portion of the Work to be used or occupied has not been found to be substantially complete, City must do so in accordance with Section 6.3 prior to such occupancy.

6.4.2 In lieu of the issuance of a Certificate of Substantial Completion as to part of the Work, City may take over operation of a facility constituting part of the Work whether or not it is substantially complete if such facility is functionally and separately usable; provided that prior to any such takeover, City and Contractor agree in writing as to the division of responsibilities between City and Contractor for security, operation, safety, maintenance, correction period, heat, utilities and insurance with respect to such facility.

6.4.3 Substantial Completion of or City's beneficial occupancy of a part of the Project will not alter the fact that the one-year warranty for the whole Project starts at the date of Final Completion of the whole Project.

6.5 **FINAL ACCEPTANCE**

6.5.1 Unless otherwise expressly agreed to in writing by City, Final Acceptance must be obtained by no later than 30 Days (60 Days for federally funded agreements) after the date of Substantial Completion. Failure to timely obtain Final Acceptance will be a material breach of the Agreement.

6.5.2 Upon receipt of written notice that the Work is ready for final inspection and acceptance, City and Contractor will jointly inspect to verify that the remaining items of Work have been completed. There will be no partial acceptance. Final Acceptance will not occur until all items of Work, including Punch List Items, have been completed to City's satisfaction as reflected in the written Final Acceptance.

6.5.3 Final Payment will not be due, owing, or paid by City until Final Acceptance is issued.

6.5.4 Landscape Establishment Period. Unless otherwise expressly agreed to in writing by City, the Landscape Establishment Period will begin on the date of Final Acceptance of the Project and will run 90 Calendar Days thereafter. Landscape Establishment Period requirements are detailed in General Conditions Appendices, attached herein.

6.6 **CONTINUATION OF WORK**

6.6.1 Permitting Contractor to continue and finish the Work or any part of it after the time fixed for its completion (whether milestone, phase, Substantial Completion or Final Acceptance) or after the date to which the time fixed for any completion may have been extended, does not operate as a waiver by City of any rights under the Agreement Documents, law or equity.

6.6.2 Furthermore, the timely completion of the Work being of the utmost importance under this Agreement, notwithstanding the existence of one or more disputes between the parties

concerning the scope of the Work, the Project Schedule, Agreement Time, payments or any other matter, and further notwithstanding a party's invocation of the Dispute Resolution provisions specified in Appendix 6 of these General Conditions, unless City suspends the Agreement or Contractor's performance pursuant to Section 10 of these General Conditions, Contractor will continue to prosecute the Work, including any Change Order work or Extra Work Orders, in a diligent and timely manner and not stop, slow down or impede by action or inaction the progress of the Work, including commencing performance of and thereafter completing any additional work called out in any Change Order or Extra Work Order issued by Project Manager with the approval of City, so long as City makes payment to Contractor in accordance with Section 8 of these General Conditions.

SECTION 7 - AGREEMENT PRICE

7.1 UNIT PRICE AGREEMENTS

- 7.1.1 The Agreement Price for all Unit Price Agreements will be the amount set forth in the Agreement or Change Order multiplied by the verified quantity provided.
- 7.1.2 Measurements of quantities to determine the total Agreement Price must be in accordance with MAG Specification §§ 109.1 and 109.2.
- 7.1.3 The Unit Price may only be changed as set forth in Section 9 below.

7.2 CHANGE ORDERS

- 7.2.1 Unit Price Change Orders. The Change Order Price for all Unit Price Change Orders will be the amount set forth in the Change Order multiplied by the verified quantity provided.
- 7.2.2 Measurements of quantities to determine the total Change Order Price must be in accordance with MAG Specifications §§ 109.1 and 109.2.
- 7.2.3 The Unit Price may only be changed as set forth in Section 9 below.
- 7.2.4 MAG Specification § 109.4.1 is modified as follows: Before § 109.4.1, the following is added: Any deduction or increase in the Agreement Price must be supported by a signed, written Change Order fully executed by City, and supported by such backup as the Project Manager may require.

7.3 SALES TAX

Contractor is required to pay all applicable sales tax in accordance with the law of the state of Arizona and this cost must be included in all Agreement Prices. When equipment, materials or supplies generally taxable to Contractor are eligible for a tax exemption due to the nature of the Project, Contractor must assist City in applying for and obtaining such tax credits and exemptions which will be paid or credited to City.

SECTION 8 - PAYMENT

8.1 PAYMENT FOR CONSTRUCTION SERVICES

- 8.1.1 Payment for the Work will be made in accordance with MAG Standard Specification § 109 as amended below.
- 8.1.2 Contractor must submit to City for review a completed Contractor Payment Request signed

by Contractor, covering the Work completed as of the date of the Request and accompanied by such supporting documentation as is required by the Agreement Documents and also as City may reasonably require. A Contractor Payment Request will not be considered complete unless it is accompanied by an updated Project Schedule and a certification that the on-site, red lined, as built Drawings are up to date. If payment is requested on the basis of materials and equipment not incorporated in the Work but delivered and suitably, securely stored at the Site or at another location (such as a bonded warehouse) agreed to in writing, the Contractor Payment Request must also be accompanied by such data, satisfactory to City, as will establish City's title to the material and equipment and protect City's interest therein, including applicable insurance. Each subsequent Contractor Payment Request must include an affidavit of Contractor stating that all previous progress payments received on account of the Work have been applied to discharge in full all of Contractor's obligations reflected in prior Contractor Payment Requests.

- 8.1.3 Except for Work performed under a JOC Agreement, the Contracting Agency will retain 10 percent of all estimates as a guarantee for complete performance of the Agreement in accordance with Arizona Revised Statutes Section 34-221 or 34-607. The Contractor may elect to deposit securities in lieu of retention in accordance with Arizona Revised Statutes Section 34-221, Paragraph C.5. or 34-607, Paragraph B.5.
- 8.1.4 The payment process functions as follows: Prior to the payment cycle date, Contractor must send a draft Contractor Payment Request to Project Manager. The Project Team will review the Request and agree upon any necessary adjustments. Contractor must certify the final Request by signing and returning to Project Manager.
- 8.1.5 When construction of the Project is fifty percent (50%) completed, Contractor may request payment of one-half of the retention pursuant to A.R.S. § 34-609(B)(3), subject to all of City's rights to withhold or offset payments, and other rights of City, under the Agreement.
- 8.1.6 City reserves the right under A.R.S. § 34-609(B)(3) to reinstate the ten percent (10%) retention if City determines that satisfactory progress is not being made.
- 8.1.7 Contractor's Warranty of Title.
 - 8.1.7.1 Contractor warrants and guarantees that title to all Work, materials and equipment covered by any Contractor Payment Request, whether incorporated in the Project or not, will pass to City at the time of payment, free and clear of all liens, claims, security interests, and encumbrances, provided that this will not preclude the Contractor from installing metering devices or other equipment of utility companies or municipalities, the title of which is commonly retained by the utility company or municipality.
 - 8.1.7.2 No materials, supplies, or equipment for the Work under this Agreement will be purchased subject to any chattel mortgage or under a conditional sale contract or other agreement by which an interest therein, or any part thereof, is retained by the seller or supplier.
 - 8.1.7.3 Nothing contained in this Section will defeat or impair the right of such persons furnishing materials or labor under any bond given by the Contractor for their protection, or any right under any law permitting such persons to look to funds due the Contractor in the hands of the City. The provisions of this Section must be inserted in all subcontracts and material agreements, and notices of its provision must be given to all persons furnishing materials for the Work when no formal agreement is entered into for such materials.

8.2 PAYMENT UPON SUBSTANTIAL COMPLETION

8.2.1 No payment will be made upon Substantial Completion, except for a regularly-scheduled monthly progress payment, as allowed by Section 8.2.2.

8.2.2 No further payments will be made to Contractor until Final Acceptance.

8.3 FINAL PAYMENT

8.3.1 Subject to all of City's rights to withhold or offset payment, and other rights under the Agreement, Final Payment including remaining retainage will be paid only after:

- a. Work has been fully completed (including completion of all incorrect or incomplete work items) and the written Final Acceptance has been issued by City;
- b. Necessary operating manuals, any excess materials and supplies necessary for matching materials and supplies incorporated into the Work, acceptable sewer video results (if applicable), and complete "as-built" Drawings (including the Building Information Model, if required by the Agreement Documents) have been delivered to City, as specified in this Section 8.3;
- c. Full and unconditional lien waivers and releases by Contractor and any person performing labor or supplying material, machinery, fixtures, or tools for the Work have been delivered to Contractor;
- d. All conditions and requirements imposed by City or any financing entity for the corresponding disbursement have been met; and
- e. Contractor delivers to City a Contractor Payment Request requesting Final Payment.

8.3.2 Contractor must also submit a signed copy of Contractor's Affidavit Regarding Settlement of Claims, Appendix 3 to these General Conditions, and Certificate of Completion, Appendix 7 to these General Conditions, prior to Final Payment.

8.3.3 In addition, if required under the Project Specific Special Provisions, Contractor must compile a complete equipment list and maintenance manual to be submitted to City as a precondition to Final Payment. The list must include the following items for all equipment supplied under the Plumbing, Electrical, Air Conditioning, Elevator, and other Special Equipment Specifications:

- a. Name, Model and Manufacturer.
- b. Complete parts lists and Drawings.
- c. Local source of supply for replacement parts along with suppliers' telephone numbers.
- d. Local service organizations serving the equipment and their telephone numbers.
- e. All tags, inspection slips, instruction packages, etc., removed from equipment must be properly identified as to pieces of equipment from which they were taken.

8.3.4 Contractor must also deliver to City, prior to Final Payment, one (1) digital (in the format specified by City), and if requested by City, one (1) hard copy, of any applicable Maintenance manuals. Each manual must include all manufacturer's operation and maintenance instructions and "as-built" Drawings with the list herein specified. It must also include all other diagrams and instructions necessary to properly operate and maintain the equipment, the name, address and telephone number of Contractor and all Subcontractors involved.

8.4 **CITY'S RIGHT TO WITHHOLD PAYMENT**

City may withhold payment to such extent as may be necessary in City's opinion to protect City from loss for which Contractor is responsible, including, without limitation, if any of the following conditions exist:

- a. Defective Work not remedied;
- b. Third party claims filed or reasonable evidence indicating probable filing of such claims unless security acceptable to City is provided by Contractor;
- c. Failure of Contractor to make payments properly to Subcontractors or for labor, materials or equipment;
- d. Reasonable evidence that the Work cannot be completed for the unpaid balance of the Agreement Price;
- e. Damage to City or another Contractor;
- f. Reasonable evidence that the Work will not be completed within the Agreement Time, and that the unpaid balance would not be adequate to cover actual or liquidated damages for the anticipated delay;
- g. Failure to carry out the Work in accordance with the Agreement Documents;
or
- h. Contractor is in default of any of its other obligations under the Agreement Documents.

8.5 **JOINT/DIRECT CHECKS**

To promote the timely completion and progress of the Work or when appropriate and necessary, payments to Contractor may be made jointly to Contractor and its employees, agents, Subcontractors and suppliers, or any of them. For federally funded agreements, see federal provisions for additional requirements for the joint check process.

8.6 **PAYMENT NOT A WAIVER**

No payment (nor use or occupancy of the Project by City) will be deemed acceptance or approval of the Work or as a waiver of any claims, rights, or remedies of City.

8.7 **LIENS AND BOND CLAIMS**

Contractor must make all payments, in the time required, of all labor and materials furnished to Contractor in the course of the Work and must promptly furnish evidence of such payments as City may require. Contractor must pay when due all claims arising out of performance of the Work covered by this Agreement for which a lien may be filed either against the real estate or leasehold interest of City, or against payments due from City to Contractor, or for which a claim may be made against any payment or performance bond or both. To the fullest extent permitted by law, Contractor agrees that no liens or other claims in the nature of a lien against the real estate, leasehold, or other interest of City,

against payment due from City to Contractor, or against any payment or performance bond, must be filed or made in connection with the Work by any party who has supplied professional services, labor, materials, machinery, fixtures, tools, or equipment used in or in connection with the performance of this Agreement, and Contractor agrees to remove or to cause to be removed any such liens or claims in the nature of a lien or bond claim within 10 Days upon receiving notice or obtaining actual knowledge of the existence of such liens or claim. In addition, Contractor agrees to defend, indemnify, and hold harmless City from and against any and all such liens and claims. This paragraph does not apply to claims and liens of Contractor due to non-payment for work performed.

8.8 FINANCIAL RECORDKEEPING AND CITY'S AUDIT RIGHT

8.8.1 Records for all Agreements between City and Contractor must, upon reasonable notice, be open to inspection and subject to audit, scanning, and reproduction during normal business working hours. Such audits may be performed by any City's representative or any outside representative engaged by City for the purpose of examining such records. City or its designee may conduct such audits or inspections throughout the term of this Agreement and for a period of five years after Final Payment or longer if required by law. City's representatives may (without limitation) conduct verifications such as counting employees at the Site, witnessing the distribution of payroll, verifying information and amounts through interviews and written confirmations with Contractor employees, field and agency labor, Subcontractors, and vendors.

8.8.2 Contractor's "records" must include any and all information, materials and data of every kind and character, including without limitation, records, books, papers, documents, subscriptions, recordings, agreements, purchase orders, leases, contracts, commitments, arrangements, notes, daily diaries, superintendent reports, drawings, receipts, vouchers and memoranda, and any and all other agreements, sources of information and matters that may in City's judgment have any bearing on or pertain to any matters, rights, duties or obligations under or covered by any Agreement Document. Such records must include (hard copy, as well as computer readable data if it can be made available), written policies and procedures; time sheets; payroll registers; payroll records; cancelled payroll checks; subcontract files (including proposals of successful and unsuccessful bidders, bid recaps, negotiation notes, etc.); original bid estimates; estimating work sheets; correspondence; Change Order files (including documentation covering negotiated settlements); back-charge logs and supporting documentation; invoices and related payment documentation; general ledger, information detailing cash and trade discounts earned, insurance rebates and dividends; and any other Contractor records which may have a bearing on matters of interest to City or the Project in connection with Contractor's dealings with City or the Project (all foregoing hereinafter referred to as "records") to the extent necessary to adequately permit evaluation and verification of any or all of the following:

- a. Compliance with Agreement requirements for deliverables;
- b. Compliance with approved Plans and Specifications;
- c. Compliance with § 14.9 below;
- d. Compliance with Agreement provisions regarding the pricing of Change Orders;
- e. Accuracy of Contractor representations regarding the pricing of invoices; or
- f. Accuracy of Contractor representations related to claims submitted by

Contractor or any of their employees.

- 8.8.3 Contractor must require all payees (examples of payees include Subcontractors, Suppliers, Insurance Carriers, etc.) to comply with the provisions of this Section by including the requirements hereof in a written agreement between Contractor and payee. Contractor will ensure that all payees (including those entering into lump sum agreements) have the same right to audit provisions contained in this Agreement included in their agreements with Contractor.
- 8.8.4 City's authorized representative(s) (including, without limitation, Project Manager) must have reasonable access to Contractor's facilities, must be allowed to interview all current or former employees to discuss matters pertinent to the performance of this Agreement and must be provided adequate and appropriate work space, in order to conduct audits in compliance with this Section.
- 8.8.5 If an audit inspection or examination in accordance with this Section, discloses overpricing or overcharges to City (of any nature) by Contractor or Contractor's Subcontractors in excess of \$100,000 in addition to making adjustments for the overcharges, the reasonable actual cost of City's audit must be reimbursed to City by Contractor. Any adjustments or payments which must be made as a result of any such audit or inspection of Contractor's invoices or records must be made within a reasonable amount of time (not to exceed 90 Days) from presentation of City's findings to Contractor.
- 8.8.6 In addition to the normal paperwork documentation Contractor typically furnishes to City, Contractor agrees to furnish, upon written request from City, any of the documentation necessary for City to exercise its audit rights under this Section 8.8 in computer readable file formats (Word, Excel, or .pdf), as City may designate.
- 8.8.7 City, its authorized representative, and the appropriate agency, reserve the right to audit Contractor's records in compliance with local, state or federal policies, statutes or at City's discretion, within three (3) years of Final Acceptance of the Work.

SECTION 9 - CHANGES TO THE AGREEMENT

9.1 FIELD ORDERS

City may authorize minor changes in the Work not involving an adjustment in the Agreement Price or the Agreement Times, which are consistent with the overall intent of the Agreement Documents. These may be accomplished by a written Field Order on the standard form approved and executed by City. Such Field Orders must be binding and Contractor must perform the change promptly. If Contractor believes that a Field Order justifies an increase in the Agreement Price or Agreement Time, Contractor may make a claim therefor as provided in Section 7.2.

9.2 EXTRA WORK/CHANGES IN THE WORK

- 9.2.1 City reserves the right to make such changes in the Plans and Specifications for the Work, as it may deem appropriate and any such change as set forth in a written Change Order must be deemed a part of this Agreement as if originally incorporated herein.
- 9.2.2 In the event City and Contractor cannot agree on the terms of a Change Order, or when circumstances otherwise require, the Project Manager has the authority to direct the Contractor to perform extra work, if the work in question is an item not provided for in the

Agreement as awarded. The Project Manager will have the authority to determine, based upon factual evidence presented by the Contractor, whether the work in question is an item not provided for in the Agreement as awarded. If the Project Manager directs the Contractor to perform extra work, the Project Manager's instructions will include a price that the Contractor cannot exceed in charging the City for the extra work. Upon receipt of the Project Manager's directions to perform extra work, the Contractor must promptly proceed with the extra work and document the actual cost thereof. Contractor's right to payment for extra work will be determined under Subsection 9.2.4 below. The Contractor is responsible to manage the extra work to ensure that the price limits set by the Project Manager are not exceeded. Contractor must perform the extra work and submit documentation for the actual cost of the extra work to the City. A Change Order will be issued to cover this work.

9.2.3 Contractor will not be entitled to payment for extra work unless a written Change Order, in form and content prescribed by City, has been executed by City. On all requests for Change Orders, Contractor must specify the increased or decreased costs and whether it believes any extensions of time will be necessary to complete its Work as modified by the Change Order. If extra work is performed under Subsection 9.2.2 above, a corresponding Change Order will be prepared, approved and processed by City before payment can be made to Contractor.

9.2.4 In general, pricing for Change Orders will include the same mark-up percentages that were in effect when the Agreement was awarded. The cost or credit to the City resulting from a change in the Work is subject to Appendix 1 (Policy Statement for Calculating Delays and Damages) and will be determined, based on the type of pricing for the Agreement involved, as follows:

- a. By mutual acceptance of a lump sum properly itemized in a form acceptable to City;
- b. By unit prices stated in the Agreement Documents;
- c. When the City determines that a Unit Price Book Job Order associated with a Job Order Agreement requires a Change Order, by using the same Total Cost Data and CCI that are in effect when the Change Order is anticipated to be issued; or
- d. By actual cost and a percentage fee covering overhead and profit, as follows:
 - (i) Contractor will perform the extra work and be compensated for actual cost of labor, materials and equipment.
 - (ii) Contractor will have the right to add the fee percentage applicable to the Work under the Agreement, or if no such fee has been agreed to by the parties, not more than five percent (5%) to the Subcontractor's prices for authorized extra work performed solely by Subcontractors. Such percentage will include all of Contractor's charges for overhead, profit, administration and supervision.
 - (iii) Contractor or Subcontractor will have the right to add the fee percentage applicable to Work under the Agreement for self-performed extra work, or if no such fee has been agreed to by the parties, Contractor's or Subcontractor's maximum total allowable additions for overhead, profit, administration and supervision will

not exceed ten percent (10%) of actual verifiable labor, materials and equipment for such self- performed extra work.

- 9.2.5 Any agreement which modifies the terms of the Agreement (including Change Orders) will be approved in writing by the Project Manager. Once properly executed by both parties, these modifications to the Agreement will have the same effect as if they had been included in the original Agreement.

9.3 **ACCURACY OF CHANGE ORDER PRICING INFORMATION**

- 9.3.1 Subject to Sections 9.3.2 through 9.3.4, signature by the contracting parties constitutes full accord and satisfaction between City and Contractor for all costs, damages, and expenses of whatever kind of nature, including delay, impact or acceleration damages, which may be occasioned by a Change Order of other modification of the Agreement agreed to in writing.

- 9.3.2 Accurate Change Order Pricing Information: Contractor agrees that it is responsible for submitting accurate cost and pricing data to City to support its Fixed Price, Unit Price, or Cost Plus Change Order Proposals or other Agreement Price adjustments under the Agreement. Contractor further agrees to submit Change Order proposals with cost and pricing data which is accurate, complete, current, and in accordance with the terms of the Agreement with respect to pricing of change orders. Contractor agrees that any “buy-out savings” on Change Orders will accrue 100% to Owner. “Buy-out savings” are defined as any savings negotiated by the Contractor with a Subcontractor or a Material Supplier after receiving approval of a Change Order amount that was designated to be paid to a specific Subcontractor or Supplier for the Approved Change Order work.

- 9.3.3 Right to Verify Change Order Pricing Information: Contractor agrees that City, through its designated representative, will have the right to examine, copy, and scan the records of the Contractor, Subcontractor or Sub-Subcontractor’s records (during the Agreement period and up to three years after final payment is made on the Agreement) to verify the accuracy and appropriateness of the pricing data used to price all Change Order proposals or claims. Contractor agrees that if City determines the cost and pricing data submitted (whether approved or not) was inaccurate, incomplete, not current, or not in compliance with the terms of the Agreement regarding pricing of Change Orders, an appropriate Agreement Price adjustment will be made. Such post-approval Contact Price adjustments will apply to all levels of contractors and Subcontractors and to all types of Change Order proposals, specifically including Fixed Price, Unit Price, and Cost Plus Change Orders.

- 9.3.4 Requirements for Detailed Change Order Pricing Information: Contractor agrees to provide a detailed breakdown of allowable labor and labor burden cost (i.e., base wage rate of applicable classifications of workers, payroll taxes, and insurance and benefits costs). This information will be used to evaluate the potential cost of labor and labor burden related to Change Order work. It is intended that this information represent an accurate estimate of the Contractor’s actual labor and labor burden cost components. Information is not intended to establish fixed billing or Change Order pricing labor rates. However, at the time Change Orders are priced, the submitted cost data for labor rates may be used to price Change Order work. The accuracy of any such agreed upon labor rate cost components used to price Change Orders will be subject to later audit. Approved Change Order amounts may be adjusted later to correct the impact of inaccurate labor cost components if the agreed upon labor cost components are determined to be inaccurate.

9.4 **EMERGENCIES**

In any emergency affecting the safety of persons or property, Contractor will act, at its discretion, to prevent threatened damage, injury or loss. Any change in the Agreement Price or Agreement Time resulting from emergency work will be determined as provided in this Section.

9.5 **DIFFERING SITE CONDITIONS**

- 9.5.1 If Differing Site Conditions are encountered at the Project Site, then notice by the observing party must be given to the other party promptly before conditions are disturbed (to the extent practicable) and in no event later than 14 Days after first observance of the conditions. City will promptly investigate such conditions and, if City determines that Differing Site Conditions exist and they materially cause an increase in the cost of, or time required for, performance of any part of the Work, Contractor will be entitled to equitable adjustment in the Agreement Price or Construction Schedule (and other time requirements), or both. If it is determined by City that the conditions at the Project Site are not Differing Site Conditions and no change is justified, then City will so notify Contractor in writing, stating the reasons. Claims in opposition to such determination must be made within 14 Days after City has given notice of its decision. If City and Contractor cannot agree on an adjustment in the Agreement Price or Construction Schedule (and other time requirements), the adjustment may be submitted to dispute resolution as provided these General Conditions.

9.6 **CHANGES IN LAWS, REGULATIONS, OR LEGAL REQUIREMENTS OR TAXES**

In the event of a material change in applicable Laws, Regulations, or Legal Requirements, or taxes subsequent to the date of the Agreement by the parties, Contractor may be entitled to a Change Order, in City's discretion, to the extent Contractor can document to the satisfaction of City that such change significantly increases Contractor's actual cost of performance of the Work.

SECTION 10 -SUSPENSION AND TERMINATION

10.1 **SUSPENSION**

City may suspend the Agreement and Contractor's performance in accordance with MAG Specifications § 105.1 and 108.7.

10.2 **TERMINATION BY THE CITY FOR CAUSE**

- 10.2.1 MAG Specifications § 108.11 applies to the Agreement.

- 10.2.2 City may also terminate the Agreement if City determines, in its sole discretion that Contractor has:

- a. After prior written notice, refused or failed to supply enough properly skilled workers or proper materials;
- b. After prior written notice, failed to make payment to Subcontractors for materials or labor in accordance with the respective agreements between Contractor and the Subcontractors;
- c. After prior written notice, disregards laws, ordinances, or rules, regulations or orders of a public authority having jurisdiction;
- d. After prior written notice, repeatedly failed to comply with written directives from City;

- e. Is adjudged as bankrupt or insolvent;
- f. Made a general assignment for the benefit of creditors;
- g. Appointed a trustee or receiver for itself or any of its property;
- h. Filed a petition to take advantage of any debtor's act, or to reorganize under the bankruptcy or similar laws; or
- i. Otherwise breached a provision of the Agreement Documents or any other Agreement between City and Contractor.

10.2.3 When any of the above reasons exist, City may terminate the Agreement, without prejudice to any other rights or remedies of City, after giving Contractor and Contractors' surety, if any, 7 Days written notice of City's intent to terminate the Agreement and Contractor's failure to cure any such reasons. Upon such termination, City may: (1) take possession of the Site and of all materials thereon owned by Contractor; or (2) finish the Work by whatever reasonable method City may deem expedient. When City terminates the Agreement for one of the reasons state above, Contractor will not be entitled to receive further payment until the Work is finished. If the unpaid balance of the Agreement Price existing at the time of such termination exceeds the costs and expenses of finishing the Work and any other damages incurred by City, such excess will be paid to Contractor. If such costs, expenses and damages exceed such unpaid balance, Contractor must pay the difference to City. This obligation for payment will survive termination of the Agreement.

10.3 **TERMINATION BY CITY FOR CONVENIENCE**

City may also terminate the Agreement at any time for its convenience upon 7 Days written notice to Contractor specifying the termination date. In the event of termination which is not the fault, in whole or in part, of Contractor, City will pay to Contractor only such compensation, including reimbursable expenses, due for Work properly performed on the Project prior to the termination date. Upon any termination of the Agreement, no further payments will be due from City to Contractor.

10.4 **A.R.S. § 38-511**

The Agreement is subject to, and may be terminated by City in accordance with, the provisions of A.R.S. § 38-511.

SECTION 11 -INSURANCE AND BONDS

11.1 **INSURANCE REQUIREMENTS**

11.1.1 After Agreement award, the Contractor must furnish the City a certificate of insurance on a standard insurance industry ACORD form. The ACORD form must be issued by an insurance company authorized to transact business in the State of Arizona possessing a current A.M. Best, Inc. rating of A-7, or better and legally authorized to do business in the State of Arizona with policies and forms satisfactory to City. Provided, however, the A.M. Best rating requirement may not be deemed to apply to required Worker's Compensation coverage.

11.1.2 The Contractor and any of its Subcontractors must procure and maintain, until all of their obligations have been discharged, including any warranty periods under this Agreement are satisfied, the insurances set forth below.

11.1.3 The insurance requirements set forth below are minimum requirements for this Agreement and in no way limit the indemnity covenants contained in this Agreement.

- 11.1.4 The City in no way warrants that the minimum insurance limits contained in this Agreement are sufficient to protect Contractor from liabilities that might arise out of the performance of the Agreement services under this Agreement by Contractor, its agents, representatives, employees, or Subcontractors and the Contractor is free to purchase any additional insurance as may be determined necessary.
- 11.1.5 Failure to demand evidence of full compliance with the insurance requirements in this Agreement or failure to identify any insurance deficiency will not relieve the Contractor from, nor will it be considered a waiver of its obligation to maintain the required insurance at all times during the performance of this Agreement.
- 11.1.6 Use of Subcontractors: If any Work is subcontracted in any way, the Contractor must execute a written agreement with Subcontractor containing the same Indemnification Clause and Insurance Requirements as the City requires of the Contractor in this Agreement. The Contractor is responsible for executing the Agreement with the Subcontractor and obtaining Certificates of Insurance and verifying the insurance requirements.
- 11.2 **MINIMUM SCOPE AND LIMITS OF INSURANCE**
- 11.2.1 The Contractor must provide coverage with limits of liability not less than those stated below.
- 11.2.1.1 Commercial General Liability-Occurrence Form. Contractor must maintain "occurrence" form Commercial General Liability insurance with a limit of not less than \$2,000,000 for each occurrence, \$4,000,000 aggregate. Said insurance must also include coverage for products and completed operations, independent contractors, personal injury and advertising injury. If any Excess insurance is utilized to fulfill the requirements of this paragraph, the Excess insurance must be "follow form" equal or broader in coverage scope than underlying insurance.
- 11.2.1.2 Automobile Liability-Any Automobile or Owned, Hired and Non-Owned Vehicles. Contractor must maintain Business/Automobile Liability insurance with a limit of \$1,000,000 each accident on Contractor owned, hired, and non-owned vehicles assigned to or used in the performance under this Agreement. If any Excess or Umbrella insurance is utilized to fulfill the requirements of this paragraph, the Excess or Umbrella insurance must be "follow form" equal or broader in coverage scope than underlying insurance.
- 11.2.1.3 Workers Compensation and Employers Liability Insurance. Contractor must maintain Workers Compensation insurance to cover obligations imposed by federal and state statutes having jurisdiction of Contractor employees engaged in the performance of Work under this Agreement and must also maintain Employers' Liability insurance of not less than \$1,000,000 for each accident and \$1,000,000 disease for each employee.
- 11.2.1.4 Builders' Risk/Installation Floater Insurance. The Contractor bears all responsibility for loss to all equipment or Work under construction. Unless waived in writing by the City the Contractor will purchase and maintain in force Builders' Risk/Installation Floater insurance on the entire Work until completed and accepted by the City. This insurance will be Special Causes of Loss policy form, (minimally including perils of fire, flood, lightning, explosion, windstorm and hail, smoke, aircraft and vehicles, riot and civil commotion, theft, vandalism, malicious mischief, and collapse), completed value, replacement cost policy form equal to the Agreement Price and all subsequent modifications. The Contractor's Builders'

Risk/Installation Floater insurance must be primary and not contributory.

- a. Builders' Risk/Installation Floater insurance must cover the entire Work including reasonable compensation for architects and engineers' services and expenses and other "soft costs" made necessary by an insured loss. Builders' Risk/Installation Floater insurance must provide coverage from the time any covered property comes under the Contractor's control and or responsibility, and continue without interruption during course of construction, renovation and or installation, including any time during which any Project property or equipment is in transit, off Site, or while on Site for future use or installation. Insured property must include, but not be limited to, scaffolding, false work, and temporary buildings at the Site. This insurance must also cover the cost of removing debris, including demolition as may be legally required by operation of any law, ordinance, regulation or code.
- b. The Contractor must also purchase and maintain Boiler and Machinery insurance with the same requirements as Builders' Risk/Installation Floater insurance cited above if the Work to be performed involves any exposures or insurable property normally covered under a Boiler and Machinery insurance policy or made necessary as required by law or testing requirements in the performance of this Agreement. The Contractor will be responsible for any and all deductibles under these policies and the Contractor waives all rights of recovery and subrogation against the City under the Contractor- Builders' Risk/Installation Floater insurance described herein.
- c. Builders' Risk/Installation Floater Insurance must be maintained until whichever of the following first occurs: (i) final payment has been made; or, (ii) until no person or entity, other than the City, has an insurable interest in the property required to be covered.
- d. The Builders' Risk/Installation Floater insurance must be endorsed so that the insurance will not be canceled or lapse because of any partial use or occupancy by the City.
- e. The Builders Risk/Installation Floater insurance must include as named insureds, the City, the Contractor, and all tiers of Subcontractors and others with an insurable interest in the Work who will be named as additional insureds unless they are able to provide the same level of coverage with the City and Contractor named as additional insureds. Certificates must contain a provision that the insurance will not be canceled or materially altered without at least 30 Days advance notice to the City. The City must also be named as a Loss Payee under the Builders' Risk/Installation Floater coverage.
- f. The Builders Risk/Installation Floater insurance must be written using the Special Causes of Loss policy form, replacement cost basis.
- g. All rights of subrogation under the Builders Risk/Installation Floater insurance are, by this Agreement, waived against the City, its officers, officials, agents and employees.
- h. The Contractor is responsible for payment of all deductibles under the Builders' Risk/Installation Floater insurance policy.

11.2.1.5 Pollution Liability Insurance (Including Errors and Omissions). For Job Orders, Pollution Liability Insurance is only required if applicable and determined on a project specific basis. Contractor must maintain Pollution Liability Insurance with a limit of not less than \$5,000,000 per loss, \$5,000,000 aggregate for losses caused by pollution conditions including coverage for bodily injury, property damage, defense costs, clean-up costs, and completed operations that arise from the operations of Contractor as described in this Agreement.

- a. The policy must provide for complete professional service coverage, including coverage for pollution liability that is a result of a breach of professional duties.
- b. The policy must provide for protection again claims for third-party bodily injury, property damage, or environmental damage caused for pollution conditions resulting from general contracting activities for which Contractor is legally liable.
- c. The policy must provide for cleanup costs when mandated by governmental entities, when required by law, or as a result of third-party claims.
- d. Completed Operations Coverage must be kept in place for up to the statute of repose.
- e. The policy must be endorsed to include the following additional insured language: "City, its elected officials, trustees, employees, agents, and volunteers must be named as additional insureds with respect to liability arising out of the activities performed by, or on behalf of Contractor".
- f. If Work under this Agreement requires the transportation of any hazardous material or regulated substances, Contractor must carry Auto Liability with a CA 9948 endorsement or equivalent.
- g. If Work under this Agreement requires the disposal of any hazardous materials from the job site, Contractor must obtain a certificate of insurance for Pollution Legal Liability from the disposal site operator with a limit of not less than \$5,000,000 per loss, \$5,000,000 aggregate.

11.3 **ADDITIONAL POLICY PROVISIONS REQUIRED**

11.3.1 Self-Insured Retentions or Deductibles. Any self-insured retentions and deductibles must be declared and approved by the City. If not approved, the City may require that the insurer reduce or eliminate any deductible or self-insured retentions with respect to the City, its officers, officials, agents, employees, and volunteers.

11.3.2 The Contractor's insurance must contain broad form contractual liability coverage.

11.3.3 The Contractor's insurance coverage must be primary insurance with respect to the City, its officers, officials, agents, and employees. Any insurance or self-insurance maintained by the City, its officers, officials, agents, and employees will be in excess of the coverage provided by the Contractor and must not contribute to it.

11.3.4 The Contractor's insurance must apply separately to each insured against whom claim is made or suit is brought, except with respect to the limits of the insurer's liability.

11.3.5 Coverage provided by the Contractor must not be limited to the liability assumed under the

indemnification provisions of this Agreement.

11.3.6 The policies must contain a severability of interest clause and waiver of subrogation against the City, its officers, officials, agents, and employees, for losses arising from Work performed by the Contractor for the City.

11.3.7 The Contractor, its successors and or assigns, are required to maintain Commercial General Liability insurance as specified in this Agreement for a minimum period of 3 years following completion and acceptance of the Work. The Contractor must submit a Certificate of Insurance evidencing Commercial General Liability insurance during this 3 year period containing all the Agreement insurance requirements, including naming the required Additional Insureds set forth herein.

11.3.8 If a Certificate of Insurance is submitted as verification of coverage, the City will reasonably rely upon the Certificate of Insurance as evidence of coverage but this acceptance and reliance will not waive or alter in any way the insurance requirements or obligations of this Agreement.

11.3.9 Insurance Cancellation During Agreement Term.

11.3.9.1 If any of the required policies expire during the life of this Agreement, the Contractor must forward renewal or replacement Certificates to the City within 10 Days after the renewal date containing all the required insurance provisions.

11.3.9.2 Each insurance policy required by the insurance provisions of this Agreement must provide the required coverage and must not be suspended, voided or canceled except after 30 Days prior written notice has been given to the City, except when cancellation is for non-payment of premium, then 10 Days prior notice may be given. Such notice must be sent directly to Chandler Law-Risk Management Department, Post Office Box 4008, Mailstop 628, Chandler, Arizona 85225. If any insurance company refuses to provide the require notice, the Contractor or its insurance broker must notify the City of any cancellation, suspension, non-renewal of any insurance within 7 Days of receipt of insurers' notification to that effect.

11.3.10 City as Additional Insured. The above-referenced policies are to contain, or be endorsed to contain, the following provisions:

11.3.10.1 The Commercial General Liability and Automobile Liability policies are to contain, or be endorsed to contain, the following provisions: The City, its officers, officials, agents, and employees are additional insureds with respect to liability arising out of activities performed by, or on behalf of, the Contractor including the City's general supervision of the Contractor; Products and Completed Operations of the Contractor; and automobiles owned, leased, hired, or borrowed by the Contractor.

11.3.10.2 The City, its officers, officials, agents, and employees must be additional insureds to the full limits of liability purchased by the Contractor even if those limits of liability are in excess of those required by this Agreement.

11.4 **BONDS AND OTHER PERFORMANCE SECURITY**

11.4.1 After Agreement award, Contractor must provide a Performance Bond and a Payment Bond, each in an amount equal to the full amount of the Agreement Price.

11.4.2 Each such bond must be executed by a surety company or companies holding a Certificate

of Authority to transact surety business in the State of Arizona, issued by the Director of the Arizona Department of Insurance and must be named in the current list of "Companies Holding Certificates of Authority as Acceptable Sureties on Federal Bonds and as Acceptable Reinsuring Companies" as published in Circular 570 (amended) by the Audit Staff Bureau of Accounts, U.S. Treasury Department. A copy of the Certificate of Authority must accompany the bonds. The Certificate must have been issued or updated within two (2) years prior to the execution of this Agreement. The bonds must be written or countersigned by an authorized representative of the surety who is either a resident of the state of Arizona or whose principal office is maintained in this state, as by law required.

- 11.4.3 The bonds must be made payable and be acceptable to City. The bond forms for the performance and payment bonds must be in the forms required under A.R.S. § 34-221, *et. Seq.*, as in Appendices 4 and 5 of these General Conditions.
- 11.4.4 Upon the request of any person or entity appearing to be a potential beneficiary of bonds covering payment of obligations arising under the Agreement Documents, Contractor must promptly furnish a copy of the bonds or must permit a copy to be made.
- 11.4.5 All bonds submitted for this Project must be provided by a company which has been rated AM Best rating of A- or better for the prior four quarters by the latest edition of the 'Results Best's Key Rating Guide (Property/Casualty)' published by the A.M. Best Company.
- 11.4.6 Personal or individual bonds are not acceptable.
- 11.4.7 If the surety on any Bond furnished by Contractor is declared a bankrupt or becomes insolvent, or Contractor's right to do business is terminated in any state where any part of the Project is located, or it ceases to meet the requirements of this Section 11.4, Contractor must within 5 Days thereafter substitute another Bond and surety, both of which must be acceptable to City.

SECTION 12 - INDEMNIFICATION

- 12.1 To the extent permitted by law, the Contractor and its owners, officers, directors, agents, employees, and subconsultants (collectively "Indemnitor") must indemnify, save, and hold harmless the City and its officers, officials, agents, and employees (collectively "Indemnitee") from any and all claims, actions, liabilities, damages, losses, or expenses (including court costs, attorneys' fees, and costs of claim processing, investigation, and litigation) (collectively "Claims") caused or alleged to be caused, in whole or in part, by the negligent, reckless, wrongful, or willful acts, errors, or omissions of Indemnitor in connection with this Agreement. This indemnity includes any Claim or amount arising out of or recovered under workers' compensation laws or on account of Indemnitor's failure to conform to any federal, state, or local law, statute, ordinance, rule, regulation, or court decree. Indemnitor must indemnify Indemnitee from and against any and all Claims, except those arising solely from Indemnitee's own negligent, reckless, wrongful, or willful acts, errors, or omissions. Indemnitor is responsible for primary loss investigation, defense, and judgment costs where this indemnification applies. In consideration of the award of this Agreement, Indemnitor agrees to waive all rights of subrogation against Indemnitee for losses arising from or related to this Agreement. Indemnitor's obligations under this provision survive the termination or expiration of this Agreement.

SECTION 13 -DISPUTE RESOLUTION

- 13.1 All disputes arising out of or relating to the Agreement, the Work or the Project, other than termination under Section 10, will be resolved pursuant to the Dispute Resolution process set forth in Appendix 6 of these General Conditions, and not pursuant to MAG Specifications § 110.
- 13.2 Contractor agrees that during any dispute between the parties, Contractor will continue to perform its obligations under the Agreement until such dispute is resolved.
- 13.3 Notwithstanding any other provision in this Agreement, City has the right to immediately file in court and pursue an action for a temporary restraining order and injunctive relief against Contractor if City determines that such action is necessary to protect its interests under the Agreement, to obtain specific performance of any provision of the Agreement, to advance the completion of the Project, or to protect health, welfare and safety.

SECTION 14 - MISCELLANEOUS PROVISIONS

14.1 AGREEMENT DOCUMENTS

- 14.1.1 The Agreement Documents are intended to permit the parties to complete the Work and all obligations required by the Agreement Documents within the Agreement Times for the Agreement Price. The Agreement Documents are intended to be complementary and interpreted in harmony so as to avoid conflict, with words and phrases interpreted in a manner consistent with construction and design industry standards.
- 14.1.2 It is the intent of the Agreement Documents to describe a functionally complete Project (or part thereof) to be constructed in accordance with the Agreement Documents. Any labor, documentation, services, materials, or equipment that may reasonably be inferred from the Agreement Documents or from prevailing custom or trade usage as being required to produce the intended result must be provided by Contractor whether or not specifically called for at no additional cost to City.
- 14.1.3 The Agreement Documents establish the rights and obligations of the parties and include the Agreement, Addenda (which pertain to the Agreement Documents), Contractor's Bid or Proposal (including documentation accompanying the Bid and any post-Bid documentation submitted prior to Agreement award) when attached as an exhibit to the Agreement, the accepted Project Schedule, the Notice to Proceed, the Performance Bond, the Payment Bond, Project Design, Engineering and Specifications, these General Conditions, the Project Specific Special Provisions, Technical Specifications, Agreement Drawings, as the same may be more specifically identified in the Agreement, Change Orders, Work Change Directives, Field Orders and the written interpretations and clarifications of the Design Professional or City representative and Modifications issued after execution of the Agreement. Approved Shop Drawings and the reports and drawings of subsurface and physical conditions are not Agreement Documents.
- 14.1.4 In the event of any inconsistency, conflict, or ambiguity between or among the Agreement Documents, the Agreement Documents will take precedence as follows from highest to lowest: Change Orders, Addenda, Agreement, Project Specific Special Provisions, General Conditions, Technical Specifications, Drawings/Plans, Chandler Amendments to MAG Standard Specifications and Chandler Standard Details, and MAG Uniform Standard Specifications and Details for Public Works Construction. If applicable to this Agreement, Federal Provisions prevail.

- 14.1.5 On the Drawings, given dimensions will take precedence over scaled measurements and large scale drawings over small-scale drawings.
- 14.1.6 Clarifications and interpretations of the Agreement Documents will be issued by the Design Professional through the City.
- 14.1.7 The headings used in this Agreement or any other Agreement Documents, are for ease of reference only and must not in any way be construed to limit or alter the meaning of any provision.
- 14.1.8 The Agreement Documents form the entire agreement between City and Contractor. No oral representations or other agreements have been made by the parties except as specifically stated in the Agreement Documents.
- 14.1.9 The Agreement Documents may not be changed, altered, or amended in any way except in writing signed by a duly authorized representative of each party in the form of a Change Order.
- 14.1.10 Re-Use of Documents. Neither Contractor nor any Subcontractor, manufacturer, fabricator, supplier or distributor will have or acquire any title to or ownership rights in any of the Drawings, Specifications or other documents (or copies of any thereof) prepared by or bearing the seal of the Design Professional; and they must not re-use any of them on extensions of the Project or any other project without written consent of City and the Design Professional and specific written verification or adaptation by the Design Professional.

14.2 **REFERENCE STANDARDS**

- 14.2.1 Reference to standards, specifications, manuals, or codes of any technical society, organization, or association, or to Laws or Regulations, whether such reference be specific or by implication, will mean the standard, specification, manual, code, or Laws or Regulations in effect at the time of opening of Bids (or on the Effective Date of the Agreement if there were no Bids), except as may be otherwise specifically stated in the Agreement Documents.
- 14.2.2 The provisions of any such standard, specification, manual or code, or any instruction of a Supplier will not change the duties or responsibilities of City, Contractor, Design Professional or Project Manager, or any of their Subcontractors, consultants, agents, or employees from those set forth in the Agreement Documents, nor will any such provision or instruction assign to City, Contractor, Design Professional, or any of their agents, or employees any duty or authority to supervise or direct the performance of the Work or any duty or authority to undertake responsibility inconsistent with the provisions of the Agreement Documents.

14.3 **COMPLIANCE WITH ARIZONA LAW AND FEDERAL LAW**

- 14.3.1 Compliance with A.R.S. § 41-4401. Pursuant to the provisions of A.R.S. § 41-4401, the Contractor hereby warrants to the City that the Contractor and each of its subcontractors ("Subcontractors") must comply with all Federal Immigration laws and regulations that relate to the immigration status of their employees and the requirement to use E-Verify set forth in A.R.S. §23-214(A).
- 14.3.2 A breach of the Contractor Immigration Warranty constitutes a material breach of this Agreement and subject to penalties up to and including termination of this Agreement.

- 14.3.3 The City retains the legal right to inspect the papers of any Contractor or Subcontractor employee who works on this Agreement to ensure that the Contractor or Subcontractor is complying with the Contractor Immigration Warranty. The Contractor agrees to assist the City in the conduct of any such inspections.
- 14.3.4 The City may, at its sole discretion, conduct random verifications of the employment records of the Contractor and any Subcontractors to ensure compliance with Contractors Immigration Warranty. The Contractor agrees to assist the City in performing any such random verifications.
- 14.3.5 The provisions of this Article must be included in any agreement the Contractor enters into with any and all of its subcontractors who provide services under this Agreement or any subcontract. "Services" are defined as furnishing labor, time or effort in the State of Arizona by a contractor or subcontractor. Services include construction or maintenance of any structure, building or transportation facility or improvement to real property.

14.4 **HAZARDOUS ENVIRONMENTAL CONDITIONS**

- 14.4.1 Contractor will not be responsible for any Hazardous Environmental Condition uncovered or revealed at the Site which was not shown or indicated in Drawings or Specifications or identified in the Agreement Document to be within the scope of the Work. Contractor will be responsible for a Hazardous Environmental Condition created with any materials brought to the Site by Contractor, Subcontractors, Suppliers, or anyone else for whom Contractor is responsible.
- 14.4.2 If Contractor encounters a Hazardous Environmental Condition or if Contractor or anyone for whom Contractor is responsible creates a Hazardous Environmental Condition. Contractor must immediately:
- a. Secure or otherwise isolate such condition;
 - b. Stop all Work in connection with such condition and in any area affected thereby; and
 - c. Notify City and promptly thereafter confirm such notice in writing.
- 14.4.3 City will promptly retain a qualified expert to evaluate such condition or take corrective action, if any.
- 14.4.4 Contractor will be responsible for any and all civil or criminal penalties, fines, damages, or other charges imposed by any regulatory agency or court for sewage discharges that are in violation of applicable statutes and laws and that are a result, direct or indirect, of work performed under this Agreement. Contractor will also be responsible for reimbursement to City for administration, reporting, and tracking expenses required as a result of any spill event. In the event the regulatory agency or court imposes a probationary period, Contractor must post bond for the probationary period to ensure that all such costs are reimbursed to City. This responsibility will apply whether penalties are imposed directly on Contractor or any of its Subcontractors, or the City of Chandler. Contractor must defend and indemnify City against such penalties. Regulatory agencies may include, but are not limited to, the Arizona Department of Environmental Quality (ADEQ) and the United States Environmental Protection Agency (USEPA).

14.5 **COOPERATION AND FURTHER DOCUMENTATION**

Contractor agrees to provide City such other duly executed documents as may be reasonably requested by City to implement the intent of the Agreement Documents.

14.6 **ASSIGNMENT**

Neither Contractor nor City will, without the written consent of the other assign, transfer or sublet any portion of this Agreement or part of the Work or the obligations required by the Agreement Documents, any such assignment will be void, will transfer no rights to the purported assignee, and would be a material breach of the Agreement.

14.7 **SUCCESSORS**

Contractor and City intend that the provisions of the Agreement Documents are binding upon the parties, their employees, agents, heirs, successors and assigns.

14.8 **LAWFUL PRESENCE**

Pursuant to A.R.S. §§ 1-501 and 1-502, City is prohibited from awarding an agreement to any natural person who cannot establish that such person is lawfully present in the United States. To establish lawful presence, a person must produce qualifying identification and sign a City-provided affidavit affirming the identification provided is genuine. This requirement will be imposed at the time of agreement award. This requirement does not apply to business organizations such as corporations, partnerships, or limited liability companies.

14.9 **NO BOYCOTT OF ISRAEL CERTIFICATION**

By Contractor's signature on this Agreement, Contractor certifies under A.R.S. § 35-393.01 that Contractor is not currently engaged in and for the duration of this Agreement will not engage in a boycott of Israel.

14.10 **NO THIRD PARTY BENEFICIARY**

Nothing under the Agreement Documents will be construed to give any rights or benefits in the Agreement Documents to anyone other than City and Contractor, and all duties and responsibilities undertaken pursuant to the Agreement Documents will be for the sole and exclusive benefit of City and Contractor and not for the benefit of any other party, unless otherwise expressly set forth in the Agreement Documents.

14.11 **GOVERNING LAW AND VENUE**

The Agreement and all Agreement Documents will be deemed to be made under, and will be construed in accordance with and governed by the laws of the State of Arizona without regard to the conflicts or choice of law provisions thereof. Any court action to enforce any provision of the Agreement or to obtain any remedy with respect hereto must be brought in the Superior Court, Maricopa County, Arizona, and for this purpose, each party hereby expressly and irrevocably consents to the jurisdiction and venue of such Court.

14.12 **SEVERABILITY**

If any provision of the Agreement Documents or the application thereof to any person or circumstance will be invalid, illegal or unenforceable to any extent, the remainder of the affected provision, the remainder of the Agreement Documents, and the application thereof will not be affected and will be enforceable to the fullest extent permitted by law.

14.13 **LEGAL REQUIREMENTS**

At all times relevant to its entry into this Agreement and performance of the Services and the Work, Contractor must fully comply with all Laws, Regulations, or Legal Requirements applicable to City, the Project, and the Agreement, including, without limitation, those set

forth on Exhibit C of the Agreement.

14.14 **PARTIAL INVALIDITY**

If any provision of the Agreement is held by a court of competent jurisdiction to be invalid, void or unenforceable, the remaining provisions will nevertheless continue in full force without being impaired or invalidated in any way.

14.15 **ATTORNEYS' FEES**

Should either party to the Agreement bring an action to enforce any provision of the Agreement, the prevailing party will be entitled to recover reasonable attorneys' fees and costs in connection therewith.

14.16 **CONFLICT OF INTEREST**

14.16.1 Contractor agrees to disclose any financial or economic interest with the Project property, or any property affected by the Project, existing prior to the execution of the Agreement. Further, Contractor agrees to disclose any financial or economic interest with the Project property, or any property affected by the Project, if Contractor gains such interest during the course of this Agreement. If Contractor gains financial or economic interest in the Project during the course of this Agreement, this may be grounds for terminating this Agreement. Any decision to terminate the Agreement must be at the sole discretion of City.

14.16.2 Contractor will not engage the services on this Agreement of any present City employee who was involved as a decision maker in the selection or approval processes, or who negotiated or approved billings or Agreement Modifications for this Agreement.

14.16.3 Contractor agrees that it will not perform services on this Project for a contractor, subcontractor, or any supplier, not covered under this Agreement.

14.17 **INDEPENDENT CONTRACTOR**

Contractor is and must be an independent contractor. Any provisions in the Agreement Documents that may appear to give City the right to direct Contractor as to the details of accomplishing the Work or to exercise a measure of control over the Work means that Contractor must follow the wishes of City as the results of the Work only. These results must comply with all applicable laws and ordinances.

14.18 **NOTICE OF INJURY**

Should City or Contractor suffer injury or damage to their person or property because of any error, omission or act of the other party or of any of the other party's employees or agents or others for whose acts the other party is legally liable, claim must be made in writing to the other party within 7 Days of the first observance of such injury or damage.

14.19 **CONFIDENTIALITY**

Contractor, for the benefit of City, hereby agrees it will not release or cause or permit to be released to the public any press notices, publicity (oral or written) or advertising promotion relating to, any statement regarding, or any other public announcement or disclosure or cause or permit to be publicly announced or disclosed, in any manner whatsoever, the specific terms and conditions of this Agreement or any comment relating to the Project or the Site. Notwithstanding the foregoing, Contractor will be entitled to disclose the terms of the Agreement to the extent required by law or in the course of enforcing or defending a claim or action hereunder. Contractor must give City reasonably prompt notice of any disclosure or statement made pursuant to this provision.

14.20 **DATA CONFIDENTIALITY**

- 14.20.1 As used in the Agreement, “data” means all information, whether written or verbal, including plans, specifications, renderings, photographs, studies, investigations, audits, analyses, samples, reports, calculations, internal memos, meeting minutes, data field notes, work product, proposals, correspondence and any other similar documents or information prepared by, obtained by, or transmitted to the City in the performance of this Agreement.
- 14.20.2 Contractor agrees that all data, regardless of form, including originals, images, and reproductions, prepared by, obtained by, or transmitted to City in connection with the Contractor’s performance of this Agreement is confidential and proprietary information belonging to City.
- 14.20.3 Except as specifically provided in this Agreement, Contractor or its Subcontractors must not divulge data to any third party without prior written consent of City. Contractor or its Subcontractors must not use data for any purposes except to perform Work required under this Agreement. These prohibitions will not apply to the following data provided Contractor has first given the required notice to City:
- a. Data which was known to Contractor or its Subcontractors prior to its performance under this Agreement unless such data was acquired in connection with Work performed for City;
 - b. Data which was acquired by Contractor or its Subcontractors in its performance under this Agreement and which was disclosed to Contractor or its Subcontractors by a third party, who to the best of Contractor’s or its Subcontractor’s knowledge and belief, had the legal right to make such disclosure and Contractor or its Subcontractors are not otherwise required to hold such data in confidence; or
 - c. Data which is required to be disclosed by virtue of law, regulation, or court order, to which the Contractor or its Subcontractors are subject.
- 14.20.4 In the event the Contractor or its Subcontractors are required or requested to disclose data to a third party, or any other information to which the Contractor or its Subcontractors became privy as a result of any other agreement with City, the Contractor must first notify City as set forth in this Section of the request or demand for the data. The Contractor or its Subcontractors must give City sufficient facts so that City can be given an opportunity to first give its consent or take such action that City may deem appropriate to protect such data or other information from disclosure.
- 14.20.5 Unless prohibited by law, within 10 Days after completion of services for a third party on real or personal property owned or leased by City, the Contractor must promptly deliver, as set forth in this Section, a copy of all data to City. All data will continue to be subject to the confidentiality agreements of this Agreement.
- 14.20.6 Contractor or its Subcontractors assume all liability for maintaining the confidentiality of the data in its possession and agree to compensate City if any of the provisions of this Section are violated by Contractor, its employees, agents, or Subcontractors. Solely for the purposes of seeking injunctive relief, it is agreed that a breach of this Section will be deemed to cause irreparable harm that justified injunctive relief in court. Contractor agrees that the requirements of this Section will be incorporated into all subcontracts entered into by Contractor. A violation of this Section may result in immediate termination of this

Agreement without notice.

14.21 **SURVIVAL**

All warranties, representations and indemnifications by Contractor must survive the completion or termination of this Agreement.

14.22 **COVENANTS AGAINST CONTINGENT FEES**

Contractor warrants that no person has been employed or retained to solicit or secure this Agreement upon an agreement or understanding for a commission, percentage, brokerage, or contingent fee, and that no member of City Council, or any employee of City has any interest, financially, or otherwise, in the firm. For breach or violation of this warrant, City will have the right to annul the Agreement without liability or at its discretion to deduct from the Agreement Price or consideration, the full amount of such commission, percentage, brokerage, or contingent fee.

14.23 **NO WAIVER**

The failure of either party to enforce any of the provisions of the Agreement Documents or to require performance of the other party of any of the provisions hereof must not be construed to be a waiver of such provisions, nor will it affect the validity of the Agreement Documents or any part thereof, or the right of either party to thereafter enforce each and every provision.

14.24 **NONEXCLUSIVE REMEDIES**

The remedies set forth in this Agreement are cumulative and not exclusive, and failure to exercise any remedy (including, without limitation, any right to terminate) will not preclude any party from exercising any other right in seeking any other remedy available to it at law or in equity.

14.25 **PROJECT COMMUNICATIONS**

14.25.1 All communications concerning the performance of the Work or the Project will be provided to the designated Project Manager and Contractor's Representative set forth in Article 1 of the Agreement. City may change the designated Project Manager and, subject to Section 4.4.20 of these General Conditions, Contractor may change Contractor Representative, by written notice to the other.

14.25.2 Project communications may be exchanged by e-mail, but email communications cannot change the terms of the Agreement or the Scope of Work, or effectuate any change that requires a written Change Order.

14.25.3 When any provisions of the Agreement Documents requires Contractor or the Design Professional to give written notice to City, it will be deemed to have been validly given if delivered in person or if delivered at or sent by registered or certified mail, postage prepaid, to the Parties indicated in Agreement Article 1, incorporated by reference.

14.25.4 When any provisions of the Agreement Documents requires City, Project Manager, or the Design Professional to give written notice to Contractor, it will be deemed to have been validly given if delivered in person to the person designated in the Agreement Documents as Contractor's Resident Superintendent, or if delivered at or sent by registered or certified mail, postage prepaid, to Contractor at the last address in the Agreement Documents or such substitute address which Contractor designates in writing, or to the business address known to the giver of notice.

14.26 **DRUG FREE WORKPLACE PROGRAM**

14.26.1 City has adopted a policy establishing a drug free workplace for itself and as a requirement for Contractors doing business with City, to ensure the safety and health of employees working on City projects.

14.26.2 Contractor must require a drug free workplace for all employees working under the Agreement. Specifically, all employees of Contractor who are working under an agreement with City must be notified, in writing, by Contractor that they are prohibited from the manufacture, distribution, dispensation, possession or unlawful use of a controlled substance in the workplace.

14.27 Failure to require a drug free workplace in accordance with the City's policy may result in termination of the Agreement and possible debarment from bidding on future City projects.

SECTION 15 - PROVISIONS APPLICABLE SOLELY TO GMP AND COST-BASED AGREEMENTS, CHANGE ORDERS, AND JOB ORDERS

15.1 **ADDITIONAL DEFINITIONS**

The definitions set forth in Section 2 apply to GMP and Cost-Based Agreements, Change Orders, and Job Orders, together with the additional definitions set forth below.

Baseline Cost Model –

A breakdown and estimate of the scope of the Project developed by CM@Risk pursuant to Section 17.5 of these General Conditions.

CM@Risk or Construction Manager at Risk –

The person or firm selected by City to provide pre-construction and/or construction services as detailed in a Construction Manager at Risk Agreement with City. In these General Conditions, the term "Contractor" includes CM@Risk under both Pre-Construction and Construction Services Agreements.

CM@Risk Fee or Contractor's Fee –

An agreed to percentage in an accepted GMP that represents the Contractor's fee for performance of the Work.

Agreement Documents –

Where compensation under the Agreement is based upon a GMP accepted by City, the term "Agreement Documents" also includes the accepted GMP Proposal.

Agreement Price –

Where compensation under the Agreement based upon a GMP accepted by City, the term "Agreement Price" refers to the GMP.

Cost-Based Agreement, Change Order, or Job Order –

A Agreement, Change Order, or Job Order where the Agreement Price is based upon the actual cost of performing the Work, subject to the terms of the Agreement Documents, including this Section 15. These would include those generally referred to as "Cost of the Work plus a Fee with a GMP," "Time and Materials," or "Cost Plus a Fee."

Cost of the Work –

The direct costs necessarily incurred by Contractor in the proper, timely, and complete performance on the Work. The Cost of the Work will include only those costs set forth in Section 15.2 of these

General Conditions.

Deliverables –

The work products prepared by Contractor in performing the scope of work described in the Agreement. Some of the major deliverables to be prepared and provided by Contractor during pre-construction may include but are not limited to: the Baseline Cost Model and Schedule that validate City's plan and budget, Construction Management Plan, Detailed Project Schedule, Schedule of Values, alternative system evaluations, procurement strategies and plans, Detailed Cost Estimates, construction market surveys, cash flow projections, GMP Proposals, Subcontractor procurement plan, Subcontractor agreements, Subcontractor bid packages, Supplier agreements, Constructability Review, Cost Control Log, Traffic control and phasing plans and others as indicated in this Agreement or required by the Project Team.

Pre-Construction Services Agreement –

The Agreement entered into between City and the CM@Risk for Pre-Construction Services to be provided by the CM@Risk, including, without limitation, the generation of a GMP Proposal. If the GMP Proposal is accepted by City and a Construction Agreement is entered into between City and CM@Risk, the duties, obligations and warranties of the CM@Risk under the Pre-Construction Services Agreement survive and are incorporated into the resulting Construction Agreement.

Pre-Construction Services –

The services to be provided under the Pre-Construction Services Agreement, including Section 17 of these General Conditions.

Detailed Project Schedule –

The Detailed Project Schedule developed by the CM@Risk for the review and approval of the Project Manager in accordance with Section 17.3 of these General Conditions, if applicable.

General Conditions Costs –

Those costs set forth in Section 4 of Appendix 9 to these General Conditions.

GMP Plans and Specifications –

The plan and specifications upon which the Guaranteed Maximum price Proposal is based.

GMP Proposal –

The proposal of Contractor submitted pursuant to Section 17.7 of these General Conditions for the entire Work and/or portion (phases) of the Work.

Guaranteed Maximum Price or GMP –

The Guaranteed Maximum Price set forth in the Agreement, Change Order, or Job Order if applicable.

15.2 AGREEMENT PRICE

15.2.1 The Agreement Price for all Agreements, Change Orders, and Job Orders based upon payment of the Cost of the Work plus a Fee with a GMP, time and materials, or cost-plus a fee will be the Cost of the Work incurred plus the Fee agreed to in writing by City, limited to the amount of the GMP, if agreed to. Unless otherwise expressly provided in the Agreement, Change Order, or Job Order, all Cost Based pricing will be subject to and limited to GMP.

15.2.2 The Agreement Price may only be changed as set forth in Section 9 above.

15.2.3 Only costs specifically designated as reimbursable costs are eligible for payment by City or may be charged against the Agreement Price. All other costs will not be paid by City and will not be chargeable against the Agreement Price.

15.2.4 Cost-Based Agreements. For Agreements, Change Orders, or Job Orders, reimbursable costs must be determined pursuant to Appendix 9 to these General Conditions, Cost of the Work, and not by MAG Specifications §109.5.

15.3 **ALLOWANCES**

15.3.1 Contractor must include in the Agreement Price all Allowances stated in the Agreement Documents and agreed to in writing by City. Items covered by these Allowances must be supplied for such amounts and by such persons as City may direct, provided Contractor will not be required to employ persons against whom Contractor makes a reasonable objection. Materials, labor, and equipment under an Allowance will be selected by City in accordance with a schedule to be mutually agreed upon by City, Design Professional and Contractor or otherwise in reasonably sufficient time to avoid delay in the Work.

15.3.2 Unless otherwise provided in the Agreement Documents:

15.3.2.1 These Allowances must cover the cost to Contractor, less any applicable trade discount, of the materials, labor, and equipment required by the Allowances, delivered at the Site, and all applicable taxes;

15.3.2.2 Contractor's costs for unloading and handling on the Site, labor, installation costs, overhead, profit and other expenses relating to materials, labor, and equipment required by the Allowance must be included in the Agreement Sum and not in the Allowance; and

15.3.2.3 Whenever the cost is more or less than the Allowance, the Agreement Sum must be adjusted accordingly by Change Order, the amount of which will recognize the difference between actual costs for an Allowance item and the amount of the Allowance item and changes, if any, in handling costs on the Site, labor, installation costs, overhead, profit and other expenses.

15.4 **CONTINGENCY**

An agreed to amount in the GMP that may only be used in accordance with the terms set forth in these General Conditions and with prior written approval by the City.

15.4.1 Construction Contingency. This GMP includes a dollar amount listed as a Construction Contingency which will be readily available for increased costs for subcontractors, material, and equipment subject to prior approval of City, which approval will not be withheld unreasonably. The Construction Contingency may also be used, at the discretion of City, to reimburse CM@Risk for unexpected costs due to (a) scope gaps between trade subcontractors; (b) agreement default by trade subcontractors; (c) unforeseen field conditions, but only as defined in Section 9.5 above; (d) work completed to meet the intent of the design, but which was not indicated on the plans; (e) costs overruns not covered by allowances; (f) costs of corrective work not provided for elsewhere; and (g) implementation of any Recovery Plan. Cost for which CM@Risk desires to be paid from the Construction Contingency must be documented by CM@Risk on a time and materials basis and are subject to verification by City. If agreed to by City, a "Use of Contingency" form will be executed by both parties authorizing the actual cost of the work to be paid and included in the Work Item Direct Costs. The Construction Contingency is not allocated to any particular

item of the Project but may be used for any portion of the work as determined above. Any amount not used in the Construction Contingency will belong to City and will reduce the GMP.

- 15.4.2 **Owner's Contingency.** This GMP also includes a dollar amount listed as an Owner's Contingency which may be used only by the City (owner department) for upgrades and changes in scope or other changes not already included within the intent of the Project Program. City will provide CM@Risk with a Work Change Directive authorizing CM@Risk to perform the additional work and to transfer funds from the Owner's Contingency to the Work Item Direct Costs category to be paid with such direct costs. These additional costs will be in an amount mutually agreed upon by CM@Risk and City or will be documented by CM@Risk on a time and materials basis and are subject to verification by City. Any amount not used in the Owner's Contingency will belong to the City and will reduce the GMP.

15.5 **REDUCTION IN RETENTION**

If the Agreement Price is based upon a GMP, in order to receive payment of one-half of the retention as set forth in Section 8.1.5 above, Contractor must also submit to the Project Manager a complete accounting of the Actual Reimbursable Cost of the Work to date, including all such documentation (including, without limitation, invoices, subcontract, subcontractor change orders, purchase orders, records of payment, etc.) as City may require, to establish whether the payments made to Contractor equal, exceed, or are less than the actual reimbursable Cost of the Work to date. Any excess payments by City, as determined by the Project Manager, will be deducted from the one-half retention payment to be made to Contractor, and any additional excess amounts paid to Contractor will be refunded by Contractor to City. The Project Manager's determinations as to Actual Reimbursable Cost of the Work will be the basis of payment until final Project Closeout and Final Payment under the Agreement.

15.6 **FINAL PAYMENT**

If the Agreement Price is based upon a GMP, as a further condition precedent to Final Payment by City, Contractor must submit to the Project Manager a complete final accounting of the Actual Reimbursable Cost of the Work, including all such documentation (including, without limitation, invoices, subcontracts, subcontractor change orders, purchase orders, records of payment, etc.) as City may require, to establish whether the payments made to Contractor equal, exceed, or are less than the Actual Reimbursable Cost of the Work to date. Any excess payments by City, as determined by the Project Manager, will be deducted from the one-half retention payment to be made to Contractor, and any additional excess amounts paid to Contractor will be refunded by Contractor to City. Disputes relating to the Final Cost of the Work will be subject to City's audit rights under Sections 8.8 above and 15.7 below, and the dispute resolution process under Section 13 above.

15.7 **OPEN BOOK**

On any GMP-based or Cost-Based Agreement, Job Order, or Change Order, City may attend any and all meetings or discussions pertaining to the Project, including bid openings, and must have access to all books, invoices, accounts, memoranda, correspondence, and written communications or records of any kind pertaining to the Project, including without limitation, those stored in electronic format.

15.8 **DIFFERING SITE CONDITIONS AND/OR CHANGE IN LAWS**

A Change Order for increased costs under Section 9.5 or 9.6 above will only be considered

or granted by City to the extent such actual, documented costs are justified.

SECTION 16 - PROVISIONS APPLICABLE SOLELY TO JOB ORDER AGREEMENTS (JOC)

16.1 ADDITIONAL DEFINITIONS

The definitions set forth in Sections 2 and below will apply to all Job Order Agreements and Job Orders. In addition, the definitions set forth in Section 15.1 above will apply to all Cost-Based Job Orders.

Agreement –

Includes the Job Order Master Agreement and Job Order Project Agreements issued and agreed to by City and JOC Contractor.

JOC Contractor's Coefficient –

A numerical factor that represents JOC Contractor total costs (indirect and direct costs, sales tax, profit, etc.) and other adjustments for market conditions.

Job Order Request for Proposal (RFP) –

The Request for Proposals issued by City for each Job Order Project Agreement relating to a specific Project.

Job Order Cost Proposal –

The Proposal submitted by JOC Contractor in response to a Job Order Request for Proposal (RFP) issued by City to develop a Job Order Project Agreement for a specific Project.

Guaranteed Maximum Price (GMP) Job Order –

Job Order under which JOC Contractor is compensated for actual costs incurred.

Job Order Project Agreement (Job Order) –

The agreement for a specific project, as it may be modified by all Change Orders, executed by the Parties, which incorporates the terms and conditions of the Job Order Master Agreement.

16.2 ORDERING AND PROCESSING PROCEDURES FOR JOB ORDERS

16.2.1 The process for developing and issuing a Job Order for a particular Project consists of three (3) procedures: (1) issuance of a RFP by City; (2) JOC Contractor's response to the RFP in the form of JOC Contractor's Job Order Cost Proposal; and (3) Issuance of a Job Order by City, as set for below.

16.2.2 RFP's For Job Orders

16.2.2.1 City will provide to JOC Contractor RFP with a Scope of Work (SOW) describing the Work to be performed, which may include special instructions and conditions, material submittal requirements, and, if applicable, a complete set of sketches, construction drawings and specifications for the Job Order.

16.2.2.2 Some Job Order RFP's will be issued by City without detailed sketches, drawing and specifications and will rely on JOC Contractor to produce them for City review and approval and is considered to be Pre-Construction and incidental design services included in JOC Contractor's overhead for GMP Job Orders. In addition JOC Contractor will not be reimbursed for any Pre-Job Order costs, including proposal preparation, attendance during negotiations, or site visits.

16.2.3 JOC Contractor's Job Order Cost Proposal

16.2.3.1 JOC Contractor must respond within ten (10) calendar days of the RFP date or site visit, whichever is later or as otherwise indicated on a case-by-case basis, by submitting JOC Contractor's Job Order Cost Proposal to the City representative.

16.2.3.2 Unless otherwise required under the terms of the RFP, JOC Contractor's Job Order Cost Proposal must include the following.

- a. JOC Contractor's Job Order Cost Proposal in PDF and electronic format;
- b. A Project Schedule and schedule of values that reflects the costs of each work element on the schedule. The schedule must show all milestones (e.g., permits, submittals, ordering materials, demolition, work phases, closeout and completion date); and
- c. Necessary documentation will be required to indicate that adequate scoping, layout, setup and planning to accomplish the Work has been done. Examples of documentation that might reasonably be expected include sketches, drawings, calculations, catalog cuts and specifications produced to a level of detail and skill that could be expected of experienced, competent Project Managers with five or more periods experience in their respective trade.

16.2.3.3 JOC Contractor must select Subcontractors based on qualifications alone or on a combination of qualifications and price and must not select Subcontractors based on price alone. A qualifications and price selection may be a one-step selection based on a combination of qualifications and price or two-step selection. In a two-step selection, the first step must be based on qualifications alone and the second step may be based on a combination of qualifications and price or on price alone.

16.2.3.4 Upon request, JOC Contractor must provide City with copies of Subcontractor quotes and the basis for selection of each Subcontractor.

16.2.3.5 If City objects to a selected Subcontractor, City will make the objection and the reasons for the objection known to the JOC Contractor. JOC Contractor must then present an acceptable Subcontractor for the applicable discipline. City will not unreasonably object to or withhold approval of a Subcontractor.

16.2.3.6 For self-performed work, the City retains the right to have the JOC Contractor establish JOC Contractor's costs by bidding their costs against at least three (3) other interested trade Contractors. No self-performed work will be allowed to be performed on a lump sum basis.

16.2.4 Issuance of Job Order

16.2.4.1 City Representative will compare the JOC Contractor's Job Order Cost Proposal with the City's estimate, schedules and other requirements, and then, if the City Representative determines it is in the best interest of City, arrange a meeting with JOC Contractor, at which time the JOC Contractor's Job Order Cost Proposal will be discussed and negotiated.

16.2.4.2 If the City Representative determines that it is in the best interest of the City, City will then issue a Job Order to JOC Contractor for execution.

16.2.4.3 Specific Job Orders may vary, but unless agreed to by City in writing otherwise, the content

of Job Orders under the Agreement will generally be as follow, all of which will be signed and/or initialed by JOC Contractor's designated representative:

- a. The description of the Scope of the Work and Project Schedule (attached as Exhibit A to the Job Order);
- b. The address or location of the Work;
- c. The Agreement Price for Work (Construction) included in the Project (attached as Exhibit B to the Job Order);
- d. The name of the JOC Contractor representative for the Project;
- e. The Drawings and Specifications for the Project;
- f. If any shop drawings, project date and/or samples are required for the Job Order, the date for delivery of each required item (included in the Project Schedule, Exhibit A to the Job order); and
- g. Project Specific Provisions, if any, in Exhibit A to the Job Order, including, without limitation, whether any of the following are required: Pre-Construction Conference, weekly progress meetings, field office, storage enclosure, materials and equipment handling facility, submittals, shop drawings, product data, equipment list, samples, project manual, schedule of values, Construction progress schedule, narrative reports, progress report, progress charts, progress photographs, materials status report, Construction diagram, Construction status report, operation and maintenance data, operating maintenance instructions and parts list, and as-build drawings.

16.2.5 Job Order Intent. Each Job Order will be interpreted to include all items reasonably necessary to complete the Project under that Job Order as described in the scope of the Work in that Job Order. All Work must be performed in a professional manner and all materials used must be new and of the highest quality and of the type best adapted to their purpose, unless otherwise specified. The Notice to Proceed date, and the award date established therein, will be deemed an integral part of the Job Order the same as if set forth therein.

16.3 **INCIDENTAL DESIGN SERVICES**

16.3.1 This effort includes all "extensions of design" for systems that are typically specified in a performance oriented manner by consultants and designers. Examples include: fire sprinkler systems, fire alarm and sprinkler systems, DDC controls, control systems, prefabricated metal building and similar situations. These designs are normally provided under submittals as a shop drawing with engineering backup and as appropriate, seals of registered engineers specializing in the particular system.

16.3.2 Incidental design includes all documents, sketches, schematic diagrams, floor plan layouts, equipment schedules and other documents produced by the JOC Contractor to define the work required for projects that the City does not develop formal or abbreviated designs requiring a seal by a registered engineer. Incidental design does not include preparation of designs requiring an architect or engineer seal.

16.3.3 JOC Contractor represents, covenants, and agrees, and contractually assumes the obligation to furnish, all of the required Design Services through properly licensed and

experienced Design Professionals in complete accordance with all of the duties imposed on a Design Professional under the Agreement Documents, Laws, Regulations, or Legal Requirements, and the common law.

- 16.3.4 All Design Documents (and all other Project-related documents, models, computer drawings and other electronic expression, photographs and other expressions CADD, and BIM files and images included) that JOC Contractor and/or JOC Contractor's Design Professional(s) prepare in connection with a Job Order and the copyrights therein (collectively, the "Instruments of Service") will be the property of City. JOC Contractor covenants and agrees to execute any additional document reasonably requested by City to confirm such assignment without any additional compensation.

16.4 **CONSTRUCTION SERVICES**

- 16.4.1 The following subsections of this Section 16.4 set forth requirements beyond those set forth in Section 4 above which apply to Construction Services performed under a Job Order.

- 16.4.2 JOC Contractor must perform the Work using only those firms, team members and individuals designated by JOC Contractor consistent with each Job Order or otherwise approved by City pursuant to the General Conditions. No other entities or individuals may be used without the prior written approval of the Project Manager.

16.4.3 Construction Phasing

- 16.4.3.1 City use of the facilities is anticipated while the Work is being performed. The Work must be planned and accomplished so that there will be a minimum of interference and inconvenience to occupants in the building and agencies in the vicinity and to other craftsmen who may have to do work in the affected facilities. Any blockage of building exits or driveways must be coordinated in advance.

- 16.4.3.2 If applicable, furniture, portable office equipment and wall appurtenances not rigidly fastened to the walls must be moved by JOC Contractor, protected from damage and replaced to the original position upon completion of the work. If the work required by the Job Order will not allow furniture and portable office equipment to be replaced to its original position, new locations will be designated by City. Incidental costs associated with moving one-piece furnishings up to approximately 150 pounds to perform such tasks as painting, carpet or tile replacement, etc., are considered a general cost of building renovation and must be included in the JOC Contractor's Coefficient. Costs for large scale or wholesale removal and replacement of large quantities of desks or modular workstations, copiers, multiple full file cabinets, etc. to another location or storage outside the work space, or disassembly and reassembly of modular furniture is not considered part of the JOC Contractor's Coefficient and will be priced separately.

- 16.4.3.3 The work must, so far as practicable, be done in definite sections or divisions and confined to limited areas which must be completed before work in other sections or divisions are begun.

- 16.4.4 Work Site Conflicts. In the event of a conflict between JOC Contractor and others in an occupied facility or where other Contractors are performing work on the same facility under other Agreements, City will decide to dispute and that decision will be final.

- 16.4.5 Ownership of Work Product. Work Product prepared or otherwise created in connection

with the performance of this Agreement, including the Work, are to be and remain the property of City. For purposes of this provision, "Work Product" will include all designs, drawings, plans, specifications, ideas, renderings and other information or matter, in whatever form created (e.g., electronic or printed) and in all media now known or hereinafter created. All Work Product will be considered Work Made for Hire as defined in the United States Copyright Act 17 U.S.C. §101 (Copyright Act). If for any reason any such Work is found not to be a work for hire, JOC Contractor hereby transfers and assigns ownership of the copyright in such Work to City. The rights in this Section are exclusive to City in perpetuity.

16.5 **OPTIONAL LIQUIDATED DAMAGES**

16.5.1 Specific Job Orders. City will have the right to assess liquidated damages in relation to any specific JOC Project Agreement as set forth below.

16.5.2 Substantial Completion Liquidated Damages. JOC Contractor acknowledges and agrees that if JOC Contractor fails to obtain Substantial Completion of the Work within the Agreement Time, City will sustain extensive damages and serious loss as a result of such failure. The exact amount of such damages will be extremely difficult to ascertain. Therefore, City and JOC Contractor agree that if JOC Contractor fails to achieve Substantial Completion of the Work within the Agreement Time, City will be entitled to retain or recover from JOC Contractor, as liquidated damages and not as a penalty, the sum per calendar day as indicated in MAG § 108.9.

16.5.3 Final Acceptance Liquidated Damages. For the same reasons set forth in Section 16.5.2 above, City and JOC Contractor further agree that if JOC Contractor fails to achieve Final Acceptance of the Work within the Agreement Time, City will be entitled to retain or recover from JOC Contractor, as liquidated damages and not as a penalty, the sum per calendar day as indicated in MAG § 108.9 commencing from the actual date of Substantial Completion or Final Acceptance as required under any specific JOC Project Agreement.

16.5.4 MAG Liquidated Damages. Liquidated damages provisions in MAG § 108.9 may apply to any specific JOC Project Agreement.

16.5.5 City may deduct liquidated damages assessed pursuant to this Section 16.5 from any unpaid amounts then or thereafter due JOC Contractor under the Agreement or any specific JOC Project Agreement between JOC Contractor and City. Any liquidated damages not so deducted from any unpaid amounts due JOC Contractor must be payable to City at the demand of City, together with interest from the date of the demand at the highest lawful rate of interest payable to JOC Contractor.

16.6 **PERFORMANCE MEASUREMENT**

16.6.1 Performance Assessment. After the Final Acceptance of Work under each Job Order, City will complete a written evaluation of the performance of JOC Contractor on the Job Order.

16.6.2 Consideration in Assignment of Work. JOC Contractor's record of cost, schedule and quality performance and comparative assessments will be significant considerations in City's determination whether to award future Job Orders. JOC Contractor agrees that any determination by City not to award future Job Orders or Option periods based on performance will be at the sole discretion of City.

**SECTION 17 - PROVISIONS APPLICABLE SOLELY TO PRE-CONSTRUCTION SERVICES FOR
CONSTRUCTION MANAGER AT RISK**

17.1 ADDITIONAL DEFINITIONS

The definitions set forth in Section 2 and 15.1 above will apply to all Pre-Construction Services Agreements.

17.2 GENERAL

17.2.1 CM@Risk must perform the Services required by, and in accordance with the Agreement Documents and as outlined in Exhibit A of the Agreement to the satisfaction of the Project Manager, exercising the degree of care, skill, diligence and judgment a professional construction manager experienced in the performance of such services for construction and/or facilities of similar scope, function, size, quality, complexity and detail to the Project in urban areas throughout the United States, would exercise at such time, under similar conditions. CM@Risk must, at all times, perform the required services consistent with sound and generally accepted engineering principles and construction management and construction contracting practices.

17.2.2 As a participating member of the Project Team, CM@Risk must provide to City and Design Professional a written evaluation of City's Project Program and budget, each in terms of the other, with recommendations as to the appropriateness of each. CM@Risk must prepare a Baseline Cost Model that validates City's budget. The Baseline Cost Model must include all assumptions and basis of estimates in enough detail so that the Project Team can compare future detail estimates to the Baseline Cost model for variances. City and Design Professional will provide all the reasonably required data that is available in order to reach agreement between the team members that the Baseline Cost Model is an accurate projection of the costs of the Project.

17.2.3 CM@Risk must attend Project Team meetings, which may include, but are not limited to, bi- weekly Project management meetings, Project workshops, special Project meetings, construction document rolling reviews, public meetings and partnering sessions. CM@Risk attendance at design or other meetings in which CM@Risk is provided the opportunity but does not actively participate and/or is not properly prepared is not acceptable. Repeated instances of non-participation and/or lack of preparedness will be grounds for termination of CM@Risk Agreement for default.

17.2.4 CM@Risk must provide Pre-Construction Services, described herein, in a timely manner and consistent with the intent of the most current Drawings and Specifications. CM@Risk must promptly notify City in writing whenever CM@Risk determines any Drawings or Specifications are inappropriate for the Project and/or cause changes in the scope of Work that deviates more than the allowed contingencies within the Baseline Cost Model or requires an adjustment in the Baseline Cost Model, Detailed Cost Estimate, Detailed Project Schedule, GMP Proposals and/or in the Agreement Time for the Work, to the extent such as established.

17.2.5 CM@Risk when requested by City, must attend, make presentations and participate as may be appropriate in public agency and or community meetings, relevant to the Project. CM@Risk must provide drawings, schedule diagrams, budget charges and other materials describing the Project when their use is required or appropriate in any such public agency meetings.

- 17.2.6 **Ownership of Work Product.** All Work Product prepared or otherwise created in connection with the performance of this Agreement, including the Work, are to be and remain the property of City. For purposes of this provision, "Work Product" will include all designs, drawings, plans, specifications, ideas, renderings and other information or material, in whatever form created (e.g., electronic or printed) and in all media now know or hereinafter created. All Work Product will be considered Work Made for Hire as defined in the United States Copyright Act 17 U.S.C. §101 (Copyright Act). If for any reason any such Work is found not to be a work for hire, Contractor hereby transfers and assigns ownership of the copyright in such Work to City. The rights in this Section are exclusive to City in perpetuity.
- 17.2.7 CM@Risk represents to City in completing Pre-Construction Services and providing the reports and analysis required thereunder, that Work can be properly and timely constructed within the GMP Proposal, if accepted. CM@Risk does not assume any design responsibilities unless specifically called for in the scope of work, but CM@Risk will be responsible for their errors, omissions or inconsistencies included in the Work.
- 17.3 **DETAILED PROJECT SCHEDULE**
- 17.3.1 The fundamental purpose of the Detailed Project Schedule is to identify, coordinate and record the tasks and activities to be performed by all of the Project Team members and then for the Project Team to utilize that Deliverable as a basis for managing and monitoring all member's compliance with the schedule requirements of the Project. Each Project Team member is responsible for its compliance with the Detailed Project Schedule requirements. CM@Risk must, however, develop and maintain the Detailed Project Schedule on behalf of and to be used by the Project Team based on input from the other Project Team members. The Baseline Project Schedule must be developed as part of the Baseline Cost Model. The Detailed Project Schedule must use the Critical Path method ("CPM") technique, unless required otherwise, in writing by City. CM@Risk must use scheduling software acceptable to City to develop the Detailed Project Schedule. The Detailed Project Schedule must be presented in graphical and tabular reports as agreed upon by the Project Team. If Project phasing as described below is required, the Detailed Project Schedule must indicate milestone dates for the phases once determined. As part of construction phase, City may require CM@Risk to prepare a "resource loaded" schedule for all work, including work performed by Subcontractors, detailing each of the project tasks and the required/anticipated number of personnel per day for each task. CM@Risk must also indicate on the schedule its ability to meet said required/anticipated personnel requirements.
- 17.3.2 CM@Risk must include and integrate in the Detailed Project Schedule the services and activities required of City, Design Professional and CM@Risk including all construction phase activities based on the input received from City and the Design Professional. The Detailed Project Schedule must define activities as determined by City to the extent required to show: (a) the coordination between preliminary design and various pre-construction documents, (b) any separate long-lead procurements, (c) any permitting issues, (d) any land, right-of-way, or easement acquisition, (e) bid packaging strategy and awards to Subcontractors and Suppliers, (f) major stages of construction, (g) start-up and commissioning, and (h) occupancy of the completed Work by City. The Detailed Project Schedule must include by example and not limitation, proposed activity sequences and durations for design, procurement, construction and testing activities, milestone dates for actions and decisions by the Project Team, preparation and processing of shop drawings

and samples, delivery of materials or equipment requiring long-lead time procurement (if any), milestone dates for various construction phases, Total Float for all activities to the extent authorized by City, relationships between the activities, City's occupancy requirements showing portions of the Project having occupancy priority, and proposed dates for Final Acceptance.

- 17.3.3 A Baseline Project Schedule must be initiated with the project Baseline Cost Model and agreed to by the project team at the same time. CM@Risk must update and maintain a detailed Project Schedule throughout pre-construction such that it will not require major changes at the start of the construction phase to incorporate CM@Risk's plan for the performance of the construction phase Work. CM@Risk must provide updates and/or revisions to the Detailed Project Schedule for use by the Project Team, whenever required, but no less often than at the Project Team meetings. CM@Risk must include with such submittals a narrative describing its analysis of the progress achieved to-date vs. the Baseline Project Schedule, including any concerns regarding delays or potential delays, and any recommendations regarding mitigating actions.
- 17.3.4 If phased construction is deemed appropriate at the time of developing the Baseline Cost Model or during the development of the Detailed Project Schedule, and City approves, CM@Risk must review the design and make recommendations regarding the phased issuance of Construction Documents to facilitate phased construction of the Work, with the objective of reducing the Project Schedule and/or Cost of the Work. CM@Risk must take into consideration such factors as natural and practical lines of work severability, sequencing effectiveness, access and availability constraints, total time for completion, construction market conditions, labor and materials availability, and any other factors pertinent to saving time and cost.
- 17.3.5 Long Lead Time Items. As part of developing the Detailed Project Schedule, CM@Risk must identify all long lead time materials, fabrications, equipment, or other items which may impact the Project Schedule and may require early action on the part of the Project Team. Dates for selecting and ordering long lead time items will be included and highlighted in the Detailed Project Schedule
- 17.3.6 Equipment Plan. Contractor must develop an Equipment Plan that addresses all rental and owned equipment, regardless of whether such equipment will be provided by CM@Risk or subcontractor(s), that will be necessary to construct the Project and the cost of which will be included as a Cost of the Work in the GMP Proposal. The Equipment Plan will seek to minimize the cost of the equipment to City and maximize the efficient and coordinated use of the equipment for completion of the Project. The Equipment Plan will not only include the costs and allowable lease rates for the equipment, but will also include an equipment schedule that will be incorporated into the Detailed Project Schedule and the Schedule of Values submitted with the GMP Proposal.
- 17.4 **DESIGN DOCUMENT REVIEWS**
- 17.4.1 CM@Risk must evaluate periodically the availability of labor, materials/equipment, cost-sensitive aspects of the design; and other factors that may create an unacceptable variance to the Baseline Cost Model and/or Baseline Project Schedule.
- 17.4.2 CM@Risk must recommend, in conjunction with the Project Team, those additional surface and subsurface investigations that, in its professional opinion, are required to provide the necessary information for CM@Risk to construct the Project. These additional

- investigations, if agreed to be necessary by the Project Manager and the Design Professional, will be acquired by City and copies of the reports will be provided to CM@Risk.
- 17.4.3 CM@Risk must meet with the Project Team as required to review designs during their development. CM@Risk must familiarize itself with the evolving documents through pre-construction. CM@Risk must proactively advise the Project Team and make recommendations on factors related to construction costs, and concerns pertaining to the feasibility and practicality of any proposed means and methods, selected materials, equipment and building systems, and, labor and material availability. CM@Risk must furthermore advise the Project Team on proposed site improvements, excavation and foundation considerations, as well as, concerns that exist with respect to coordination of the Drawings and Specifications. CM@Risk must use established value analysis principles in recommending cost effective alternatives.
- 17.4.4 CM@Risk must routinely conduct constructability and bid-ability reviews of the Drawings and Specifications as necessary to satisfy the needs of the Project Team. The reviews must attempt to identify all discrepancies and inconsistencies in the Construction Documents especially those related to clarity, consistency, completeness and coordination of Work of Subcontractors and Suppliers.
- 17.4.4.1 CM@Risk must evaluate whether: (a) the Drawings and Specifications are configured to enable efficient construction; (b) design elements are standardized; (c) construction efficiency is properly considered in the Drawings and Specifications; (d) module/preassembly design is prepared to facilitate fabrication, transport and installation; (e) sequences of Work required by or inferable from the Drawings and Specifications are practicable; (f) the design has taken into consideration efficiency issues concerning access and entrance to the site, laydown and storage of materials, staging of site facilities, construction parking, and other similar pertinent issues; and (g) the design maintains continued operation of the existing City systems and maintains traffic on adjacent roadways. CM@Risk must also review the Drawings and Specifications to ensure that what is depicted therein can be constructed as designed and must promptly inform the Project Team of any issues.
- 17.4.4.2 CM@Risk must check cross-reference and complementary Drawings and sections within the Specifications and in general evaluate whether: (a) the Drawings and Specifications are sufficiently clear and detailed to minimize ambiguity and to reduce scope interpretation discrepancies; (b) named materials and equipment are commercially available and are performing well, or otherwise, in similar installations; (c) Specifications include alternatives in the event a requirement cannot be met in the field; and (d) in its professional opinion, the Project is likely to be subject to Differing Site Conditions.
- 17.4.4.3 The results of the reviews must be provided to Project Team in formal, written reports clearly identifying all reviewed documents and the discovered discrepancies and inconsistencies in the Drawings and Specifications with notations and recommendations made on the Drawings, Specifications and other documents. CM@Risk must meet with Project Team to discuss any findings and review reports.
- 17.4.4.4 CM@Risk's reviews must be from a Contractor's perspective, and though it will serve to eliminate/reduce the number of RFIs and changes during the construction phase, responsibility for the Drawings and Specifications will remain with the Design Professional and not CM@Risk.

- 17.4.5 It is CM@Risk's responsibility to assist the Design Professional in ascertaining that, in CM@Risk's professional opinion, the Construction Documents are in accordance with applicable Laws, Regulations, or Legal Requirements, building codes, sound engineering principle's rules and regulations. If CM@Risk recognizes that portions of the Construction Documents are at variance with applicable laws, statutes, ordinances, building codes, sound engineering principle's rules and regulations, it must promptly notify the Project Team in writing, describing the apparent variance of deficiency. However, the Design Professional is ultimately responsible for the compliance of the Drawings and Specifications with those laws, statutes, ordinances, building codes, rules and regulations.
- 17.4.6 The Project Team will routinely identify and evaluate using value analysis principles and alternate systems, approaches, design changes that have the potential to reduce Project costs while still delivering a high quality and fully functional Project consistent with the Project Program. If the Project Team agrees, CM@Risk in cooperation with the Design Professional, will perform a cost/benefit analysis of the alternatives and submit such in writing to the Project Team. City, through the Project Manager, will direct which alternatives will be incorporated into the Project. The Design Professional will have full design responsibility for the review and incorporation of CM@Risk suggested alternatives into the Drawings and Specifications. CM@Risk must analyze the costs and schedule impacts of the alternatives against the Baseline Cost Model and Schedule and provide a recommendation for the Project Team's consideration and City's approval prior to the establishment of the GMP.
- 17.5 **BASELINE COSTS MODEL, DETAILED COST ESTIMATES, AND SCHEDULE OF VALUES**
- 17.5.1 At the conclusion of the Master Planning and Programming, if required, CM@Risk will review all available information regarding the design and scope of the Project using CM@Risk's experience in performing similar work, knowledge of similar projects and current and projected construction costs and, based upon that review, must develop a Baseline Cost Model for review by the Project Team and approval by City. Once approved by City, the Baseline Cost Model will be continually referenced as detailed estimates are created as the design progresses throughout Pre-Construction until the final GMP for the entire Project is established. A final GMP for the entire Project must be established and approved by City prior to the start of construction. It is the responsibility of CM@Risk to ensure City has sufficient information to evaluate and approve a final GMP prior to the time necessary to start construction so construction can be completed within the Agreement Time. The Project Detailed Cost Estimate will be the best representation from CM@Risk of what the complete functional Project's construction costs will be as indicated by the most current available documents and will be constantly checked against the Baseline Cost Model. CM@Risk must communicate to the Project Team and assumptions made in preparing the Baseline Cost Model. The Baseline Cost Model must support CM@Risk's Detailed Cost Estimates and may be broken down initially as dictated by the available information, as required by City.
- 17.5.2 After receipt of the Design Professional's most current documents from certain specified pre- construction milestones, CM@Risk must provide a draft Detailed Cost Estimate including a detailed written report detailing any variances to the Baseline Cost Model and Baseline Project Schedule. The Design Professional and CM@Risk will reconcile any disagreements on the estimate to arrive at an agreed upon Detailed Cost Estimate for the construction costs based on the scope of the Project through that specified pre-construction milestone. Pre-Construction milestones applicable to this paragraph are:

Master Planning and Programming, Schematic Design, 50% Design Development, 100% Design Development, and 50% Construction Drawings, If no consensus is reached, City will make the final determination. If the Project Team requires additional updates of the Detailed Cost Estimate beyond that specified in this paragraph, CM@Risk must provide the requested information in a timely manner.

- 17.5.3 If at any point the Detailed Cost Estimate submitted to City exceeds the previously accepted Baseline Cost Model or previously approved Detailed Cost Estimate agreed to as set forth in Section 17.5.2 above, CM@Risk must make appropriate recommendations to project Team on means/methods, materials, and or other design elements that it believes will reduce the estimated construction costs, such that it is equal to or less than the established Project Team's Baseline Cost Model.
- 17.5.4 Unless other levels of completion are agreed to in writing in the Construction Documents, at 50% Construction Drawings and included with the associated report, CM@Risk must also submit to the Project Team for review and approval a Schedule of Values that complies with the following requirements. The Schedule of Values must be based on City standard bid schedule and highlight significant variances from any previously submitted Schedule of Values. The Schedule of Values must be directly related to the breakdowns reflected in the Detailed Project Schedule and CM@Risk's Detailed Cost Estimate. In addition, the Schedule of Values must: (a) detail unit prices and quantity take-offs, (b) detail all other contingencies and unit price Work shown and specified in the detailed design documents.
- 17.5.5 CM@Risk is to track, estimate/price and address the Project Team's overall project cost issues that arise outside of the Baseline Cost Model and the latest approved Detailed Cost Estimate such as: City generated changes, Project Team proposed changes, alternate system analysis, constructability items and value engineering analysis. The system used to implement this process will be referred to as the Design Evolution Log. This is to be addressed between the Baseline Cost Model and the Master Planning and Programming Detailed Cost Estimate, and then (unless other levels of completion are agreed to in writing in the Construction Documents) between the Detailed Cost Estimates for each of the pre-construction milestones thereafter, Schematic Design, 50% Design Development, 100% Design Development, and 50% Construction Documents, and the bid packages for all Phases.
- 17.5.6 Upon request by City, CM@Risk must submit to City a cash flow projection for the Project based on the current updated/revised Detailed Project Schedule and the anticipated level of payments for CM@Risk during the design and construction phases. In addition, if requested by City and based on information provided by City, CM@Risk must prepare a cash flow projection for the entire Project based on historical records for similar types of projects to assist City in the financing process.
- 17.5.7 Construction Water. CM@Risk must estimate the quantity of water to be used and include the cost thereof in each Detailed Cost Estimate and GMP Proposal provided by City.

17.6 **SUBCONTRACTOR AND MAJOR SUPPLIER SELECTIONS**

- 17.6.1 There are two ways to select Subcontractors and major Suppliers prior to submission of a GMP Proposal: (1) qualifications-based selection; or (2) a combination of qualifications and price. Except as noted below, the selection of Subcontractors/Suppliers is the sole responsibility of CM@Risk. In any case, CM@Risk is solely responsible for the performance of the selected Subcontractors/Suppliers, and for compliance with the requirements of

- Title 34 of the Arizona Revised Statutes in the selection of a Subcontractors/Suppliers, to the extent applicable. CM@Risk must comply with its Subcontractor Selection Plan submitted with its Statement of Qualifications.
- 17.6.2 City may approve the selection of a Subcontractor(s) or Suppliers(s) based only on their qualifications when CM@Risk can demonstrate it is in the best interest of the Project. All Work that is performed, after such a qualifications-based selection, for a price that is negotiated by CM@Risk will be billed in accordance with the GMP for actual costs and may be subject to audit by City.
- 17.6.2.1 Qualifications based selection of a Subcontractor(s)/Supplier(s) should only occur prior to the submittal of the GMP Proposal.
- 17.6.2.2 If a Subcontractor/Supplier selection plan was submitted and agreed to by City, CM@Risk must apply the plan in the evaluation of the qualifications of a Subcontractor(s) or Supplier(s) and provide City with its review and recommendations.
- 17.6.2.3 CM@Risk must receive written City approval for each selected Subcontractor(s) and Supplier(s).
- 17.6.2.4 CM@Risk must negotiate costs for services/supplies from each Subcontractor/Supplier selected under this method.
- 17.6.3 All Work must be competitively bid unless a Subcontractor or Supplier was selected pursuant to Section 17.6.2 above.
- 17.6.3.1 CM@Risk must develop Subcontractor and Supplier interest, submit the names of a minimum of three qualified Subcontractors or Suppliers for each trade in the Project for approval by City and solicit bids for the various Work categories. If there are not three qualified Subcontractors/Suppliers available for a specific trade or there are extenuating circumstances warranting such, CM@Risk may request approval by City to submit less than three names. Without prior written notice to City, no change in the recommended Subcontractors/Supplies will be allowed.
- 17.6.3.2 If City objects to any nominated Subcontractor/Supplier or to any self-performed Work for good reason, CM@Risk must nominate a substitute Subcontractor/Supplier that is acceptable to City.
- 17.6.3.3 CM@Risk must distribute Drawings and Specifications, and when appropriate, conduct a Pre- Bid Conference with prospective Subcontractors and Suppliers.
- 17.6.3.4 If CM@Risk desires to self-perform certain portions of the Work, it must request to be one of the approved Subcontractor bidders for those specific bid packages. CM@Risk's bid will be evaluated in accordance with the process identified below. If events warrant and City concurs that it is necessary in order to ensure compliance with the Project Schedule and/or the most recent Detailed Cost Estimate, CM@Risk may be authorized to self-perform Work without bidding or rebidding the Work. When CM@Risk self-performs work without bidding, only the actual costs associated with performing the Work in accordance with the approved GMP will be billed and may be subject to audit by City.
- 17.6.3.5 CM@Risk must receive, open, record and evaluate the bids; provided, however, that if CM@Risk or one of its affiliates is bidding to self-perform the Work that is the subject of the bid, then the bids must be received, opened, recorded and evaluated by Project Manager

instead of CM@Risk. Bids for each category of Work must be opened and recorded at a pre-determined time. The apparent low bidders must be interviewed to determine the responsiveness of their proposals. In evaluating the responsiveness of bid proposals CM@Risk, in addition to bid price, may consider the following factors: past performance on similar projects, qualifications and experience of personnel assigned, quality management plan, approach or understanding of the Work to be performed, and performance schedule to complete the Work. The final evaluation of Subcontractor/Supplier bids must be done with Project Manager in attendance to observe and witness the process. CM@Risk must resolve any Subcontractor/Supplier bid withdrawal, protest or disqualification in connection with the award at no increase in the Cost of Work.

17.6.4 CM@Risk will be required to prepare two different reports on the subcontracting process.

17.6.4.1 Within fifteen days after each major Subcontractor/Supplier bid opening process; CM@Risk must prepare a report for City's review and approval identifying the recommended Subcontractors/Supplier for each category of Work. The report must detail: (a) the name of the recommended Subcontractor/Supplier and the amount of the Subcontractor/Supplier bid for each sub-agreement; (b) the sum of all recommended Subcontractor/Supplier bids received; (c) and trade work and its cost that CM@Risk intends to self-perform, if any.

17.6.4.2 Upon completion of the Subcontractor/Supplier bidding process, CM@Risk must submit a summary report to City of the entire Subcontractor/Supplier selection process. The report must indicate, by bid process, all Subcontractors/Suppliers contacted to determine interest, the Subcontractors/Suppliers solicited, the bids received and costs negotiated, and the recommended Subcontractors/Suppliers for each category of Work.

17.6.5 The approved Subcontractors/Suppliers will provide a Schedule of Values with their bid proposals, which will be used to create the overall Project Schedule of Values.

17.6.6 If after receipt of sub-bids or after award to Subcontractors and Suppliers, City objects to any nominated Subcontractor/Supplier or to any self-performed Work without any reasonable basis, CM@Risk must nominate a substitute Subcontractor or Supplier, preferably if such option is still available, from those who submitted Subcontractor bids for the Work affected. Once such substitute Subcontractors and Suppliers are consented to by City, CM@Risk's proposed GMP for the Work or portion thereof must be correspondingly adjusted to reflect any higher or lower costs from any such substitution.

17.7 **GMP PROPOSAL**

17.7.1 When a GMP Proposal is submitted for a phase of the Work, the GMP will have a Detailed Cost Estimate of the Costs of the Work (as set forth in Section 15.2) in each phase of the Work that is being proposed plus the current estimate for all other Work. City will not approve the GMP for the phase of work without a total estimate for the complete Project. City may request a GMP Proposal for all or any portion of the Project and at any time during pre-construction. Any GMP Proposals submitted by CM@Risk must be based on and consistent with Baseline Cost Model and the current update/revised Detailed Cost Estimate at the time of the request and include any clarifications or assumptions upon which the GMP Proposal(s) are based.

17.7.2 A GMP Proposal for the entire Project will be the sum of the Cost of the Work, CM@Risk Fee, and General Conditions Cost. CM@Risk guarantees to complete the Project at or less than

the final GMP Proposal amount plus approved Change Orders. CM@Risk will be responsible for any costs for expenses that would cause the Cost of the Work actually incurred, including the Construction Fee and General Conditions Costs, to exceed the GMP.

17.7.3 CM@Risk must prepare its GMP Proposal in accordance with City's request for GMP Proposal requirements based on the most current completed Drawings and Specifications at that time, which unless otherwise directed by City in writing, will be at 100% Construction Drawings. CM@Risk must mark the face of each document of each set upon which its GMP Proposal is based. These documents must be identified as the GMP Plans and Specifications. CM@Risk must send one set of those documents to the Project Manager, keep one set and return the third set to the Design Professional.

17.7.4 An updated/revised Detailed Project Schedule, Equipment Plan, and Schedule of Values must be included in any GMP Proposal(s), all of which must reflect the GMP Plans and Specifications the Detailed Project Schedule must be shown in relationship to the Project Schedule and identify any variance to the Baseline Project Schedule. Any such Detailed Project Schedule updates/revisions must continue to comply with the requirements of Section 17.3.1 through 17.3.5.

17.7.5 **GMP Proposals(s) Review and Approval**

17.7.5.1 CM@Risk must meet with the Project Team to review the GMP Proposal(s) and the written statement of its basis. In the event the Project Team discovers inconsistencies or inaccuracies in the information presented, CM@Risk must make adjustments as necessary to the GMP Proposal.

17.7.5.2 If during the review and negotiation of GMP Proposals design changes are required, City may authorize and cause the Design Professional to revise the GMP Plans and Specifications to the extent necessary to reflect the agreed-upon assumptions and clarifications contained in the final approved GMP Proposal. Such revised GMP Plans and Specification will be furnished to CM@Risk. CM@Risk must promptly notify the Project Team in writing if any such revised GMP Plans and Specifications are inconsistent with the agreed upon assumptions and clarifications.

17.7.6 All portions of or items comprising the GMP Proposal are subject to audit by City, as deemed appropriate by City, including, without limitation, any based upon unit prices or Work to be self-performed by CM@Risk, or its affiliates.

17.8 **PAYMENT PROCEDURE FOR PRE-CONSTRUCTION SERVICES**

17.8.1 Requests for monthly payments by CM@Risk for Pre-Construction Services must be submitted monthly and must be accompanied by a progress report, detailed invoices and receipts, if applicable. Any requests for payment must include, as a minimum, a narrative description of the tasks accomplished during the billing period, a listing of any Deliverables submitted, and copies of any Subconsultants' requests for payment, plus similar narrative and listings of Deliverables associated with their Work. Payment for services negotiated as a lump sum will be made in accordance with the percentage of work completed during the preceding month.

17.8.2 In no event will City pay more than seventy-five (75%) of the Agreement Price until acceptance of ALL Pre-Construction Services and award of the final approved Construction Services Agreement for the entire Project by City Council. If CM@Risk does not prepare a

GMP Proposal that is acceptable to City, or the GMP Proposal exceeds the City's Construction Budget, then CM@Risk understands and acknowledges that it will forfeit any right to receive the 25% of the Agreement Price being retained by City.

17.8.3 CM@Risk agrees that no charges or claims for costs or damages of any type will be made by it for any delays or hindrances beyond the reasonable control of City during the progress of any portion of Pre-Construction Services specified in this Agreement. Such delays or hindrances, if any, will be solely compensated for by an extension of time for such reasonable period and may be mutually agreed between the parties. It is understood and agreed, however, that permitting CM@Risk to proceed to complete any such Services, in whole or in part after the date to which the time of completion may have been extended, will in no way act as a waiver on the part of City of any of their respective legal rights herein.

17.8.4 No compensation to CM@Risk will be allowed contrary to Article I, Chapter I, Title 34 of the Arizona Revised Statutes.

17.8.5 If any service(s) executed by CM@Risk is abandoned or suspended in whole or in part, for a period of more than 180 days through no fault of CM@Risk, CM@Risk is to be paid for the services performed prior to the abandonment or suspension.

17.9 **SURVIVAL OF THE DESIGN SERVICES AGREEMENT, DUTIES, OBLIGATIONS AND WARRANTIES**

If the GMP Proposal is accepted by City and a Construction Agreement is entered into between City and CM@Risk, the duties, obligations and warranties of CM@Risk under the Pre- Construction Services Agreement survive and are incorporated into the resulting Construction Agreement.

General Conditions Appendices

SECTION 15 – APPENDICES

The following Appendices attached hereto are referenced in the General Conditions and are incorporated herein.

- Appendix 1 – Policy Statement for Calculating Delays and Damages
- Appendix 2 – Cost Reduction Incentive Proposals for Design Bid Build Agreements
- Appendix 3 – Contractor's Affidavit Regarding Settlement of Claims
- Appendix 4 – Forms of Performance Bond
- Appendix 5 – Forms of Payment Bond
- Appendix 6 – Dispute Resolution
- Appendix 7 – Certificate of Completion
- Appendix 8 – Construction Sign Detail
- Appendix 9 – Cost of the Work (Applicable solely to Construction Manager at Risk and Job Order Contracting)
- Appendix 10 – Landscape Establishment Period

CALCULATING DELAYS AND DAMAGES

The purpose of this policy statement is to establish guidelines and procedures for negotiation between the Contractor and City of Chandler relating to compensation for delays pursuant to Arizona Revised Statutes (A.R.S.) 34-221(F). This policy statement contains notice requirements in addition to those set forth in the Agreement Documents, and will be the Agreement Provision contemplated by that statute.

NOTE: As used herein, the term "Engineer" will refer to the City of Chandler City Engineer or his/her designated representative. Nothing in this Policy Statement will be construed to void any provision in the Agreement which requires timely notice of delays or provides for arbitration or any other procedure for settlement or provides for liquidated damages.

I. TYPES OF DELAYS:

For the purposes of this document, there are essentially four types of delays encountered by City of Chandler Construction Contractors; excusable/compensable, excusable/non-compensable, non-excusable, and concurrent. Only delays that extend Agreement Completion Time set forth in the Agreement Document will be considered for issues relating to Agreement extensions or additional compensation. All other delays are considered to be activity delays and do not entitle the Contractor to either time extensions or additional compensation. Agreement Completion Time will be defined as the date set forth in Maricopa Association of Governments (MAG) Uniform Standard Specification Section 101 and as may be modified by the Agreement Documents.

A. Excusable/Compensable:

These are delays caused solely by the City's actions or inactions, are unreasonable under the circumstances, and which were not within the contemplation of the parties to the Agreement at or prior to the time of execution of the Agreement. Since the Contractor presumably has no control over the events causing the delay, he may be entitled to both Agreement time extensions and additional compensation for delay damages. Further, he/she may be entitled to additional compensation from the impact of that delay on other work. Examples of excusable/compensable (E/C) delays include: failure to properly locate an underground City-owned utility within 2 feet of the actual location; failure to relocate City-owned utilities far enough in advance of construction in an area where the Contractor is scheduled to work that it delays start or completion of the Contractor's regularly scheduled work; failure to provide City-furnished equipment or materials in a timely manner if required by the Agreement; failure to acquire necessary Right-of-Way or Public Utility Easements prior to the Contractor beginning Work in the area; failure to timely return Shop Drawings or other Agreement Submittals in accordance with the Agreement; unreasonable delay by the City in making decisions which affect critical activities; surveying errors when the City is contractually responsible for providing Project Surveying. This list is not meant to be all inclusive, but is intended merely as examples of the type of City action or inaction which can result in a Contractor's claim for additional time and

compensation.

B. Excusable/Non-compensable:

These are delays over which neither the City nor the Contractor had control. Since both parties to the Agreement have been potentially damaged by the delay, but neither have caused it, only Time Extensions are warranted. Examples of excusable, non-compensable (E/N) delays include: unusually severe weather; fire; acts of God; failure of non-City owned utilities (SRP, CenturyLink, Cable TV, Southern Pacific Railroad, and Southwest Gas, etc.) to properly or timely locate accurately; failure of non-City owned utilities to relocate in advance of construction; the voluntary or involuntary filing for Bankruptcy protection by a Supplier or Subcontractor which causes the Supplier/Subcontractor to fail to meet a contractual deadline provided the Contractor can provide documentation that he/she executed the required Purchase Orders/Subcontract Agreements and received delivery schedules which, if met, would have eliminated the delay; delays as a result of an incomplete shutdown of a City or non-City owned utility main (the City does not guarantee a complete shutdown). This list also is not necessarily all inclusive but merely indicative of type and class of E/N delays.

C. Non-excusable/Non-compensable:

These are delays caused by the actions or inactions of Contractor or an officer, employee, agent, Subcontractor, Supplier or any other party for whom the Contractor is responsible. Since the Contractor has assumed responsibility for the risks associated with the events that caused the delay, he/she are not entitled to either time extensions or monetary delay damages. All non-excusable delays are also non-compensable. Examples of non-excusable, non-compensable (N/N) delays include: failure to perform by the Contractor, its Subcontractors and/or Suppliers (except as noted in section I.B above); failure to provide adequate labor, materials, and/or equipment on the Project; failure to perform contractually-required coordination with utilities, agencies and other Contractors; failure to notify the Engineer, in writing, of delay impacts within two working days, as required by MAG 104.2.3, or the next work day, as required by MAG 109.8.2; failure to timely submit Shop Drawings; failure to pothole or otherwise visually locate utilities sufficiently ahead of the Work to allow the Engineer to direct corrective action when necessary; delays due to retesting of previously failed work, re-inspection, and/or restaking resulting from faulty workmanship, poor quality control, or lack of compliance with Agreement Specifications. Again, this list is not necessarily all inclusive.

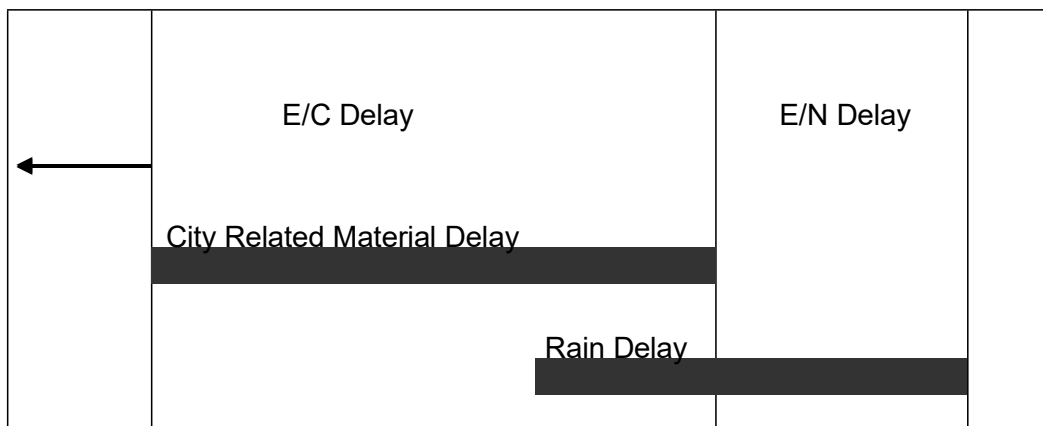
D. Concurrent:

When two or more delays occur simultaneously or overlap, each delay is analyzed separately to determine its impact on the overall project completion date based on when that delay started. Once again, only those delays which actually extend the Agreement completion time are considered as delays. The concurrent delay is considered an additional delay only to the extent it prolongs

the delay to the Agreement Completion Time beyond the date that the one it is concurrent with had already delayed that date. For example, if two delays are concurrent, and one is five days long and the second is seven days long, the second concurrent delay will only extend the Agreement Completion Time by two days. The same method of analysis is used when there are multiple concurrent delays. Only those extending the Project Completion Date are considered to be delays for the purposes of this policy. The portion of each concurrent delay that delays the completion of the work is classified in the same manner as described previously for individual delays and being either E/C, E/N or N/N.

An example of a concurrent delay is where the City delays furnishing material, but the Contractor could not have installed it anyway due to unusually severe weather. The effect of the first delaying activity will extend for the full duration and will be considered controlling on the Contractor's schedule. A subsequent, concurrent delay will thereafter only be considered to effect the project completion (if at all) once the first delaying activity has ceased to impact the project completion. In this case, if the unusually severe weather continued and delayed the work after the material was delivered, the first portion of the delay would be classified E/C (delay for material) and the second as E/N (delay due to unusually severe weather). Using the procedure set forth above, the entire concurrent portion would be considered E/C as shown in the chart which follows.

Example of a Concurrent Delay:



II. ANALYZING THE DELAY:

The Contractor must provide all documents required or requested by the Engineer to analyze the delay(s). It is important to understand that, prior to the delay analysis, delays and their impacts are alleged issues. The information the Contractor provides will be compared with the Inspector's Daily Log, Schedules and other available Project information and together they will support or refute that delays occurred and, if so, how they impact other work and the overall project completion. The Contractor's delay in providing these documents will be considered prima facie evidence that either the delay did not occur or it did not impact the Project Completion Date and any claim for time extension or damages will be denied.

General Conditions

Appendix 1

The Engineer will accept delay analyses in CPM format, as these may demonstrate to his/her satisfaction whether or not Project Completion has been impacted by a specific event. If the Contractor chooses not to use CPM scheduling procedures, then the burden will be on the Contractor to prove to the Engineer's satisfaction that the Project Completion has been impacted. The procedures below assume that the Contractor is using CPM scheduling methods. As a minimum the Contractor must provide the following materials to the Engineer:

- A. **As-Planned Schedule.** The initial construction schedule, required by the Agreement Documents, will be considered the baseline schedule. It is to the Contractor's advantage that the As-Planned (baseline) Schedule be as detailed as possible in order for delays, as they occur, to be incorporated into the schedule in representative locations. It is also to the Contractor's advantage to use a computer software program to generate the schedule since updated schedules are required monthly by the Agreement Documents and since updated schedules are required to support delays and requests for additional compensation for delays. The As-Planned (baseline) Schedule must be presented in network format which clearly shows the interrelationships of the activities. The Contractor must also provide a printout of the activities showing early start, early finish, late start, late finish, duration and float. The activity list printout must also indicate predecessor and successor activities.
- B. **As-Built Schedules.** The as planned (baseline) schedule must be updated with complete progress-to-date information (actualized) up to the date of the start of the alleged delay. Each updated schedule will serve as the as-built schedule for analyzing the alleged delay and provide a new baseline as-planned schedule for the next delay. This process must be repeated for each alleged delay as it occurs. In updating the baseline schedule, the alleged delay must be treated as an activity and inserted into the schedule as a predecessor to the impacted activity (ies). When an activity that has already started is impacted, it is preferable to divide this activity into two parts and show the impact affecting the second part. For schedules which incorporate a time line (or data date), the delay activity must be inserted at the time it actually occurred. Some software scheduling programs have a PAUSE-RESUME feature that can be used to facilitate the requirements. The updated schedule must also be accompanied by a listing of activities as with the baseline schedule. This activities list must contain the alleged delay as an activity showing the duration and the activities which are predecessors and successors to it. When computer generated schedules are used, the Contractor must provide, in electronic media format, the complete data files for the updated schedule that included the delay activity, preferably either in Suretrak or in Microsoft Project. Each electronic media must contain a label identifying the Project name, Contractor's name, program name and version number, data date and project finish date.
- C. **Other Documents:** In order to determine the amount of the alleged delay and if it is compensable, the Contractor must provide all backup documentation relevant to the issue and as required by the Engineer. This documentation must include copies of such items as: purchase orders; delivery schedules; correspondence; memoranda of telephone calls; force account daily worksheets (initialed by the Inspector); payroll data; estimating (bid) worksheets; and any other materials which may be

requested by the Engineer.

- D. Procedure: Only after receipt of sufficient documentation will the Engineer analyze each alleged delay and determine if it is supported or refuted. If supported, the Engineer will determine if it is excusable or non-excusable, compensable or non-compensable. If the Engineer determines that the delay did not affect the Project Completion, the as-planned schedule, which has been updated to the date of the alleged delay, must be revised to indicate this. If the Engineer determines the delay did occur but was N/N, then no time extension will be granted. It is imperative that an actualized schedule be submitted as soon as the occurrence of the alleged delay is known. In no event will the Contractor submit an actualized updated schedule later than 60 days after the occurrence of the alleged delay becomes known.

If the Engineer determines the delay did occur and was excusable but, due to a reason listed in section I.B. is non-compensable, he/she will determine the length of the E/N delay and prepare a Change Order to add that time to the Agreement. The Engineer's decision will be final.

If the Engineer determines the delay was excusable and compensable, he/she will determine the length of the E/C delay and proceed to review the Contractor's damage calculations in accordance with Section III. The Engineer will check the Contractor's calculations, review the backup documentation provided, and prepare a Change Order to cover both the additional compensation and the time extension. The Engineer's decision on both the time extension and additional compensation for the delay will be final.

If the issue involves a concurrent delay, the Engineer will analyze available data to determine the portions which are E/C, E/N, and/or N/N as described above. The Engineer will proceed to determine the length of E/C delay and verify the Contractor's delay damage calculations, if any are provided. Upon completion of this review, the Engineer will prepare a Change Order for the Contractor's review and signature. The Engineer's decision regarding excusable delay and additional compensation for the delay is final.

The amount of time the Engineer will require to analyze the alleged delay(s) will depend upon the Engineer's workload, the complexity of the delay analysis, availability of supporting data, extent of cooperation by the Contractor, and other factors beyond the Engineer's control. It is entirely possible other delay(s) may occur while the Engineer is analyzing particular claim for delay(s). The Engineer's failure to respond to the Contractor in a set period of time will not be used as the basis for a further delay claim or as justification for extending and existing delay claim. The time required for delay analysis by the Engineer will not be counted against the time allotted for processing Final Payment as required by (MAG Section 109.7(B)) or the release of retention and Final Payment as prescribed by A.R.S. Arizona Revised Statutes §34-221.

III. CALCULATING MONETARY DELAY DAMAGES:

Additional compensation for delay, when authorized by the Engineer, will be calculated in accordance

with MAG Section 109.5 ACTUAL COST WORK with the following exceptions:

- A. No additional compensation or other monetary damages will be awarded or paid for any loss of anticipated profits by the Contractor, Subcontractors or Suppliers.
- B. No additional compensation or other monetary damages will be awarded for home office overhead or non-project general conditions of the Contractor, Subcontractors or Suppliers.
- C. Equipment:
 - 1. Contractor-owned equipment rate calculations must be computed in accordance with Section 109.04(D)(3), Arizona Department of Transportation "Standard Specifications for Road and Bridge Construction," 2008 or latest edition and as modified herein. Year and regional adjustment factors must be based on the most recent publications of the Rental Rate Blue Book for Construction Equipment, published by the Equipment Guide-Book Company, San Jose, CA, same as provided by ADOT and in print as of the date of alleged delay. In no event will the compensation for Contractor-owned equipment exceed the purchase price, including tax, paid by the Contractor for the equipment. Compensation will not be allowed for small tools or equipment that show a daily equipment rental rate of less than \$5.00 per day or for unlisted equipment that has a value of less than for hundred dollars (\$400.00).
 - 2. For leased and rented equipment or equipment not otherwise listed in the Blue Book, rental contracts, or other supporting data will be used to establish the hourly rate. No hourly operating expense will be allowed for delay on standby equipment. In no case will equipment be considered for rental which exceeds the hourly rate for the first eight hours and the daily rate divided by eight for all additional hours as compared with similar equipment listed in the Blue Book. The hourly standby rate must be computed as the lesser of:
 - a. Dividing the monthly invoice or rental value by 176 hours per month when the equipment is utilized by the Contractor for more than three weeks;
 - b. Dividing the monthly invoice or rental value by 40 hours per week when the equipment is utilized by the Contractor for more than three days.

In no event will compensation be paid for delay at more than 8 hours per day or 40 hours per week.
 - 3. Except for vehicles used by supervisory personnel, all equipment will be paid at the "standby" rate during the delay period.
 - 4. Equipment brought solely to mitigate the delay (such as pumps, light plants, etc.) may be paid in accordance with ADOT section 109.04(D) (3).

5. The Blue Book regional adjustment will apply in determining rental rates.

D. Material:

Allowable material charges may include, in addition to material incorporated in the work material used to mitigate the delay such as barricades, plates, shoring, cold mix, etc. Except in emergencies the Contractor will not employ such material without the prior written approval of the Engineer.

E. Labor:

1. Except for Supervisory Personnel (Superintendent, Project Engineer, and Foremen), labor wages will not be paid after the first one-half day of claimed delay or impact. It is expected the Contractor will reassign or layoff unneeded employees.
2. For Foreman wages to be included, that Foreman must have been actively employed on the project prior to the commencement of the delay and be directly responsible for the activity being delayed.
3. Labor burden must be actual amounts incurred but must not exceed the ADOT approved rate.

F. All costs (equipment, material, and labor) must be substantiated by the City of Chandler's Daily Work Reports.

IV. DOCUMENT REQUIRED FOR CLAIM ANALYSIS:

For purposes of reviewing the Contractor's request for additional compensation, it will be required that the Contractor submit the following listed information. Information requested must be prepared on forms which are substantially similar to the City of Chandler's Daily Work Report form, a copy of which is attached as an exhibit.

A. Labor:

For each employee, laborer, and foreman, for which compensation is requested: Name, classification, dates of work performed, daily hours worked, total hours worked, labor rates, labor burden rates, overtime or premium time charges. Further, the Contractor must make available for inspection and copying to the Engineer the following listed documentation.

1. Certified payroll reports for the period of work claimed.
2. Accounting of Fringe Benefits – certified by a CPA.
3. Contractor's and Subcontractor's daily field reports and daily diaries.

B. Materials:

For all materials for which compensation is requested, if any, total quantities of materials, prices, extensions and transportation costs must be provided on a daily

basis. Further, the Contractor must make available for inspection and copying to the Engineer the following listed documentation.

1. Invoices for all materials incorporated.
2. Weigh tickets.
3. Purchase orders.
4. Delivery schedules.
5. Quotes or proposals from manufacturers or supplier.
6. Freight bills, Bills of Lading, or other documentation to show transportation costs.
7. Restocking charges-invoices from vendor.

C. Equipment:

For all equipment, the Contractor must provide the Engineer with the designation, dates and hours of usage, dates and hours of standby, if any, daily hours, total hours, rental rates and extension for each unit of equipment and machinery. Rental rates will be as established in Section III. Further, the Contractor must make available for inspection and copying to the Engineer the following listed documentation.

1. Owned:
 - a. Purchase contracts(s).
 - b. Depreciation schedule(s).
 - c. Invoices for fuel, lube, repairs and other operating costs.
2. Leased:
 - a. Lease agreement with hourly rate, overtime rate, double shift rate, etc.
 - b. Invoices or other documentation showing hours worked on a daily basis.

D. Subcontractors/Owner-Operators:

In the event the Contractor submits a claim which includes requests for compensation for Subcontractors of Owner-Operators, the same information requested of the Contractor must be provided by the Subcontractor/Owner-Operator. Further, the Contractor must make available for inspection and copying to the Engineer the following listed documentation.

1. Bid/Estimate work sheets and/or spreadsheets.
2. Subcontract Agreements or Agreements with Owner-Operator.
3. All invoices and billing statements received from the Subcontractor/Owner-Operator which relates to the amount requested.

E. Miscellaneous:

Further, the Contractor must make available for inspection and copying to the Engineer the following listed documentation.

1. Evidence of payment for bonds and insurance premiums (MAG 109.5.6).

General Conditions

Appendix 1

2. Taxes – unless the Contractor can show otherwise, taxes are reimbursable at 65% of the total cost (less bonds and insurance).

V. TIME LIMIT ON SUBMISSIONS OF CLAIM FOR DELAY OR IMPACT DAMAGES:

No claims for delay or impact damages will be considered or allowed more than 45 days after the event or occurrence which the Contractor claims gives rise to the delay or impact. In no event will a claim for delay or impact damages be considered after submission by the Contractor of the Final Payment Request.

COST REDUCTION INCENTIVE PROPOSALS FOR DESIGN BID BUILD AGREEMENTS

The Contractor may submit to the Engineer proposals for modifying the Plans, Specifications, or other requirements of the Agreement for the sole purpose of reducing the total cost of Project construction. The proposals must not impair in any manner the essential functions or characteristics of the project; including but not limited to service life, economy of operations, ease of maintenance, desired appearance, compatibility with existing or planned equipment, standardization of systems, or design and safety standards.

It must not be inferred from this Policy that the Engineer is required to consider any proposal submitted.

Submissions that propose changes in the basic design of a bridge, propose changes in pipe line size, materials, bedding conditions, pipe specifications; or that propose any change in pavement design will not be considered.

Proposals submitted pursuant to this Policy will be identified as Cost Reduction Incentive Proposals. They must be submitted in writing and, at a minimum, contain the following.

1. Complete the attached or similar cost reduction incentive proposal form.
2. A description of both the existing Agreement Requirements for performing the work and the proposed changes.
3. All Engineering Drawings and computations necessary for the thorough and expeditious evaluation.
4. An itemization of the existing Agreement Requirements that must be changed if the Proposal is adopted and a recommendation as to the manner in which the change should be made.
5. A detailed estimate of the cost of performing the Work under the existing Agreement and under the proposed changes, including the cost of developing and implementing the changes.
6. The Agreement items affected by the proposed changes and any variations in quantities resulting from the changes.
7. An objective estimate of any effects the proposal will have on collateral cost to the City, costs of related items, and cost of maintenance and operation.
8. A statement as to the effect that the Proposal will have on the time for the completion of the Project.
9. A statement as to the time by which a Change Order adopting the Proposal must be executed or when the Engineer must have given verbal approval.

General Conditions Appendix 2

Proposals will be processed expeditiously; however, the City will not be liable for any delay in acting upon any Proposal nor for any failure to accept any Proposal pursuant to this Special Provision.

The Engineer will be the sole judge of the acceptability of a Proposal and of the estimated net savings in construction costs from the adoption of all or any part of the Proposal. The Contractor will be notified in writing by the Engineer as to whether his/her Proposal has been accepted. The decision by the Engineer is final.

When the City deems such action to be appropriate, it reserves the right to require the Contractor to share equally in the cost to the City of investigating, evaluating, and processing the proposal as a condition for the consideration of such Proposal. Such cost must be shared whether the Proposal is accepted or rejected. When such a condition is imposed, the City will estimate these costs and the Contractor must indicate his acceptance thereof in writing. Such acceptance will authorize the City to deduct the Contractor's share of the costs from any monies due or that may become due to the Contractor under the Agreement.

If the Contractor's Proposal is accepted in whole or in part, the necessary Agreement Modifications and Agreement Price Adjustments will be affected by the execution of a Change Order which will specifically state that it is executed pursuant to this Special Provision.

The Contractor must continue to perform the work in accordance with the requirements of the Agreement until a Change Order incorporating the Proposal has been executed or until he/she has been given verbal approval by the Engineer that his/her Proposal has been accepted. If the Change Order has not been executed or he/she has not been given verbal approval on or before the date specified on the attached cost reduction incentive proposal form or on or before such other date as the Contractor may have subsequently specified in writing, the Proposal may be deemed to be rejected.

The executed Change Order will incorporate the changes in the Plans, Specifications, or other requirements of the Agreement which are necessary to permit the Proposal, or such part of it which has been accepted, to be put into effect, and will include any condition – upon which the City's approval thereof is based, if such approval is conditional. The executed Change Order may also extend the time for the completion of the Agreement if such an extension has been deemed to be warranted by the Engineer as a result of his evaluation of the Proposal.

The executed Change Order will also establish the estimated net savings in the cost of performing the Work attributable to the Proposal effectuated by the Change Order. In determining the net savings, the right is reserved to the Engineer to disregard the Agreement bid prices if, in his/her judgment, such prices do not represent a fair measure of the value of the Work to be performed or to be deleted. The net savings will be established by determining the Contractor's cost of performing the Work, taking into account his/her cost of developing the Proposal and implementing the change, and reducing this amount by any ascertainable collateral costs to the City. The executed Change Order may provide that the Contractor be paid 50 percent of the estimated net savings amount.

The executed Change Order may also provide for the adjustment in Agreement prices. Agreement prices may be adjusted by subtracting the City's share of the accrued net savings.

General Conditions Appendix 2

The amount specified to be paid to the Contractor in the executed Change Order which effectuates a Cost Reduction Proposal will constitute full compensation to the Contractor for the Cost Reduction Proposal and the performance of the work thereof pursuant to the said Change Order.

Upon acceptance of a Cost Reduction Incentive Proposal, any restrictions imposed by the Contractor on its use or on disclosure of the information will become void, and the City thereafter will have the right to use all or any part of the Proposal without obligation or compensation of any kind to the Contractor.

COST REDUCTION INCENTIVE PROPOSAL FORM

TO: CIP City Engineer

FROM:

PROJECT NAME: PECOS SURFACE WATER TREATMENT PLANT ADMIN B
BUILDING HVAC AND WATER QUALITY LAB RENOVATION

CITY PROJECT NUMBER: WA2106.401

DATE:

Summary of Change (Brief description of proposed change including advantages and disadvantages):

ESTIMATED COST SUMMARY (Attached detailed estimate):

A.	Original Cost:	\$
B.	Proposed Cost:	\$
C.	Construction Savings (A-B):	\$
D.	Gross Savings (Included OH % , Bond %)	\$
E.	Contractor Implementing	\$
F.	City Implementing Cost:	\$
	Reduction in Agreement Price (C+D-E-F) x 50%:	\$

Date by which a Change Order must be issued so as to obtain maximum cost reduction:

**CITY OF CHANDLER, ARIZONA
PUBLIC WORKS & UTILITIES DEPARTMENT**

CONTRACTOR'S AFFIDAVIT REGARDING SETTLEMENT OF CLAIMS

_____, Arizona

Date _____

Project Name: PECOS SURFACE WATER TREATMENT PLANT ADMIN BUILDING HVAC AND WATER
QUALITY LAB RENOVATION

City Project No.: WA2106.401
To the City of Chandler, Arizona

Gentlemen:

This is to certify that all lawful claims for materials, rental of equipment and labor used in connection with the construction of the above project, whether by subcontractor or claimant in person, have been duly discharged.

The undersigned, for the total compensation of \$_____, as set out in the final pay application, as full and complete payment under the terms of the Agreement, hereby waives and relinquishes any and all further claims or right of lien under, in connection with, or as a result of the above described project. The undersigned further agrees to indemnify and save harmless the City of Chandler against any and all liens, claims or liens, suits, actions, damages, charges and expenses whatsoever, which said City may suffer arising out of the failure of the undersigned to pay for all labor performances and materials furnished for the performance of said installation.

Signed and dated at _____, this _____ day of _____ 20____.

CONTRACTOR

By _____

STATE OF ARIZONA)
) SS
COUNTY OF MARICOPA)

The foregoing instrument was subscribed and sworn to before me this _____ day of _____ 20____.

Notary Public

My Commission Expires

PERFORMANCE BOND

ARIZONA STATUTORY PERFORMANCE BOND
PURSUANT TO TITLES 28, 34, AND 41, ARIZONA REVISED STATUTES
(Penalty of this bond must be 100% of the Agreement amount)

KNOW ALL MEN BY THESE PRESENTS THAT:_____

(hereinafter "Principal"), and _____ (hereinafter "Surety"), a corporation organized and existing under the laws of the State of _____ with its principal office in the City of _____, holding a certificate of authority to transact surety business in Arizona issued by the Director of Insurance pursuant to Title 20, Chapter 2, Article 1, as Surety, are held and firmly bound unto _____(hereinafter "Obligee") in the amount of _____ (Dollars) (\$_____), for the payment whereof, Principal and Surety bind themselves, and their heirs, administrators, executors, successors and assigns, jointly and severally, firmly by these presents.

WHEREAS, the Principal has entered into a certain written Agreement with the Obligee, dated the _____ day of _____, 20__ for construction of **PECOS SURFACE WATER TREATMENT PLANT ADMIN BUILDING HVAC AND WATER QUALITY LAB RENOVATION, WA2106.401** which Agreement is hereby referred to and made a part hereof as fully and to the same extent as if copies at length herein.

NOW, THEREFORE, THE CONDITION OF THIS OBLIGATION IS SUCH, that if the Principal faithfully performs and fulfills all the undertakings, covenants, terms, and conditions of the Agreement during the original term of the Agreement and any extension of the Agreement, with or without notice of the Surety, and during the life of any guaranty required under the Agreement, and also performs and fulfills all the undertakings, covenants, terms, conditions, and agreements of all duly authorized modifications of the Agreement that may hereafter be made, notice of which modifications to the Surety being hereby waived, the above obligation is void. Otherwise it remains in full force and effect.

PROVIDED, HOWEVER that this bond is executed pursuant to the provisions of Title 34, Chapter 2, Article 2, Arizona Revised Statutes, and all liabilities on this bond will be determined in accordance with the provisions of Title 34, Chapter 2, Article 2, Arizona Revised Statutes, to the same extent as if it were copied at length in this Agreement.

The prevailing party in a suit on this bond may recover as part of the judgment reasonable attorney fees that may be fixed by a judge of the court.

Witness our hands this _____ day of _____, 20__.

AGENT OF RECORD

PRINCIPAL SEAL

By _____

SURETY SEAL

AGENT ADDRESS

PAYMENT BOND

ARIZONA STATUTORY PAYMENT BOND
PURSUANT TO TITLES 28, 34, AND 41, OF THE ARIZONA REVISED STATUTES
(Penalty of this Bond must be 100% of the Agreement amount)

KNOW ALL MEN BY THESE PRESENTS THAT:_____

(hereinafter "Principal"), as Principal, and _____(hereinafter "Surety"), a corporation organized and existing under the laws of the State of _____ with its principal office in the City of _____, holding a certificate of authority to transact surety business in Arizona issued by the Director of the Department of Insurance pursuant to Title 20, Chapter 2, Article 1, as Surety, are held and firmly bound unto _____ (hereinafter "Obligee") in the amount of _____ (Dollars) (\$_____), for the payment whereof, the Principal and Surety bind themselves, and their heirs, administrators, executors, successors and assigns, jointly and severally, firmly by these presents.

WHEREAS, the Principal has entered into a certain written Agreement with the Obligee, dated the _____ day of _____, 20__ for construction of **PECOS SURFACE WATER TREATMENT PLANT ADMIN BUILDING HVAC AND WATER QUALITY LAB RENOVATION, WA2106.401** which Agreement is hereby referred to and made a part hereof as fully and to the same extent as if copied at length herein.

NOW, THEREFORE, THE CONDITION OF THIS OBLIGATION IS SUCH, that if the Principal promptly pays all moneys due to all persons supplying labor or materials to the Principal or the Principal's subcontractors in the prosecution of the work provided for in said Agreement, this obligation is void. Otherwise it remains in full force and effect.

PROVIDED, HOWEVER that this bond is executed pursuant to the provisions of Title 34, Chapter 2, Article 2 Arizona Revised Statutes, and all liabilities on this bond will be determined in accordance with the provisions, conditions and limitations of Title 34, Chapter 2, Article 2, Arizona Revised Statutes, to the same extent as if it were copied at length in this Agreement.

The prevailing party in a suit on this bond may recover as part of the judgment reasonable attorney fees that may be fixed by a judge of the court.

Witness our hands this _____ day of _____, 20__.

PRINCIPAL

SEAL

AGENT OF RECORD

By _____

SURETY

SEAL

AGENT ADDRESS

DISPUTE RESOLUTION

A. INFORMAL DISPUTE RESOLUTION

The parties to the Agreement agree that time is of the essence in relation to performance of the Agreement and completion of the Project, therefore any and all disputes in relation to the Agreement will initially be referred to the Project Manager, the Design Professional Representative and/or the Contractor Representative as applicable to the dispute, for immediate resolution. If, after good faith efforts to reach a resolution, none is reached, any party to the dispute may submit the dispute to the Dispute Resolution Representative ("DRR") process set forth below, which is intended to be an expedited process.

B. DISPUTE RESOLUTION REPRESENTATIVE ("DRR") PROCESS

1. The Parties under the Agreement agree that all claims and disputes in relation to the Project which are not resolved in the ordinary course of the Project ("Claim" or "Claims") will, as a prerequisite to any mediation, or litigation of the Claim, first be submitted for resolution between the designated Dispute Resolution Representatives of the Parties as set forth herein (the "DRR Process").
2. The DRR Process will be initiated through service of a DRR Notice as set forth below:
 - a. For claims by the Contractor or the Design Professional, the DRR Process will be initiated by the party asserting the claim serving written notice on the City setting forth in detail: (i) the basis for the claim; (ii) the effect of the Claim upon the construction of, and/or Project Schedule for, the Project; (iii) the specific relief requested, the amount thereof, and how such was calculated; (iv) the parties involved in the Claim, and how they are involved; (v) the specific Agreement provisions in the Agreement Documents (including, if applicable, drawings and specifications) which apply; and (vi) efforts made to date to resolve the Claim.
 - b. For claims by the City, the DRR process will be initiated by the City providing written notice to the other parties of the basis and amount of its claim, the parties involved in the Claim, and how they are involved, the provisions in the Agreement Documents that apply, and the relief requested.
 - c. The DRR Notice will be hand-delivered and e-mailed to the other parties' designated Dispute Resolution Representatives.
3. The other parties will respond in writing to the DRR Notice ("DRR Response") within ten (10) calendar days of receipt of the DRR Notice, setting forth those items set forth in the DRR Notice that they agree with, dispute, and/or have questions concerning. The DRR Response will be hand-delivered and e-mailed to the other parties' Dispute Resolution Representatives.

4. The designated Dispute Resolution Representatives for the Parties to the claim will then meet as soon as possible and in any event within twenty (20) calendar days of submission of the DRR Notice (regardless of whether a DRR Response has been submitted by all parties involved in the dispute), at a mutually agreed upon time and place, to attempt to resolve the Claim based upon the DRR Notice and DRR Response.
5. At any time after the first meeting required above, either party may terminate the DRR Process by written notice to the other party.
6. The parties may agree, in writing, to extend or modify the time limits or other provisions of the DRR process in relation to a specific pending Claim.
7. Unless otherwise designated in a written notice to the other parties, the City and the representatives of the Contractor and of the Design Professional will act as the parties' designated Dispute Resolution Representatives.
8. If a resolution of the Claim is reached, that resolution must be set forth in writing and must be signed by the Parties' designated Dispute Resolution Representative. If the resolution involves a change in any Agreement Documents, the Agreement Price, the Project Schedule, or any other change requiring a written Change Order or Amendment, the parties must execute an appropriate written Change Order or Amendment pursuant to the terms of the Agreement Documents.

C. MEDIATION

1. Unless extended by written agreement of the parties involved in the dispute, any Claim not resolved through the DRR process set forth above within five (5) calendar days after the meeting required under B (4) above, or after the DRR is terminated pursuant to B (5) above, whichever is earlier, will be submitted to mediation as a condition precedent to litigation by either party.
2. The mediation will be commenced by written demand upon the other party for mediation. If the parties cannot agree upon a mediator within ten (10) calendar days of the written demand, either party may make a request to the Civil Presiding Judge of the Maricopa County Superior Court to appoint a mediator. The mediation will occur within forth (40) calendar days of the written demand for mediation, unless the parties agree, in writing, to a longer period of time.
3. The qualifications for the mediator will be that he/she be: (a) an experienced mediator, arbitrator or litigator of construction disputes; and (b) having engaged a significant portion of his/her time involving and/or resolving construction disputes for at least the past five (5) years.
4. Each party will provide to the other party and the mediator all of the information and documentation required under B(1) and (2) above, together with any additional information and documentation which the party believes relevant. In addition, the parties will exchange, and provide to the mediator

such additional memoranda, information and/or documentation, as the mediator may request, and in the form and at such times, as the mediator may direct.

5. The parties will share the mediator's fee and any filing fees equally. The mediation will be held in Chandler, Arizona, unless another location is mutually agreed upon. Agreements reached in mediation will be specifically enforceable in any court having jurisdiction thereof.

D. LITIGATION

Any claim arising out of or related to the Agreement, except Claims relating to aesthetic effect and except those claims waived as provided for in the Agreement Documents, must be resolved through litigation in the Maricopa County, Arizona Superior Court.



**CITY OF CHANDLER, ARIZONA
PUBLIC WORKS & UTILITIES DEPARTMENT**

CERTIFICATE OF COMPLETION

PROJECT NAME:	PECOS SURFACE WATER TREATMENT PLANT ADMIN BUILDING HVAC AND WATER QUALITY LAB RENOVATION		
CITY PROJECT NO.:	WA2106.401		
If Federally Funded:			
FEDERAL NO.:		ADOT NO:	

(This section to be completed by Prime)

I HEREBY CERTIFY THAT ALL GOODS AND/OR SERVICES REQUIRED BY CITY OF CHANDLER FOR THIS PROJECT HAVE BEEN DELIVERED IN ACCORDANCE WITH THE AGREEMENT DOCUMENTS AND BID SPECIFICATIONS AND ALL ACTIVITIES REQUIRED BY THE AGREEMENTOR UNDER THE AGREEMENT HAVE BEEN COMPLETED AS OF THE COMPLETION DATE LISTED HERE:

<u>FINAL ACCEPTANCE DATE:</u>	
--------------------------------------	--

PRIME CONTRACTOR:

FIRM NAME:			
PRINCIPAL:			
TITLE:			
SIGNATURE:		DATE:	

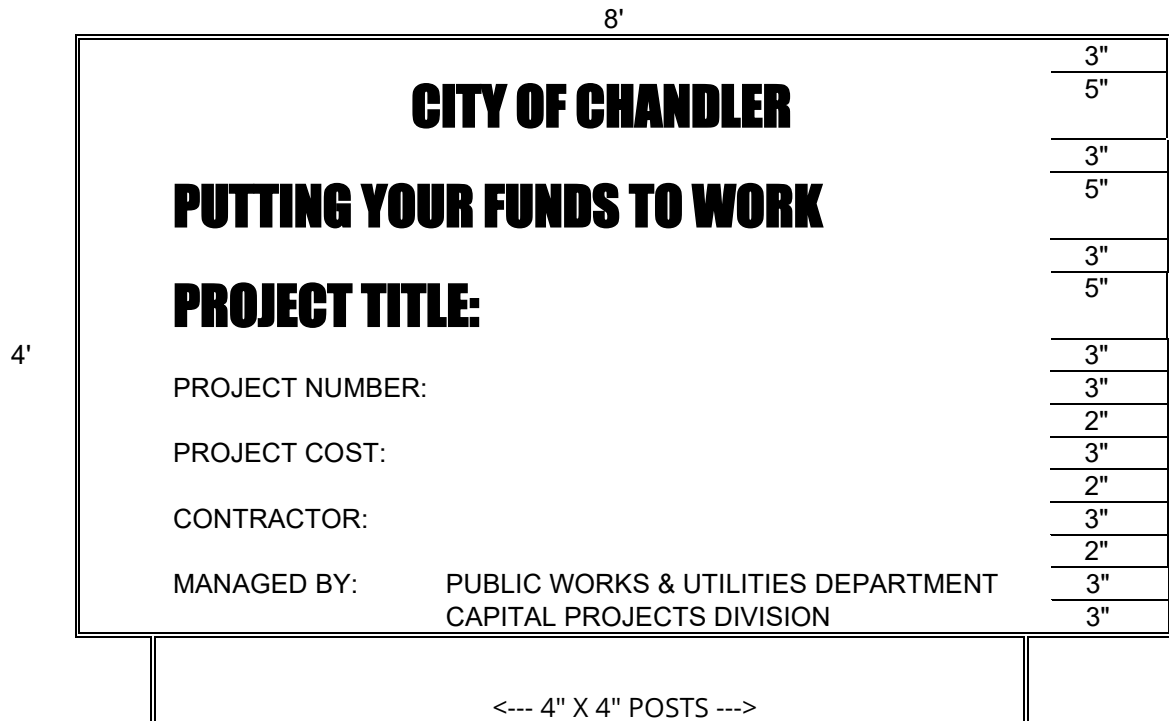
CERTIFIED BY [INSERT NAME AND TITLE OF PARTY THAT OVERSEES CONSTRUCTION]:

FIRM NAME:			
SIGNATURE:		DATE:	

PROJECT ACCEPTED BY CITY OF CHANDLER:

NAME:			
SIGNATURE:		DATE:	

CONSTRUCTION SIGN DETAIL



NOTES:

SIGN(S) MUST BE FURNISHED AND ERECTED PRIOR TO COMMENCEMENT OF CONSTRUCTION. POSTS MUST BE ANCHORED A MINIMUM OF TWO FEET INTO THE GROUND. BOTTOM OF SIGN MUST BE A MINIMUM OF FOUR FEET ABOVE THE GROUND.

TYPICAL PROJECT IDENTIFICATION SIGN FOR GENERAL PROJECTS MUST BE NON-REFLECTORIZED GREEN BACKGROUND, AND NON-REFLECTORIZED WHITE LETTERS AND NUMERALS.

ONE SIGN MUST BE ERECTED FOR BUILDINGS AND OTHER LIMITED AREA SINGLE SITES. FOR MULTIPLE SITES, ONE SIGN MUST BE ERECTED AT EACH SITE.

FOR LINEAR PROJECTS ONE HALF MILE OR LONGER, PLACE ONE SIGN AT EACH END OF THE PROJECT.

COST OF THE WORK

(APPLICABLE SOLELY TO CONSTRUCTION MANAGER AT RISK AND JOB ORDER CONTRACTING)

SECTION 1 – COSTS TO BE REIMBURSED

1.1 Cost of the Work

The term Cost of the Work will mean costs necessarily incurred by Contractor in the proper performance of the Work. Such costs must be at rates not higher than the standard paid at the place of the Project except with prior consent of City. The Cost of the Work will include only the items set forth in this Section 1.

1.2 Labor Costs

- 1.2.1 Wages of construction workers directly employed by the Contractor to perform the construction of the Work at the site or, with City's approval, at off-site workshops. Cost to be reimbursed will be the actual wages paid to the individuals performing the work.
- 1.2.2 Wages or salaries of the Contractor's supervisory and administrative personnel when stationed at the site with City's approval. No Contractor personnel stationed at the Contractor's home or branch offices will be charged to the Cost of the Work. Non-field office based Contractor management and support personnel are expected to provide service and advice from time to time throughout the job and his/her time devoted to Project matters is considered to be covered by the Contractor's Fee.
- 1.2.3 Wages and salaries of Contractor's supervisory or administrative personnel who would normally be stationed at the field office in accordance with Section 1.2.2 but who become engaged, at factories, workshops or on the road, in expediting the production or transportation of materials or equipment required for the Work, but only for that portion of his/her time required for the Work. Employee bonuses and/or costs associated with Employee Stock Ownership Plans ("ESOP") will not be considered reimbursable labor or labor burden costs and will be considered non-reimbursable costs considered to be covered by the Contractor's Fee.
- 1.2.4 Costs paid or incurred by Contractor for taxes, insurance, contributions, assessments and benefits required by law or collective bargaining agreements and, for personnel not covered by such agreements, customary benefits such as sick leave, medical and health benefits, holiday, vacations and pensions, provided such costs are based on wages and salaries included in the Cost of the Work under Subparagraphs 1.2.1 through 1.2.3.
 - 1.2.4.1 Cost of the Work will include the actual net cost to Contractor for worker's compensation insurance attributable to the wages chargeable to the Cost of Work per this Agreement. The actual net cost of worker's compensation must take into consideration all cost adjustments due to experience modifiers, premium discounts, policy dividends, retrospective rating plan premium adjustments, assigned risk pool rebates, any applicable weekly maximums, etc. Contractor may charge an estimated amount for worker's compensation insurance costs, but will make appropriate cost adjustments to actual costs within 45 days of receipt of actual cost adjustments from the insurance carrier.

- 1.2.4.3 Overtime wages paid to salaried personnel (if approved in advance in writing by City) will be reimbursed at the actual rate of overtime pay paid to the individual. No time charges for overtime hours worked on the Project will be allowed if the individual is not paid for the overtime worked.
- 1.2.4.4 Any overtime premium or shift differential expense to be incurred by Contractor for hourly workers will require City's advance written approval before the incremental cost of the overtime premium or shift differential will be considered a reimbursable cost. If the Contractor is required to work overtime as a result of an inexcusable delay or other coordination problems caused by the Contractor or anyone he/she is responsible for, the overtime premium and/or shift differential expense portion of the payroll expense and related labor burden costs will be considered as cost not to be reimbursed.
- 1.2.4.5 Reimbursable labor burden costs will be limited to payroll taxes, worker's compensation insurance, the employer's portion of union benefit costs for union employees working on the Project, and the actual verifiable fringe benefit costs incurred by Contractor for non-union individuals working on the Project subject to the following maximum percentages for the following reimbursable non-union fringe benefit costs. The following maximums (as a percentage of reimbursable actual wages by individual) will apply for each of the following types of fringe benefit costs specifically attributable to each of the non-union personnel working on the Project:

- | | |
|---|--------|
| • Medical Insurance, Dental, Life & AD&D Insurance: | 12.00% |
| • Holiday, vacation and other paid time not worked: | 10.00% |
| • Pension Plan Contributions to Vested Employee Account, Simplified Employee Pension Plans, or 401K matching plans (Note: ESOP related costs are covered by the Contractor Fee) | 10.00% |

For non-union personnel, no other fringe benefit costs (other than the three specific categories listed immediately above, will be considered reimbursable Cost of Work. Any labor burden costs that are in excess of the amounts considered reimbursable or are otherwise not considered reimbursable under the terms of this agreement are intended to be covered by the Contractor Fee.

1.3 Subcontract Costs

- 1.3.1 Payments made by Contractor to Subcontractors in accordance with the requirements of the subcontracts.
- 1.3.2 For Scope of Work Bid Packages typically performed by Subcontractors, Contractor may "self- perform" such work on an actual cost basis subject to an agreed upon Guaranteed Maximum Price for the "self-performed work". The Contractor must, unless agreed to by City in writing, bid his/her proposed guaranteed Maximum Price for the work to be "self-performed" against at least three other interested trade Contractors. All savings under any such Subcontract for "self-performed work" must be applied to reduce the Cost of Work under the Agreement and the Guaranteed Maximum Price. For purposes of defining "self-performed work" subject to this provision, any division of Contractor, or any separate Contractor or Subcontractor that is partially owned or wholly owned by the Contractor or any of his/her employees or employee's relatives will be considered a related party entity

and will be subject to this provision regarding “self-performed work”. No self-performed work will be allowed to be performed on a Fixed Price basis.

- 1.3.3 Contractor (with respect to its Suppliers, Subcontractors and all lower tier Subcontractors) must provide City advance written notice and must obtain City's approval for any proposed Subcontract Change Order, Material Purchase Order, or other financial commitment in an amount in excess of \$5,000 prior to placing such order or entering into such agreement (regardless of whether or not any such commitment will affect the prime Agreement Guaranteed Maximum Cost). It is agreed that sums applicable to any Subcontract Change Order, Purchase Order or other financial commitment entered into in violation of the above notice and approval requirement will not be included in the amounts owing to Contractor, Subcontractors or Suppliers whether as Costs of the Work or as reasonable termination costs in the event of termination.

1.4 Costs of Material and Equipment Incorporated in the Completed Construction

- 1.4.1 Costs, including transportation and storage, of materials and equipment incorporated or to be incorporated in the completed construction.
- 1.4.2 Costs of materials described in the preceding Subparagraph 1.4.1 in excess of those actually installed to allow for reasonable waste and spoilage. Unused excess materials, in any, will become City's property at the completion of the Work or, at City's option, may be sold by the Contractor. Any amounts realized from such sales must be credited to City as a deduction from the Cost of Work.
- 1.4.3 Proceeds from the sale of recyclable materials, scrap, waste, etc. will be credited to job cost.

1.5 Costs of Other materials and Equipment, Temporary Facilities and Related Items

- 1.5.1 Costs, including transportation and storage, installation, maintenance, dismantling and removal of materials, supplies, temporary facilities, machinery, equipment and hand tools not customarily owned by construction workers, that are provided by the Contractor at the site and fully consumed in the performance of the Work; and cost (less salvage value) of such items if not fully consumed, whether sold to others or retained by Contractor. Cost for items previously used by Contractor will mean fair market value.
- 1.5.2 Rental charges for temporary facilities, machinery, equipment, and hand tools not customarily owned by construction workers that are provided by Contractor at the site, whether rented from Contractor or others, and costs of transportation, installation, minor repairs and replacements, dismantling and removal thereof. Rates and quantities of equipment rented will be subject to City's prior written approval.
- 1.5.2.1 The Projected usage for each piece of equipment to be rented for use on the Project and the estimated total rentals must be considered by Contractor before the piece of equipment is rented so that an appropriate rent versus buy decision can be made. Purchased equipment must be considered “job owned”. At the completion of the Project, Contractor must transfer title and possession of all remaining job-owned equipment to City, or Contractor may keep any such equipment for an appropriate fair market value credit to job cost, which will be mutually agreed to by City and Contractor.

1.5.2.2 Each piece of equipment to be rented must have hourly, daily, weekly and monthly rates and the most economical rate available will be reimbursed based on the circumstances of actual need and usage of the piece of equipment while it is stationed at the jobsite. When the piece of equipment is no longer needed for the work, no rental charges will be reimbursed if the piece of equipment remains at the jobsite for the convenience of Contractor.

1.5.2.3 Equipment Rental Rates

1.5.2.3.1 Compensation for equipment used on the Project will be paid in accordance with the Equipment Plan submitted by Contractor in the accepted GMP Proposal and no payments will be made in excess of the rates set forth in the Equipment Plan, or actual documented costs, whichever is less.

1.5.2.3.2 All equipment rental rates and costs are subject to City's right to audit when submitted as part of Equipment Plan and/or at any time during the Project.

1.5.2.4 The aggregate rentals chargeable for each piece of Contractor owned tools or equipment must not exceed 50% of the fair market value of such equipment at the time of its commitment to the Work. The original purchase price and date of purchase of the equipment will be documented with a copy of the purchase invoice for the piece of equipment. Such aggregate limitations will apply and no further rentals will be charged even if a piece of equipment is taken off the job and is later replaced by a similar piece of equipment. For purposes of computing the aggregate rentals applicable to aggregate rental limitations, rental charges for similar pieces of equipment will be combined if the pieces of equipment were not used at the same time.

1.5.2.5 Fair market value for used material and equipment as referred to in the Agreement Documents will mean the estimated price a reasonable purchaser would pay to purchase the used material or equipment at the time it was initially needed for the job. Note: This is usually lower than the price a reasonable purchaser would pay for similar new construction material or construction equipment.

1.5.2.6 All losses resulting from lost, damaged or stolen tools and equipment will be the sole responsibility of Contractor, and not City, and the cost of such losses will not be reimbursable under the Agreement.

1.5.2.7 Contractor will be required to maintain a detailed equipment inventory of all job-owned equipment (either purchased and charged to job cost or job-owned through aggregate rentals) and such inventory must be submitted to City each month. For each piece of equipment, such inventory should contain at a minimum (1) original purchase price or acquisition cost (2) acquisition date (3) approved Fair Market Value at the time the piece of equipment was first used on the job and (4) final disposition.

1.5.2.8 All costs incurred for minor maintenance and repairs will be reimbursed at actual cost. Such costs include routine and preventative maintenance, minor repairs and other incidental costs. Repairs and/or replacement of a capital nature are considered to be covered by the rental rates. Major repairs and overhauls are not considered routine and ordinary; consequently such costs are not reimbursable and are intended to be covered by the rental

rates.

- 1.5.3 Costs of removal of debris from the Site.
- 1.5.4 Costs of document reproductions, facsimile transmissions and long-distance telephone calls, postage and parcel delivery charges, telephone service at the site and reasonable petty cash expenses of the site office.
- 1.5.5 That portion of the reasonable expenses of Contractor's personnel incurred while traveling in discharge of duties connected with the Work.
 - 1.5.5.1 No travel expenses will be reimbursed to Contractor's representatives unless Project related travel required them to travel to a destination more than 100 miles from the Project location. Any travel involving airfare will require advance written approval by an authorized City's representative.
- 1.5.6 Costs of materials and equipment suitably stored off the site at a mutually acceptable location, if approved in advance by the City.
- 1.5.7 Reproduction costs will be the actual costs of reproduction subject to a maximum of five cents (\$.05) per square foot for prints and a maximum of five cents (\$.05) per 8 ½ by 11-inch page for offset print or photo copied agreement documents, specifications, etc. Telephone costs will be the actual costs paid to the third party telephone company for the field office telephone.

1.6 Miscellaneous Costs

- 1.6.1 That portion of insurance and bond premiums that can be directly attributed to the Agreement. The City will reimburse Contractor for contractually required bond at time of first pay application for GMP and Cost-Based Agreements upon receipt of proof of payment from the Contractor. If the Contractor completes Work for less than the Agreement Price, Contractor must credit the City a pro-rated amount for the unused portion of the bond payment
 - 1.6.1.1 Contractor's actual cost for insurance will be considered to be included within the Maximum limit for General Conditions Costs. All premiums for any insurance and bonds required for the Project must reflect the net actual costs to Contractor after taking into consideration cost adjustments due to experience modifiers, premium discounts, policy dividends, retrospective rating plan premium adjustments, assigned risk pool rebates, refunds, etc.
 - 1.6.1.2 The amount to be reimbursed to Contractor for all contractually required insurance will be actual costs not to exceed a total of 2% of the Agreement Value, unless Contractor establishes to City's satisfaction that the actual cost is higher and City agrees to such actual higher cost in writing. If Contractor's cost of contractually required insurance is greater than the amount agreed to be reimbursed per this Agreement Provision, the difference will be considered to be covered by the Contractor's Fee. The City will reimburse Contractor for contractually required insurance on a monthly basis for GMP and Cost-Based Agreements. If Contractor can demonstrate substantial savings by paying for all insurance in advance, the City may agree to reimburse all insurance costs at time of first pay

application for GMP and Cost-Based Agreements with proof of payment from Contractor.

- 1.6.2 Sales, use or similar taxes imposed by a governmental authority that are related to the Work.
- 1.6.3 Fees and assessments for the building permit and for other permits, licenses and inspections for which Contractor is required by the Agreement Documents to pay.
- 1.6.4 Fees of laboratories for tests required by the Agreement Documents, except those related to defective or nonconforming Work and which do not fall within the scope of ¶ 1.7.3 below.
- 1.6.5 Royalties and license fees paid for the use of a particular design, process or product required by the Agreement Documents; the cost of defending suites or claims for infringement of patent rights arising from such requirement of the Agreement Documents; and payments made in accordance with legal judgments against Contractor resulting from such suites or claims and payments of settlements made with City's consent. However, such costs of legal defenses, judgments and settlements must not be included in the calculation of the Contractor's Fee or subject to the Guaranteed Maximum Price.
- 1.6.6 Data processing costs related to the Work. However, any such data processing costs will be limited to the cost of personal computer hardware used at the field office in the normal day to day administration, management and control of the Project. The aggregate charges for any such hardware must not exceed the Fair Market Value of the hardware at the time it was brought to the field office. If the total charges for any particular piece of hardware reach an amount equal to the Fair Market Value, that particular piece of hardware must be turned over to City whenever it is no longer needed for the Project. If Contractor elects to keep the particular piece of hardware, the job costs must be credited with a mutually agreeable amount which will represent the Fair Market Value of the particular piece of hardware at the time it was no longer needed for the job. Software or other costs associated with the use of computer programs will not be considered to be a reimbursable cost and will be considered to be covered by the Contractor's Fee.
- 1.6.7 Deposits lost for causes other than Contractor's negligence or failure to fulfill a specific responsibility to City as set forth in the Agreement Documents.
- 1.6.8 Legal, mediation and arbitration costs, including attorneys' fees, other than those arising from disputes between City and Contractor, reasonably incurred by Contractor in the performance of the Work and with City's prior written approval; which approval will not be unreasonably withheld.
- 1.6.9 Expenses incurred in accordance with Contractor's standard personnel policy for relocation and temporary living allowances of personnel required for the Work, if pre-approved by City in writing. If City authorizes the reimbursement of relocation costs, the reimbursable relocation expenses will be limited to a maximum of \$50,000 per person. Any relocation cost incurred by Contractor in excess of the amount reimbursed by City will be considered to be covered by the Contractor's Fee.

1.7 Other Costs and Emergencies

- 1.7.1 Other costs incurred in the performance of the Work if and to the extent approved in

advance in writing by City.

- 1.7.2 Costs due to emergencies incurred in taking action to prevent threatened damage, injury or loss in case of an emergency affecting the safety of persons and property.
- 1.7.3 Costs of repairing or correcting damaged or nonconforming Work executed by Contractor, Subcontractors or Suppliers, provided that such damaged or nonconforming Work was not caused by negligence or failure to fulfill a specific responsibility of Contractor and only to the extent that the cost of repair or correction is not recoverable by Contractor from insurance, sureties, Subcontractors or Suppliers.

1.8 Related Party Transactions

- 1.8.1 The term “related party” will mean a parent, subsidiary, affiliate or other entity having common ownership or management with Contractor; any entity in which any stockholder in, or management employee of, Contractor owns any interest in excess of ten percent in the aggregate; or any person or entity which has the right to control the business or affairs of Contractor. The term “related party” includes any member of the immediate family of any person identified above.
- 1.8.2 If any of the costs to be reimbursed arise from a transaction between Contractor and a related party, Contractor must notify City in writing of the specific nature of the contemplated transaction, including the identity of the related party and the anticipated cost to be incurred, before any such transaction is consummated or cost incurred. If City, after such notification, authorizes in writing the proposed transaction, then the cost incurred will be included as a cost to be reimbursed, and Contractor must procure the Work, equipment, goods or service from the related party, as a Subcontractor. If City fails to authorize the transaction, Contractor must procure the Work, equipment, goods or service from some person or entity other than a related party.

SECTION 2 – COSTS NOT TO BE REIMBURSED

- 2.1 The Cost of Work must not include:
 - 2.1.1 Salaries and other compensation of Contractor’s personnel stationed at Contractor’s principal office or offices other than the site office, except as specifically provided in Subparagraphs 1.2.2 and 1.2.3.
 - 2.1.2 Expenses of Contractors’ principal office and offices other than the site office.
 - 2.1.3 Overhead and general expenses, except as may be expressly included in Section 1.
 - 2.1.3.1 Costs of Contractor’s home office computer services or other outside computer processing services will be considered overhead and general expense. Accordingly, Contractor should not plan to perform any such computer related services or alternatives at the field office when such services or functions can be performed at Contractor’s home or branch offices, or other outside service locations.
 - 2.1.4 Contractor’s capital expenses, including interest on Contractor’s capital employed for the Work.

- 2.1.5 Rental costs of machinery and equipment, except as specifically provided in subparagraph 1.5.2.
- 2.1.6 Except as provided in Subparagraph 1.7.3 of the Agreement, costs due to the negligence or failure to fulfill a specific responsibility of Contractor, Subcontractors and Suppliers or anyone directly or indirectly employed by any of them or for whose acts of them may be liable.
- 2.1.7 Any cost not specifically and expressly described in Section 1.
- 2.1.8 Costs, other than costs included in Change Orders approved by City that would cause the GMP to be exceeded.

SECTION 3 – DISCOUNTS, REBATES, REFUNDS AND SAVINGS

- 3.1 Cash discounts obtained on payments made by Contractor will accrue to City if (1) before making the payment, Contractor included them in an Application for Payment and received payment therefore from City, or (2) City has deposited funds with Contractor with which to make payments; otherwise, cash discounts will accrue to Contractor. Trade discounts, rebates, refunds and amounts received from sales or surplus materials and equipment will accrue to City, and Contractor must make provisions so that they can be secured.
 - 3.1.1 Cost of the Work will be credited with all insurance policy discounts, performance and payment bond rebates or refunds, refunds or return premiums from any Subcontractor default insurance, refunds or rebates from any Contractor controlled insurance programs applicable to the Project, merchandise rebates of any nature, refunds of any nature, insurance dividends; and a portion of any volume rebates or free material credits earned with purchase of material or other goods and services charged to the job.
 - 3.1.2 “Cash” discounts which may accrue to Contractor will be limited to a maximum of 1.5% of invoice cost. Any portion of “Cash” discounts greater than 1.5% will automatically accrue to City if Contractor is eligible to take advantage of the discounts.
- 3.2 Amounts that accrue to City in accordance with the provisions of Paragraph 3.1 will be credited to City as a deduction from the Cost of the Work.
- 3.3 Any and all savings on the GMP, or any separately guaranteed items comprising the GMP, will belong to City, subject to any express right in the Agreement for Contractor to share in savings. Savings are subject to City’s right to audit, and may be audited separately.

SECTION 4 – GENERAL CONDITIONS COSTS

- 4.1 General Conditions Costs may include, but are not limited to, the following types of costs incurred by Contractor during construction of the Work to the extent they are reimbursable Costs of the Work as delineated above: payroll costs for Work conducted at the site, payroll costs for the superintendent and full-time general foremen, payroll costs for management

personnel resident and working on the site workers not included as direct labor costs engaged in support (e.g. loading/unloading, clean-up, etc.), administrative office personnel, costs of offices and temporary facilities including office materials, office supplies, office equipment, minor expenses, utilities, fuel, sanitary facilities and telephone services at the site, costs of liability insurance premiums not included in labor burdens for direct labor costs, costs of bond premiums, costs of consultants not in the direct employ of Contractor or Subcontractors, fees for permits and licenses.

- 4.2 General Conditions Costs may be paid on a percentage of the Agreement Price or on a lump/stipulate sum basis as set forth in the Agreement. All costs included in the General Conditions Costs will not be separately invoiced to or paid by City.
- 4.3 The total amount of General Conditions Costs for the Work may be divided by the number of days allowed for performance of the Work, to determine a fixed daily rate for General Conditions Costs that may be used in computing the General Conditions Costs allocated to any period of time, or for any adjustments in the General Conditions Costs agreed to in writing by City.

LANDSCAPE ESTABLISHMENT PERIOD

Section 1 – Description and General

Contractor is in direct control of work performed under the Landscape Establishment Period. If work is subcontracted, a representative of the Contractor will be present at the site of the work for all hours that the subcontractor works. Subcontracting of Landscape Establishment work will be permitted for weed eradication with herbicides, because of special licensing. A licensed temporary service may be used to supply labor to Contractor if Contractor has received approval from City Representatives. Contractor will submit the required subcontract documentation.

Contractor must provide adequate personnel to accomplish the required maintenance of the plant materials at intervals acceptable to City Representatives.

If not healthy at the end of the maintenance period, the maintenance must be continued until the plant material is approved by City.

1.1 Time and Schedule

Unless otherwise expressly agreed to in writing by City, the Landscape Establishment Period will be per General Conditions Section 6.5.4.

1.2 Planted Stock and Seeding Establishment

- 1.2.1 Tree planting and staking must be per City of Chandler Standard Detail C-801.
- 1.2.2 All trees will stand erect on their own without stakes when brought to this site. If the tree cannot stand on its own when nursery stakes are removed, the tree will be removed and replaced.

1.3 Pre-Emergent Herbicide and Weed Control

- 1.3.1 Contractor will provide three applications of an approved pre-emergent herbicide on all unpaved areas of the project, as directed by City Representatives, to control weed growth in all areas of the project. The number of applications may be increased as directed by the City Representative, and at no additional cost to City, if the City Representative deems additional applications are required to control weed growth.
- 1.3.2 Application sequence will be approved in advance by City. The first application of pre-emergent will be completed prior to the application of Decomposed Granite and will be included with the cost of the Decomposed Granite as specified and part of the Construction Phase portion of work. The second application of pre-emergent will be completed after installation of the Decomposed Granite and no later than half-way through the Landscape Establishment Period. The third and final application of pre-emergent will be applied 15 days prior to completion of the Landscape Establishment portion of the project. The second and third pre-emergent applications will be included with the cost of Landscape Establishment. Watering will be completed in accordance with the manufacturer's recommendations, as included and as related to each application.
- 1.3.3 The pre-emergent herbicide will be applied in accordance with the Technical Specifications and the recommendations of the pre-emergent herbicide manufacturer, as approved by City Representatives.

- 1.3.4 The control of weeds will be accomplished by the use of herbicides. Manual removal of weeds will be required, after herbicides have taken affect.
- 1.3.5 Contractor is responsible for the removal and disposal of all trash and debris that during the Landscape Establishment Period. Contractor will keep the project in a neat and orderly manner during the duration of the Landscape Establishment Period.

1.4 Water

The water used during Landscape Establishment to properly maintain the plant material will be furnished by City, at designated sources from within the project limits, at no charge to Contractor. Contractor will be responsible for all equipment, materials and labor necessary to load, transport and unload water for watering purposes.

1.5 Plant Material Replacements

The plant material replacement will be considered as included in the work for Landscape Establishment, and will be made at no charge to the City.

- 1.5.1 Shrub and Plant Replacement - During the second half of the Landscaping Establishment period, Contractor will provide, where required, plant replacements as follows:

<u>Original Size</u>	<u>Replacement Size</u>
1 gallon	5 gallon
5 gallon	15 gallon
15 gallon	24-inch box
36-inch box	48-inch box

- 1.5.2 Tree Replacement – During the second half of the Landscape Establishment Period, Contractor will provide plant material replacements for existing plants that die as follows:

<u>Existing Plant Material Sizes</u>	<u>Replacement Size</u>
Trees:	
2-inch Caliper	24-inch box
4-inch Caliper	36-inch box
6-inch Caliper and greater	54-inch box
Shrubs:	
All Existing Shrubs	15 gallon

1.6 Measurement and Payment

See Technical Specifications for Measurement Payment provisions.

EXHIBIT C
TECHNICAL SPECIFICATIONS

03/11/2022

Specifications – Construction Document – City Submittal

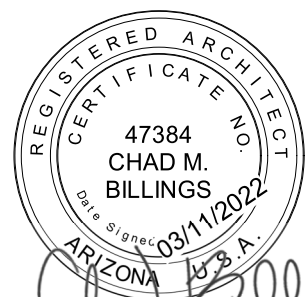
Pecos SWTP Water Quality Lab and HVAC Renovation

City Project #WA2106.401

1475 E Pecos Rd.,
Chandler, Arizona 85225



DFDG Architecture
4545 E McKinley St
Phoenix, Arizona 85008
(602) 954-9060



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PECOS SWTP WATER QUALITY LAB AND HVAC RENOVATION CITY PROJECT # WA2106.401 1475 E. PECOS ROAD CHANDLER, ARIZONA

March 11, 2022

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MEASUREMENT, PRICING AND PAYMENT

PART 1 GENERAL

1.01 PRICING

- A. General Contractor to provide individual lump sum pricing for each division in the project specifications excluding Division 00 and Division 01. Each division will be measured as a single unit of work and paid at the contract lump sum price, which price will be full compensation for the work completed as related to the division. The approved schedule showing percent of work completed per division will be the basis on which monthly progress payments will be made.

PART 2 PRODUCTS

NOT APPLICABLE

PART 3 EXECUTION

NOT APPLICABLE

END OF SECTION

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SECTION 01 11 00

SUMMARY OF WORK

1.01 WORK COVERED BY CONTRACT DOCUMENTS

- A. Scope of Project:
 - 1. Remodel of existing laboratory building for City of Chandler Pecos Surface Water Treatment Plant (SWTP) Building Improvements (CIP#WA2106), located at 1475 East Pecos Road, Chandler, Arizona. There will be 2 separate design packages. Other than work required for new mechanical equipment penetrations, no exterior work is anticipated within this scope of service. No site work is to be included.
 - 2. The existing lab space to be remodeled is located on the second floor of the Surface Water Treatment Control Building (SWTP) and is approximately 2,405 square feet. The space consists of a large general lab, 4 sub labs and a small office space. The exterior walls of the lab space are CMU block with the interior walls comprised of metal studs and drywall.
 - 3. New sink and casework to be added on Level 1 at Chlorine Analyzer Room
 - 4. Exterior stair to be added from Level 2 to Roof.
- B. Work consists of providing labor, materials, equipment, services, and administration required in conjunction with or properly incidental to Project construction.

1.02 DEFINITIONS PERTAINING TO THE CONTRACT DOCUMENTS

- A. Furnish: To purchase and deliver.
- B. Install: To place into final position and connect.
- C. Provide: To furnish and install.
- D. "As shown", "as detailed", "as indicated" or words of similar import mean as indicated on the drawings
- E. "As selected", "as approved" or words of similar import mean as selected by, as approved by, or as accepted by the Architect and Owner.
- F. "Approved equal", "or equal" shall mean as approved and accepted by the Architect and Owner.
- G. "Shall" means mandatory.
- H. "As required" means as required by the contract documents.
- I. "As necessary" means essential to the completion of the work.
- J. "Concealed" means not visible in the finished work.
- K. "Exposed" means visible in the finished work.
- L. "Days" means calendar days.

- M. Final Completion: That stage in the progress of the Work when the Work or designated portion thereof is complete in accordance with the Contract Documents so that the Owner can occupy or utilize the Work for its intended use.

1.03 WORK BY OWNER

- A. Items noted 'NIC' (Not in Contract) will be furnished and installed by Owner.
- B. Furniture, Fixtures & Equipment (FF&E).
 - 1. FF&E refers to furniture, fixtures and equipment and in general is anything not permanently affixed to the building. Fume hoods and other laboratory equipment as specified in this Project Manual and included on the Drawings are considered permanently affixed to the building and shall be furnished and installed by Contractor. It is anticipated that furniture will be designed and specified by a vendor selected directly by the City of Chandler. Equipment for the project (including computers, copiers, appliances, phones, etc.) are excluded from this scope and will be procured directly by the City of Chandler.
 - 2. All built-in fixtures, millwork and casework, including lab casework, will included in the general Contractor's scope of work.
 - 3. City of Chandler will purchase all loose furnishings and workstations. Architect will provide basic layout for proposed furniture, but detailed layouts will be provided by the vendor.
 - 4. Responsibilities for furnishing and/or installation of equipment shall be in accordance with Lab Equipment Schedule on Drawings Sheet A226.1.

1.04 WORK RESTRICTIONS

- A. Coordinate use of premises with Owner. All work must be conducted within the hours described by the City of Chandler building permits.
- B. Assume responsibility for protection and safekeeping of products stored on site under this Contract.
- C. Move stored products which interfere with operations of Owner or separate contractors.
- D. Conduct operations to ensure least inconvenience to public and occupants; and to adjacent occupied buildings.
- E. Obtain and pay for use of additional storage or staging areas needed for operations.
- F. Do not load structure with weight that would jeopardize its safety.
- G. Should it be necessary to use portions of existing streets, sidewalks or right of ways for operations, obtain approval and pay for use of such areas in accordance with requirements of authorities having jurisdiction.
- H. Construction Safety: Contractor shall be responsible for construction safety, including maintaining a safe working environment for building occupants. Maintain unobstructed and delineated entrance/egress to and from building, including emergency exit routes (location and widths as applicable to building occupancy), throughout construction period.

1.04 APPROVED APPLICATORS

- A. Where specific instructions in the Specifications require that a particular product and/or material be applied and/or installed by an "approved applicator" it shall be the Contractor's responsibility to insure that any Subcontractor or Subsubcontractor used for such Work is in fact currently certified by the particular Manufacturer for this type of installation or application.

1.05 APPROVED MANUFACTURERS

- A. Each Section includes a list of Manufacturers whose equipment is acceptable as to manufacture, subject to conformance with the Contract Documents. Careful checking must be made by the Contractor and the manufacturer or equipment supplier to verify that the equipment will meet all capacities, requirements, space allocations and is suitable to the intended purpose.

1.06 REFERENCE DATA

- A. Reference data made available to the Contractor is for the Contractor's information only, and neither the Owner nor the Architect assume any responsibility for the Contractor's conclusions.
- B. The Contractor shall establish and maintain all buildings and construction grades, lines, levels, and bench marks. This Work shall be performed by a licensed Civil Engineer or Surveyor under the employ of the Contractor, who shall certify to the Architect that he has performed this service.
- C. The Contractor shall not remove any property line markers or monuments or data established by the Owner.

1.07 ARCHITECTURAL BARRIERS

- A. It is the desire of the Owner that the facilities and improvements constructed under this Contract meet or exceed the intent of applicable public law concerning prohibition of discrimination, and that no individual be discriminated against on the basis of disability in the full and equal enjoyment of the goods, services, facilities, privileges, advantages, or accommodations of this completed Project.
- B. The designers and drafters of these Documents have intended to incorporate those Owner's intentions into these Documents.
- C. It is recognized that there may be products not incorporated into these Documents that may more nearly meet the Owner's desires than those included.
- D. The Owner hereby solicits those providing elements of this Project to contract for the Project as required by these Documents, but at the time of submitting Shop Drawings, or sooner when appropriate, and without causing delay in the Project, to also submit proposals for improving the accessibility of the Project to physically or mentally impaired persons.

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SECTION 02 40 19

SELECTIVE DEMOLITION

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. General

- a. Provide selective demolition within existing buildings to remain in place as indicated on Drawings.
- b. The scope of the demolition includes demolition of the interior construction within the project area with the exception of the electrical panels, which will be relocated, and the existing transformer. The existing windows and doors into the lab space will stay as is. Generally, demolition will include the existing lab casework, ceilings, lighting, interior concrete block partitions, HVAC ductwork and piping, electrical distribution back to the service panels in the vertical cores, and plumbing within the lab spaces.

2. HVAC System

- a. The overhead exhaust ductwork system serving the remodel scope is to be removed completely along with all (4) roof mounted exhaust fans and all the associated appurtenances. Overhead low pressure VAV supply air ductwork serving the lab space needs to be removed back to the duct main in the remodel scope. Existing medium pressure supply air ductwork main needs to be demolished back to VAV-5 (Electrical Room) take off. Any pipe or duct penetrations not to be used in the new work are to be infilled and sealed air and water tight to match existing construction and finish. Ductwork mains to be demolished as part of the laboratory remodel scope as indicated on Mechanical Drawings.
- b. Existing HVAC control devices, appurtenances and control wiring serving the remodel scope will be demolished back up to the existing Building Management System (BMS) connection.

3. Process and Plumbing Systems:

- a. All existing process branch piping, plumbing piping, and devices are to be removed back to the main located beneath the Level-1 floor. Provide valves and caps on existing branch taps where connection to new system will not occur. Unused existing floor drains will be demolished and floor slab openings will be grouted in place. Temporary caps on systems to be used in new work shall be provided to protect systems during construction.

4. New roof openings for the HVAC unit or exhaust ductwork thru the roof: X-ray the existing roof to locate the tendons within the concrete planks.

1.02 SUBMITTALS

A. Submit the following in accordance with City of Chandler General Conditions:

1. Copies of permits and notices authorizing building demolition as may be required by law, including permits to transport and dispose of debris.
2. Shop Drawings: Drawings of temporary structural support locations and calculations sealed by a Structural Engineer registered in the State where the project is located.

3. Demolition Plan:
 - a. The scope of the demolition plan for both structure and selective demolition will be carefully reviewed and coordinated with City of Chandler and Design Team to ascertain the existence of any hazardous materials requiring special attention. Most laboratory equipment will require decontamination before demolition and/or removal, i.e., fume hoods, laminar flow enclosures, clean benches, biological safety cabinets, etc.
 - b. The demolition plan for both structure and selective demolition shall identify all materials/equipment, etc., which are to be reused and/or salvaged by either the City of Chandler or the Contractor. Please keep in mind that all equipment and building material is ultimately the property of the City of Chandler and only when its salvage cost exceeds its usable value is it to be considered unwanted. This determination can only be made by the City of Chandler.
 4. Insurance: Submit proof of insurance as required by Owner.
- B. Submit project record documents which accurately record actual locations of capped utilities, and concealed obstructions in accordance with City of Chandler General Conditions.

1.03 QUALITY ASSURANCE

- A. Demolition Firm Qualifications:
1. Specializing in performing the Work required by this Section and as indicated on Demolition Drawings.
 2. Minimum 5 years documented experience.
 3. Utilizing workers experienced in disconnecting and capping utilities, if applicable.
- B. Regulatory Requirements
1. Conform to applicable code(s) for demolition of structures, safety of adjacent structures, dust control, runoff control and disposal.
 2. Obtain required permits from authorities.
 3. Notify Architect immediately if hazardous or contaminated materials are discovered.

1.04 PROJECT CONDITIONS

- A. Survey existing conditions prior to beginning on-site demolition operations. Survey must be performed by a competent person.
1. Provide written pre-demolition survey to Architect and Owner that includes the following:
 - a. Determination of condition of framing, floors, and walls, and possibility of unplanned collapse of any portion of structure or adjacent structure.
 - b. Various phases of demolition and description of how employees will be protected from unplanned contact with active utilities, exposure to toxic materials and gases, falling objects, structural collapse, and any other hazards routinely associated with demolition activities.
 2. Verify that utilities have been disconnected and capped.
 3. If unanticipated mechanical, electrical or structural elements that conflict with intended function or design are encountered, investigate and measure nature and extent of conflict.
 - a. Promptly submit written report to Architect and Owner.
 - b. Pending receipt of directive from Architect and Owner, rearrange selective demolition schedule, and notify Architect and Owner as necessary to continue overall job progress without delay.

- C. Provide Demolition Survey, according to 29CFR 1926.850(a), whenever structural integrity of building components may be compromised or when structure is to be completely demolished.

1.05 SEQUENCING

- A. Sequence activities to demolish the work in accordance with the Contractor's Project Schedule.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Carefully remove salvageable items such as light fixtures, grilles, doors, hardware, plumbing fixtures, and other items which are not specifically indicated for reuse, but which may have salvage value.
 - 1. Remove materials and equipment as noted on Demolition drawings that Owner will salvage prior to demolition.
 - 2. Materials and equipment which are not salvaged by the Owner shall become the possession of the Contractor and shall be immediately removed from the site in accordance with City of Chandler General Conditions.
- B. Carefully remove materials (in whole or in part as required) that are scheduled for reuse. Store and protect for reinstallation the materials.
 - 1. Concrete: Crushed and graded concrete may be used as aggregate, sub-base material, or fill.
 - 2. Asphalt Material: Sort by type. May be recycled for asphalt paving products or used as fill off site.
 - 4. Wood: Sort by type and size for salvage. Wood unsuitable for salvage shall be properly disposed of
 - 5. Metal: Salvage metals for recycling.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions and notify the Architect in writing of discrepancies before proceeding with the work.
- B. When unanticipated mechanical, electrical, or structural elements that conflict with the intended demolition are encountered, investigate and measure the nature and extent of the conflict. Promptly submit a written report to the Architect.
- C. A complete investigation of the area(s) shall be performed so that all existing aspects and elements affected by the project are either removed under the demolition plan or incorporated into the new work with the installation drawings, i.e., existing/abandoned outlets, t-stats etc.

3.02 PREPARATION

- A. Utility Services:
 - 1. Notify affected utility companies before starting work and comply with their requirements.
 - a. Mark location of utilities.
 - b. Identify, disconnect, remove and cap designated utilities within demolition areas.
 - 2. Maintain existing utilities indicated to remain in service and protect against damage during demolition operations.
 - a. Extent of electrical and mechanical utilities to be removed is shown on Contract Drawings.
 - b. All electrical services discontinued with the demolition effort shall be properly "tagged out".
 - 3. Schedule utility outages through Architect and Owner. At least two weeks notice is required for most outages.
- B. Provide, erect, and maintain temporary barriers and security devices where required and as indicated on drawings.
- C. Protect bench marks and existing work from damage or displacement.
- D. Prevent movement or settlement of adjacent construction, provide and place bracing and be responsible for safety and support of adjacent construction.
 - 1. Assume liability for such movement, damage or injury.
- E. Protection of existing building exterior. Erect barriers as indicated and as otherwise required to protect adjacent buildings and site amenities. Maintain exit requirements.
- F. Roofing Removal: During the removal of the existing parapets and roofing, provide proper protection from falling objects.

3.03 GENERAL DEMOLITION

- A. Carry out demolition work to cause as little inconvenience to any adjacent occupied building or site areas as possible and with minimum interference to public or private accesses. Maintain protected egress and access at all times.
 - 1. Conduct demolition operations and remove debris in manner to ensure minimum interference with roads, streets, walks, and other adjacent occupied or used facilities.
 - 2. Conduct demolition operations to prevent injury to people and damage to adjacent buildings and facilities designated to remain.
 - a. Provide protective measures as required to provide free and safe passage to and from occupied portions of buildings and for the handicapped that meet ADAAG.
 - b. Provide temporary barricades and other forms of protection as required for safety and security.
 - c. Provide barriers and appropriate signs meeting requirements of 29 CFR 1910 for size and color where necessary to restrict pedestrians from wandering into construction areas.
 - d. Provide temporary weather protection during interval between demolition and removal of existing construction on exterior surfaces and installation of new construction to ensure no water leakage or damage occurs to structure or interior areas of existing building.
 - e. Protect walls, ceilings, floors, and existing finish work that are to remain in place and are exposed during demolition operations.

- f. Cover and protect furniture, equipment, and fixtures that are to remain from soiling or damage.
 - 3. Demolition work is usually associated with trash and dust. Appropriate provisions shall therefore be made to address mitigation procedures in the demolition work.
 - a. Erect and maintain dust-proof partitions and temporary enclosures to limit dust or dust migration, and to separate areas from fumes and noise.
 - 4. Provide and maintain interior and exterior shoring, bracing or structural support to preserve stability and prevent movement, settlement, or collapse of structures and adjacent facilities that are not part of demolition.
 - 5. Provide acceptable temporary security barriers where physical security of buildings or fences is compromised due to demolition work.
- B. Shore existing construction as required to maintain safe working environment.
- C. Cease operations immediately if adjacent structures appear to be in danger. Notify authority having jurisdiction and Architect. Do not resume operations until safety is restored as directed by Architect.
- D. Provide hoses and water connections for sprinkling of debris as necessary to limit dust to lowest practicable level.
- E. Demolition
 - 1. General: Perform demolition work in accordance with 29 CFR 1926, with particular attention to requirements set forth in Subpart T, "Demolition".
 - a. Perform work in safe and systematic manner.
 - b. Use such methods as required to complete work indicated on Contract Drawings and minimize disturbance of Owner's normal operations.
 - 2. Demolish and remove existing construction only to extent required, and as indicated in Contract documents.
 - 3. Wear proper personal protective equipment at all times.
 - 4. Use water as necessary to lay dust when chipping, coring, or sawing concrete, masonry or similar materials. Water must be controlled inside buildings by damming, mopping or vacuuming. Prevent water from entering underfloor electrical ducts.
 - 5. Completely backfill below-grade areas and voids resulting from utility removal and other demolition work.
 - 6. Remove debris from roof or other above-grade location through enclosed chute or bundle, and lower by hand or with hoisting device.
- F. Repairs
 - 1. Repair demolition performed in excess of that required.
 - 2. Return structures and surfaces not part of demolition, to conditions existing prior to commencement of demolition work.
 - 3. Promptly repair adjacent construction or surfaces soiled or damaged by demolition work at no cost to Owner.
- G. Explosives: Use of explosives is not permitted.
- H. Material Disposal: In accordance with City of Chandler General Conditions and as follows.
 - 1. General: Promptly dispose of debris, rubbish, and other materials resulting from building site demolition operations.
 - a. Remove materials from site and dispose of in accordance with the City of Chandler General Conditions.

- b. No materials are to be sold on, or adjacent to, the site. Signs advertising the sale of materials shall not be allowed.
 - c. Burning of materials on site is not permitted.
 - 2. If Contractor encounters material during removal that is suspected to be potential hazard, stop work immediately and notify Architect and Owner. Remove from site, contaminated, vermin infested, or dangerous materials encountered and dispose of by safe means so as not to endanger health of workers and public.
 - 3. Architect and Owner shall determine salvageable items, if not indicated in Contract documents.
 - 4. Debris from the demolition shall not be allowed to accumulate within the building or on the site.
 - 5. Fluorescent light fixture tubes and certain light fixture ballasts must be separately disposed of in accordance with applicable environmental regulations.
- I. Cleaning
- 1. Remove tools, equipment and demolished materials from site upon completion of demolition work.
 - 2. Remove protections as approved by Architect and Owner and leave interior areas broom clean.

END OF SECTION

SECTION 03 30 00

CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: Cast-in-place concrete including, but not limited to, the following:
 - 1. The existing recessed slab within the pilot room shall be infilled in to allow for the new lab space. The void will be infilled with steel decking as specified in Section 05 31 00 and concrete topping slab as indicated on Structural Drawings.
 - 2. Repairs to existing concrete as noted on Drawings or as indicated on Drawings.

1.02 SYSTEM DESCRIPTION

- A. Performance Requirements – New concrete floor slabs: Interior slabs on grade scheduled to receive applied floor finishes (VCT, carpet, etc.) shall be tested as specified herein under Field Quality Control Calcium chloride test requirements. Moisture vapor from the floor must be less than 3 pounds per 1,000 square feet per 24 hours. Floor slabs that exceed this requirement shall be treated with a Vapor Reduction Floor Coating as specified in Section 07 26 53 as required to provide a satisfactory substrate for applied floor finish at no additional cost to Owner.

1.03 SUBMITTALS

- A. Mix Design: Submit mix design for each class of concrete to the Architect for review. Review of mix designs by Architect and/or Engineer shall in no way relieve the Contractor of responsibility for the performance of the concrete.
- B. Product Data:
 - 1. Accessory Products: Submit Manufacturer's Specifications and performance data.
 - 2. Concrete Resurfacing: Submit manufacturer's specifications and installation instructions.
- C. Shop Drawings:
 - 1. Concrete Reinforcement Submittals: Prepare shop drawings in accordance with Chapter 6, ACI 301 & Chapter 3, Part B, ACI SP66.
- D. Samples: Submit 4 inch long samples of expansion/contraction joint and control joint.

1.04 QUALITY ASSURANCE

- A. Standards:
 - 1. Concrete Standards: Comply with the most recent version of ACI 117, 223, 301, 302, 1R, 305R, 306R, 308, SP66 and 347R.
 - 2. Standard for measuring, mixing, transporting and placing of concrete shall be ACI-301 and ACI-304.
 - 3. Standard for measuring, mixing and delivery of ready mixed shall be ASTM C94, except that time in mixer after water has been added at batch plant is limited to 1-1/2 hours.
 - 4. Job-mixed concrete shall be subject to Architect's review of design, mixing and handling procedures.

- B. Quality Control: In accordance with City of Chandler General Conditions

1.05 PROJECT CONDITIONS

- A. Rain protection: Do not place concrete during rain unless adequate protection has been provided.
- B. Cold weather protection: Comply with ACI-306R.
- C. Hot weather protection: Comply with ACI-305R.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Portland Cement: ASTM C150, Type II, alkali content not to exceed 0.6 percent. Use one brand and type of cement throughout Project unless otherwise specified.
- B. Aggregate:
 - 1. Structural Concrete: Clean, coarse aggregate and gravel, free from foreign matter, conforming to ASTM C33. Aggregate shall be graded from coarse to fine in accordance with ASTM C33, Size 67.
- C. Admixtures and air entrained concrete to comply with ASTM C494, ASTM C260, and ACI 211. Calcium chloride and admixtures containing more than 0.05% chloride ions are not to be used in any concrete mix.
- D. Water: Potable.
- E. Reinforcing steel: ASTM A615, Grade 60, fabricated and installed in compliance with the requirements of ACI 301, 315 and 318.

2.02 ACCESSORIES

- A. Bonding Agent:
 - 1. Interior Only (PVA): L&M Construction Chemicals EVERWELD www.lmcc.com, US Spec "Bondcoat" www.usspec.com, or Larsens' Weld Crete www.larsenproducts.com
 - 2. Interior Only for Bonding Existing Concrete to Fresh Concrete (Epoxy): Sika Sikadur 32, Hi-Mod www.sikausa.com, US spec Maxi-Bond 2500 www.usspec.com, or W.R. Meadows Rezi-Weld www.wrmeadows.com.
 - 3. Exterior and Interior (acrylic latex): Euclid Eucobond www.euclidchemical.com, W.R. Meadows Intralok www.wrmeadows.com, US Spec Acylcoat www.usspec.com, or Dayton Bond J40 www.daytonsuperiorchemical.com.
- B. Non-Shrink Grout:
 - 1. Premixed or prepackaged, non-metallic, non-gaseous, bleed free compound; non-shrink when tested in accordance with ASTM C 1107, Grade B at a fluid (flow cone) consistency of 20 to 30 seconds.
 - 2. Attain minimum compressive strength of 5,000 psi in 28 days at above fluid consistency.
 - 3. Fluid grouts: Remain workable, flow through flow cone after 20 minutes with slight agitation, in temperatures from 40 to 90 degrees F.

4. Acceptable manufacturer and products: Dayton Superior (Suregrip High Performance) www.daytonsuperiorchemical.com, Sika (Sikagrout 212) www.sikausa.com, Master Builders (Masterflow 713) www.masterbuilders.com, W.R. Meadows No. 588 Grout www.wrmeadows.com, L&M Construction Chemicals (DURAGROUT) www.lmcc.com, US Spec "MP Grout" www.usspec.com, and Euclid N-S Grout www.euclidchemical.com.
- C. Preformed Expansion Joint Filler: ASTM D1751.
- D. Liquid Curing Compound: Provide acrylic resin or dissipating hydrocarbon resin type as applicable to final floor finish as recommended by curing compound manufacturer. See also General Structural Notes.
 1. Acrylic Resin Type:
 - a. VOC compliant, ASTM C309, Type 1, Class B; acrylic type.
 - b. W. R. Meadows Sealtight VOCOMP-20, L&M Construction Chemicals Dress & Seal WB, US Spec Hydrasheen 15%, or Dayton Superior J-18 are acceptable products.
 2. Dissipating Hydrocarbon Resin Type: US Spec Maxcure Resin Clear HS, water-based, high solid, dissipating resin curing compound.
 3. Verify that specified curing compound is compatible with the floor finish material(s) and adhesive(s) that will be applied to floor surface prior to delivery of curing compound to jobsite. If it is determined that the curing compound is not compatible with the floor finish material(s) and adhesive(s) that will be applied to floor surface, Contractor shall immediately notify Architect.
- E. Sealer: VOC compliant, acrylic copolymer type for floor applications.
- F. Light-Duty Dust-Proofing: For use during construction. To be topped with acrylic sealer.
 1. Magnesium fluosilicate: Burk-O-Lith, L&M Construction Chemicals FluoHard, Sonneborn Lapidolith, Euclid Surfhard, Dayton-Superior J-15 Day Chem Hardener or W.R. Meadows Penalith.
 2. Sodium silicate: L&M Construction Chemicals Chem Hard, W.R. Meadows Dustgard or Cure-Hard, Dayton-Superior J-13, Sonneborn Sonosil, Euclid Eucosil, or US Spec Permasil..
- G. Leveling Agent: Sonneborn Sonoflow, Euclid Flo-Top, Ardex K-15, L&M Construction Chemicals Levelex, US Spec "Self-Leveling Underlayment, or Dayton-Superior Levelayer 1 are acceptable products.
- H. Concrete Accessories: Gateway Engineering Company, Dayton-Superior Corporation, or Burke Concrete Accessories.
 - i. Evaporation Retarder:
 1. Type: Monomolecular film, compatible with subsequent coatings and floor finishes.
 2. Acceptable Manufacturer and Products: L&M Construction Chemicals (E-Con), Master Builders (Confilm), Sika (Sika Film), W.R. Meadows (Evapre), US Spec (Monofilm ER), or Dayton Superior (Surefilm J-74). U.S. Spec "Top-Etch."

2.03 MIXES

- A. Design of Mixes: ACI 301 and ACI 304, except as otherwise specified.
- B. Selection of proportions for normal weight concrete: ACI 301.

- C. Mix and deliver ready-mixed concrete in accordance with requirements of ASTM C94, Option A.
 - 1. Not more than 90 minutes shall elapse from time water is introduced into the concrete mixture until completion of placement.
 - 2. Do not add water to mix that has stiffened to increase its workability.
 - 3. At no time shall concrete mix exceed a bulb thermometer reading of 90 degrees F. or over.
 - 4. Use ice or other method as reviewed by Architect, to keep concrete below 90 degrees F. temperature.
- D. Water-cement ratio for concrete used for interior slab construction: 0.50.
- E. Use of water reducing admixture, if needed, shall be submitted for approval. Proportion water reducing admixture in accordance with Manufacturer's recommendations. Delivery tickets shall state the amount and kind of admixture.
- F. Compressive strength (28 day): In accordance with General Structural Notes.
- G. Slump: Place concrete at an average slump of no less than 3 inches. Slump is not to exceed 4 inches.

PART 3 EXECUTION

3.01 PREPARATION

- A. Prior to placing concrete:
 - 1. Clean equipment involved.
 - 2. Remove debris and foreign material from the forms.
 - 3. Remove concrete laitance from reinforcing steel.
 - 4. Wet wood forms and masonry units in contact with concrete.
- B. No wood other than built-in bucks or nailing blocks will be permitted to remain permanently inside the forms.
- C. Coordinate the necessary Trades as required to provide the sleeves, bolts, anchors, holes, etc., to be built in.

3.02 PLACING OF CONCRETE

- A. Concrete Work shall be performed in accordance with ACI-301 except as amended by this Section.
 - 1. Set forms with survey instrument. Wet screeding is not allowed. Placement method should eliminate concrete segregation.
 - 2. Provide finishing tools including power floats and trowels to produce the required flatness/levelness specified herein and hand trowel finish. Monitor flatness during finish operation with 10'-0" highway straightedge and verify with testing lab.
- B. Convey concrete from the mixer to place of final deposit by methods which will prevent segregation of aggregate or loss of material. Place concrete at such a rate that concrete is at all times plastic and to insure a practically continuous flow of concrete. Concrete not in place 1-1/2 hours after water has been added at batch plant may be rejected by Architect.

- C. Place concrete as nearly as practicable in its final position to avoid segregation due to rehandling or flowing. Do not deposit concrete that has partially hardened or been retempered.
- D. Do not place concrete during rain unless adequate protection has been provided.
- E. Thoroughly compact concrete by suitable means during the placing, and work around the reinforcement and embedded items into the corners of the forms.
 - 1. Use vibrators to aid in the placement of the concrete, operated by experienced personnel.
 - 2. Keep at least one spare operating vibrator on the job at all times during the concrete operations.

3.03 CONSTRUCTION JOINTS, EXPANSION/CONTRACTION JOINTS AND CONTROL JOINTS

- A. Construction Joints: Provide as required to facilitate construction in accordance with reviewed shop drawings. See Structural Foundation Plan and General Structural Notes for additional information.
 - 1. Saw cut control joints in a square pattern before temperature checking and cracking begins as soon as strength is such that cutting will not disturb large aggregate (maximum 8 hours after start of pour).
 - 2. Control joint depth is to be 25% of slab depth.
 - 3. Joints are to be spaced equally in feet to 2 to 3 times the slab depth in inches (5-1/2 inch would be 11'-0" to 16'-6")
 - 4. Provide isolation joints as recommended by ACI 302 for ASTM C150 cement mixes and ACI223 for ASTM C845 cement.
 - 5. Provide dowels with no bond on one or both ends at isolation joints.

3.04 FINISHING VERTICAL (FORMED) SURFACES

- A. Formed surface finishes:
 - 1. Pits, tunnels, mechanical rooms and concealed surfaces: Remove fins, patch tie holes.
 - 2. Interior exposed surfaces and exterior exposed surfaces: Remove fins, patch tie holes, stone joint marks and out-of-plane surfaces to within 1/16 inch of flush, to produce uniformity, dense and smooth concrete.
 - 3. Exposed elements: Removal all scale. Make ready and provide preparation as required for acceptance of finish primer, pain, and/or seal.

3.05 FINISHING HORIZONTAL SURFACES

- A. Rake concrete into place, screed and compact with a light tamp, except do not tamp topping and slabs not on grade. Screed with sawing motion and float surface to bring fines to the top.
- B. Mix and apply evaporation retarder in accordance with manufacturer's printed instructions immediately after floating. In extreme drying conditions, apply additional material as needed. Apply lightly on hard to trowel floor areas.
- C. When concrete has hardened sufficiently so that excess fines will not be brought to the surface, trowel slab with a steel trowel to a smooth surface free of pinholes and other imperfections. A mechanical trowel with rotating steel blades, approved by Architect, may be used for this operation.

- D. After the surface has hardened sufficiently to ring under a trowel, trowel again with a steel trowel to a hard, burnished surface free of blemishes. A mechanical rotating trowel will not be permitted for this operation.
- E. Concrete Finishes:
 - 1. Exposed floor: Hard steel trowel finish in compliance with Class 5 requirements per Table 3.14.2(a) of ACI 301 without topping.
 - 2. Under carpet, thin set ceramic tile, and resilient tile: Steel trowel finish.
 - 3. External concrete ramps, driveways and parking lots: Stiff broom finish. Provide truncated dome surface at ADA accessible ramps..
 - 4. Stair treads and all other paving: Light broom finish.
 - 5. Hardscape to have integral color with light acid wash finish.
 - 6. Concrete Columns (exposed to view in final work): Class A Finish.

3.06 SLABS

- A. Saw cut or score control joint pattern indicated on Drawings. Use 3/16 inch thick blade or scoring tool, cutting 1/4 of depth of slab thickness.
- B. Slope to drains 1/4 inch per foot nominal across entire room or area to be drained.

3.07 REPAIR OF SURFACE DEFECTS

- A. Modify or replace concrete not conforming to required lines, detail and elevations.
- B. Repair or replace concrete not properly placed, resulting in excessive honeycombing and other defects. Do not patch, repair or replace exposed architectural concrete except upon express direction of Architect.
- C. After forms are removed, fill tie rod holes, correct honeycomb spots, remove fins and clean and finish damaged surfaces. Wipe off excess mortar and rub to match adjoining surfaces.
- D. When excessive honeycombing is revealed, remove the defective material immediately after stripping forms to a depth of 3/4 inch to 1 inch. Cut edge of area perpendicular to surface to avoid feathered edges. Saturate with water for several inches beyond cutout and brush-in a grout consisting of equal parts Portland cement and sand. Follow immediately with the patching mortar. Leave the patch slightly higher than the surrounding surface. After an hour or two, finish flush with the adjoining surface. Wipe and rub patch to match adjoining surfaces. Keep patches moist for 7 days.
- E. Patching mortar shall consist of the same materials and proportions as the original concrete except that the coarse aggregate shall be omitted.
- F. Cracks caused by expansion, shrinkage and the like that occur in natural color concrete up through final acceptance of building shall be carefully patched with floorstone, epoxy grouting mortar or other method acceptable to the Architect.

3.08 CURING

- A. Protect freshly deposited concrete from premature drying and maintain without drying at a relatively constant temperature for the period of time necessary for the hydration of the cement and proper hardening of the concrete.

- B. Curing Methods: Cure concrete surfaces receiving finish materials, including, but not limited to; cementitious toppings, paint, and flooring, using one of the following two methods immediately after finishing operations. Consideration shall be given to the construction schedule impact and the compatibility of finish materials with the concrete when selecting a method.
 - 1. Keep concrete continuously moist for at least 7 days using polyethylene film or other acceptable covering. Interior floor slabs on grade shall be continuously moist cured for a minimum of 7 days in accordance with ACI standards, liquid curing compounds shall not be acceptable.
 - 2. Apply liquid curing compound in accordance with the manufacturer's instructions. Remove curing compound before finish materials are applied unless it has been demonstrated that the curing compound can satisfactorily serve as a base for finish materials. Method of removal shall result in a satisfactory base for finish materials.
- C. Prevent rapid drying of the concrete at the end of the curing period.
- D. During the curing period, protect the concrete from damaging mechanical disturbances, particularly load stresses, heavy shock, and excessive vibrations. Protect finished concrete surfaces from damage caused by construction equipment, materials or methods.
- E. Slab Curing, Hardening and Sealing Compound:
 - 1. Curing compounds and form release agents shall be non-staining and compatible with the wall and floor finishes specified.
 - 2. Sealed concrete: Prior to application of sealer, floors shall be cleaned with a "side by side" machine, wet vacuum and rinsed.
 - 3. Penetrating sealers on exposed interior concrete floors shall be compatible with Waxie "Floorstar" products. Sealer or finish should be applied immediately after the dissipation of the curing compound in order to protect floors during construction and then cleaned and reapplied prior to final acceptance.
 - 4. Apply in accordance with manufacturer's printed instructions.
 - 5. Buff to achieve high-gloss finish.
 - 6. Comply with Manufacturer's specification and ACI308.

3.09 FIELD QUALITY CONTROL

- A. Tests: Inspection and testing of concrete mix will be performed by a testing laboratory in accordance with City of Chandler General Conditions.
 - 1. Provide free access to Work and cooperate with appointed firm.
 - 2. Tests of cement and aggregates may be performed to ensure conformance with specified requirements.
 - 3. Four concrete test cylinders shall be taken for every 100 or less cubic yards of concrete placed. One cylinder shall be tested after 7 days for information. Test two cylinders after 28 days. Hold one cylinder for additional information, as required.
 - 4. Take one additional test cylinder during cold weather concreting, and cure on job site under same conditions as concrete it represents.
 - 5. Take one slump test for each set of test cylinders taken.
 - 6. Concrete which does not meet the compressive strength requirement at 28 days will be rejected and removed from the Project, and disposed of in a legal manner.

- B. Calcium chloride test requirements:
1. Two weeks before installation of the ceramic tile, VCT, vinyl, wood, carpet, epoxy flooring and/or other finish flooring systems over the interior concrete slabs, provide calcium chloride test to determine the level of water vapor transmission in the slab.
 2. Conduct testing in accordance with ASTM F1869 or ASTM E1907 (quantitative anhydrous calcium chloride test).
 3. Conduct calcium chloride tests after HVAC system has been in continuous use for 36 hours with a minimum ambient temperature of 72 degrees F. Water vapor transmission levels are directly affected by ambient room temperature and readings conducted without a sustained ambient temperature is NOT acceptable.
 4. Document test results and provide copy to Architect with a marked up floor finish plan showing test results.
 5. Provide a written clarification on status of HVAC system before and during the test and the length of time the ambient air temperature was maintained before the tests.

3.10 PROTECTION

- A. Protect finished surfaces from stains or abrasions. Protect surfaces or edges by leaving forms in place or by providing temporary covers. Protect concrete from rain, flowing water or mechanical injury.
- B. Protect floor slabs from the droppings of plaster, paint, dirt, and other marring by covering with acceptable floor protection covering, well lapped and sealed. Polyethylene plastic sheet and the use of adhesive tapes may create condensation and/or alkali staining of concrete surface and their use shall be carefully considered.
1. Method used to hold protective sheets and coverings in place where slabs comprise the finished surface shall not leave permanent discoloration. Duct tape (and other similar non-breathable adhesive tapes) shall not be used to hold coverings in place on floor slabs that will remain exposed in the final work.
 2. Where concrete slabs are scheduled to be the finished floor surface, or where slab is treated with a special concrete finish serving as the finished floor surface, provide a continuous covering of 1/2 inch particle board, joints tightly butted and cut to sizes tight to wall construction, over entire floor area with Owner approved acceptable floor protection sheeting.
 - a. Maintain covering (protective sheeting and particleboard) in good condition until danger of damage is past.

3.11 CLEANING

- A. During the course of the Work and on completion of the Work, remove and dispose of excess materials, equipment and debris away from premises.

END OF SECTION

SECTION 05 12 00

STRUCTURAL STEEL FRAMING

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: Structural steel framing including, but not limited to:
 - 1. Columns
 - 2. Beams
 - 3. Lintels
 - 4. Anchor Bolts
 - 5. Shelf Angles
 - 6. Bearing Plates,
 - 7. Miscellaneous Structural steel items.

1.02 SUBMITTALS

- A. Shop Drawings: In accordance with City of Chandler General Conditions
 - 1. Submit shop and erection Drawings clearly showing each piece required for fabrication and erection.
 - 2. Drawings shall include material grade, camber, holes and other pertinent data.
 - 3. Indicate welds by standard AWS symbols showing size, length, and type of each weld.
 - 4. Submit anchor setting drawings clearly showing location of all anchor bolts and embedded plates to be anchored in concrete and masonry construction. Provide templates for anchor bolts.
- B. Test Reports: Submit reports for welded connection tests.

1.03 QUALITY ASSURANCE

- A. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category STD.
- B. Welding:
 - 1. Performed by certified welders in compliance with AWS D.1 Structural Welding Code.
 - 2. Welders shall be duly qualified within the last 12 months in the position in which they are to weld and the qualifications and Specifications for workmanship shall comply with the AWS requirements "AWS Structural Welding Code - Steel."
- C. Certifications:
 - 1. Prior to fabrication or shipment of material to the job site, furnish certification of the Manufacturer of the structural steel that material furnished meets or exceeds requirements of ASTM standards specified or noted on Drawings, for each type of material.
 - 2. Prior to site welding operation, submit welders' written certifications and qualifications.
- D. Tolerances: All steel exposed to view shall be architectural steel, and tolerances as a minimum shall comply with section 10 of AISC code of standard practice.

1.04 DELIVERY, STORAGE AND HANDLING

- A. Exercise care during unloading, storage and erection to avoid damage. Dumping on the ground is not permitted.
- B. Support material stored at the site completely free of the ground, and cover to avoid damage from the elements.

PART 2 PRODUCTS

2.01 MATERIALS

- A. General: Materials shall be new, of uniform quality, suitable and without defects affecting the strength or service of the structure.
- B. Structural Steel: ASTM A572 or A992, except angles, channels and plates shall be ASTM A36 (Fy = 36ksi).
- C. Bolts:
 - 1. Machine Bolts: ASTM A307, unless otherwise indicated.
 - 2. High Strength Bolts: ASTM A325.
- D. Welded Anchors and Shear Connectors: ICBO approved, as manufactured by KSM or Nelson.
- E. Welding Rods: AWS A5.0, E70 series, low hydrogen type.
- F. Metal Primer: VOC compliant, Tnemec FD88-559 Gray.
- g. Exposed steel to be galvanized.

2.02 FABRICATION

- A. Workmanship and details of construction (except as otherwise indicated or specified) shall be in conformity with applicable articles of the latest AISC Manual, Parts 1 through 4; AISC Specifications; except Section A7 (Design Documents) and Chapter N (Plastic Design); and the applicable building codes. Sections 3.1, 3.4 and 4.2 of AISC code of Standard Practice are specifically excluded from this work.
 - 1. Sections shall be of dimensions, weight and design as indicated, assembled complete at the shop, with base plates and other detailed materials attached.
 - 2. Furnish 1/4 inch thick leveling plates at columns where base plates are shop fabricated to columns.
 - 3. Make connections as indicated or detailed, on the Drawings and the reviewed shop and erection Drawings.
 - 4. Exposed steel shall have smooth, clean surfaces with no identifying trade marks, names etc., exposed to view.
 - 5. Leave in condition for finish painting.
- B. Bolted connections shall be as detailed or shall conform to AISC standard bolted connections with maximum number of 3/4-inch diameter bolts. See Framed Beam Connections Tables II, III, or IV of AISC Manual of Steel Construction.
- C. No slotted holes permitted at steel connections unless shown on Drawings or approved by Structural Engineer.

- D. Where bolt holes in steel members are enlarged to more than 1/16 inch diameter oversize, provide 3/16 inch x 2-1/2 inch x 2-1/2 inch plate washers to steel members with 3/16 inch fillet weld all around.
- E. Loose Steel Lintels: Provide loose structural steel shape lintels for openings and recesses in masonry walls and partitions, as shown. Weld adjoining members together to form a single unit. Provide not less than 4 inch bearing at each side of openings, unless otherwise shown.
- F. Shelf Angles: Provide structural steel shelf angles of sizes shown for attachment to concrete framing. Provide slotted holes to receive 3/4 inch bolts, spaced not more than 6 inches from ends and not more than 24 inches o.c., unless otherwise shown.
- G. Loose Bearing Plates: Provide loose bearing plates for steel items bearing on masonry or concrete construction, made flat, free from warps or twists, and of required thickness and bearing area. Drill plates to receive anchor bolts and for grouting as required.

2.03 SHOP FABRICATION FOR USE OF HIGH STRENGTH BOLTS

- A. Joint surfaces, including those adjacent to the bolt heads, nuts or washers, shall be free of loose mill scale, burrs, or any foreign material (including paint). Field paint these areas with the specific shop paint after erection and completion.
- B. Provide "n" type bolts for bearing only.

2.04 SHOP WELDING

- A. Make welds by the electric-arc process.
- B. Grind exposed welds smooth.
- C. Where weld size is not indicated, it shall develop full strength of member and connection.

2.05 PAINTING - SHOP COAT

- A. Items of steel and iron Work indicated or specified to be encased in concrete shall not be painted.
- B. Clean steel Work by wire brushing, or by other means selected by the fabricator, of loose mill scale, loose rust, accessible weld slag, or flux deposit, dirt and other matter. Remove oil and grease deposits by solvent.
- C. After cleaning, give steel Work one coat of metal primer. Apply primer thoroughly and evenly to dry surfaces by brush, spray, roller coating, flow coating or dipping at the selection of the fabricator.
- D. Apply primer at a rate of 350 sq. ft. per gallon to provide a wet film of 4.5 mils.
- E. Paint erection marks on painted surfaces. Touch-up surfaces where welding, grinding of welds, joints, etc. are done in the field.
- F. The paint shall be thoroughly dry before the members are handled or loaded.

2.06 SOURCE QUALITY CONTROL

- A. Tests: Where a welded splice is fabricated in beams or columns other than those detailed, fabricator shall have splice connection tested using one of the following methods: magnetic particle, radiographic, or ultrasonic. Testing shall be conducted by an independent testing laboratory and a report submitted to the Architect. The costs of this testing shall be borne by the fabricator.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 - 1. Verify anchor bolt locations, grouting and elevation of base and setting plates, and other material set by other Trades before commencing Work.
 - 2. Notify Architect of Work set by others which does not comply with specified tolerances. Do not erect material upon such Work until it has been satisfactorily corrected.
 - 3. Start of Work implies acceptance of Work of other Trades affecting structural frame erection.

3.02 ERECTION

- A. Erect Work to the proper lines and levels, plumb and true, and in correct relation to other Work maintain this condition to completion.
- B. Connections:
 - 1. Machine Bolting:
 - a. Fair-up holes with pins to align holes before bolting.
 - b. Ream unfair holes to obtain alignment or drill new holes.
 - c. Enlargement of holes with drift pins or burning of new holes is not permitted.
 - d. Draw bolts up tight after members are aligned and leveled, and set or deform threads to prevent loosening.
 - 2. Welding:
 - a. Weld by shielding arc method per AWS standard code for arc and gas welding in building construction.
 - b. Submit certification that welders have passed AWS code qualification tests.
 - c. Refer to Shop Drawings for weld size and dimensions.
 - d. Close joints exposed to weathering with continuous 1/8 inch weather welds.
 - e. Grind smooth exposed welds, but grinding shall not reduce weld strength or required cross section.
 - f. Protect finish material from damage due to welding.
 - g. Remove unsatisfactory welds by chipping or arc method.
 - 3. Connect members temporarily and align completely before making permanent connections.
 - a. Temporary conditions shall consist of bolts in no less than 1/3 of the holes and in no case less than 3 bolts in any single connection.
 - b. Surfaces in contact shall be thoroughly clean when assembled.
 - c. Provide necessary temporary bracing and guying to align the structure properly for permanent connections, and safely resist erection, dead load and wind stress.

- d. Take particular care to have the Work plumb and level (maximum slope ratio tolerance 1 to 500 for interior members, 0 to 1000 for exterior members) before making permanent connections.
 - e. Remove bracing and guys only after permanent alignment and assembly and structure is capable of completely sustaining design and temporary construction loads.
- C. Exposed Steel:
 - 1. Verify the condition of exposed steel after erection.
 - 2. Exert particular care to provide a neat, accurate installation with members straight and true, corners and edges square, sharp and free from burrs and irregularities, adjacent members perfectly matched and no bolts or rivets exposed.
 - 3. Remove erection bolts and seats and plug weld and grind holes smooth.
 - 4. Provide galvanize coating per General Structural Notes on Drawings.
- D. Touch-up Painting:
 - 1. Remove temporary guys, bracing and bracing clips, and grind flush remaining burrs, before painting. Remove welding slag, spatter, rust and burnt paint and wire brush clean welds before touch-up.
 - 2. Touch-up Painting: Touch-up welds, abrasions, bolted connections, and other areas where shop prime paint has been removed or is damaged with specified prime paint or galvanizing repair paint.

3.03 CLEANING

- A. During the course of the Work and on completion of the Work, remove excess materials, equipment and debris and dispose of away from premises.

END OF SECTION

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SECTION 05 31 00

STEEL DECKING

PART 1 GENERAL

1.01 SYSTEM DESCRIPTION

- A. Design Requirements:
 - 1. Increase S and I properties for simple or two span continuous to achieve equivalent load capacity. Minimum allowable diaphragm shear furnished, per ICC report, shall be 520 pounds per foot.
 - 2. Sections and properties shall meet AISC Specifications.

1.02 SUBMITTALS

- A. Shop Drawings: Submit shop and erection Drawings showing layout, material and fastening methods and each piece to be erected. Note deck welding pattern and physical properties of decking.
- B. Report: Submit ICC report showing diaphragm shear test.

1.03 QUALITY ASSURANCE

- A. Welding: Performed by certified welders in compliance with AWS D.1.3 requirements and procedures for manual shielded metal arc welding.
- B. Certifications:
 - 1. Prior to fabrication or shipment of material to the job site, furnish certification of the manufacturer of the steel decking that material furnished meets or exceeds requirements of ASTM standards specified or noted on Drawings, for each type of material.
 - 2. Prior to site welding operation, submit welders' written certifications and qualifications.

1.04 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store and handle metal decking in manner which will prevent damage or deformation.
- B. Stack decking stored at the site before erection on platforms or pallets, and suitably protect from the weather.
- C. Exercise special care so as not to damage or overload the decking during the construction period.
- D. Do not use metal decking for storage or as a working platform until the sheets have been welded in position.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Furnish products of one of the following Manufacturers, except as approved by Architect, subject to conformance with Specification requirements:
 - 1. Consolidated Systems, Inc. www.csisteel.com
 - 2. Metal Deck, Inc.
 - 3. United Steel Deck, Inc. www.njb-united.com/usd.htm
 - 4. Vercor Manufacturing, Inc. www.vercodeck.com
 - 5. Vulcraft Division, Nucor Corp. www.vulcraft.com/sc
 - 6. Wheeling Corrugating Division www.wheelingcorrugating.com

2.02 RIBBED DECK

- A. Steel: ASTM A611, Grade C, having a minimum yield strength of 33,000 psi (2,275MPa). Verify with Structural General Notes on Drawings.
- B. Configurations: Gauge, height, pattern to be as indicated on architectural and structural drawings.
- C. Finish:
 - 1. Typical: Galvanized, G60, unless noted otherwise.
 - 2. Mechanical screen to be painted to match existing building color.

2.03 ACCESSORIES

- A. Provide closures, and other accessories where required or as shown on Drawings and of same material and finish as steel deck.
- B. Furnish miscellaneous supporting members at openings and edges, as shown on Drawings and as required.
- C. Galvanizing Repair Paint: High zinc-dust content paint complying with SSPC Paint 20 (94 percent minimum zinc dust content, dry film, by weight).

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions: Erector shall examine subsurfaces to receive Work and report detrimental conditions, in writing, with a copy to Architect. Commencement of Work will be construed as acceptance of subsurfaces.
- B. Before proceeding, verify that required inspections of existing conditions have been completed.

3.02 ERECTION - RIBBED DECK

- A. Place deck sheets in accordance with approved erection layout Drawings.
- B. Deck units shall be fabricated to span three or more support spacings, with end laps of at least two inches which shall occur over supports. Male joint of side laps shall engage female joint by at least 5/8 inch.

- C. Openings shown on the erection layout Drawings shall be cut by the deck erector. Openings not shown on the erection diagram, such as those required for stacks, conduits, plumbing vents, etc. shall be cut and reinforced if necessary, by the Trade requiring the openings.
- D. Attach deck to supporting members by fusion welding. Care shall be exercised by the welder in the selection of electrodes and amperage to provide positive welds and prevent high amperage blow holes. Welds shall be made from the top side of the deck with the welder following close behind the placement crew.
- E. Welding washers are not necessary for ribbed deck of 22 gauge or heavier, or when the bottom rib width equals or exceeds 5/8 inch.
- F. Where washers are required, weld deck to steel framing through 16 gauge welding washers with 1 inch x 3/8 inch puddle welds. Maximum weld spacing shall be as follows unless noted otherwise on the Structural Drawings:
 - 1. End and end laps: 6 inches o.c.
 - 2. Intermediate supports: 6 inches o.c.
 - 3. Edges, perimeter beams and angles parallel to deck flutes: 12 inches on center
 - 4. Opening edges: 6 inches on center
- G. Weld sheets to each other with side seam welds at 12 inches on center.

3.03 FIELD QUALITY CONTROL

- A. Tests: When required by the Architect, installation of metal decking and welding shall be subject to inspection by a qualified Testing Agency acceptable to Architect, the cost of which will be paid out of the Testing Allowance.
- B. The Testing Agency shall:
 - 1. Test and inspect metal decking and workmanship to verify compliance with Contract Documents.
 - 2. Check material, equipment, procedures, welds, ability of welders.
 - 3. Furnish Architect with a verified report that completed Work conforms with Contract Documents.

3.04 CLEANING

- A. During the course of the Work and on completion of the Work, remove excess materials, equipment and debris and dispose of away from premises. Leave Work in clean condition.

END OF SECTION

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SECTION 05 50 00

METAL FABRICATIONS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: Metal fabrications, including items fabricated from iron and steel shapes, plates, bars, strips, tubes, pipes and castings which are not a part of structural steel or other metal systems in other Sections of these Specifications. Types of metal items include, but are not limited to, the following:
 - 1. Framework for floor infill and mechanical screens.
 - 2. Carpenter's ironwork.
 - 3. Miscellaneous framing and supports.
 - 4. Miscellaneous steel trim.
 - 5. Other items as indicated.

1.02 SUBMITTALS

- A. Shop Drawings: Submit Drawings for the fabrication and erection of assemblies of items which are not completely shown by the Manufacturer's data sheets.
 - 1. Include plans and elevations at not less than 1 inch to 1'-0" scale, and include details of sections and connections at not less than 3 inches to 1'-0" scale.
 - 2. Show anchorage and accessory items.

1.03 QUALITY ASSURANCE

- A. Standards: Comply with the following, except as otherwise shown and specified:
 - 1. AISC "Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings."
 - 2. AISI "Specifications for the Design of Cold-Formed Steel Structural Members."
 - 3. AWS "Structural Welding Code-Steel."
 - 4. ASTM A6 "General Requirements for Rolled Steel Plates Shapes, Sheet Piping and Bars for Structural Use."
- B. Qualifications: Qualify welding processes and welding operators in accordance with AWS "Standard Qualification Procedure."

1.04 DELIVERY, STORAGE AND HANDLING

- A. Exercise care during unloading, storage and erection to avoid damage. Dumping on the ground is not permitted.
- B. Support material stored at the site completely free of the ground, and cover to avoid damage from the elements.

1.05 PROJECT/SITE CONDITIONS

- A. Field Measurements: Take field measurements prior to preparation of Shop Drawings and fabrication, where possible, to ensure proper fitting of the Work. Allow for trimming and fitting wherever the taking of field measurements before fabrication might delay the Work.

2.03 FABRICATION

- A. General: For fabrication of Miscellaneous Metal Work which will be exposed to view, use only materials which are smooth and free of surface blemishes including pitting, seam marks, roller marks, rolled trade names and roughness. Remove such blemishes by grinding or by welding and grinding, prior to cleaning, treating and application of surface finishes, including zinc coatings.
- B. Shop Assembly: Preassemble items in shop, when possible, to minimize field splicing and assembly of units at the site. Disassemble units only to extent necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.
- C. Workmanship:
 - 1. Use materials of the size and thickness shown, or if not shown, of the required size and thickness to produce adequate strength and durability of the finished product for the intended use. Work to the dimensions of fabrication and support. Use type of materials shown or specified for various components of Work.
 - 2. Form exposed Work true to line and level with accurate angles, surfaces and straight sharp edges. Ease exposed edges to a radius of approximately 1/8 inch unless otherwise shown. Form bent-metal corners to the smallest radius possible without causing grain separation or otherwise impairing the Work.
 - 3. Metal trim in continuous runs shall have concealed splices and be of sufficient gauge that natural distortions are not visually apparent. All exposed edges to the public shall be radiused or sharp edges eased.
 - 4. Weld corners and seam continuously and in accordance with the recommendations of AWS. Grind exposed welds smooth and flush to match and blend with adjoining surfaces.
 - 5. Form exposed connections with hairline joints which are flush and smooth, using concealed fasteners wherever possible. Use exposed fasteners of the type shown, or if not shown, use Phillips flat-head (countersunk) screws or bolts.
 - 6. Provide for anchorage of type shown, coordinated with supporting structure and the progress schedule. Fabricate as required to provide adequate support for the intended use of the Work.
 - 7. Cut, reinforce, drill and tap Miscellaneous Metal Work as may be required to receive finish hardware and similar items of Work.
 - 8. Use hot-rolled steel bars for Work fabricated from bar stock, unless Work is indicated to be fabricated from cold-rolled, or cold-finished stock.
- D. Carpenter's Iron Work:
 - 1. Furnish bent or otherwise custom fabricated bolts, plates, anchors, hangers, dowels and other miscellaneous steel and iron shapes as required for framing and supporting woodwork, and for anchoring or securing woodwork to concrete or other structures. Straight bolts and other stock rough hardware are specified in Division 6 Sections.
 - 2. Manufacture or fabricate items of sizes, shapes and dimensions required. Furnish malleable iron washers for heads and nuts which bear on wood structural connections; elsewhere, furnish steel washers.
- E. Loose Bearing Plates: Provide loose bearing plates for steel items bearing on masonry or concrete construction, made flat, free from warps or twists, and of required thickness and bearing area. Drill plates to receive anchor bolts and for grouting as required.

- F. Loose Steel Lintels: provide loose structural steel shape lintels for openings and recesses in masonry walls and partitions, as shown. Weld adjoining members together to form a single unit. Provide not less than 4 inch bearing at each side of openings, unless otherwise shown.
- G. Miscellaneous Framing and Supports:
1. Provide miscellaneous steel framing and supports which are not a part of the structural steel framework, as required to complete Work.
 2. Fabricate miscellaneous units to sizes, shapes and profiles shown, or if not shown, of the dimensions required to receive adjacent plates, doors or other Work to be retained by the framing. Except as otherwise shown, fabricate from structural steel shapes and plates and steel bars of all welded construction using mitered corners, welded brackets and splice plates, and a minimum number of joints for field connection. Cut, drill and tap units to receive hardware and similar items to be anchored to the Work.
 3. Equip units with integrally welded anchor straps for casting into concrete or building into masonry wherever possible. Furnish inserts if units must be installed after concrete is poured. Except as otherwise shown, space anchors 24 inches o.c., and provide minimum anchor units of 1-1/4 inch x 1/3 inch x 8 inch steel straps.
- H. Mechanical Screens:
1. Fabricate to sizes, configurations and shapes indicated using steel tubing, shapes, plate, and rod as detailed. Provide steel decking as specified in Section 05 31 00.
 2. Continuously weld all joints and grind smooth.
 3. Provide exposed surfaces smooth, square, and free of surface blemishes, including pitting, rust and scale seam marks, roller marks, rolled trade names, and roughness, except where these features are a design feature of the ornamental item.
 4. Comply with fabrication requirements, including tolerance limits, of AISC's "Code of Standard Practice for Steel Buildings and Bridges" for architecturally exposed structural steel.
- I. Miscellaneous Steel Trim: Provide shapes and sizes as required for the profiles shown. Except as otherwise noted, fabricate units from structural steel shapes and plates and steel bars, with continuously welded joints and smooth exposed edges. Use concealed field splices wherever possible. Provide cutouts, fittings and anchorages as required for coordination of assembly and installation with other Work.
- J. Shelf Angles: Provide structural steel shelf angles of sizes shown for attachment to concrete framing. Provide slotted holes to receive 3/4 inch bolts, spaced not more than 6 inches from ends and not more than 24 inches o.c., unless otherwise shown.

2.04 FINISHING

- A. Shop Painting:
1. Shop paint Miscellaneous Metal Work, except those members or portions of members to be embedded in concrete or masonry, surfaces and edges to be field welded, and galvanized surfaces, unless otherwise indicated.
 2. Remove scale, rust and other deleterious materials before shop coat of paint is applied. Clean in accordance with SSPC SP-2, SP-3, or SP-7, as required. Remove oil, grease and similar contaminants in accordance with SSPC SP-1.
 3. Apply one shop coat of metal primer paint to fabricated metal items, except apply 2 coats of paint to surfaces which are inaccessible after assembly or erection.

4. Immediately after surface preparation, brush or spray on metal primer paint in accordance with Manufacturer's instructions, and to provide a uniform dry film thickness of 2 mils for each coat.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions: Examine subsurfaces to receive Work and report detrimental conditions in writing to Architect. Commencement of Work will be construed as acceptance of subsurfaces.
- B. Coordination: Coordinate with other Work which affects, connects with, or will be concealed by this Work.

3.02 PREPARATION

- A. Clean and strip primed steel items to bare metal where site welding is required.
- B. Supply items required to be cast into concrete or embedded in masonry with setting templates to appropriate Trades.
- C. Set sleeves in concrete with tops flush with finish surface elevations. Protect sleeves from water and concrete entry.

3.03 INSTALLATION

- A. Install items plumb and level, accurately fitted, free from distortion or defects. Manufactured items to be installed in accordance with manufacturer's printed instructions.
- B. Allow for erection loads, and for sufficient temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.
- C. Field weld components indicated on Shop Drawings.
- D. Perform field welding in accordance with AWS D1.1.
- E. Obtain Architect approval prior to site cutting or making adjustments not scheduled.
- F. Touch-up Painting: Touch-up welds, abrasions, and other areas where shop prime paint has been removed or is damaged with specified prime paint or galvanizing repair paint.

3.04 ERECTION TOLERANCES

- A. Maximum Variation from Plumb: 1/4 inch per story, non-cumulative.
- B. Maximum Offset from True Alignment: 1/4 inch

3.05 CLEANING

- A. During the course of the Work and on completion, remove and dispose of excess materials, equipment and debris away from premises.

END OF SECTION

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SECTION 05 51 00

METAL STAIRS

PART 1 GENERAL

1.01 SYSTEM DESCRIPTION

- A. Design Requirements: Steel stairs including stringers, treads, risers and landings, shall be designed and fabricated to support dead load plus live load of 100 psf or a concentrated load of 300 pounds, whichever governs. Limit maximum live load deflection to 1/360 span.

1.02 SUBMITTALS

- A. Shop Drawings: Submit Drawings showing dimensions, details and erection diagrams.

1.03 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with local code and regulatory agency requirements for stair design and the following:
 - 1. 2010 ADA Standards for Accessible Design.
 - 2. Public Law 101-336 "The Americans with Disabilities Act of 1990 (ADA) revised September 15, 2012.
- B. Welding: Conforming to AWS D1.1 and performed by certified welders.

1.04 DELIVERY, STORAGE AND HANDLING

- A. Exercise care during unloading, storage and erection to avoid damage. Dumping on the ground is not permitted.
- B. Support material stored at the site completely free of the ground, and cover to avoid damage from the elements.

1.05 PROJECT/SITE CONDITIONS

- A. Field Measurements: Verify existing conditions by taking field measurements.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Structural Steel Shapes, Plates, Bars and Bar-Size Shapes: ASTM A36.
- B. Steel Tubing: ASTM A500, Grade B (Fy = 46 ksi).
- C. Steel Pipe: ASTM A53.
- D. Structural Steel Sheet: ASTM A569 or ASTM A570, Grade 30
- E. Diamond Pattern Structural Steel Sheet: ASTM A611 or ASTM A570, Grade B with diamond checker pattern.

- F. Metal Primer: VOC compliant.
1. Interior Steel: Zinc alkyd, high-solids primer, conforming to FS TT-P-645b.
 2. Exterior Steel (exposed): 2-component, moisture-cured zinc-rich primer conforming to SSPC-PS12.01.

2.02 FABRICATION

- A. Fabrication, General:
1. Conform to Standard Specifications, Rules and Practice of the AISC as described in the "Steel Construction Manual"
 2. Form and fabricate the Work to meet installation requirements.
 3. Include accessories to adequately secure the Work in place.
- B. Shop fabricate metal stairs to designs and configurations indicated on Drawings and to comply with the "Recommended Voluntary Standards for Fixed Metal Stairs" of NAAMM (National Association of Architectural Metal Manufacturers) Standard AMP 510 "Metal Stairs Manual" for Industrial Classification of stairs, except where more stringent requirements are specified:
- C. Metal Tread Units:
1. Form metal treads of thick diamond pattern (checker plate) structural steel sheets. Thickness of diamond pattern (check plate) structural steel sheets shall be as follows:

Maximum Tread Span (Stair Width)	Plate Thickness
44 inches	1/4 inch
56 inches	5/16 inch
66 inches	5/16 inch
 2. Shape treads to conform to configurations shown.
 3. Construct riser and metal treads with steel angle or bar supporting brackets, of size shown, welded to stringers.
 4. Secure metal pans to brackets with welds, as shown.
 5. Secure subplatform metal pans to platform frames with welds.
- D. Fabricate stringers of structural steel shapes as shown. Provide closures for exposed ends of stringers.
- E. Provide metal framing, hangers, columns, struts, clips, brackets, bearing plates and other components as required for support of stairs and platforms.
- F. Drainage: Construct exterior treads and exterior platforms pitched slightly to drain. In no case will water ponding be permitted on treads and platforms.
- G. Shop/Factory/Finishing: Clean metal work of grease, rust, mill scale and other foreign matter, and give a coat of primer.
- H. Galvanizing: ASTM A653, Class G-60.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions: Examine subsurfaces to receive Work and report detrimental conditions in writing to Architect. Commencement of Work will be construed as acceptance of subsurfaces.
- B. Coordination: Coordinate with other work which affects, connects with, or will be concealed by this Work.

3.02 PREPARATION

- A. Where masonry walls support the Steel Stair Work, provide temporary supporting struts, designed for the erection of steel stair components before installation of masonry.

3.03 ERECTION

- A. Make connections between members, unless otherwise indicated, by the use of welds or bolts.
- B. Conceal connections in finished Work where possible.
- C. Accurately align members for miter exposed joints with hairline joints.
- D. Perform welding by the shielded arc method.
- E. Grind welds in finished surfaces smooth with no identifying marks remaining exposed.
- F. Fabricate units so that bolts and other fastenings do not appear on finish surfaces. Make joints true and tight.
- G. Touch-Up Painting:
 - 1. After erection, prime welds, abrasions, and surfaces not shop primed.
 - 2. Remove temporary guys, bracing and bracing clips. Grind flush remaining burrs before painting. Remove welding slag, splatter, rust and burnt paint and clean welds by wire brushing before touch-up.
- H. At the top and bottom of stair landings, a contrasting color and texture to the normal stair treads shall be used to facilitate the blind and visually impaired.

3.04 CLEANING

- A. During the course of the Work and on completion, remove and dispose of excess materials, equipment and debris away from premises.

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SECTION 05 52 13

PIPE AND TUBE RAILINGS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: Standard pipe handrails at stairs, floor openings and other locations indicated on Drawings.

1.02 SYSTEM DESCRIPTION

- A. Performance Requirements: Structural performance of handrails and railing systems: shall comply with ASTM E985 based on testing in accordance with ASTM E894 and E935.
 - 1. Design handrails, guardrails and posts to resist a concentrated load of 200 pounds in any direction at any point of the top of the rail or 50 pounds per foot applied horizontally to top of the rail, whichever is more severe, without exceeding allowable design working stresses of materials for railings, anchors, and connections.
 - 2. Guardrail intermediate posts shall be designed for a uniform load of not less than 50 pounds on an area equal to 1 square foot, including openings and space between rails. Reactions due to this loading need not be added to the loading specified for the main supporting members of the guardrails.
- B. Design Requirements: Comply with ASTM E985 and IBC Section 1607.7.

1.03 SUBMITTALS

- A. Shop Drawings: Submit Drawings showing dimensions, details and erection diagrams, connections with other work, and calculations sealed by a qualified Structural Engineer registered in the State where the Project is located, certifying conformance with Code and Performance Requirements.
- B. Submit manufacturer's installation instructions.

1.04 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with local code and regulatory agency requirements for handrail and railing design and the following:
 - 1. 2010 ADA Standards for Accessible Design.
 - 2. Public Law 101-336 "The Americans with Disabilities Act of 1990 (ADA) revised September 15, 2012.
- B. Engineer Qualifications: A qualified engineer who is registered in the State of Arizona and who is experienced in providing engineering services of the kind indicated for metal handrails and railing similar to those of this Project in material, design, and extent.
- C. Certifications:
 - 1. Furnish certification that all components and fittings are furnished by the same manufacturer or approved by the primary component manufacturer.
 - 2. Furnish certification that components were installed in accordance to the manufacturer's engineering data to meet the specified design loads.

- D. Pre-Installation Meeting
 1. Prior to the beginning of work, conduct a pre-job conference at the job site.
 2. Provide seven calendar days advance written notice ensuring the attendance by competent authorized representatives of the fabricator, building owner's representative, architect and subcontractors whose work interfaces with the work of this section.
 3. Review the specifications to determine any potential problems, changes, scheduling, unique job site conditions, installation requirements and procedures and any other information pertinent to the installation.
 4. Record the results of the conference and furnish copies to all participants.
- E. Welding: Conforming to AWS D1.1 and performed by certified welders.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Packing and Shipping: Deliver materials to site in manufacturer's original unopened packaging with labels intact. Protect finished surfaces with removable wrapping or coating which will not bond when exposed to sunlight.
- B. Deliver materials to the job site in good condition and properly protected against damage to finished surfaces.
- C. Storage: Adequately protect against damage while stored at the site.
 1. Stacking shall be done in a way, which will prevent bending.
 2. Store material in a clean, dry location away from uncured concrete and masonry. Cover with waterproof paper, tarpaulin, or polyethylene sheeting in a manner that will permit circulation of air inside the covering.
- D. Handling: Comply with manufacturer's instructions. Keep handling on site to a minimum. Exercise particular care to avoid damage to finishes of material.

1.06 PROJECT/SITE CONDITIONS

- A. Field Measurements: Verify existing conditions by taking field measurements.

PART 2 PRODUCTS

2.01 MATERIALS – STEEL RAILINGS

- A. General
 1. Metal used for railings should be tube stock, not solid stock, and conform to ASTM A 500. Unsupported length shall not exceed 6'-0" for diameters 2 inches or less.
 2. The use of expansion bolts to secure railing assemblies to vertical or horizontal surfaces is not allowable. Anchorage systems shall consist of direct imbeds (sleeves or plates) and/or welding.
 3. Exterior handrails and other steel items exposed to high traffic and the potential for abuse related wear and damage is to be made of galvanized steel.
- B. Structural Steel Shapes, Plates, Bars and Bar-size Shapes: ASTM A36.
- C. Steel Tubing: ASTM A500, Grade B (Fy = 46 ksi).
- D. Gray Iron Castings: ASTM A48, Class 30.
- E. Malleable Iron Castings: ASTM A47, Grade as selected.

- F. Steel Pipe: ASTM A53, type as selected, Grade A standard weight (Schedule 40).
- G. Metal Primer: VOC compliant.
 - 1. Interior Steel: Zinc oxide, alkyd primer, high-solids content, conforming to SSPC-Paint 25.1.
 - 2. Exterior Steel (exposed): 2-component, moisture-cured zinc-rich primer conforming to SSPC-PS 12.01.
- H. Wall Bracket (Pipe Handrails): Julius Blum #382 www.juliusblum.com with appropriate fastener and anchor plate.
- I. Anchoring Cement: Prepackaged, erosion-resistant, non-shrink hydraulic controlled anchoring cement recommended for exterior use.
- J. Nonshrink, Nonmetallic Grout: Prepackaged, non-shrink, nonstaining grout complying with ASTM C 1107 and recommended for interior and exterior use as applicable.

2.02 FABRICATION – STEEL RAILING

- A. Shop Assembly:
 - 1. Conform with AISC Standard Specifications, Rules and Practice in the "Steel Construction Manual."
 - 2. Preassemble items in shop to the greatest extent possible to largest practicable sizes to minimize field splicing/welding and assembly of units at the site.
 - 3. Limit size of shop assembled units only to extent necessary for shipping and handling limitations and galvanizing of exterior units after fabrication. Clearly mark units for reassembly and coordinated installation.
 - 4. Form and fabricate the Work to meet installation conditions.
 - 5. Include accessories to adequately secure the Work in place.
 - 6. Make provisions to connect with or to receive abutting construction.
- B. Shop/Factory/Finishing: Clean surfaces of grease, rust, mill scale, and other foreign matter, and apply coat of primer, except galvanized surfaces.
- C. Galvanizing: Galvanize all exterior railing, sleeves, brackets and flanges after fabrication to comply with ASTM A123 and ASTM 153 as applicable.
- D. Make connections between members, unless otherwise indicated by welding.
 - 1. Cope and cut components for hairline fit prior to welding.
 - 2. Accurately align members.
 - 3. Fabricate joints watertight for exterior applications.
 - 4. Welds shall be flush type, with fillets dressed to uniform radius, using the shielded arc method.
- E. Where bolted or screw connections are indicated or necessary, use round or oval head bolts and tamper-resistant screws and conceal in the finished work to the greatest extent possible.
- F. Provide metal end caps at exposed or open end conditions.
- G. Grind welds, projections and corners in finished surfaces smooth. No identifying marks shall remain exposed.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions: Examine subsurfaces to receive Work and report detrimental conditions in writing to Architect. Commencement of Work will be construed as acceptance of subsurfaces.
- B. Coordination: Coordinate with other work which affects, connects with, or will be concealed by this Work.

3.02 INSTALLATION – TYPICAL RAILINGS

- A. Install railings and handrails at locations indicated.
- B. Install items anchored in concrete in the formwork, where practicable.
- C. Install items to be built into masonry so masonry can be built up to them.
- D. Where indicated, anchor posts in concrete with core drilled holes or pre-set sleeves of diameter at least 3/4" more than diameter of post being anchored and not less than 5" deep. Fill space with non-shrink, non-metallic grout or anchoring cement.
- E. Install posts and vertical members plumb within 1/8 inch of vertical. Install longitudinal members parallel with each other and to floor surfaces or slope of stairs to within 1/8 inch per 10 running feet.
- F. Securely anchor wall brackets.

3.03 CLEANING

- A. During the course of the Work and on completion of the Work, remove and dispose of excess materials, equipment and debris away from premises. Leave Work in clean condition.
- B. As installation is completed, wash thoroughly using clean water and soap; rinse with clean water.
- C. Do not use acid solution, steel wool or other harsh abrasives.
- D. If stain remains after washing, remove finish and restore in accordance with NAAMM Metal Finishes Manual.
- E. Finish must not be removed from anodized aluminum. Reanodizing can only be done by removing railing and returning it to the anodizer.

3.06 REPAIR OF DEFECTIVE WORK

- A. Remove stained or otherwise defective work and replace with material that meets specification requirements.
- B. Repair damaged finish as directed by Architect.
- C. Replace defective or damaged components as directed by Architect.

END OF SECTION

SECTION 06 10 53

MISCELLANEOUS ROUGH CARPENTRY

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: Rough carpentry including, but not limited to:
 - 1. Plywood telephone and electrical backer boards
 - 2. Miscellaneous backing, blocking, nailers wood countertop framing, curbs and other miscellaneous rough carpentry as noted on Drawings.. Note that sheet metal blocking as specified in Section 09 22 16 shall be provided for wall mounted millwork and equipment, and for restroom accessories.

1.02 SUBMITTALS

- A. Product Data: Submit technical data for wood preservative and fire retardant products.

1.03 QUALITY ASSURANCE

- A. Identify each piece of lumber or plywood used for structural framing with grade and trade mark of a lumber grading organization. Trade mark of manufacturer shall also appear on each piece.
- B. Grading Rules: Conform with applicable requirements of American Lumber Standards "Simplified Practice Recommendation R-16" and to grading rules of manufacturer's association under whose rules the lumber is produced.
- C. Standards: Conform with requirements of American Plywood Association, U. S. Dept. of Commerce Commercial Standards and American Wood Preservers Association Standards, as they apply.

1.04 DELIVERY, STORAGE AND HANDLING

- A. Packing and Shipping: Deliver materials to site in manufacturer's original unopened packaging with labels intact.
- B. Storage: Store off ground to assure adequate ventilation, and protect against damage while stored at the site.
- C. Handling: Comply with manufacturer's instructions.

1.05 PROJECT CONDITIONS

- A. Environmental Requirements: Store materials for which a maximum moisture is specified in areas where humidity can be controlled.

PART 2 PRODUCTS

2.01 LUMBER MATERIALS

- A. Species: Douglas Fir – Larch, Hem Fir graded in accordance with Standard Grading and Dressing Rules of WCLIB. Framing lumber shall be stress grade. All sides shall be surfaced.
- B. Lumber Grades: As follows unless noted differently on the Drawings:
 - 1. Misc. blocking, bridging, etc: Utility.
 - 2. Grounds and furring: Construction Grade Douglas Fire or No. 2 White Pine.
- C. Moisture Content:
 - 1. Lumber shall be air-dried or kiln-dried.
 - 2. At time of installation, moisture content, expressed as a percentage of the weight of the oven-dry wood, shall not exceed 19 percent for lumber of up to two inches nominal thickness and 15 percent for exterior trim and siding.
 - 3. Moisture content of lumber over two inches nominal thickness shall conform to the rules of the association under which it is graded.

2.02 SHEATHING MATERIALS

- A. Plywood Backing Panels: For mounting of telephone and electrical equipment, provide Grade C-D Exposure 1 plywood panels, 15/16 inch thick, unless otherwise indicated.

2.03 FACTORY WOOD TREATMENT

- A. Preservative Treatment:
 - 1. Materials:
 - a. Chromated copper arsenate (CCA) shall not be allowed.
 - b. Provide ammoniacal copper quaternary (ACQ) or copper boron azole (CBA) as produced by the following manufacturers:
 - 1) Arch Wood Protection, Inc., Smyrna, GA (866) 789-4567, www.wolmanizedwood.com or www.naturalselect.com.
 - 2) Chemical Specialties, Inc., Charlotte, NC (800) 421-8661, www.treatedwood.com
 - 3) Osmose, Inc., Wood Preserv.ing Division, Griffin, GA (800) 241-0240, www.osmose.com.
 - 2. Locations Required:
 - a. Wood sillplates and ledgers bolted in direct contact with concrete or masonry, located at or below grade only shall be pressure treated lumber.
 - b. Blocking occurring on top of or above the roof deck, including the nailer beneath the flashing at parapet caps, shall be treated lumber.
 - c. Other locations as required by Code.
- B. Fire-Retardant Treatment: Hickson Corp. Dricon FRTW in accordance with UL label.
 - 1. Where required by code, wood studs, plates, sheathing, blocking, etc. shall be pressure treated.
 - 2. Dimensioned lumber shall be kiln dried to a maximum moisture content of 18 percent before and after milling and fire protective treatment..

2.04 ACCESSORIES

- A. Nails: Common wire, galvanized for exterior Work, meeting ASTM F1667 of the sizes indicated on the Drawings.
- B. Screws: Standard domestic manufacture, bright steel, except galvanized for exterior use and of brass, bronze, aluminum or stainless steel when used to attach items made of those materials. Screws used for attaching interior trim and finish to drywall partitions shall be Type S self-drilling, self-tapping corrosion resistant coated steel drywall screws of required lengths as specified in Section 09 29 00.
 - 1. Screws used for attaching preservative treated wood shall be Type S self-drilling, self-tapping corrosion resistant coated steel screws. Acceptable products include the following:
 - a. DEC-KING Exterior Wood Screw with Climacoat.
 - b. Tapcon Concrete Anchor with Blue Climaseal or White UltraShield.
 - c. Wood-To-Metal TEKS with Grey Spex.
 - d. Roofgrip with Spex or Blue Climaseal.
 - e. GY-FAST Nail with Climacoat.
 - f. Maxi-Set Tapcon White UltraShield.
- C. Bolts: Standard mild steel, square head machine bolts with square nuts and malleable iron or steel plate washers or carriage bolts with square nuts and cut washers as indicated. Bolts, nuts and washers, wholly or partially exposed on exterior shall be galvanized.
- D. Lag screws, shear plates and split ring connectors: Conform to requirements of the "National Design Specifications for Stress Grade Lumber and its Fastenings" of National Forest Products Association.
- E. Power driven inserts: Ramset, or as approved by Structural Engineer through Architect meeting FS GGG-D-777a. Install as per manufacturer's printed directions. Charge shall be powerful enough to prevent spalling of concrete.
- F. Galvanizing: ASTM A653.
- G. Toggle Bolts: FS FF-B-588.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Wood Backing: Provide wood backing, furring, stripping or blocking indicated or required for installation and attachment of work of other trades. Provide fire-proofed wood backing approved by Building Official where required by Code in noncombustible or fire-rated construction.
- B. At roofs: Provide crickets, cants, equipment curbs, wood saddles, cant strips, curbs for plywood at parapet walls; other miscellaneous backing, blocking, curbing, and wood nailers bolted to tops of concrete, as specified or required.
- C. Plywood Backing Panels: Install with the "C" or best face on exposed side.
- D. Connections: Subdrill where necessary to avoid splitting.

- E. Bolts: Drill bolt holes 1/32 inch larger than bolt diameter. Use square plate or malleable iron washers under heads and nut where they bear against wood. Re-tighten bolts immediately prior to concealing with finish materials. Re-tighten exposed bolts immediately prior to final inspection by Building Official.
- F. Lag Screws and Screws: Subdrill, use square plate or malleable iron washer under lag screw heads when they bear on wood.

3.02 CLEANING

- A. During the course of the Work and on completion, remove excess materials, equipment and debris and dispose of away from premises.

END OF SECTION

2.02 MATERIALS

- A. Batt Insulation (Fiberglass):
 - 1. ASTM C665, Type I, unfaced glass fiber batts. Batts shall be a single thickness to meet the required R value, multiple layers of batts will not be accepted.
 - 2. Batts shall be a single thickness to meet the required R value, multiple layers of batts will not be accepted.
 - 3. Thickness: Provide minimum thickness as required to provide the resistance values as indicated on Drawings, for various locations.
- B. Sound Batt Insulation:
 - 1. ASTM C665, Type 1 (unfaced), glass or mineral fiber batts, with a Fire Hazard Classification of less than 50 when tested in accordance with ASTM E-84.
 - 2. Thickness: As indicated on Drawings.
 - 3. Provide paintable scrim batts where exposed to view in final work, paint color to be as selected by Architect. Painting of sound attenuation batts shall not affect the acoustical properties and shall occur prior to installation of adjacent finishes.
- C. Insulation Stick Pins: Insul-Anchors with applicable Self-Locking Washers as manufactured by Gemco, Danville, IL. Length of fasteners shall be as recommended by the stick pin and insulation manufacturers. Provide suitable adhesive for attachment to Sheet Membrane Air Barrier.
- D. Insulating-Foam Sealant (small openings and wall penetrations): Dow Great Stuff insulating foam sealant.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions: Examine subsurfaces to receive Work and report detrimental conditions in writing to Architect. Commencement of Work will be construed as acceptance of subsurfaces.
- B. Coordination: Coordinate with other work which affects, connects with, or will be concealed by this Work.

3.02 INSTALLATION

- A. Batt Insulation:
 - 1. Apply no insulation until such time as the Construction has progressed to the point that inclement weather will not damage or wet the insulation material.
 - 2. Fully insulate small areas between closely spaced framing members, pipes, conduits or other obstruction by cutting and fitting insulation material as required to maintain the integrity of the insulation.
 - 3. Batt insulation at metal studs, concrete tees, and other non-nailable members shall be installed continuously tight against framing members. Secure in place with string wire or other method as approved by Architect.
 - 4. Place insulation tight to exterior wall or roof substrate without voids.
 - 5. End match neatly with ends fitting snugly.

- B. Sound Batt Insulation:
 - 1. Install acoustical insulation batts in sound-rated stud partition walls where indicated on Drawings. Size batts for a friction fit and install in accordance with Manufacturer's recommendations.
 - 2. Butt ends of batts closely together and fill all voids.
- C. Installation shall limit defects, very small gaps around wiring, electric outlets, etc and compression or incomplete fill amounting to 2% or less of the total surface area covered by the insulation. Wall insulation is to be enclosed on all six sides and in substantial contact with the sheathing materials on at least one side (interior or exterior) of the cavity.
- D. Provide a pre-drywall thermal bypass inspection. Contractor shall submit a written statement of compliance following inspection and upon completion of insulation installation.
- E. At wall/floor/roof penetrations including windows, skylights, doors, and through-wall equipment provide expanding foam insulation to minimize air infiltration. Provide continuous beads of minimum 1" wide expanding foam VOC-compliant insulating foam sealant equivalent to Dow "Great Stuff". Pack stud cavities, door frames, box headers, and similar hollow framing conditions at exterior walls with thermal batt insulation.

3.03 CLEANING

- A. During the course of the Work and on completion of the Work, remove excess materials, equipment and debris and dispose of away from premises. Leave Work in clean condition.
- B. Protection: Take precautions to protect insulation, both during and after installation, from damage of any kind until covered.

END OF SECTION

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SECTION 07 24 29

REPAIRS TO EXTERIOR INSULATION AND FINISH SYSTEM

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: Patch/repair of existing EIFS at exterior masonry wall where the existing ladder is removed new stair is provided.

1.02 SYSTEM DESCRIPTION

- A. Design Requirements:
1. At all locations the insulation board shall be completely encapsulated by the reinforcing mesh and adhesive or substrate.
 2. Insulation Board: Use and maximum thickness shall be in accordance with applicable building code requirements. Length and slope of inclined surfaces shall follow guidelines listed below:
 - a. Minimum slope: 6 inches of rise in 12 inches of horizontal projection.
 - b. Maximum length of slope: 2.3 times the thickness of the insulation.
 - c. Inclined surfaces shall not be used for areas as defined as roofs by building codes.
 3. Expansion Joints: Install continuous expansion joints at the following locations:
 - a. Where expansion joints occur in the substrate.
 - b. Where building expansion joints occur.
 - c. Where the EIFS abuts other materials.
 - d. Where the substrate changes.
 - e. Where significant structural movement occurs, such as at:
 - 1) Changes in roof lines.
 - 2) Long continuous elevations.
 - 3) Changes in building shape and structural systems.
 - f. Expansion and contraction of the field applied EIFS and adjacent materials shall be taken into account in the design of expansion joints, with proper consideration given to sealant properties, installation conditions, temperature range, coefficient of expansion of materials, joint width-to-depth ratios, etc.
 4. Details and specifications: Follow EIFS manufacturer's latest published information for standard detail treatments and repairs to existing EIFS. Corners shall be reinforced by wrapping the standard reinforcing mesh around the corner from both directions for a minimum of 8 inches (200mm) as recommended by the manufacturer. Openings shall be reinforced using a 9 inch (230mm) wide strip of standard reinforcing mesh laid at a 45 degree angle to the opening corner as recommended by the manufacturer.

1.02 SUBMITTALS

- A. Certificates: Submit a copy of applicator's current certificate of approval from EIFS manufacturer for this Project.

1.03 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. Insulation Board: Listed in the UL Building Materials Directory and have Flame Spread and Smoke Developed rating of not greater than 25 and 450, respectively, in accordance with ASTM E84.
 - 2. EIFS: Approved for use by ICC as described in current ICC Research Committee Report.
- B. Quality Assurance Program: Work of this Section shall be in accordance with the following:
 - 1. Approved Applicators: Application of EIFS materials shall be performed by manufacturer approved applicators that possess current Labor and Material applicator certificates.
 - 2. Pre-Installation Conference: Schedule a pre-installation conference at least 15 days prior to start of Work of this Section to review exterior insulation and finish system specifications and procedures.
 - a. Attendees: Authorized representatives of the Architect, Contractor, E.I.F.S. installer, E.I.F.S. manufacturer's representative, Owner and other trades relevant to the work are required to attend.
 - b. Agenda: Discuss items of importance, including the following:
 - 1) Review Construction Documents to ensure all parties present are in possession of the latest approved documents.
 - 2) Coordination of the E.I.F.S. applicator's Work with other work which connects with, is adjacent to, or will be concealed by Work of this Section.
 - 3) Storage of materials and staging areas.
 - 4) Physical requirements for proper installation or application and, if applicable, proposed protection procedures.
 - 5) Schedule of required quality assurance inspections.
 - 6) Lines of communication and establishment of responsibility for the proper communication of non-conforming work and correction procedures.

1.04 DELIVERY, STORAGE AND HANDLING

- A. Packing and Shipping: Deliver materials to site in manufacturer's original unopened packaging with labels intact.
- B. Storage: Adequately protect against damage while stored at the site.
- C. Handling: Comply with manufacturer's instructions.

1.05 PROJECT/SITE CONDITIONS

- A. Physical Requirements for Proper Installation or Application:
 - 1. Ambient air temperature shall be 40 degrees F. or greater and rising at the time of installation of the EIFS materials, and remain so for at least 24 hours thereafter.
 - 2. For EIFS installation in ambient temperatures less than 40 degrees F., maintain supplementary heat for at least 24 hours after EIFS installation. Subsequent to installation of the EIFS, the wall shall remain free of residual moisture.

PART 2 PRODUCTS

2.01 MATERIALS

- A. General: Match existing and in accordance with approved submittals.
- B. Adhesives: 100% acrylic polymer dispersion with a quartz or silica aggregate that is field blended with Type I or Type II Portland Cement 1:1 by weight.
- C. Insulation Board: Expanded polystyrene, ASTM C578 Class II, aged (air dried) for 6 weeks at 68 degrees F. minimum, or for 5 days at 140 degrees F. before use.
 - 1. Flame Spread (ASTM E84 or UL 723): Less than 25.
 - 2. Average Density: 1.0 pound per cubic foot.
 - 3. K-value: 0.23 per inch.
 - 4. Thickness: One inch, or as indicated.
 - 5. Size: 24 inches x 48 inches.
- D. Standard Reinforcing Mesh: Treated, balanced, open weave, glass fiber type, minimum weight of 4 oz./yd., available in 38 inch and 9 inch widths.
- E. High Impact Armor Mesh: Treated, balanced, open weave, glass fiber type, minimum weight of 20 oz./yd., available in 38 inch widths.
- F. Waterproofing Base Coat for Low-Slope and Sill Conditions: Acrylic-based, portland cement mixed, waterproof base coat and adhesive specifically formulated as a waterproofing base coat for use at low slope parapets, sills, and projections.
- G. Finish Coat Materials: Factory mixed, acrylic based finish coat with colorfast mineral pigments, sound stone particles, and fillers to achieve finish indicated.
 - 1. Color: Match existing.
- H. Portland Cement: ASTM C150, Type I or II.
- I. Water: Clear, potable, and free of all foreign matter.
- J. Sealant System: Shall be one of the following:
 - 1. Tremco Dymeric Plus, with Primer No. 1. www.tremcosealants.com
 - 2. Pecora Dynatrol II with Type P75 Primer. www.pecora.com
 - 3. Dow-Corning 790 with 1200 Primer and Ethafoam Backer Rod for EIFS to EIFS joints, Dow-Corning 795 for EIFS to dissimilar materials. www.dowcorningsealants.com

2.03 MIXES

- A. Adhesive:
 - 1. Use clean container, free of foreign substance, for mixing and preparing material. Do not use container which has been used for or cleaned with a petroleum product.
 - 2. Use a mixer similar to Goldblatt Jiffler Mixer No. 15311H7, powered by 1/2 inch drill 400-500 RPM.
 - 3. Measure a given weight of adhesive into a container, and an equal weight of Portland cement into another container.
 - 4. While stirring the adhesive, add small amounts of Portland cement in increments to obtain a final ratio of one-to-one by weight. Continue stirring until the mixture is homogenous.
 - 5. Small amounts of water may be added to the adhesive mixture to adjust

- workability. The mixture shall not be "watered down."
6. A period of 5 minutes shall elapse after the initial mixing, then the mixture shall be tempered by stirring again.
 7. Use mixture immediately after tempering. Pot life is the same as plaster-like materials and depends on ambient temperature and humidity conditions and substrate. Keep container closed when not in use.
 8. Under no circumstances use additives, or materials of any kind such as rapid binders, antifreeze, accelerators, fillers, or pigments.
- B. Finish Coating:
1. Thoroughly stir coating with a clean high speed mixer as specified above until a uniform workable consistency is obtained.
 2. A small amount of water may be added to adjust workability. Coating shall not be "watered down." Maximum water, 8 ounces per pail.
 3. Under no circumstances use additives, or materials of any kind such as rapid binders, antifreeze, accelerators, fillers, or pigments.
 4. Apply coating immediately after mixing. Keep container closed when not in use. Pot life depends on ambient temperature and humidity conditions.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions: Ensure that existing substrates are acceptable to EIFS manufacturer.
1. Masonry, concrete and brick substrates shall be flat within 1/4 inch (6mm) within any 4 feet. Follow manufacturer's recommendations for application of additive or leveling coat to assure a smooth surface.

3.02 APPLICATION

- A. Application of the exterior insulation finish system shall be in accordance with the Manufacturer's printed instructions, ASTM C1397 "Standard Practice for Application of Class PB Exterior Insulation and Finish Systems" and as specified herein.
- B. Insulation Board:
1. Begin application at the base from firm, permanent or temporary support.
 2. Apply adhesion to clean hard surface.
 3. Apply board with long edge oriented horizontally with its joints offset with respect to the substrate joints and using a running bond pattern.
 4. Precut insulation board as required to fit openings, corners and projections.
 5. Stagger vertical joints and interlock at corners.
 6. Insulation board pieces smaller than 24 inches x 48 inches may be used, such as at corners. In all cases the perimeter of the insulation board shall have the 2 inch ribbon per the Ribbon and Dab Method. Maintain 32 percent minimum contact area.
- D. Adhesive Mixture:
1. Ribbon and Dab Method (Masonry Substrates): By trowel apply ribbon of mixed adhesive to one surface of insulation board. Ribbons shall be 2 inches wide x 3/8 inch thick around the entire perimeter of each board. The adhesive shall not be applied to the ends of the insulation board. Apply 8 dabs of adhesive mixture 4 inches diameter x 3/8 inch thick to the area within the perimeter ribbon. A minimum of 32 percent of the insulation board surface shall be in contact with the adhesive mixture.

2. Notched Trowel Method: Apply beads of adhesive mixture to one surface of the insulation board using a notched trowel having an edge profile meeting EIFS manufacturer's requirements. The beads shall stand out 5/8 inch from the surface of the insulation board. Apply ribbons of adhesive mixture 2 inches wide x 5/8 inches thick around entire perimeter of the insulation board using a trowel. Adhesive mixture shall not be applied to the ends of the insulation board. Use this method for gypsum sheathing substrates only.

E. Mesh:

1. Reverse roll as necessary to remove the tendency of the mesh to curl.
2. Standard Mesh Base Coat:
 - a. Using a stainless steel trowel, apply the adhesive mixture to the surface to a uniform dry thickness of 1/16 inch. Apply base coat in 2 applications.
 - b. Immediately embed the standard reinforcing mesh into the wet adhesive mixture using a trowel.
 - c. Smooth the surface of the adhesive mixture with a trowel until the reinforcing mesh is fully embedded.
 - d. The pattern of the mesh shall not be visible beneath the surface of the adhesive mixture.
 - e. Lap reinforcing mesh pieces a minimum of 2-1/2 inches on all sides, working from the center to the edge while smoothing out wrinkles.
 - f. A period of 24 hours shall elapse to allow the base coat to form a positive bond.
 - g. Protect base coat from damage and weather while curing.
3. Double Mesh Base Coat: Provide at first panel at bottom of building, at corner panels, and other locations as indicated.
 - a. When double layers of standard reinforcing mesh are used for local reinforcing only, the smaller impact layer shall be installed first.
 - b. Install impact layer as specified above.
 - c. Examine the surface of the first layer after curing for projections, loose strands of mesh, and correct to produce a flat surface.
 - d. Apply the second layer in the same manner as the first layer.
 - e. Offset edges of mesh in the two layers.
4. Heavy Duty Mesh Basecoat: Provide the following at ground floor applications and facades exposed to abnormal stress or deliberate impacts.
 - a. Using a stainless steel trowel, apply the adhesive mixture to the surface to a uniform thickness of 3/32 inch.
 - b. Immediately embed the high impact armor mesh into the wet adhesive mixture using a trowel.
 - c. Smooth the surface of adhesive mixture with a trowel until heavy duty reinforcing mesh is fully embedded.
 - d. The pattern of the mesh shall not be visible beneath the surface of the adhesive mixture.
 - e. Ends of adjacent heavy duty mesh pieces shall be tightly butted, not lapped.
 - f. Where heavy duty mesh abuts standard mesh coat, apply sufficient adhesive mixture over adjacent standard mesh, and feather a sufficient distance to provide a smooth invisible transition between the two meshes.
 - g. Work heavy duty mesh into the adhesive mixture, working from the center to the edge while smoothing out wrinkles.
 - h. A period of 24 hours shall elapse to allow the base coat to form a positive bond.
 - i. Protect base coat from damage and weather while curing.
 - j. Examine the surface of the first layer after curing for projections, loose

- strands of heavy duty mesh, and correct to produce a flat surface.
- k. Apply a second layer consisting of adhesive mixture and standard reinforcing mesh over the heavy duty mesh as specified above.

F. Finish:

1. Apply finish continuously and in one operation to the entire wall surface.
2. Maintain a wet edge.
3. The finish shall not be allowed to set up in a distinct area.
4. Employ sufficient manpower, scaffolding and equipment to ensure a continuous operation and a uniform appearance.
5. Work shall proceed toward the joints and corners.
6. Use clean plastic float for floating.
7. A small amount of clean, potable water may be used to adjust the workability of the finish. Maximum 8 ounces (226 gm) per pail.
8. Until dry, protect the finish from airborne contamination due to dust and soot, and from weather and other damage.
9. Finish shall not be returned into sealant joints.
10. Finish Texture: Match existing.

G. Sealant:

1. System materials shall be fully cured prior to sealant installation.
2. Color of sealant shall be as selected.
3. Joint design and surface preparation shall be based on sealant manufacturer's recommendations and project conditions.
4. Sealant shall be applied to base coat materials and shall not be applied to finish material.
5. Follow additional requirements contained in EIFS manufacturer's detailed sealant specification.

3.03 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: During construction the work shall be inspected by the EIFS manufacturer or authorized representative.

3.04 CLEANING

- A. During the course of the Work and on completion, remove and dispose of excess materials, equipment and debris away from premises. Leave Work in clean condition.

END OF SECTION

SECTION 07 26 53

VAPOR REDUCTION FLOOR COATINGS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: Vapor reduction floor coatings at both new construction and existing slabs where MVT testing indicates that mitigation is required.
 - 1. Furnishing, testing, and application of floor coatings for the reduction of water vapor transmission for interior concrete slabs requiring the installation of ceramic tile, VCT, vinyl, wood, carpet, and/or epoxy flooring, if required in accordance with the Performance Requirements specified in Section 03 30 00.
 - 2. In the event that the work of this section is to be provided, the flooring supplier / installer shall be required to review the specified coating product and confirm in writing that it is compatible with the flooring and adhesive to be used.
- B. Related Sections - Coordinate work of this Section with work of other Sections to properly execute the work requirements and maintain satisfactory progress of work of other Sections.
 - 1. Section 03 30 00 – Cast-In Place Concrete: Installation and curing requirements.
 - 2. Section 09 65 19 – Resilient Tile Flooring: Installation requirements.
 - 3. Section 09 67 23 – Resinous Flooring: Installation requirements.

1.02 SYSTEM DESCRIPTION

- A. Provide one coat system to a properly prepared concrete surface as required to reduce the moisture vapor emissions from concrete floor slabs to that amount acceptable to meet finish floor manufacturer requirements.
- B. Areas Not Requiring Vapor Reduction Floor Coating
 - 1. Vapor Reduction Floor Coating is not required on interior concrete slabs without floor finish materials.
 - 2. The initial calcium chloride tests for interior concrete slab areas receiving ceramic tile, VCT, vinyl, wood, carpet, and/or epoxy flooring will determine where this system will not be required. Vapor Reduction Floor Coating is not required on concrete floors with water vapor transmission level less than 3 lbs./24 hrs per 1,000 sf. This is only acceptable if the ceramic tile, VCT, vinyl, wood, carpet, and/or epoxy flooring Manufacturer and Owner approve.

1.03 SUBMITTALS

- A. Product Data: For each type of product and process specified, which shall include:
 - 1. Manufacturer's Specification.
 - 2. Installation Instructions.
 - 3. Independent Test Data
 - 4. Certification Requirements
 - 5. Warranty Information
- B. Submit list of product use and performance history, for the same formulation and system design, listing reference sources. Similar projects shall have documented minimum initial water vapor transmission rates of 15 lbs per 1,000 sf. per 24 hrs, and have resulted in maintained water vapor reduction rate of less than 3 lbs per 1,000 sf. per 24 hrs when tested to ASTM F 1869-98.

- C. Submit calcium chloride test results (prior to and after installation of vapor reduction floor coating) to the Architect, Owner, Contractor, and Vapor Reduction Floor Coating Manufacturer's Representative.

1.04 QUALITY ASSURANCE

- A. Qualifications of applicator
 - 1. Employ an applicator currently certified by the manufacturer, experienced in surface preparation and application of the material and subject to inspection and control of the manufacturer.
 - 2. Applicator should have no less than 5 years experience in the use of epoxy resin base coating application.
- B. Manufacturer's Qualification
 - 1. Manufacturer shall have no less than 10 years experience in the manufacturing of the same water Vapor Reduction Floor Coating. The water vapor reduction system must be specifically formulated and marketed internationally for water vapor reduction and alkalinity control without change of formulation or system design for a minimum period of five (5) years.
 - 2. Manufacturer must provide independent lab test reports documenting performance per the following:
 - a. ASTM E96, Water Vapor Transmission (dry and wet methods).
 - b. ASTM D4541 Adhesion Properties (after ASTM E96).
 - c. ASTM C309, Liquid Membrane-Forming Compounds for Curing Concrete.
 - d. ASTM C156, Water Retention by Concrete Curing Materials.
 - e. ASTM D 1308; Insensitivity to alkaline environment up to pH 14.
 - f. Certify acceptance and exposure to continuous topical water exposure after final cure.
 - g. Certify acceptance to continuous exposure to topical foot traffic.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to the job site in their original unopened containers, clearly labeled with the manufacturer's name and brand designation.
- B. Store products in an approved ventilated dry area; protect from dampness, freezing, and direct sun light. Product should not be stored in areas with temperatures in excess of 90 F or below 50 degrees F.
- C. Handle product in a manner that will prevent breakage of containers and damage products.

1.06 PROJECT/SITE CONDITIONS

- A. Physical Requirements for Proper Installation or Application:
 - 1. Do not apply Vapor Reduction Floor Coating to unprotected surfaces in wet weather or to surfaces on which ice, frost, or water is visible.
 - 2. Do not apply the Vapor Reduction Floor Coatings when the ambient/surface temperatures are below 50 degrees F (or expected to fall below this temperature within 24 hours from time of application) or above 90 degrees F
 - 3. Do not apply Vapor Reduction Floor Coating in rain, fog, snow, or mist.
 - 4. Never apply Vapor Reduction Floor Coatings to surfaces exposed to the sun.

- B. Protection: Protect Vapor Reduction Floor Coating to prevent damage from active rain or topical water for a minimum period of 24 hours from time of application.

1.07 SCHEDULING

- A. Two weeks before the installation of the flooring systems over the interior concrete slabs, provide initial calcium chloride tests as specified herein to determine the level of water vapor transmission in the slab and the type of Vapor Reduction Floor Coating required.
- B. Contractor shall coordinate scheduling Vapor Reduction Floor Coating installation and allowing enough time to test, submit and apply the Vapor Reduction Floor Coating before installation of floor finish.
- C. Contractor shall allow for as much time as is reasonable for the concrete slab to dry before testing the Vapor Reduction Floor Coating performance.

1.08 WARRANTY

- A. Manufacturer shall provide the Owner with their standard ten (10) year warranty at no additional cost. Application Company of water vapor reduction system shall provide standard installation warranty for workmanship.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Koester American Corporation, 1206 Laskin Road, Suite 201 E, Virginia Beach, VA 23451 (757) 425-1206 locally distributed by Specified Polymers (Michael Hyduk), San Diego, CA (619) 294-8010, www.koester.com.

2.02 MATERIALS

- A. General: Use specified materials of one manufacturer throughout project.
- B. Vapor Reduction Floor Coating: Water-based primer/curing agent, 100% solids VAP 1® 2000 System containing specifically formulated chemicals and resins to provide the following characteristics and properties.
 - 1. ASTM E 96, Water Vapor Transmission (dry and wet methods) Performance shall be documented by an independent testing laboratory at a minimum of 70% for Koester VAP 1 Primer System, 95% for Koester VAP 1® 2000 System water vapor transmission reduction compared to untreated ACI Committee 201 durable concrete.
 - 2. ASTM D 4541; Adhesion Properties after ASTM E 96 wet method testing, minimum of 375 psi tensile stress, with cohesive failure in the substrate.
 - 3. ASTM C 309; Liquid Membrane-Forming Compounds for Curing Concrete.
 - 4. ASTM C 156; Water Retention by Concrete Curing Materials, minimum retention of 0.36 kg/m².
 - 5. ASTM D 1308; Insensitivity to alkaline environment up to pH 14.
 - 6. Certify acceptance and exposure to continuous topical water exposure after final cure.
 - 7. Certify acceptance to continuous exposure to topical foot traffic.

- C. Cementitious underlayment system (if required to level the floor over the VAP Systems):
As required by vapor reduction floor coating manufacturer.
 - 1. Tested and approved by Koester American prior to installation.
 - 2. No underlayment system with gypsum will be allowed.

2.03 MIXING

- A. Use clean containers, mix thoroughly as per Manufacturer's requirements to obtain a homogeneous mixture using a low speed motor (below 400 rpm) and a Jiffy two blade type mixer. DO NOT AERATE.
- B. VAP 1® 2000 Mix Ratio: Mix Component A and B at a ratio of 2.4 :1

PART 3 EXECUTION

3.01 EXAMINATION

- A. Inspect surfaces with regard to their suitability to receive Vapor Reduction Floor Coating with the Manufacturer's Representative.
- B. Verify that surfaces to be treated with Vapor Reduction Floor Coatings have NOT previously been treated with other materials like underlayments, screeds, penetrating sealants, etc. Inform vapor reduction system Manufacturer if concrete additives like chlorides or any other soluble compounds that can contaminate surfaces have been used in the concrete mix design. If this is the case, consult with the Vapor Reduction Floor Coating Manufacturers Representative prior to any application of Vapor Reduction Floor Coatings.
- C. Calcium chloride test requirements:
 - 1. Two weeks before installation of the ceramic tile, VCT, vinyl, wood, carpet, and/or epoxy flooring systems over the interior concrete slabs provide calcium chloride test to determine the level of water vapor transmission in the slab.
 - 2. Conduct testing in accordance with ASTM F1869 or ASTM E1907 (quantitative anhydrous calcium chloride test).
 - 3. Conduct calcium chloride tests after HVAC system has been in continuous use for 36 hours with a minimum ambient temperature of 72 degrees F. Water vapor transmission levels are directly affected by ambient room temperature and readings conducted without a sustained ambient temperature is NOT acceptable.
 - 4. Document test results and provide recommendations on the type of Vapor Reduction Floor Coating to be used by area.
 - 5. Provide test results with a marked up floor finish plan showing test results.
 - 6. Provide a written clarification on status of HVAC system before and during the test and the length of time the ambient air temperature was maintained before the tests.
 - 7. Provide a marked up floor plan showing areas with Vapor Reduction Floor Coating recommendations.

3.02 PREPARATION

- A. Clean surfaces to receive Vapor Reduction Floor Coatings.
 - 1. Shotblast floors to receive system to CSP 3 or 4 and clean surfaces with Shop Vac's to remove all residue off the substrate.

2. Remove defective materials, and foreign matter such as dust, adhesives, leveling compounds, screeds, paint, dirt, floor hardeners, bond breakers, oil, grease, curing agents, form release agents, efflorescence, laitance, Shotblast beebees, abandoned anchors, etc.
 3. Repair cracks, expansion joint, control joints, and open surface honeycombs and fill in accordance with Manufacturers recommendations.
 4. Reinforcing fibers must be burned off, scraped and vacuumed. Remove, after shot blasting, leaving no fibers left on the concrete surface.
 5. Acid etching or grinding is not acceptable for surface preparation.
 6. Provide uncontaminated surface.
- B. Dampen, Surface Saturated Dry (SSD), uncontaminated concrete, leaving NO standing water. Surfaces shall be damp, not wet to the touch. Use clean potable water to pre-dampen concrete surfaces. Only pre-dampen concrete prior to first VAP Primer coat. Do NOT pre-dampen between subsequent coats of VAP Systems.

3.03 APPLICATION

- A. VAP 1® 2000 System Application:
1. The coverage rates for this single coat system depend on the surface texture and porosity of the substrate as well as the measured level of moisture from Section 3.1 Examination. On average, coverage of 90 to 130 sq. ft./gal. Can be expected.
 2. Approximate coverage's relative to existing levels of moisture vapor as follows.
 - a. Up to 8 lbs./1,000 sq.ft./24hr. 130 sq.ft./gal.
 - b. Up to 15 lbs./1000 sq. ft./24hr. 90 sq.ft./gal.
 - c. Up to 25 lbs./1000 sq.ft./24hr. 70 sq.ft./gal.
 3. Apply one (1) coat of VAP 1® 2000 at an average coverage rate of 90 to 130 sq.ft./gal. using a squeegee and or a 3/8-inch nap roller leaving no areas untreated. Allow to cure a minimum of 12 hours before installing flooring system. Consult Koester VAP 1® 2000 System technical data sheets for additional application instructions.
- B. Optional: VAP 1 Primer System Application: (For very porous surfaces to avoid out gassing / air displacement, see technical brochures for installation requirements and contact Manufacturers Representative. No Exceptions.
1. Dampen uncontaminated concrete surface, (SSD) Surface Saturated Dry, leaving NO standing water. Surfaces must be damp, not wet to the touch. Always use clean potable water to pre-dampen concrete surfaces. Only pre-dampen concrete prior to the first VAP Primer coat. Do NOT pre-dampen between subsequent coats of the VAP Systems. Verify ambient temperature and relative humidity with Manufacturers Representative for accelerated cure schedules.
 2. Spray VAP 1 Primer leaving no areas untreated. Back brush thoroughly.
 3. Avoid puddling and pinholes when back brushing. Provide continuous ventilation and air movement during curing process. No exceptions.
 4. Apply VAP Primer at a rate of approximately 200 sq.ft. /gal minimum and allow to cure a minimum of 6 hours. Consult Koester technical data sheets for additional instructions.
- C. Cementitious underlayment system with an approved epoxy primer if required by the Floor Covering Installer, or the Floor Covering Manufacturer may be used to level and smooth surfaces after shotblasting the floor on top of the water vapor reduction system. The underlayment system utilized must be tested and approved (no exceptions) by the manufacturer of the underlayment system prior to installation. No underlayment system containing gypsum will be allowed. When water based adhesives are utilized in the floor covering installation, use an approved underlayment system with primer prior to the

installation of the flooring system. Please consult adhesive manufacturer for their minimum (approximately 1/8") recommended thickness of cementitious underlayment to absorb excess moisture in the adhesive. Leveling of the substrate shall not be considered part of the water vapor reduction system. No exceptions.

- D. For installation of resilient flooring directly over the water vapor reduction system, the contractor responsible for installing the floor covering system shall use a 100% solids adhesives and or contact type adhesives with long working times that can be applied to substrates with a pH up to 10. The method of use is to apply the contact type adhesives to the substrate and allow the materials water to flash off prior to the flooring installation. Always test proper adhesion of adhesive to water vapor reduction system prior to installation of entire flooring systems. No exceptions.

3.04 FIELD QUALITY CONTROL

- A. Floor treatment calcium chloride tests:
1. After drying of the final coat of the Vapor Reduction Floor Coating, provide calcium chloride tests to determine if the level of water vapor transmission has been reduced below 3 lbs./ per 1,000 sf./ per 24 hrs.
 2. Contact Architect, Owner, and Vapor Reduction Floor Coating Manufacturer's Representative concerning any areas with a water vapor transmission level greater than 3 lbs./24 hrs. per 1,000 sf.
- B. Adhesion tests:
1. Test adhesion of flooring adhesives, coatings, and leveling compounds to the final VAP Primer Coat.
 2. Contact flooring Manufacturer for recommendations.

3.05 CLEANING

- A. Clean tools and equipment outside of building envelope with water for VAP Primer System and xylene for VAP 1® 2000 System immediately after use.
- B. Remove debris resulting from VAP Systems installation from project site.

3.06 PROTECTION

- A. Protect each coat during specified cure period from any kind of traffic, topical water, and contaminants.

END OF SECTION

SECTION 07 59 00

REPAIRS TO EXISTING ROOFING

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: Patch and repair to existing roofing resulting from remodeling.
 - 1. Existing roofing consists of elastic sheet roofing with ballast over rigid board-type roof insulation with insulating concrete roof insulation thickness varies from 7-1/4 inch deep at high point to 2 inch deep at roof drains
 - 2. Core Sampling:
 - a. Contractor shall take core samples of roofing materials (not including structural deck) at location where roof is to be cut out for installation of new AHU. to determine existing materials and shall be responsible for determining materials required for repairs.
 - b. Costs associated with the cutting of core samples, and repairs of cut-out sections shall be borne by the Contractor.
- B. Related Sections:
 - 1. Cutting and Patching: In accordance with City of Chandler General Conditions
 - 2. Section 02 41 00 - Demolition

1.02 SUBMITTALS

- A. Product Data: Submit manufacturer's literature and technical data (specifications, installation instructions and evidence of UL, ICC, CCRC, "Energy Star" and FMG ratings, as applicable) on each material included to provide a complete system, including manufacturer's Letter of Certification that their products meet and comply with the materials and intent of the Specification, and manufacturer's application or installation instructions.
- B. Shop Drawings: Submit shop drawings indicating locations of patches and repairs, drainage pattern, slopes, and depth of roofing system to be provided.

1.03 QUALITY ASSURANCE

- A. Contractor Qualifications:
 - 1. Prior experience in repairs to roofing of the type which is existing on this project..\\
 - 2. Approved by the manufacturer of the roofing materials.
- B. Pre-Installation Conference:
 - 1. Approximately two weeks prior to schedule commencement of roofing installation and associated work, a meeting shall be held at the project site with installers of rooftop HVAC units and other work in and around roofing which must precede or follow roofing work (including mechanical and sheet metal work as applicable), General Contractor, Architect, Owner, roofing system manufacturer's representative, and other representatives directly concerned with the performance of the work. Contractor shall prepare minutes of the meeting and furnish copy of record to each party attending. Review foreseeable methods and procedures related to roofing work, including but not necessarily limited to the following:
 - a. Tour representative areas of roofing substrates (decks), inspect and discuss condition of substrate, roof drains, curbs, penetrations and other preparatory work performed by other trades.

- b. Review structural loading limitations of existing roof deck construction, and inspect deck for loss of flatness and for required mechanical fastening.
 - c. Review roofing system requirements (drawings, specifications and other Contract Documents).
 - d. Review and finalize construction schedule related to roofing work and verify availability of materials, installer's personnel, equipment and facilities needed to make progress and avoid delays.
 - e. Review required inspection, testing, certifying and material usage accounting procedures.
 - f. Review weather and forecasted weather conditions, and procedures for coping with unfavorable conditions, including possibility of temporary roofing (if not a mandatory requirement).
2. Notify Architect at least 48 hours prior to starting Work.
 3. Contractor shall review materials, details, etc. and submit a report including revised details to Architect. Incorporate revised details approved by Architect in the Project at no additional cost to Owner.

1.04 DELIVERY, STORAGE AND HANDLING

- A. Packing and Shipping: Deliver materials to site in manufacturer's original unopened packaging with labels intact. Protect finished surfaces with removable wrapping or coating which will not bond when exposed to sunlight.
- B. Storage: Adequately protect against damage while stored at the site.
- C. Handling: Comply with manufacturer's instructions.

1.05 PROJECT/SITE CONDITIONS

- A. Physical Requirements for Proper Installation or Application: Air temperature and substrate temperature shall be within manufacturer's limits for the materials to be used.

1.06 WARRANTY

- A. Provide manufacturer's 10 year full warranty for patches and repairs. Written warranty shall include materials and labor required to repair water leaks in the protective coatings system caused by deterioration resulting from ordinary weather conditions.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Match existing and in accordance with approved submittals.
- B. Primer/Sealer (if required): Per manufacturer's specific recommendations. Primer shall be formulated to be airless sprayed and designed expressly to enhance adhesion of roofing system to the substrates applicable to this project.
- C. Sealant: Sealant for use around roof penetrations shall be Type "D" as specified in Section 07 92 00 unless otherwise directed by roofing material manufacturer..

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions: Examine subsurfaces to receive Work and report detrimental conditions in writing to Architect.
 - 1. Prior to the application of roofing materials, the Contractor shall examine the roof deck, flashings, and other surfaces that are to receive roofing materials to ensure that surfaces are true, even, dry, clean and in proper condition to receive the roofing system.
 - 2. All penetrations through roofing including drains, scuppers, miscellaneous pipe and vent penetrations, and electrical conduits shall be completed prior to the starting of work.
 - 3. The Contractor shall report in writing to the Owner anything or condition not to the Contractor's satisfaction prior to proceeding with the work of this section.
 - 4. Application of roofing material shall constitute the roofing Contractor's acceptance of surfaces and flashings to receive the materials.
- B. Commencement of Work will be construed as acceptance of subsurfaces.
- C. Coordination: Coordinate with other work which affects, connects with, or will be concealed by this Work.

3.02 PREPARATION

- A. General Area:
 - 1. If applicable, notify the Architect and visitors to the site of potential fugitive overspray.
 - 2. Cars, etc., will be moved or covered to prevent inadvertent spraying. Contractor shall coordinate subcontractor traffic during roof operations.
 - 3. Provide barricades as required and place them in a way to be in an adequate and sufficient number so that there is no doubt that the area is completely barricaded off.
 - 4. Use appropriate barricading methods to shelter walking traffic from the work area's equipment and overspray.
 - 5. Any damage caused during this construction process shall be restored to pre-project condition or replaced at the Contractor's expense.
 - 6. Provide protective covering as needed to protect building walls, adjacent structures and vegetation, etc., from the effects of the spraying process.
 - 7. When work is finished, no evidence of re-roofing work shall be visible from the ground level, other than the work on the roofing plane.
- C. Roof Deck Surface Preparation:
 - 1. Free from dust, loose and foreign materials. Provide a clean and smooth surface ready for installation.
 - 2. Surface shall be dry before commencement of roofing application.
 - 3. Deck shall be kept clean and free of loose and foreign material other than tools and equipment of the roofer.
 - 4. Metal surfaces shall be free of moisture, rust, dirt and other foreign materials.
 - 5. Oils or other foreign materials, attached to the roof decking that prevent satisfactory adhesion, shall be cleaned for the deck.

3.03 INSTALLATION — GENERAL

- A. Install materials in strict compliance with written instructions of the manufacturer and regulations of local, state and/or federal agencies, which have jurisdiction.

- B. Notify the architect in writing of defects in the deck assembly, which will be detrimental to the proper functioning of the patched/repaired roof system. Do not commence work over defective area until advised in writing by Architect of the action to be taken in such areas. The commencement of work on the defective areas of the roof deck shall signify the Contractor's acceptance of such decks for the application of the specified roof system.
- C. Patches and repairs to the roofing to be provided when work penetrating the roof is completed. Mechanical work, plumbing vents, drains and electrical penetrations shall be in place. There shall not be trades-people working on the roof when the roof repairs are being installed. HVAC units which will cover roofing shall not be installed until the roof system is in place.
- D. Substrate shall have sufficient slope to eliminate excessive ponding water.
 - 1. Excessive ponding is defined as "an area of 100 square feet or more which holds in excess of 1/2 inch of water, as measured 72 hours after a rainfall". Low areas measuring less than this standard are acceptable.
 - 2. If the substrate does not have sufficient slope, it is to be brought to the attention of the Architect.
 - 3. Excessive ponding of water shall be eliminated by building in slope with the application by the proper placement of drains as approved by Architect.
- E. Metal: Install metal stop at roof edges. Nail new flashings at 1'-0" o.c. with galvanized large head roofing nails. Nails in areas where the underside of the roof is exposed (such as overhangs), shall be short enough to avoid penetration of the exposed underside.

3.05 FIELD QUALITY CONTROL

- A. Inspections by Roofing Manufacturer's Representative:
 - 1. The manufacturers representative for the materials used on this project shall make inspections as outlined by the manufacturer as required to provide the specified warranty.
 - 2. In addition to the inspections required for the warranty, the following inspections shall be required:
 - a. Preliminary deck inspection.
 - b. One unannounced spot inspection.
 - c. Final inspection.

3.06 CLEANING

- A. During the course of the Work and on completion of the Work, remove and dispose of excess materials, equipment and debris away from premises. Leave Work in clean condition.

END OF SECTION

SECTION 07 60 00

FLASHING AND SHEET METAL

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: Flashings, sheet metal work and related items including, but not limited to:
 - 1. Counterflashing at vertical surfaces.
 - 2. Flashing at roof penetrations.
 - 3. Repairs to existing metal copings as a result of new work.

1.02 SUBMITTALS

- A. Shop Drawings: Submit Drawings indicating type of material, gage, dimensions, profiles, locations where used, fastening and anchoring methods, joints, and provisions of expansion and contraction.
- B. Samples: Submit samples of each type of prefinished metal in selected color.

1.03 QUALITY ASSURANCE

- A. Standards:
 - 1. Comply with design and installation methods of SMACNA Architectural Sheet Metal Manual.
 - 2. Comply with The NRCA Roofing and Waterproofing Manual installation details.

1.04 DELIVERY, STORAGE AND HANDLING

- A. Packing and Shipping: Deliver materials to site in Manufacturer's original unopened packaging with labels intact.
- B. Storage: Adequately protect against damage while stored at the site.
- C. Handling: Comply with Manufacturer's instructions.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Prefinished Metal (Provide where exposed to view in final construction):
 - 1. Hot-dipped galvanized, ASTM A653 Structural Quality, Grade 40, G90 coating 24 gage core steel, or prefinished Galvalume - ASTM A792.
 - 2. Finish: Full strength Kynar 500/Hylar 5000 Fluorocarbon coating, applied by the Manufacturer on a continuous coil coating line, with top side dry film thickness of 0.70 to 0.90 mil over 0.25 to 0.35 mil prime coat, to provide a total dry film thickness of 0.95 to 1.25 mil.
 - a. Bottom side: Coated with primer with a dry film thickness of 0.25 mil.

- b. Finish: Conform to all tests for adhesion flexibility, and longevity as specified by the Kynar 500 finish supplier.
- c. Color: As selected by Architect from manufacturer's full range of colors.
- 3. Strippable film: Liquid applied to top side of painted coil to protect finish during fabrication, shipping and field handling.

- B. Galvanized Steel (Provide where NOT exposed to view in final construction): ASTM A653, 24 gage minimum and as indicated, with G-60 coating.

2.02 ACCESSORIES

- A. Sealant: As specified in Section 07 92 00.
- B. Plastic Cement: ASTM D4586.
- C. Sheet Metal Fasteners: Pre-finished galvanized steel with soft neoprene washers at exposed fasteners. Where exposed in the finished work of prefinished metal, provide fasteners with prefinished heads matching prefinished metal.
- D. Prefinished Metal Seam Sealers and Adhesives: As recommended by prefinished metal manufacturer for waterproof and weather-resistant seaming and adhesive applications of flashing and sheet metal work.

2.03 FABRICATION

- A. Fabricate sheet metal with lines, arris, and angles sharp and true, and plane surfaces free from objectionable wave, warp or buckle. Hem exposed edges to form a 1/2 inch wide hem on the side concealed from view.
- B. Forming, anchoring, expansion and contraction details, shall conform to referenced quality standards.
- C. Provide for thermal expansion of running trim, flashing, expansion joints, and other items exposed for more than 15 feet continuous length.
- D. Fabricate cleats and starter strips of same material as sheet.
- E. Form pieces in longest practical lengths, except form flashing and facias in 8 to 10 foot units.
- F. Fabricate coping covers with butt seam with backup plate, fastened one side seams (item 19, figure 3-3 per SMACNA Architectural Sheet Metal Manual).
- G. Fabricate corners from one piece with minimum 18 inch long legs, with mitered corners; seal with sealant.
- H. Fabricate flashings to allow toe to extend 2 inches over roofing. Return and brake edges.
- I. Where prefabricated counterflashing and reglet system is used, form upper edge of counterflashing with an approved snap lock flange to engage reglet receiver and to provide a spring action at bottom edge against roofing base flashing.
- J. Flashing Pans: If acceptable to Architect, flashing pans may be used for limited applications. Form sheet metal pans 6 inch nominal square size, with 3 inch upstand, and 4 inch flanges. Fill pans watertight with plastic cement.

2.04 FINISH

- A. Shop prepare and prime exposed ferrous metal surfaces.
- B. Backpaint concealed metal surfaces with protective backing paint to a minimum dry film thickness of 1.5 mil.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions: Examine subsurfaces to receive Work and report detrimental conditions in writing to Architect. Commencement of Work will be construed as acceptance of subsurfaces.
 - 1. Verify roof openings, curbs, pipes, sleeves, ducts, or vents through roof are solidly set, cant strips and reglets in place, and nailing strips located.
 - 2. Verify membrane termination and base flashings are in place, sealed, and secure.
- B. Coordination: Coordinate with other Work which affects, connects with, or will be concealed by this Work.

3.02 INSTALLATION

- A. Installation shall conform to NRCA and SMACNA manuals.
- B. Expansion Seams: Maintain a watertight installation at expansion seams. Locate expansion seams as shown or if not shown, at the following maximum spacing for each general flashing use:
 - 1. Flashing, expansion joints, gravel stops, and trim: At 10 foot intervals, 24 inches on each side of corners and intersections.
 - 2. Sealant-type expansion joints: Where sealant-filled expansion joints are used, embed the hooked flanges of the joint members not less than 1 inch into the sealant. Form joints to completely conceal the sealant. When ambient temperature is moderate at the time of installation (40 to 70 degrees F.), set joint members for 50 percent movement either way. Adjust setting proportionately for installation at higher ambient temperatures. Do not install sealant type joints at temperatures below 40 degrees F. Installation of sealant is specified in Section 07 92 00.
- C. Where dissimilar materials abut, provide proper separation or protection to minimize the possibility of galvanic action.
- D. Reglets: Install reglets in masonry, concrete or stucco to receive flashings, where required.
- E. Counterflashing: Match existing.
 - 1. Provide metal counterflashing at top edges of base flashings and at other locations indicated.
 - 2. Lap end joints a minimum of 3 inches. Do not solder or weld joints. Make flashing continuous at angles. Counterflashing shall overlap base flashing a minimum of 4 inches, unless otherwise indicated.
 - 3. Where counterflashing terminates in reglets, fasten flashing with lead wedges every 12 inches. Fill reglets continuously with synthetic rubber type sealant in accordance with requirements of Section 07 92 00.

- F. Copings: Match existing.
 - 1. Cover top of parapet walls where indicated with 24 gage galvanized metal coping formed to design shown. Before applying metal, cover top of wall or wood blocking with polyethylene.
 - 2. Extend front edge of coping covering down over the lock into a previously placed continuous edge strip. Secure edge strips with nails spaced 12 inches apart.
 - 3. Join rear edge of coping covering to adjacent flashings as indicated.

3.03 CLEANING

- A. During the course of the Work and on completion, remove and dispose of excess materials, equipment and debris away from premises. Leave Work in clean condition.

END OF SECTION

SECTION 07 72 00

ROOF ACCESSORIES

PART 1 GENERAL

1.01 SUBMITTALS

- A. Product Data: Submit Manufacturer's Specifications, design data and installation instructions.
- B. Shop Drawings: Submit Drawings showing layout, dimensions and construction details.

1.02 DELIVERY, STORAGE AND HANDLING

- A. Packing and Shipping: Deliver materials to site in Manufacturer's original unopened packaging with labels intact.
- B. Storage: Adequately protect against damage while stored at the site.
- C. Handling: Comply with Manufacturer's instructions.

1.03 PROJECT CONDITIONS

- A. Field Measurements: Verify dimensions shown on Drawings by taking field measurements; proper fit and attachment of parts is required.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Furnish products of one of the following Manufacturers, except as approved by the Architect, subject to compliance with Specifications requirements:
 - 1. Bilco Co. www.bilco.com
 - 2. Bristolite www.bristolite.com
 - 3. Cierra Products www.cierraproducts.com
 - 4. J.L. Industries www.jlindustries.com
 - 5. Pate Co. www.patecurbs.com
 - 6. Milcor, Inc. www.milcorinc.com
 - 7. Nystrom Building Products www.nystrom.com
 - 8. O'Keeffe's Inc. www.okeefes.com

2.02 MANUFACTURED UNITS

- A. Curbs: Pate Style pc-1b, or as approved, box section design, heavy gage galvanized steel construction, continuous mitered and welded corner seams, integral base plate, factory installed wood nailer, and insulated with 1-1/2 inch thick rigid fiberglass board insulation.
- B. Equipment Supports: Pate Style es-1 monolithic construction, heavy gage galvanized steel, continuous mitered and welded corner seams, integral base plate, factory installed 2 inch x 4 inch wood nailer, and heavy gage galvanized steel counterflashing.

- C. Pipe Curb Assemblies: Pate Style pca-1, with curb constructed of heavy gage galvanized steel with continuous welded corner seams, factory installed wood nailer insulated with 1-1/2 inch thick rigid fiberglass board insulation, cover of acrylic clad ABS thermoplastic, including graduated step PVC, boots, adjustable stainless steel clamps and cap fastening screws. Each assembly shall include curb, cap, boots and clamps. See Drawings for size and quantity of pipe penetrations.
- D. Roof Pipe Sleepers (Condensate piping and other low slung piping): Mifab CXM & C5 (as applicable) Small Rubber Support Series, 100% recycled rubber, UV resistant. Provide pipe strap clamps or strut clamps as applicable to series. The use of wood blocks shall not be acceptable.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions: Examine subsurfaces to receive Work and report detrimental conditions in writing to Architect. Commencement of Work will be construed as acceptance of subsurfaces.
- B. Coordination: Coordinate with other Work which affects, connects with, or will be concealed by this Work.

3.02 INSTALLATION

- A. Install roof specialties at locations shown or required in accordance with Manufacturer's instructions and as detailed on Drawings.
- B. Install equipment supports and bases, curbs and curb assemblies, at locations indicated, fastening securely to deck through curb flange.

3.03 CLEANING

- A. During the course of the Work and on completion, remove and dispose of excess materials, equipment and debris away from premises. Leave Work in clean condition.

END OF SECTION

SECTION 07 92 00

JOINT SEALERS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Joint sealers are new construction where indicated on Drawings and as specified.
 - 2. Joint sealers at existing construction. Existing caulk and sealant shall be removed and replaced in its entirety where deemed necessary to maintain a waterproof structure.

1.02 SUBMITTALS

- A. General: Provide submittals to verify product compliance, color selection, and samples of sealants used in applicable unique joint conditions.
- B. Product Data:
 - 1. Submit manufacturer's current specifications and recommended installation procedures.
 - 2. Submit sample warranty to be signed jointly by applicator and manufacturer.
 - 3. Submit manufacturer's standard color chart.
- C. Shop Drawings: Illustrations in sufficient detail to show installation and interface of the work of this Section with the work of adjacent trades.
- D. Field Adhesion Test and Stain Reports: Submit copies of logs and test reports showing results of field adhesion testing and stain testing. In lieu of field adhesion test reports, contractor may provide manufacturer's certification that products are suitable for use indicated based on previous testing and successful use.
- E. Contract Closeout: Submit Manufacturer's Warranty.

1.03 QUALITY ASSURANCE

- A. Primary products, as produced and supplied from a single manufacturer shall be provided, which has produced that product successfully for not less than 5 years.
- B. Qualifications:
 - 1. An approved manufacturer's installer shall perform the work, and have not less than 5 years of successful experience in the installation of caulks and sealants.
 - 2. Installers shall be thoroughly trained and experienced in the necessary skills and shall be thoroughly familiar with the specified requirements.
- C. Mockups: Sealants to be used in conjunction with materials to have Mockups shall be included in the Mockup.
- D. Field Color and Workmanship Samples: Caulk a section of joint as directed, under job conditions, at least 7 days prior to start of work for review by Architect. When approved, sample shall be used as a standard of comparison for remainder of work.

1.04 DELIVERY, STORAGE AND HANDLING

- A. Packing and Shipping: Deliver materials to site in manufacturer's original unopened packaging with labels intact.
- B. Storage: Adequately protect against damage while stored at the site. Maintain product in accordance with manufacturer's recommendations with proper precautions to ensure fitness of material when installed.
- C. Handling: Comply with manufacturer's instructions.

1.05 PROJECT/SITE CONDITIONS

- A. Physical Requirements for Proper Installation or Application: Observe manufacturer's temperature service range. Do not apply sealant when weather conditions will inhibit bonding and curing.

1.06 WARRANTY

- A. Provide warranty, in writing and signed jointly by the installer and sealant manufacturer, to replace sealants which fail at no additional cost to the Owner because of loss of cohesion or adhesion, or do not cure, and which fail to achieve air-tight and water-tight seal as follows:
 - 1. Sealant Types "A" and "B": 5 years.
 - 2. Sealant Types "C1" and "C2": 20 years.
 - 3. Sealant Types "D," "E" and "F": 2 years.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Single Source Responsibility for Joint Sealer Materials:
 - 1. Obtain joint sealer materials from a single manufacturer for each different product required.
 - 2. If sealants from separate manufacturers must be used and could come in contact with each other, provide written certification from every manufacturer involved that the sealants are compatible and will adhere to each other.

2.02 MATERIALS

- A. General:
 - 1. Provide primer, back-up materials, bond breakers and preformed joint fillers compatible with sealant as required.
 - 2. Backing materials shall be part of a manufacturer's total system for the joint size and type indicated.
- B. Sealant:
 - 1. The selection of proper sealant for a particular joint shall be in accordance with current published recommendations of the manufacturer.
 - 2. Types: See Schedule in Part 3 for the location where each type of sealant is to be provided.
 - a. Type "A": 2-part or 3-part (self-leveling) urethane, conforming to ASTM C920, Type M, Grade P, Class 25, Use T.

- b. Type "B": 3-part chemically curing polyurethane sealant conforming to ASTM C920, Type M, Grade NS, Class 25, Use NT, M, A, O, and capable of withstanding movement of 50% in extension and compression, and sustained temperatures of 250 degrees F in service.
 - c. Type "C-1": One-part low modulus moisture cure silicone rubber sealant conforming to FS TT-S-001543A, Class A, FS TT-S-00230C, Type II, Class A and ASTM C 920, Type S, Grade NS, Class 25, Use NT, M, G,A, and O, and capable of withstanding movement of 100% in extension and 50% in compression in service.
 - d. Type "C-2": One-part medium modulus neutral cure silicone rubber sealant conforming to FS TT-S-001543A, Class A, FS TT-S-00230C, Type II, Class A and ASTM C 920, Type S, Grade NS, Class 25, Use NT, M, G,A, and O, and capable of withstanding movement of 50% in extension and 50% in compression in service.
 - e. Type "D": ASTM C920, Type S, Grade NS, Class 25, Use NT, M,A,O.
 - f. Type "E": Silicone rubber sealant with mold inhibitor.
 - g. Type "F": Acoustical sealant, non-hardening sound stopping sealants shall be provided.
3. Color: Provide standard or custom colors as selected by Architect, In general, colors shall match adjacent materials.
- C. Primer: Non-staining type, recommended by sealant manufacturer to suit application.
- D. Joint Cleaner: Non-corrosive and non-staining type, recommended by sealant manufacturer; compatible with joint forming materials.
- E. Joint Filler (Backer): ASTM D1565; round closed cell polyethylene, urethane or neoprene foam rod; oversized 30 to 50 percent.
- F. Bond Breaker: Pressure sensitive tape recommended by sealant manufacturer to suit application.
- G. Gloss Reducer: Silica sand No. 20, color to match adjacent surface. Gloss reducer shall be provided at traffic sealant applications.
- H. Other Materials: Provide other materials, not specifically described but required for a complete and proper installation, as selected by the Contractor and approved by the sealant manufacturer as compatible, subject to the review of the Architect.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions: Examine subsurfaces to receive Work and report detrimental conditions in writing to Architect. Commencement of Work will be construed as acceptance of subsurfaces. Verify, before proceeding with this Work, that required inspections of existing conditions have been completed.
- B. Coordination: Coordinate with other work which affects, connects with, or will be concealed by this Work.
- C. Maximum allowable exterior joint width, for caulking/sealant, shall not exceed 1".

3.02 PREPARATION

- A. Clean, prepare, and prime joints in accordance with manufacturer's instructions. Remove loose materials and other foreign matter which may impair adhesion of sealant.
- B. Verify that joint shaping materials and release tapes are compatible with sealant.
- C. Examine joint dimensions and size materials to achieve required width/depth ratios.
- D. Use joint filler to achieve required joint depths, to allow sealants to perform properly.
- E. Use bond breaker where required.
- F. Protect adjacent surfaces from damage by masking when necessary.

3.03 INSTALLATION

- A. General:
 - 1. Install sealant in accordance with manufacturer's instructions.
 - 2. In general, seal openings and other locations which normally require sealant to seal against infiltration from air, water and most insects, including; but not limited to:
 - a. Construction and expansion joints.
 - b. Joints between dissimilar materials.
 - c. Joints around windows, door frames, louvers and other penetrations and openings in the exterior wall.
 - d. Interior wall openings.
 - e. Other locations indicated on drawings.
 - 3. Apply sealant within recommended temperature ranges. Consult manufacturer when sealant cannot be applied within recommended temperature ranges.
- B. Joints:
 - 1. Free of air pockets, foreign embedded matter, ridges, and sags.
 - 2. Tool joints concave.
- C. Apply sealant under pressure with hand or power actuated gun or other appropriate means. Gun shall have nozzle of proper size and provide sufficient pressure to completely fill joints as detailed.
- D. Neatly point or tool joint surfaces to provide slightly concave surfaces, free of wrinkles and skips, uniformly smooth and with perfect adhesion along both sides of joint.

3.04 CLEANING

- A. Clean adjacent surfaces of sealant as work progresses.
- B. Use solvent or cleaning agent as recommended by sealant manufacturer.
- C. During the course of the Work and on completion, remove and dispose of excess materials, equipment and debris away from premises.

3.05 SCHEDULE

- A. Expansion and Control Joints:
 - 1. Horizontal traffic: Type "A". Provide gloss reducer. Pavement joint sealants shall be limited to walks and slabs around the building perimeter and major driveway expansion joints. Do not seal saw cut control joints.
 - 2. Masonry (including existing building), concrete to concrete, stucco, steel and wood: Type "B".
 - 3. Glass (except insulating glass or special coated glass), aluminum, E.I.F.S., Natural Stone, and plastics: Type "C-1".
 - 4. Glass (including insulating glass or special coated glass), aluminum and plastics: Type "C-2".
- B. Non-expanding Joints:
 - 1. Glass (except insulating glass or special coated glass), aluminum, E.I.F.S., Natural Stone, and plastics: Type "C-1".
 - 2. Glass (including insulating glass or special coated glass), aluminum and plastics: Type "C-2".
 - 3. Concrete to concrete, stucco, masonry, aluminum, steel, and wood: Type "D".
- C. Mechanical (ductwork and air conditioning): Type "D".
- D. Plumbing Fixtures (around toilet, bath, kitchen fixtures, and food service equipment): Type "E".
 - 1. Colors:
 - a. At plumbing fixtures: White
 - b. Stainless steel conditions (such as at food service): Silver
- E. Acoustical (acoustical applications where sealant is required): Type "F".

END OF SECTION

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SECTION 08 11 13

HOLLOW METAL DOORS AND FRAMES

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: Provide Hollow metal flush doors and hollow metal frames where indicated on Drawings.
 - 1. Doors and frames shall be painted hollow metal (steel). Door hardware (as specified in Section 08 71 00) is to include glass lights, heavy duty hinges, closers, door protection (where required), and locksets.
 - a. Laboratories: 3'-6" wide x 7' high hollow metal wide stile door with half glass panel.
 - b. Offices: 3'-0" wide x 7' High hollow metal wide stile door with half glass panel.

1.02 SUBMITTALS

- A. Shop Drawings: Submit Drawings showing elevations of each door and frame type, typical and details of construction, location and installation requirements for hardware, size and thickness of material.
- B. Fire Rated Doors and Frames:
 - 1. Installation Instructions: Door and frame manufacturer shall clearly identify the hardware products, other materials and work requirements necessary to maintain compliance with UL 10(c) (positive pressure testing).
 - 2. Certification: Submit certification that fire rated doors (including frames and hardware as a unit) will comply with UL 10(c) (positive pressure testing).
- C. Furnish recognized independent test lab certification that products comply with ANSI A250.4.

1.03 DELIVERY AND STORAGE

- A. Deliver welded frames with spreaders and doors with wrappers.
- B. Store doors and frames under protective cover in dry, enclosed spaces at the site. Place doors and frames on non-staining blocking. Raise bottoms of doors at least 4 inches high and provide 1/4 inch air space between stacked doors to avoid metal to metal contact and permit air circulation.

1.04 QUALITY ASSURANCE

- A. Doors and frames shall be certified to comply with ANSI A250.4, Test Procedure and Acceptance Criteria for Physical Endurance for Steel Doors and Hardware Reinforcing, and ANSI A250.8, Recommended Specifications for Standard Steel Doors and Frames.

1.05 WARRANTY

- A. Doors shall carry a life of installation warranty from the manufacturer.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Furnish steel doors and frames from one of the following Manufacturers subject to compliance with Specification requirements:
 - 1. Steelcraft Manufacturing Co.
 - 2. Curries Company www.curries.com
 - 3. The Ceco Corporation www.cecodoor.com
 - 4. The Kewanee Corp. www.kewaneecorp.com
 - 5. Republic Builders Products www.republicdoor.com
 - 6. Fleming Steel Doors and Frames
 - 7. Other manufacturers as acceptable to Owner and Architect, compliant with SDI and NAAMM standards.
- B. Doors and frames shall be furnished by the same Manufacturer.

2.02 MATERIALS

- A. General: Doors and frames shall be commercial heavy duty quality. Minimum door thickness shall be 1 3/4 inch thick.
 - 1. Interior doors shall comply with SDI-100, Grade II, heavy duty, minimum 18 gauge faces.
 - 2. Exterior doors shall comply with SDI-100 Grade III, extra heavy duty, minimum 16 gauge faces.
 - 3. Where doors are to be used as part of an acoustical barrier assembly, they shall be rated a minimum of STC 33.
- B. Steel: ASTM A1008 cold-rolled or ASTM A1011 hot-rolled. Hot-dip galvanized meeting ASTM A653, Grade G60 for exterior openings.
- C. Glazing Beads: Minimum 20 gauge steel.
- D. Paint: Non-lifting, rust-inhibitive grey primer meeting ANSI A224.1, compatible with field finish specified in Section 09 91 00, applied after bonderizing.

2.03 FABRICATION- DOORS

- A. Door Edge Joint and Treatment: Joints at the edges of doors shall have manufacturer's standard edge construction with seam edge filled, dressed smooth.
- B. Where heavy duty hinges have been specified, provide 7 gauge or equivalent reinforcing at hinge cut outs. Coordinate with hardware schedule.
- C. Exterior Doors: Close top and bottom edges of all exterior doors flush as an integral part of the door construction, or by placing end closure channel with web of channel flush with top and bottom edge of door (not inverted), or by addition of end cap at top and bottom of door, spot welded to each face at least 3 inches on center, filled and dressed smooth.
- D. Reinforce openings in doors for lites and vents on all sides with 14 gauge steel channel.
- E. Provide non-egress double doors with one-piece astragals of 14 gauge steel unless otherwise indicated or scheduled. Provide solid drip cap at top of exterior out-swinging doors.

- F. Accurately mortise doors for locks and hinges. Provide adequate box type reinforcement with steel plates welded to the interior reinforcing channels and drilled and tapped. Provide reinforcement for all other items of hardware.
- G. Doors with glass lite openings shall have trim recessed from the face of the door, beveled and attached with screws.
- H. Louvers: Provide sightproof louvers inserted into the panels. Form louver frames of minimum 20-gauge steel. Weld or tenon minimum 24 gauge blades to frame and fasten the entire assembly to the door with moldings. The moldings, when used, shall be an integral part of the louver.
- I. Fire-Rated Doors: Provide fire rated doors investigated and tested as fire door doors, complete with type of hardware to be used. Identify each fire door with recognized testing laboratory labels, indicating applicable fire rating of steel doors. Doors required to meet smoke and draft control assembly requirements shall have labels that identify that the door has been tested and approved for smoke and draft control assemblies (S-label). Construct doors to comply with NFPA Standard No. 80 and UL-10(c).

2.04 FABRICATION - FRAMES

- A. Construct to shapes and sizes shown, meeting various wall thicknesses in accordance with ANSI/SDI-100.
- B. Provide fully profile welded type frames with welds ground and dressed smooth. Continuously weld, fill, grind and dress smooth face frame miters. Continuously back-weld casing, stop, soffit and rabbet.
- C. Mortise, reinforce, drill and tap for standard weight, full mortise template hinges and template strike.
 - 1. Prepare frames to accept electric strikes where applicable.
 - 2. Frames to have enlarged strike box and a strike box extension to accommodate security devices. The extension shall permit the installation of a door position switch near the strike box, consolidating wiring to one location.
 - 3. To accommodate motorized strikes and door position switches, frames shall have conduit raceway from the head of the frame to the strike box.
 - 4. Provide conduit/electrical chase within door frames for scan card access wiring.
- D. Provide not less than three 18 gauge anchors per jamb, or as shown on Drawings, spaced for maximum stiffness. Frames shall have wall anchors a minimum of 16 inch o.c. per jamb. Provide adjustable 18 gauge floor clips at each jamb, welded to back face of jamb, punched for securing to floor with two spaced anchors.
- E. Make cutouts for required hardware specified under Section 08 71 00, from templates furnished. Reinforce butt cutouts with minimum 8 gauge thick steel plate drilled and tapped and welded in place. When heavy duty hinges are specified, provide high frequency reinforcing at frames for hinges. Coordinate with hardware vendor. Provide strike stops of frames with holes for three rubber door silencers; on double door frames, provide for two silencers per door at head.
- F. For openings over 42 inches wide and at double openings, reinforce head members full length with a matching profile of 12 gauge steel. Provide anchor at midpoint of door, if practical.

- G. Construct frames for UL labeled doors in accordance with UL requirements and label as scheduled. Frames required to meet smoke and draft control assembly requirements shall have labels that identify that the frame has been tested and approved for smoke and draft control assemblies (S-label).

- H. Exterior doors to have drip edge at head.

2.05 FABRICATION - GLAZING FRAMES

- A. Construct in accordance with applicable parts of door frame Specification and as detailed. Extend partition frames around all four sides of openings.
- B. Provide glazing stops as detailed on Drawings.

2.06 FABRICATION TOLERANCES

- A. Allowable Tolerances for Fabrication: As specified in ANSI/SDI-117, Manufacturing Tolerances Standard Steel Doors and Frames.

2.07 PAINTING

- A. Bonderize and prime doors and frames with one shop coat of rust inhibitive primer.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install metal door frames plumb, level, rigid and in true alignment as recommended in SDI 105 and ANSI/DHI A115.IG.
- B. Install doors and fasten to maintain alignment with frames to achieve maximum operational effectiveness and appearance.
 - 1. Maintain clearances as specified in ANSI A250.8, 2.1.8.
 - 2. Shim as required per NFPA 80, ANSI/A115.IG and SDI 122.
- C. Fill backs of frames solid with mortar at concrete and masonry construction.
- D. Install fire doors and frames to comply with NFPA 80 and in accordance with manufacturer's printed instructions.
- E. Prepare and install doors in accordance with ANSI A115 and SDI 122.
- F. Coordinate installation of electric hardware with electrical subcontractor to ensure that conduits are extended from door frame locations to above ceiling locations.

3.02 FIELD QUALITY CONTROL

- A. Manufacturer's representative shall inspect fire rated doors (including frames and hardware as a unit) and verify compliance with UL 10C (positive pressure testing) as required by 2003 IBC Section 714. Fire rated doors (including frames and hardware as a unit) which do not comply with UL 10C (positive pressure testing) as required by 2003 IBC Section 714 shall be removed and replaced at no additional cost to Owner.

3.03 CLEANING

- A. During the course of the Work and on completion of the Work, remove excess materials, equipment and debris and dispose of away from premises. Leave Work in clean condition.

END OF SECTION

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SECTION 08 14 00

FLUSH WOOD DOORS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: Provide flush wood doors with wood frames as indicated on Drawings.
 - 1. Trace Metals Suite Construction: Due to the low detection level performance of the ICP-MS (or similar ICP-based instrumentation), the room environments for Sample Prep and Instrument are constructed as metals-free as possible in terms of what the room enclosure/environment “sees”. Provide non-metallic doors/door frames.
 - 2. Doors and frames shall be factory finish as specified herein. Door hardware (as specified in Section 08 71 00) is to include glass lights, heavy duty hinges, closers, door protection (where required), and locksets.
 - a. Laboratories: 3'-6" wide x 7' high hollow metal wide stile door with half glass panel.
 - b. Offices: 3'-0" wide x 7' High hollow metal wide stile door with half glass panel.

1.02 SUBMITTALS

- A. Shop Drawings: Submit Drawings showing schedule of door sizes and types, door details and elevations. Note discrepancies between the Drawings and door schedules, and the requirements of regulatory and testing agencies.
- B. Product Data: Submit Manufacturer's data showing door construction.
- C. Samples: Before fabrication, submit sample of each type of door to be furnished, showing face, edge, core construction and factory finish for each type specified.

1.03 QUALITY ASSURANCE

- A. Coordination: Contractor shall be responsible for coordinating and obtaining necessary information from Hardware and Metal Frame Manufacturers. Door Manufacturer shall be responsible for coordinating necessary information received by Contractor from Hardware and Metal Frame Manufacturers in order that doors shall be properly prepared to receive hinges and hardware. Contractor shall provide door supplier with approved frame schedule, hardware schedule, and hardware templates. Furnish to door supplier 60 days prior to desired delivery date of doors.

1.04 DELIVERY, STORAGE AND HANDLING

- A. Prior to delivery, provide protection compatible with finish specified for door edges and faces.
- B. Delivery:
 - 1. Deliver doors to the jobsite only when proper storage site is available.
 - 2. Store doors in an area having controlled temperature and humidity as recommended by NWWDA, AWI and the door manufacturer.
 - 3. Store doors flat on factory pallets, or three full 2 x 4's, one centered and the other two 12 inches from each end. Do not stack doors on end, or on their vertical edge.

4. Protect wood doors from construction activity, dirt, and exposure to sunlight.
- C. Handling:
1. Always handle doors with clean hands or gloves.
 2. Do not drag doors across one another.
 3. Maintain factory packaging or other means of protection on doors, until date of Final Completion.

1.05 WARRANTY

- A. Special Warranty: Furnish the following warranty to Owner:
1. Warrant doors from the date of installation against defects in materials and workmanship. Periods of warranty after date of installation:
 - a. Interior solid core and mineral core: Life of installation.
 2. Replacement under warranty shall include removal of the defective door, hanging, installation of hardware, and finishing.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Doors shall be products of one of the following Manufacturers:
1. VT Industries <https://www.vtindustries.com/> (Basis of Design)
 2. Masonite www.masonite.com
 3. Lambton www.lambtondoors.com
 4. Oshkosh Architectural Door Company www.oshkoshdoor.com

2.02 FLUSH DOORS

- A. General:
1. Doors shall be solid core flush with veneer faces, commercial heavy duty minimum grade, 1-3/4 inch thick. Minimum width to be 3'-0". Maximum height to be 7'-0".
 2. Doors shall be provided from a single manufacturer.
 3. Where doors are to be used as part of an acoustical barrier assembly, they shall be rated a minimum of STC 33.
- B. Cores - Solid Core: Shall conform to ANSI A208.1 1LD2, 32 lbs. per cubic foot density. For doors scheduled to receive closers, provide minimum 5 inch solid wood top rail.
- C. Edge Bandings:
1. Stiles (Dimensions given are minimum sizes allowed after factory trimming to booksize or prefitting) - Particleboard Core: 1-1/2 inch double banded laminated hardwood stile, laminated strand lumber or structural composite lumber (no finger joints allowed) in inner and outer band to be at least 1/2 inch wide same species lumber as face veneer with the exception of birch doors which will have hard maple stiles.
 2. Rails (Dimensions given are minimum sizes allowed after factory trimming to booksize or prefitting) - Particleboard Core: 1-1/4 inch minimum mill option hardwood rail.

- D. Face Veneers, Crossbands and Backers: Doors shall be 5 ply (AWI PC-5) [or] [7 ply (AWI PC-7)], made up of a face veneer, crossbanding and a core unit, all securely bonded together utilizing type 1 (fully waterproof) adhesive and the hot press assembly technique. All plies must be placed at right angles to adjacent plies.
 - 1. Cross banding shall be thoroughly dried hardwood extending full width and height of door with grain at right angles to face and back veneer.
 - 2. Face Veneer Species: White Maple
 - 3. Color: Clear CL 18, Factory Applied
- E. Glue: Type 1 per NWWDA/WDMA T.M.-6 for interior and exterior doors.

2.03 FRAMES

- A. As provided by door manufacturer and as detailed on Drawings.
- B. Frames shall have wall anchors a minimum of 16 inch o.c.per jamb.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine door frames to assure that jambs are true and plumb. Correct frames which are not true and plumb before doors are hung.

3.02 INSTALLATION

- A. Doors shall be hung true and plumb with standard bevel and with uniform 3/32 inch clearance at jambs and head, and 1/2 inch bottom clearance, unless otherwise required. Mortise, drill or otherwise prepare doors for finish hardware specified in Section 08 71 00, Finish Hardware. Pilot drill screw and bolt holes.
- B. Doors that are cut or planed for fitting shall be immediately resealed with a transparent wood sealer. Doors shall operate freely without sticking or binding, without hinge-bound conditions and with hardware installed, properly adjusted and functioning.
- C. Field Finish: Provide as specified in Section 09 91 00 and in accordance with Door Manufacturer's written instructions.

3.03 CLEANING

- A. During the course of the Work and on completion of the Work, remove excess materials, equipment and debris and dispose of away from premises. Leave Work in clean condition.

END OF SECTION

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SECTION 08 31 13

ACCESS DOORS AND FRAMES

PART 1 GENERAL

1.01 SUMMARY

- A. Provide ceiling hatch panel with louver and insect screen at pilot pit to provide access to plumbing, mechanical and electrical equipment.

1.02 SUBMITTALS

- A. Shop Drawings: Submit Drawings showing sizes, construction and installation details.

1.03 DELIVERY, STORAGE AND HANDLING

- A. Packing and Shipping: Deliver materials to site in Manufacturer's original unopened packaging with labels intact.
- B. Storage and Protection: Deliver and store items in dry, protected areas. Adequately protect against damage while stored at the site.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Furnish products of one of the following Manufacturers, except as approved by the Architect, subject to compliance with Specification requirements:
 - 1. Babcock-Davis (Cierra Products) www.babcockdavis.com
 - 2. Nystrom Building Products www.nystrom.com
 - 3. Karp Associates www.karpinc.com
 - 4. J.L. Industries www.jlindustries.com
 - 5. Milcor Inc. www.milcorlp.com

2.02 ACCESS DOORS

- A. Doors: Sizes as shown on the Drawings. Units shall be stainless steel, in types as required by ceiling construction:
- B. Door and Frame: Stainless steel with louvers and insect screen. Provide screwdriver operated cam locks for doors at ceilings. 16 gage stainless steel shall be used for door and frame. Size as required or as indicated on the Drawings.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install access doors in accordance with Manufacturer's directions at locations shown on Drawings or necessary for access to valves, dampers and other devices or equipment requiring periodic access. Do not install panels in locations where frame will extend over transition between two separate ceiling finish materials.
- B. Install plumb and level, true to line, and in alignment with adjacent walls.

3.02 CLEANING

- A. During the course of the Work and on completion of the Work, remove excess materials, equipment and debris and dispose of away from premises. Leave Work in clean condition.

END OF SECTION

SECTION 08 71 00

DOOR HARDWARE

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes:

1. Mechanical and electrified door hardware
2. Electronic access control system components
3. Field verification, preparation and modification of existing doors and frames to receive new door hardware.

B. Section excludes:

1. Windows
2. Cabinets (casework), including locks in cabinets
3. Signage
4. Toilet accessories
5. Overhead doors

C. Related Sections:

1. Division 01 Section "Alternates" for alternates affecting this section.
2. Division 06 Section "Rough Carpentry"
3. Division 06 Section "Finish Carpentry"
4. Division 07 Section "Joint Sealants" for sealant requirements applicable to threshold installation specified in this section.
5. Division 08 Sections:
 - a. "Metal Doors and Frames"
 - b. "Flush Wood Doors"
 - c. "Stile and Rail Wood Doors"
 - d. "Interior Aluminum Doors and Frames"
 - e. "Aluminum-Framed Entrances and Storefronts"
 - f. "Stainless Steel Doors and Frames"
 - g. "Special Function Doors"
 - h. "Entrances"
6. Division 09 sections for touchup, finishing or refinishing of existing openings modified by this section.
7. Division 26 "Electrical" sections for connections to electrical power system and for low-voltage wiring.
8. Division 28 "Electronic Safety and Security" sections for coordination with other components of electronic access control system and fire alarm system.

1.02 REFERENCES

A. UL - Underwriters Laboratories

1. UL 10B - Fire Test of Door Assemblies
2. UL 10C - Positive Pressure Test of Fire Door Assemblies
3. UL 1784 - Air Leakage Tests of Door Assemblies
4. UL 305 - Panic Hardware

B. DHI - Door and Hardware Institute

1. Sequence and Format for the Hardware Schedule
2. Recommended Locations for Builders Hardware
3. Keying Systems and Nomenclature
4. Installation Guide for Doors and Hardware

C. NFPA – National Fire Protection Association

1. NFPA 70 – National Electric Code
2. NFPA 80 – 2016 Edition – Standard for Fire Doors and Other Opening Protectives
3. NFPA 101 – Life Safety Code
4. NFPA 105 – Smoke and Draft Control Door Assemblies
5. NFPA 252 – Fire Tests of Door Assemblies

D. ANSI - American National Standards Institute

1. ANSI A117.1 – 2017 Edition – Accessible and Usable Buildings and Facilities
2. ANSI/BHMA A156.1 - A156.29, and ANSI/BHMA A156.31 - Standards for Hardware and Specialties
3. ANSI/BHMA A156.28 - Recommended Practices for Keying Systems
4. ANSI/WDMA I.S. 1A - Interior Architectural Wood Flush Doors
5. ANSI/SDI A250.8 - Standard Steel Doors and Frames

1.03 SUBMITTALS

A. General:

1. Submit in accordance with Conditions of Contract and Division 01 Submittal Procedures.
2. Prior to forwarding submittal:
 - a. Comply with procedures for verifying existing door and frame compatibility for new hardware, as specified in PART 3, "EXAMINATION" article, herein.
 - b. Review drawings and Sections from related trades to verify compatibility with specified hardware.
 - c. Highlight, encircle, or otherwise specifically identify on submittals: deviations from Contract Documents, issues of incompatibility or other issues which may detrimentally affect the Work.

B. Action Submittals:

1. Product Data: Submit technical product data for each item of door hardware, installation instructions, maintenance of operating parts and finish, and other information necessary to show compliance with requirements.

2. Riser and Wiring Diagrams: After final approval of hardware schedule, submit details of electrified door hardware, indicating:
 - a. Wiring Diagrams: For power, signal, and control wiring and including:
 - 1) Details of interface of electrified door hardware and building safety and security systems.
 - 2) Schematic diagram of systems that interface with electrified door hardware.
 - 3) Point-to-point wiring.
 - 4) Risers.
3. Samples for Verification: If requested by Architect, submit production sample of requested door hardware unit in finish indicated and tagged with full description for coordination with schedule.
 - a. Samples will be returned to supplier. Units that are acceptable to Architect may, after final check of operations, be incorporated into Work, within limitations of key coordination requirements.
4. Door Hardware Schedule:
 - a. Submit concurrent with submissions of Product Data, Samples, and Shop Drawings. Coordinate submission of door hardware schedule with scheduling requirements of other work to facilitate fabrication of other work critical in Project construction schedule.
 - b. Submit under direct supervision of a Door Hardware Institute (DHI) certified Architectural Hardware Consultant (AHC) or Door Hardware Consultant (DHC) with hardware sets in vertical format as illustrated by Sequence of Format for the Hardware Schedule published by DHI.
 - c. Indicate complete designations of each item required for each opening, include:
 - 1) Door Index: door number, heading number, and Architect's hardware set number.
 - 2) Quantity, type, style, function, size, and finish of each hardware item.
 - 3) Name and manufacturer of each item.
 - 4) Fastenings and other pertinent information.
 - 5) Location of each hardware set cross-referenced to indications on Drawings.
 - 6) Explanation of all abbreviations, symbols, and codes contained in schedule.
 - 7) Mounting locations for hardware.
 - 8) Door and frame sizes and materials.
 - 9) Degree of door swing and handing.
 - 10) Operational Description of openings with electrified hardware covering egress, ingress (access), and fire/smoke alarm connections.
5. Key Schedule:
 - a. After Keying Conference, provide keying schedule that includes levels of keying, explanations of key system's function, key symbols used, and door numbers controlled.
 - b. Use ANSI/BHMA A156.28 "Recommended Practices for Keying Systems" as guideline for nomenclature, definitions, and approach for selecting optimal keying system.
 - c. Provide 3 copies of keying schedule for review prepared and detailed in accordance with referenced DHI publication. Include schematic keying diagram and index each key to unique door designations.
 - d. Index keying schedule by door number, keyset, hardware heading number, cross keying instructions, and special key stamping instructions.

- e. Provide one complete bitting list of key cuts and one key system schematic illustrating system usage and expansion. Forward bitting list, key cuts and key system schematic directly to Owner, by means as directed by Owner.
- f. Prepare key schedule by or under supervision of supplier, detailing Owner's final keying instructions for locks.

C. Informational Submittals:

- 1. Provide Qualification Data for Supplier, Installer and Architectural Hardware Consultant.
- 2. Provide Product Data:
 - a. Certify that door hardware approved for use on types and sizes of labeled fire-rated doors complies with listed fire-rated door assemblies.
 - b. Include warranties for specified door hardware.

D. Closeout Submittals:

- 1. Operations and Maintenance Data: Provide in accordance with Division 01 and include:
 - a. Complete information on care, maintenance, and adjustment; data on repair and replacement parts, and information on preservation of finishes.
 - b. Catalog pages for each product.
 - c. Final approved hardware schedule edited to reflect conditions as installed.
 - d. Final keying schedule
 - e. Copy of warranties including appropriate reference numbers for manufacturers to identify project.
 - f. As-installed wiring diagrams for each opening connected to power, both low voltage and 110 volts.

E. Inspection and Testing:

- 1. Submit written reports to the Owner and Authority Having Jurisdiction (AHJ) of the results of functional testing and inspection for:
 - a. fire door assemblies, in compliance with NFPA 80.
 - b. required egress door assemblies, in compliance with NFPA 101.

1.04 QUALITY ASSURANCE

A. Qualifications and Responsibilities:

- 1. Supplier: Recognized architectural hardware supplier with a minimum of 5 years documented experience supplying both mechanical and electromechanical door hardware similar in quantity, type, and quality to that indicated for this Project. Supplier to be recognized as a factory direct distributor by the manufacturer of the primary materials with a warehousing facility in the Project's vicinity. Supplier to have on staff, a certified Architectural Hardware Consultant (AHC) or Door Hardware Consultant (DHC) available to Owner, Architect, and Contractor, at reasonable times during the Work for consultation.
- 2. Installer: Qualified tradesperson skilled in the application of commercial grade hardware with experience installing door hardware similar in quantity, type, and quality as indicated for this Project.

3. Architectural Hardware Consultant: Person who is experienced in providing consulting services for door hardware installations that are comparable in material, design, and extent to that indicated for this Project and meets these requirements:
 - a. For door hardware: DHI certified AHC or DHC.
 - b. Can provide installation and technical data to Architect and other related subcontractors.
 - c. Can inspect and verify components are in working order upon completion of installation.
 - d. Capable of producing wiring diagram and coordinating installation of electrified hardware with Architect and electrical engineers.
4. Single Source Responsibility: Obtain each type of door hardware from single manufacturer.

B. Certifications:

1. Fire-Rated Door Openings:
 - a. Provide door hardware for fire-rated openings that complies with NFPA 80 and requirements of authorities having jurisdiction.
 - b. Provide only items of door hardware that are listed products tested by Underwriters Laboratories, Intertek Testing Services, or other testing and inspecting organizations acceptable to authorities having jurisdiction for use on types and sizes of doors indicated, based on testing at positive pressure and according to NFPA 252 or UL 10C and in compliance with requirements of fire-rated door and door frame labels.
2. Smoke and Draft Control Door Assemblies:
 - a. Provide door hardware that meets requirements of assemblies tested according to UL 1784 and installed in compliance with NFPA 105
 - b. Comply with the maximum air leakage of 0.3 cfm/sq. ft. (3 cu. m per minute/sq. m) at tested pressure differential of 0.3-inch wg (75 Pa) of water.
3. Electrified Door Hardware
 - a. Listed and labeled as defined in NFPA 70, Article 100, by testing agency acceptable to authorities having jurisdiction.
4. Accessibility Requirements:
 - a. Comply with governing accessibility regulations cited in "REFERENCES" article 087100, 1.02.D3 herein for door hardware on doors in an accessible route. This project must comply with all Federal Americans with Disability Act regulations and all Local Accessibility Regulations.

C. Pre-Installation Meetings

1. Keying Conference
 - a. Incorporate keying conference decisions into final keying schedule after reviewing door hardware keying system including:
 - 1) Function of building, flow of traffic, purpose of each area, degree of security required, and plans for future expansion.
 - 2) Preliminary key system schematic diagram.

- 3) Requirements for key control system.
- 4) Requirements for access control.
- 5) Address for delivery of keys.

2. Pre-installation Conference

- a. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
- b. Inspect and discuss preparatory work performed by other trades.
- c. Inspect and discuss electrical roughing-in for electrified door hardware.
- d. Review sequence of operation for each type of electrified door hardware.
- e. Review required testing, inspecting, and certifying procedures.
- f. Review questions or concerns related to proper installation and adjustment of door hardware.

3. Electrified Hardware Coordination Conference:

- a. Prior to ordering electrified hardware, schedule and hold meeting to coordinate door hardware with security, electrical, doors and frames, and other related suppliers.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Inventory door hardware on receipt and provide secure lock-up for hardware delivered to Project site. Promptly replace products damaged during shipping.
- B. Tag each item or package separately with identification coordinated with final door hardware schedule, and include installation instructions, templates, and necessary fasteners with each item or package. Deliver each article of hardware in manufacturer's original packaging.
- C. Maintain manufacturer-recommended environmental conditions throughout storage and installation periods.
- D. Provide secure lock-up for door hardware delivered to Project. Control handling and installation of hardware items so that completion of Work will not be delayed by hardware losses both before and after installation.
- E. Handle hardware in manner to avoid damage, marring, or scratching. Correct, replace or repair products damaged during Work. Protect products against malfunction due to paint, solvent, cleanser, or any chemical agent.
- F. Deliver keys to manufacturer of key control system for subsequent delivery to Owner.

1.06 COORDINATION

- A. Coordinate layout and installation of floor-recessed door hardware with floor construction. Cast anchoring inserts into concrete.
- B. Installation Templates: Distribute for doors, frames, and other work specified to be factory or shop prepared. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.
- C. Security: Coordinate installation of door hardware, keying, and access control with Owner's security consultant.
- D. Electrical System Roughing-In: Coordinate layout and installation of electrified door hardware with connections to power supplies and building safety and security systems.
- E. Existing Openings: Where existing doors, frames and/or hardware are to remain, field verify existing functions, conditions and preparations and coordinate to suit opening conditions and to provide proper door operation.

1.07 WARRANTY

- A. Manufacturer's standard form in which manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within published warranty period.
 - 1. Warranty does not cover damage or faulty operation due to improper installation, improper use or abuse.
 - 2. Warranty Period: Beginning from date of Substantial Completion, for durations indicated in manufacturer's published listings.
 - a. Mechanical Warranty
 - 1) Locks
 - a) Schlage ND Series: 10 years
 - 2) Exit Devices
 - a) Von Duprin: 3 years
 - 3) Closers
 - a) LCN 4000 Series: 30 years
 - 4) Automatic Operators
 - a) LCN: 2 years

1.08 MAINTENANCE

- A. Furnish complete set of special tools required for maintenance and adjustment of hardware, including changing of cylinders.
- B. Turn over unused materials to Owner for maintenance purposes.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. The Owner requires use of certain products for their unique characteristics and project suitability to ensure continuity of existing and future performance and maintenance standards. After investigating available product offerings, the Awarding Authority has elected to prepare proprietary specifications. These products are specified with the notation: "No Substitute."
 - 1. Where "No Substitute" is noted, submittals and substitution requests for other products will not be considered.
- B. Approval of manufacturers and/or products other than those listed as "Scheduled Manufacturer" or "Acceptable Manufacturers" in the individual article for the product category shall be in accordance with QUALITY ASSURANCE article, herein.
- C. Approval of products from manufacturers indicated in "Acceptable Manufacturers" is contingent upon those products providing all functions and features and meeting all requirements of scheduled manufacturer's product.
- D. Where specified hardware is not adaptable to finished shape or size of members requiring hardware, furnish suitable types having same operation and quality as type specified, subject to Architect's approval.

2.02 MATERIALS

A. Fabrication

1. Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. provide screws according to manufacturer's recognized installation standards for application intended.
2. Finish exposed screws to match hardware finish, or, if exposed in surfaces of other work, to match finish of this other work including prepared for paint surfaces to receive painted finish.
3. Provide concealed fasteners wherever possible for hardware units exposed when door is closed. Coordinate with "Metal Doors and Frames", "Flush Wood Doors", "Stile and Rail Wood Doors" to ensure proper reinforcements. Advise the Architect where visible fasteners, such as thru bolts, are required.

B. Modification and Preparation of Existing Doors: Where existing door hardware is indicated to be removed and reinstalled.

1. Provide necessary fillers, Dutchmen, reinforcements, and fasteners, compatible with existing materials, as required for mounting new opening hardware and to cover existing door and frame preparations.
2. Use materials which match materials of adjacent modified areas.
3. When modifying existing fire-rated openings, provide materials permitted by NFPA 80 as required to maintain fire-rating.

C. Provide screws, bolts, expansion shields, drop plates and other devices necessary for hardware installation.

1. Where fasteners are exposed to view: Finish to match adjacent door hardware material.

D. Cable and Connectors:

1. Where scheduled in the hardware sets, provide each item of electrified hardware and wire harnesses with number and gage of wires enough to accommodate electric function of specified hardware.
2. Provide Molex connectors that plug directly into connectors from harnesses, electric locking and power transfer devices.
3. Provide through-door wire harness for each electrified locking device installed in a door and wire harness for each electrified hinge, electrified continuous hinge, electrified pivot, and electric power transfer for connection to power supplies.

2.03 HINGES

A. Manufacturers and Products:

1. Scheduled Manufacturer and Product:
 - a. Ives 5BB series, Building Standard

B. Requirements:

1. Provide hinges conforming to ANSI/BHMA A156.1.
2. Provide five knuckle, ball bearing hinges.
3. 1-3/4 inch (44 mm) thick doors, up to and including 36 inches (914 mm) wide:
 - a. Exterior: Standard weight, bronze or stainless steel, 4-1/2 inches (114 mm) high
 - b. Interior: Standard weight, steel, 4-1/2 inches (114 mm) high
4. 1-3/4 inch (44 mm) thick doors over 36 inches (914 mm) wide:
 - a. Exterior: Heavy weight, bronze/stainless steel, 5 inches (127 mm) high
 - b. Interior: Heavy weight, steel, 5 inches (127 mm) high
5. 2 inches or thicker doors:
 - a. Exterior: Heavy weight, bronze or stainless steel, 5 inches (127 mm) high
 - b. Interior: Heavy weight, steel, 5 inches (127 mm) high
6. Adjust hinge width for door, frame, and wall conditions to allow proper degree of opening.
7. Provide three hinges per door leaf for doors 90 inches (2286 mm) or less in height, and one additional hinge for each 30 inches (762 mm) of additional door height.
8. Where new hinges are specified for existing doors or existing frames, provide new hinges of identical size to hinge preparation present in existing door or existing frame.
9. Hinge Pins: Except as otherwise indicated, provide hinge pins as follows:
 - a. Steel Hinges: Steel pins
 - b. Non-Ferrous Hinges: Stainless steel pins
 - c. Out-Swinging Exterior Doors: Non-removable pins
 - d. Out-Swinging Interior Lockable Doors: Non-removable pins
 - e. Interior Non-lockable Doors: Non-rising pins
10. Provide hinges with electrified options as scheduled in the hardware sets. Provide with number and gage of wires enough to accommodate electric function of specified hardware. Locate electric hinge at second hinge from bottom or nearest to electrified locking component. Provide mortar guard for each electrified hinge specified.

2.04 ELECTRIC POWER TRANSFER

A. Manufacturers:

1. Scheduled Manufacturer and Product:
 - a. Von Duprin EPT-10, Building Standard

B. Requirements:

1. Provide power transfer with electrified options as scheduled in the hardware sets. Provide with number and gage of wires enough to accommodate electric function of specified hardware.
2. Locate electric power transfer per manufacturer's template and UL requirements, unless interference with operation of door or other hardware items.

2.05 FLUSH BOLTS

A. Manufacturers:

1. Scheduled Manufacturer:
 - a. Ives, Building Standard

B. Requirements:

1. Provide automatic, constant latching, and manual flush bolts with forged bronze or stainless-steel face plates, extruded brass levers, and with wrought brass guides and strikes. Provide 12 inch (305 mm) steel or brass rods at doors up to 90 inches (2286 mm) in height. For doors over 90 inches (2286 mm) in height increase top rods by 6 inches (152 mm) for each additional 6 inches (152 mm) of door height. Provide dust-proof strikes at each bottom flush bolt.

2.06 CYLINDRICAL LOCKS – GRADE 1

A. Manufacturers and Products:

1. Scheduled Manufacturer and Product:
 - a. Schlage ND series
2. Acceptable Manufacturers and Products:
 - a. No Substitute

B. Requirements:

1. Provide cylindrical locks conforming to ANSI/BHMA A156.2 Series 4000, Grade 1, and UL Listed for 3-hour fire doors.
2. Cylinders: Refer to "KEYING" article, herein.
3. Provide locks with standard 2-3/4 inches (70 mm) backset, unless noted otherwise, with 1/2-inch latch throw. Provide proper latch throw for UL listing at pairs.
4. Provide locksets with separate anti-rotation thru-bolts, and no exposed screws.
5. Provide independently operating levers with two external return spring cassettes mounted under roses to prevent lever sag.
6. Provide standard ASA strikes unless extended lip strikes are necessary to protect trim.
7. Provide electrified options as scheduled in the hardware sets.
8. Lever Trim: Solid cast levers without plastic inserts and wrought roses on both sides.
 - a. Vandlgard: Provide levers with vandal resistant technology for use at exterior.
 - b. Lever Design: Rhodes.

2.07 ACCESS CONTROL READER

A. Manufacturers and Products:

1. Scheduled Manufacturer and Product:
 - a. Schlage MT Series (by security vendor)
2. Acceptable Manufacturers and Products:
 - a. No Substitute

B. Requirements:

1. Provide access control card readers manufactured by a global company who is a recognized leader in the production of access control devices. Card reader manufactured for non-access control applications are not acceptable
2. Provide multi-technology contactless readers complying with ISO 14443.
3. Provide access control card readers capable of reading the following technologies:
 - a. CSN - DESFire® CSN, HID iCLASS® CSN, Inside Contactless PicoTag® CSN, ST Microelectronics® CSN, Texas Instruments Tag-It®, CSN, Phillips I-Code® CSN
 - b. 125 KHz proximity - Schlage® Proximity, HID® Proximity, GE/CASI® Proximity, AWID® Proximity, LenelProx®
 - c. 13.56 MHz Smart card - Schlage smart cards using MIFARE Classic® EV1, Schlage smart cards using MIFARE Plus®, Schlage smart cards using MIFARE® DESFire® EV1, Schlage smart cards using MIFARE® DESFire® EV2

2.08 PASSIVE INFRARED MOTION SENSORS

A. Manufacturers and Products:

1. Scheduled Manufacturer and Product:
 - a. Schlage SCAN II Series (by security vendor)

B. Requirements:

1. Provide motion sensors as specified in hardware groups.

2.09 POWER SUPPLIES

A. Manufacturers and Products:

1. Scheduled Manufacturer and Product:
 - a. Schlage/Von Duprin PS900 Series (by security vendor)

B. Requirements:

1. Provide power supplies approved by manufacturer of supplied electrified hardware.
2. Provide appropriate quantity of power supplies necessary for proper operation of electrified locking components as recommended by manufacturer of electrified locking components with consideration for each electrified component using power supply, location of power supply, and approved wiring diagrams. Locate power supplies as directed by Architect.
3. Provide regulated and filtered 24 VDC power supply, and UL class 2 listed.
4. Provide power supplies with the following features:
 - a. 12/24 VDC Output, field selectable.
 - b. Class 2 Rated power limited output.
 - c. Universal 120-240 VAC input.
 - d. Low voltage DC, regulated and filtered.
 - e. Polarized connector for distribution boards.
 - f. Fused primary input.
 - g. AC input and DC output monitoring circuit w/LED indicators.
 - h. Cover mounted AC Input indication.
 - i. Tested and certified to meet UL294.
 - j. NEMA 1 enclosure.
 - k. Hinged cover w/lock down screws.
 - l. High voltage protective cover.

2.10 CYLINDERS

A. Manufacturers and Products:

1. Scheduled Manufacturer and Product:
 - a. Schlage Everest 29 R, City of Chandler Grand Master system.
2. Acceptable Manufacturers and Products:
 - a. No Substitute

B. Requirements:

1. Provide cylinders/cores compliant with ANSI/BHMA A156.5; latest revision; cylinder face finished to match lockset; manufacturer's series as indicated. Refer to "KEYING" article, herein.
2. Provide cylinders in the below-listed configuration(s), distributed throughout the Project as indicated.
 - a. Conventional Patented Restricted Small Format: cylinder with small format interchangeable cores (SFIC) with restricted, patented keyway.
3. Patent Protection: Cylinders/cores requiring use of restricted, patented keys, patent protected.
4. Nickel silver bottom pins.

2.11 KEYING

A. Scheduled System:

1. Existing factory registered system:

- a. Provide cylinders/cores keyed into Owner's existing factory registered keying system. Comply with guidelines in ANSI/BHMA A156.28, incorporating decisions made at keying conference.

B. Requirements:

1. Construction Keying:

- a. Replaceable Construction Cores.
 - 1) Provide temporary construction cores replaceable by permanent cores, furnished in accordance with the following requirements.
 - a) 2 construction control keys
 - b) 12 construction change (day) keys.
 - 2) Owner or Owner's Representative will replace temporary construction cores with permanent cores.

2. Permanent Keying:

- a. Provide permanent cylinders/cores keyed by the manufacturer according to the following key system.
 - 1) Master Keying system as directed by the Owner.
- b. Forward biting list and keys separately from cylinders, by means as directed by Owner. Failure to comply with forwarding requirements will be cause for replacement of cylinders/cores involved at no additional cost to Owner.
- c. Provide keys with the following features:
 - 1) Material: Nickel silver; minimum thickness of .107-inch (2.3mm)
 - 2) Patent Protection: Keys and blanks protected by one or more utility patent(s).
- d. Identification:
 - 1) Mark permanent cylinders/cores and keys with applicable blind code for identification. Do not provide blind code marks with actual key cuts.
 - 2) Identification stamping provisions must be approved by the Architect and Owner.
 - 3) Stamp cylinders/cores and keys with Owner's unique key system facility code as established by the manufacturer; key symbol and embossed or stamped with "DO NOT DUPLICATE" along with the "PATENTED" or patent number to enforce the patent protection.
 - 4) Failure to comply with stamping requirements will be cause for replacement of keys involved at no additional cost to Owner.
 - 5) Forward permanent cylinders/cores to Owner, separately from keys, by means as directed by Owner.
- e. Quantity: Furnish in the following quantities.
 - 1) Change (Day) Keys: 2 per cylinder/core.
 - 2) Permanent Control Keys: 2.
 - 3) Master Keys: 6.

2.12 KEY CONTROL SYSTEM

A. Manufacturers:

1. Scheduled Manufacturer:
 - a. Telkee
2. Acceptable Manufacturers:
 - a. No Substitute
 - b. HPC
 - c. Lund

B. Requirements:

1. Provide key control system, including envelopes, labels, tags with self-locking key clips, receipt forms, 3-way visible card index, temporary markers, permanent markers, and standard metal cabinet, all as recommended by system manufacturer, with capacity for 150% of number of locks required for Project.
 - a. Provide complete cross index system set up by hardware supplier, and place keys on markers and hooks in cabinet as determined by final key schedule.
 - b. Provide hinged-panel type cabinet for wall mounting.

2.13 DOOR CLOSERS

A. Manufacturers and Products:

1. Scheduled Manufacturer and Product:
 - a. LCN 4040XP series
2. Acceptable Manufacturers and Products:
 - a. No Substitute

B. Requirements:

1. Provide door closers conforming to ANSI/BHMA A156.4 Grade 1 requirements by BHMA certified independent testing laboratory. ISO 9000 certify closers. Stamp units with date of manufacture code.
2. Provide door closers with fully hydraulic, full rack and pinion action with high strength cast iron cylinder, and full complement bearings at shaft.
3. Cylinder Body: 1-1/2-inch (38 mm) diameter with 5/8-inch (16 mm) diameter double heat-treated pinion journal.
4. Hydraulic Fluid: Fireproof, passing requirements of UL10C, and requiring no seasonal closer adjustment for temperatures ranging from 120 degrees F to -30 degrees F.
5. Spring Power: Continuously adjustable over full range of closer sizes, and providing reduced opening force as required by accessibility codes and standards.
6. Hydraulic Regulation: By tamper-proof, non-critical valves, with separate adjustment for latch speed, general speed, and backcheck.
7. Provide closers with solid forged steel main arms and factory assembled heavy-duty forged forearms for parallel arm closers.

8. Pressure Relief Valve (PRV) Technology: Not permitted.
9. Finish for Closer Cylinders, Arms, Adapter Plates, and Metal Covers: Powder coating finish which has been certified to exceed 100 hours salt spray testing as described in ANSI Standard A156.4 and ASTM B117, or has special rust inhibitor (SRI).
10. Provide special templates, drop plates, mounting brackets, or adapters for arms as required for details, overhead stops, and other door hardware items interfering with closer mounting.

2.14 ELECTRO-HYDRAULIC AUTOMATIC OPERATORS

A. Manufacturers and Products:

1. Scheduled Manufacturer and Product:
 - a. LCN 4600 series
2. Acceptable Manufacturers and Products:
 - a. No Substitute

B. Requirements:

1. Provide low energy automatic operator units with hydraulic closer complying with ANSI/BHMA A156.19.
2. Hydraulic Fluid: Fireproof, passing requirements of UL10C, and requiring no seasonal closer adjustment for temperatures ranging from 120 degrees F to -30 degrees F.
3. Provide units with conventional door closer opening and closing forces unless power operator motor is activated. Provide door closer assembly with adjustable spring size, back-check, and opening and closing speed adjustment valves to control door
4. Provide units with on/off switch for manual operation, motor start up delay, vestibule interface delay, electric lock delay, and door hold open delay.
5. Provide drop plates, brackets, and adapters for arms as required for details.
6. Provide actuator switches and receivers for operation as specified.
7. Provide weather-resistant actuators at exterior applications.
8. Provide key switches with LED's, recommended and approved by manufacturer of automatic operator as required for function described in operation description of hardware group below. Cylinders: Refer to "KEYING" article, herein.
9. Provide complete assemblies of controls, switches, power supplies, relays, and parts/material recommended and approved by manufacturer of automatic operator for each individual leaf. Actuators control both doors simultaneously at pairs. Sequence operation of exterior and vestibule doors with automatic operators to allow ingress or egress through both sets of openings as directed by Architect. Locate actuators, key switches, and other controls as directed by Architect.
10. Provide units with vestibule inputs that allow sequencing operation of two units, and SPDT relay for interfacing with latching or locking devices.

2.15 PROTECTION PLATES

A. Manufacturers:

1. Scheduled Manufacturer:
 - a. Ives, building standard

B. Requirements:

1. Provide protection plates with a minimum of 0.050 inch (1 mm) thick, beveled four edges as scheduled. Furnish with sheet metal or wood screws, finished to match plates.
2. Sizes plates 2 inches (51 mm) less width of door on single doors, pairs of doors with a mullion, and doors with edge guards. Size plates 1 inch (25 mm) less width of door on pairs without a mullion or edge guards.
3. At fire rated doors, provide protection plates over 16 inches high with UL label.

2.16 OVERHEAD STOPS AND OVERHEAD STOP/HOLDERS

A. Manufacturers:

1. Scheduled Manufacturers:
 - a. Glynn-Johnson, building standard.

B. Requirements:

1. Provide overhead stop at any door where conditions do not allow for a wall stop or floor stop presents tripping hazard.
2. Provide friction type at doors without closer and positive type at doors with closer.

2.17 DOOR STOPS AND HOLDERS

A. Manufacturers:

1. Scheduled Manufacturer:
 - a. Ives, building standard.

B. Provide door stops at each door leaf:

1. Provide wall stops wherever possible. Provide concave type where lockset has a push button or thumbturn.
2. Where a wall stop cannot be used, provide universal floor stops.
3. Where wall or floor stop cannot be used, provide overhead stop.
4. Provide roller bumper where doors open into each other and overhead stop cannot be used.

2.18 THRESHOLDS, SEALS, DOOR SWEEPS, AUTOMATIC DOOR BOTTOMS, AND GASKETING

A. Manufacturers:

1. Scheduled Manufacturer:
 - a. Pemko, building standard.

B. Requirements:

1. Provide thresholds, weather-stripping, and gasketing systems as specified and per architectural details. Match finish of other items.
2. Smoke- and Draft-Control Door Assemblies: Where smoke- and draft-control door assemblies are required, provide door hardware that meets requirements of assemblies tested according to UL 1784 and installed in compliance with NFPA 105.
3. Provide door sweeps, seals, astragals, and auto door bottoms only of type where resilient or flexible seal strip is easily replaceable and readily available.
4. Size thresholds 1/2 inch (13 mm) high by 5 inches (127 mm) wide by door width unless otherwise specified in the hardware sets or detailed in the drawings.

2.19 SILENCERS

A. Manufacturers:

1. Scheduled Manufacturer:
 - a. Ives

B. Requirements:

1. Provide "push-in" type silencers for hollow metal or wood frames.
2. Provide one silencer per 30 inches (762 mm) of height on each single frame, and two for each pair frame.
3. Omit where gasketing is specified.

2.20 DOOR POSITION SWITCHES

A. Manufacturers: (by security vendor)

1. Scheduled Manufacturer:
 - a. Schlage
2. Acceptable Manufacturers:
 - a. GE-Interlogix

B. Requirements:

1. Provide recessed or surface mounted type door position switches as specified.
2. Coordinate door and frame preparations with door and frame suppliers. If switches are being used with magnetic locking device, provide minimum of 4 inches (102 mm) between switch and magnetic locking device.

2.21 FINISHES

A. FINISH: BHMA 626/652 (US26D); EXCEPT:

1. Hinges at Exterior Doors: BHMA 630 (US32D)
2. Aluminum Geared Continuous Hinges: BHMA 628 (US28)
3. Push Plates, Pulls, and Push Bars: BHMA 630 (US32D)
4. Protection Plates: BHMA 630 (US32D)
5. Overhead Stops and Holders: BHMA 630 (US32D)
6. Door Closers: Powder Coat to Match
7. Wall Stops: BHMA 630 (US32D)
8. Latch Protectors: BHMA 630 (US32D)
9. Weatherstripping: Clear Anodized Aluminum
10. Thresholds: Mill Finish Aluminum

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Prior to installation of hardware, examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire-rated door assembly construction, wall and floor construction, and other conditions affecting performance. Verify doors, frames, and walls have been properly reinforced for hardware installation.
- B. Field verify existing doors and frames receiving new hardware and existing conditions receiving new openings. Verify that new hardware is compatible with existing door and frame preparation and existing conditions.
- C. Examine roughing-in for electrical power systems to verify actual locations of wiring connections before electrified door hardware installation.
- D. Submit a list of deficiencies in writing and proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Mount door hardware units at heights to comply with the following, unless otherwise indicated or required to comply with governing regulations.
 1. Standard Steel Doors and Frames: ANSI/SDI A250.8.
 2. Custom Steel Doors and Frames: HMMA 831.
 3. Interior Architectural Wood Flush Doors: ANSI/WDMA I.S. 1A
 4. Installation Guide for Doors and Hardware: DHI TDH-007-20
- B. Install door hardware in accordance with NFPA 80, NFPA 101 and provide post-install inspection, testing as specified in section 1.03.E unless otherwise required to comply with governing regulations.

- C. Install each hardware item in compliance with manufacturer's instructions and recommendations, using only fasteners provided by manufacturer.
- D. Do not install surface mounted items until finishes have been completed on substrate. Protect all installed hardware during painting.
- E. Set units level, plumb and true to line and location. Adjust and reinforce attachment substrate as necessary for proper installation and operation.
- F. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.
- G. Install operating parts so they move freely and smoothly without binding, sticking, or excessive clearance.
- H. Hinges: Install types and in quantities indicated in door hardware schedule but not fewer than quantity recommended by manufacturer for application indicated.
- I. Lock Cylinders:
 - 1. Install construction cores to secure building and areas during construction period.
 - 2. Replace construction cores with permanent cores as indicated in keying section.
 - 3. Furnish permanent cores to Owner for installation.
- J. Wiring: Coordinate with Division 26, ELECTRICAL and Division 28 ELECTRONIC SAFETY AND SECURITY sections for:
 - 1. Conduit, junction boxes and wire pulls.
 - 2. Connections to and from power supplies to electrified hardware.
 - 3. Connections to fire/smoke alarm system and smoke evacuation system.
 - 4. Connection of wire to door position switches and wire runs to central room or area, as directed by Architect.
 - 5. Connections to panel interface modules, controllers, and gateways.
 - 6. Testing and labeling wires with Architect's opening number.
- K. Key Control System: Tag keys and place them on markers and hooks in key control system cabinet, as determined by final keying schedule.
- L. Door Closers: Mount closers on room side of corridor doors, inside of exterior doors, and stair side of stairway doors from corridors. Mount closers so they are not visible in corridors, lobbies and other public spaces unless approved by Architect.
- M. Closer/Holders: Mount closer/holders on room side of corridor doors, inside of exterior doors, and stair side of stairway doors.
- N. Power Supplies: Locate power supplies as indicated or, if not indicated, above accessible ceilings or in equipment room, or alternate location as directed by Architect.
- O. Thresholds: Set thresholds in full bed of sealant complying with requirements specified in Division 07 Section "Joint Sealants."
- P. Stops: Provide floor stops for doors unless wall or other type stops are indicated in door hardware schedule. Do not mount floor stops where they may impede traffic or present tripping hazard.
- Q. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.
- R. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.
- S. Door Bottoms and Sweeps: Apply to bottom of door, forming seal with threshold when door is closed.

3.03 ADJUSTING

- A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.
 - 1. Spring Hinges: Adjust to achieve positive latching when door can close freely from an open position of 30 degrees.
 - 2. Electric Strikes: Adjust horizontal and vertical alignment of keeper to properly engage lock bolt.
 - 3. Door Closers: Adjust sweep period to comply with accessibility requirements and requirements of authorities having jurisdiction.
- B. Occupancy Adjustment: Approximately three to six months after date of Substantial Completion, examine and readjust each item of door hardware, including adjusting operating forces, as necessary to ensure function of doors and door hardware.

3.04 CLEANING AND PROTECTION

- A. Clean adjacent surfaces soiled by door hardware installation.
- B. Clean operating items per manufacturer's instructions to restore proper function and finish.
- C. Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of Substantial Completion.

3.05 DOOR HARDWARE SCHEDULE

- A. The intent of the hardware specification is to specify the hardware for interior and exterior doors, and to establish a type, continuity, and standard of quality. However, it is the door hardware supplier's responsibility to thoroughly review existing conditions, schedules, specifications, drawings, and other Contract Documents to verify the suitability of the hardware specified.
- B. Discrepancies, conflicting hardware, and missing items are to be brought to the attention of the architect with corrections made prior to the bidding process. Omitted items not included in a hardware set should be scheduled with the appropriate additional hardware required for proper application.
- C. Hardware items are referenced in the following hardware schedule. Refer to the above specifications for special features, options, cylinders/keying, and other requirements.
- D. Hardware Sets:

Abbreviation	Name
GLY	Glynn-Johnson Corp
HES	Hes Inc
IVE	H.B. Ives
LCN	Lcn Commercial Division
PEM	Pemko Mfg Co
ROC	Rockwood Manufacturing Co.
SCE	Schlage Electronic Security
SCH	Schlage Lock Company
VON	Von Duprin

⚡ = Hardware Item Requiring Electrical Coordination

65553 OPT0243992 Version 3R

Legend:

 Link to catalog cut sheet**⚡** Electrified Opening

HARDWARE GROUP NO. 200

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5 NRP		652	IVE
1	EA	STOREROOM LOCK	ND80G RHO		626	SCH
1	EA	SFIC EVEREST CORE	80-037 EV29 R		626	SCH
1	EA	SURFACE CLOSER	4040XP RW/PA		689	LCN
1	EA	WALL STOP	WS401/402CCV		626	IVE
3	EA	SILENCER	SR64		GRY	IVE

HARDWARE GROUP NO. 201

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5		652	IVE
1	EA	ENTRANCE LOCK	ND53BDC RHO		626	SCH
1	EA	SFIC EVEREST CORE	80-037 EV29 R		626	SCH
1	EA	WALL STOP	WS401/402CCV		626	IVE
3	EA	SILENCER	SR64		GRY	IVE

HARDWARE GROUP NO. 203

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1HW 4.5 X 4.5 NRP		652	IVE
1	EA	ENTRANCE LOCK	ND53BDC RHO		626	SCH
1	EA	SFIC EVEREST CORE	80-037 EV29 R		626	SCH
1	EA	OH STOP	90S		630	GLY
1	EA	SURFACE CLOSER	4040XP EDA ST-2731		689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS		630	IVE
3	EA	SILENCER	SR64		GRY	IVE

HARDWARE GROUP NO. 204

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1HW 4.5 X 4.5		652	IVE
1	EA	ENTRANCE LOCK	ND53BDC RHO		626	SCH
1	EA	SFIC EVEREST CORE	80-037 EV29 R		626	SCH
1	EA	OH STOP	90S		630	GLY
1	EA	SURFACE CLOSER	4040XP		689	LCN
1	EA	PLASTIC KICK PLATE .060	K2060 10" x 2" LDW		TBD	ROC
3	EA	SILENCER	SR64		GRY	IVE

HARDWARE GROUP NO. 205

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1HW 4.5 X 4.5 NRP		652	IVE
1	EA	ENTRANCE LOCK	ND53BDC RHO		626	SCH
1	EA	SFIC EVEREST CORE	80-037 EV29 R		626	SCH
1	EA	OH STOP	90S		630	GLY
1	EA	SURFACE CLOSER	4040XP EDA ST-2731		689	LCN
1	EA	PLASTIC KICK PLATE .060	K2060 10" x 2" LDW		TBD	ROC
3	EA	SILENCER	SR64		GRY	IVE

HARDWARE GROUP NO. 206

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1 4.5 X 4.5		652	IVE
1	EA	STOREROOM LOCK	ND80BDC RHO		626	SCH
1	EA	SFIC EVEREST CORE	80-037 EV29 R		626	SCH
1	EA	ELECTRIC STRIKE	4500-C X SMARTPAC III	⚡	630	HES
1	EA	SURFACE CLOSER	4040XP		689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS		630	IVE
1	EA	WALL STOP	WS401/402CCV		626	IVE
3	EA	SILENCER	SR64		GRY	IVE
1	EA	MULTITECH READER	MT15 12 VDC BY SECURITY CONTRACTOR	⚡	BLK	SCE
1	EA	REQUEST TO EXIT	SCANII 12/24 VDC	⚡	WHT	SCE
1	EA	BY SECURITY CONTRACTOR	LOW VOLTAGE POWER	⚡		
1	SET	WIRING & CONNECTIONS	BY DIVISION 26 / DIVISION 28			
1	SET	CONDUIT & RACEWAY	BY DIVISION 26 / DIVISION 28			
1	EA	WIRING DIAGRAMS	ELEVATION 1008	⚡		VON

DOOR NORMALLY CLOSED AND LOCKED.

PRESENT CREDENTIAL TO CARD READER FOR ENTRY OR BY KEY OVERRIDE.

REQUEST TO EXIT TO SHUNT DOOR POSITION SWITCH UPON EGRESS.

FREE EGRESS AT ALL TIMES.

DOOR TO REMAIN LOCKED, FAIL SECURE DURING POWER FAILURE.

HARDWARE GROUP NO. 207

Provide each PR door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
6	EA	HINGE	5BB1HW 4.5 X 4.5 NRP		652	IVE
1	EA	POWER TRANSFER	EPT10	⚡	689	VON
1	SET	CONST LATCHING BOLT	FB51P/FB61P AS REQD		630	IVE
1	EA	DUST PROOF STRIKE	DP1/DP2 AS REQUIRED		626	IVE
1	EA	STOREROOM LOCK	ND80G RHO 14-042		626	SCH
1	EA	SFIC EVEREST CORE	80-037 EV29 R		626	SCH
1	EA	ELECTRIC STRIKE	4500-C X SMARTPAC III	⚡	630	HES
1	EA	LOCK GUARD	LG14		630	IVE
1	EA	OH STOP	90S		630	GLY
			ACTIVE LEAF			
1	EA	SURF. AUTO OPERATOR	4642 WMS 120 VAC PROVIDE LONG ARM IF REQUIRED	⚡	689	LCN
2	EA	ACTUATOR PKG	8310-3857T	⚡	630	LCN
2	EA	KICK PLATE	8400 10" X 1" LDW B-CS		630	IVE
2	EA	SILENCER	SR64		GRY	IVE
1	EA	CARD READER	BY ACCESS CONTROL INTEGRATOR	⚡	BLK	SCE
2	EA	DOOR CONTACT	679-05 HM OR WD AS REQ BY ACCESS CONTROL INTEGRATOR	⚡	BLK	SCE
1	EA	REQUEST TO EXIT	SCANII 12/24 VDC	⚡	WHT	SCE
1	EA	POWER SUPPLY	BY ACCESS CONTROL INTEGRATOR	⚡	LGR	SCE
1	EA	WIRING DIAGRAM	POINT TO POINT / RISER BY ACCESS CONTROL INTEGRATOR			
1	EA	120 V POWER	BY DIVISION 26			
1	EA	WIRING DIAGRAMS	ELEVATION 1176	⚡		VON

DOOR NORMALLY CLOSED AND LOCKED.

PRESENT CREDENTIAL TO CARD READER FOR ENTRY OR BY KEY OVERRIDE. PRESS ACTUATOR FOR AUTO OPERATOR.

MOTION SENSOR TO SHUNT DOOR POSITION SWITCH UPON EGRESS.

FREE EGRESS AT ALL TIMES.

DOOR TO REMAIN LOCKED, FAIL SECURE DURING POWER FAILURE.

HARDWARE GROUP NO. 208

Provide each SGL door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER		FINISH	MFR
3	EA	HINGE	5BB1HW 4.5 X 4.5 NRP		652	IVE
1	EA	STOREROOM LOCK	ND80G RHO		626	SCH
1	EA	SFIC EVEREST CORE	80-037 EV29 R		626	SCH
1	EA	ELECTRIC STRIKE	4500-C X SMARTPAC III	 ⚡	630	HES
1	EA	OH STOP	90S		630	GLY
1	EA	SURFACE CLOSER	4040XP EDA ST-2731		689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS		630	IVE
3	EA	SILENCER	SR64		GRY	IVE
1	EA	CARD READER	BY ACCESS CONTROL INTEGRATOR	 ⚡	BLK	SCE
1	EA	DOOR CONTACT	679-05 HM OR WD AS REQ BY ACCESS CONTROL INTEGRATOR	 ⚡	BLK	SCE
1	EA	REQUEST TO EXIT	SCANII 12/24 VDC	 ⚡	WHT	SCE
1	EA	POWER SUPPLY	BY ACCESS CONTROL INTEGRATOR	 ⚡	LGR	SCE
1	EA	WIRING DIAGRAMS	ELEVATION 1008	 ⚡		VON

DOOR NORMALLY CLOSED AND LOCKED.

PRESENT CREDENTIAL TO CARD READER FOR ENTRY OR BY KEY OVERRIDE.

MOTION SENSOR TO SHUNT DOOR POSITION SWITCH UPON EGRESS.

FREE EGRESS AT ALL TIMES.

DOOR TO REMAIN LOCKED, FAIL SECURE DURING POWER FAILURE.

END OF SECTION

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SECTION 08 80 00

GLAZING

PART 1 GENERAL

1.01 PERFORMANCE REQUIREMENTS

- A. Glass and glazing materials shall provide continuity of building enclosure vapor and air barrier.
 - 1. To utilize the inner pane of multiple pane sealed units for the continuity of air and vapor seal.
 - 2. Maintain continuous air and vapor barrier throughout glazed assembly from glass pane to heel bead of glazing sealant.
- B. Glass thickness indicated is minimum and shown for detailing only. Size glass to withstand dead loads and positive and negative live loads acting normal to plane of glass as calculated in accordance with IBC Chapter 24, as measured in accordance with ANSI/ASTM E330.
- C. Limit glass deflection to 1/175 or flexure limit of glass, with full recovery of glazing materials, whichever is less.

1.02 SUBMITTALS

- A. Product Data: Submit manufacturer's Product Data for glass units, including the following:
 - 1. Structural, physical and environmental characteristics.
 - 2. Size limitations.
 - 3. Special handling or installation requirements
 - 4. Special application requirements for glazing materials.
 - 5. Available colors of glass and glazing materials with color selections.
- B. Samples: Submit samples as follows:
 - 1. Two samples 8 x 8 inch in size, illustrating glass units, coloration and design.
 - 2. Four inch long bead of glazing sealant, color as selected.
- C. Manufacturer's Certificate: Submit Manufacturer's certification that sealed insulated glass meets or exceeds specified requirements.

1.03 QUALITY ASSURANCE

- A. Regulatory Requirements: Conform to IBC Chapter 24, to local requirements and to State law.
- B. Standards:
 - 1. ANSI/ASTM E330 - Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference.
 - 2. ANSI Z97.1 - Safety Performance Specifications and Methods of Test for Safety Glazing Used in Buildings.
 - 3. GANA'S - Glazing Manual and Laminated Glass Design Guide.
- C. Perform Work in accordance with GANA Glazing Manual, GANA Sealant Manual, and Laminators Safety Glass Association - Standards Manual for Glazing Installation Methods.

1.04 DELIVERY, STORAGE AND HANDLING

- A. Packing and Shipping: Deliver materials to site in Manufacturer's original unopened packaging with labels intact.
- B. Storage: Adequately protect against damage while stored at the site.
- C. Handling: Comply with Manufacturer's instructions.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Glass Materials: Furnish products of one of the following Manufacturers, except as approved by the Architect, subject to compliance with Specification requirements:
 - 1. Vitro Architectural Glass (formerly PPG) <https://www.vitroglazings.com/>
 - 2. Pilkington LOF. www.pilkington.com .
 - 3. Guardian Industries. www.guardian.com .
 - 4. Oldcastle Glass Group. www.oldcastleglass.com .
 - 5. Viracon. www.viracon.com .
 - 6. Visteon Float Glass www.visteon.com .

2.02 GLASS MATERIALS

- A. General: Glass types shall be a local stock item (not special order) to eliminate replacement delays.
- B. Glass:
 - 1. Glass to be in contact with normal pedestrian traffic to be tempered float glass to a height of 8' above floor surface adjacent to pedestrian traffic (or per code, whichever is stricter).
 - 2. Sidelights and/or door lights to be minimum 1/4" tempered float glass.
- C. Interior:
 - 1. Standard: Clear, 1/4" thick, ASTM C1036, Type 1 transparent flat, Class 1.
 - 2. Safety Glass: 1/4" thick, clear fully tempered glass conforming to ASTM C 1048.
 - 3. 60 minute fire rating: Provide one of the following as applicable. Doors shall have glazing that has impact resistance meeting CPSC 16CFR1201 (Cat. I or II).
 - 1. FireLite Plus Premium (polished surfaces), 60 minute fire rated, 3/16 inch thick, as manufactured by Technical Glass Products, Nippon Electric Glass Co., Ltd. www.fireglass.com .
 - 2. Superlite I-XL, 60 minute fire rated, optically clear, 1/4 inch thick, as manufactured by SAFTI (Safety and Fire Technology International), San Francisco, CA (800) 822-2088 www.safti.com.

2.03 GLAZING ACCESSORIES

- A. Setting Blocks: Neoprene or other resilient blocks of 70 to 90 Shore A durometer hardness tested for compatibility with glazing sealant, minimum length 4 inches.
- B. Spacers: Neoprene blocks of 40 to 50 Shore A durometer hardness, adhesive backed on one face only and tested for compatibility with specified glazing sealant.

- C. Interior Glazing Compound: Polymerized Butyl Rubber and Inert Fillers (pigments), solvent based with minimum 75% solids, non-sag consistency, tack-free time of 24 hours or less, paintable non-staining.
- D. Glazing Tape: Preshimmed 10 percent solids, non-shrinking, butyl rubber tape compatible with sealants. If exposed, tape shall be paintable, or colored to match frame.

2.07 MARKINGS

- A. Tempered glass shall have each light permanently etched with Manufacturer's name and his compliance with ANSI Z-97.1.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions: Examine subsurfaces to receive Work and report detrimental conditions in writing to Architect. Commencement of Work will be construed as acceptance of subsurfaces.
- B. Examine framing or glazing channel surfaces, backing, removable stop design, and conditions under which glazing is to be performed.
- C. Coordination: Coordinate with other Work which affects, connects with, or will be concealed by this Work.

3.02 INSTALLATION

- A. Comply with combined recommendations of Glass Manufacturer, aluminum frame manufacturer and manufacturer of sealants and other materials used in glazing., except where more stringent requirements are shown or specified.
- B. Clean the glazing, channel, or other framing members to receive glass, immediately before glazing. Remove coatings which are not firmly bonded to the substrate.
- C. Do not attempt to cut, seam, nip or abrade glass which is tempered or heat strengthened.
- D. Comply with "Glazing Manual" by GANA, except as shown and specified otherwise by Manufacturers of glass and glazing materials.
- E. Inspect each piece of glass immediately before installation, and discard those which have observable edge damage or face imperfections.
- F. Install setting blocks of proper size at quarter points of sill rabbet.
- G. Provide spacers inside and out, and of proper size and spacing, for glass sizes larger than 50 united inches. Provide 1/8 inch minimum bite of spacers on glass and use thickness equal to sealant width.
- H. Unify appearance of each series of lights by setting each piece to match others as nearly as possible. Inspect each piece and set with pattern, draw and bow oriented in the same direction as other pieces.

- I. Miter cut and bond ends together at corners where gaskets are used for channel glazing, so that gaskets will not pull away from corners and result in voids or leaks in the glazing system.

3.03 INTERIOR COMBINATION METHOD (TAPE AND SEALANT)

- A. Cut glazing tape to proper length and install against permanent stop, projecting 1/16 inch above sightline.
- B. Place setting blocks at 1/4 point.
- C. Rest glass on setting blocks and push against tape with sufficient pressure to ensure full contact and adhesion at perimeter.
- D. Install removable stops; spacer strips inserted between glass and applied stops at 2 foot intervals, 1/4 inch below sightline.
- E. Fill gap between glass and applied stop with sealant to depth equal to bite of frame on glass to uniform and level line.
- F. Neatly trim off excess tape to sightline.

3.04 ADJUSTING

- A. Remove and replace glass which is broken, chipped, cracked, abraded or damaged in any other way during the construction period, including natural causes, accidents and vandalism.

3.05 CLEANING

- A. During the course of the Work and on completion, remove and dispose of excess materials, equipment and debris away from premises. Leave Work in clean condition.
- B. Remove labels after Work is completed.

3.06 PROTECTION

- A. Protect glass from breakage immediately upon installation, by attachment of crossed streamers to framing held away from glass.
- B. Do not apply markers of any type to surfaces of glass.

END OF SECTION

SECTION 09 22 16

NON-STRUCTURAL METAL FRAMING

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Formed metal stud framing, furring, suspension systems and accessories as shown on Drawings and as specified.
 - 2. New partitions shall be gypsum wallboard over metal stud framing at 16" o.c., extending full height between laboratories.
 - a. Minimum framing shall be 25 ga. galvanized metal studs to a maximum height of 12'.
 - b. Minimum 20 gauge galvanized metal framing to be provided where wall heights exceed 12'.

1.02 SUBMITTALS

- A. Product Data: Submit data describing standard framing member materials and finish, product criteria, load charts, limitations, and installation instructions.
- B. Certificates: Mill Certification shall be provided with shipment to verify chemical composition, yield strength, tensile strength, elongation and coating thickness. Include listing of applicable ASTM standards specified in this section and comparison of ASTM requirements to actual materials provided to jobsite.
- C. Manufacturer's letter: Manufacturer shall provide letter stating that the material supplied to the specific project meets or exceed the performance standards listed in these specifications.

1.03 QUALITY ASSURANCE

- A. Perform Work in accordance with ASTM C 754 requirements.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Furnish products as manufactured by a manufacturing member of the Steel Stud Manufacturers Association (SSMA), subject to compliance with Specification requirements.

2.02 FRAMING MATERIALS

- A. Studs, Runners and Furring Channels:
 - 1. ASTM C 645, electro-galvanized to meet ASTM A 591, manufactured from steel supplied in accordance with ASTM A 653, Structural Quality Grade 33; G60 designation galvanized sheet steel.
 - 2. Thickness: In accordance with stud schedule provided herein.
 - 3. Flange Width: ASTM C645 requires the stud members have a minimum flange of 31.75 mm (1 ¼ in.)

3. Deflection Track:
 - a. Slotted Top Track (non-fire rated and fire-rated, as applicable): SLP-TRK® as manufactured by Sliptrack Systems (888) 475-7875 www.BradyInnovations.com, as distributed by Cemco (800) 775-2362 (western U.S) and Unimast Inc. (800) 654-7883 (eastern U.S.), gauge as per ICBO ER-5344, Table 2. Provide fire rated assemblies in accordance with manufacturer's literature, where applicable.
 - b. Non-Fire Rated Slotted Top Track - Single Track Slip System for Interior Partitions: As manufactured by Metal Lite, Inc., 3070 E. Miraloma Avenue, Anaheim, CA 92806 (800) 886-6824. Provide for partitions that are not required to be fire rated.
- B. Studs: C-shaped, non-load bearing rolled steel, punched for utility access, of size shown on Drawings.
- C. Ceiling Runners: Cold or hot-rolled steel, meet ASTM C 754.
- D. Hanger and Tie Wire: Meet ASTM C 754.
- E. Furring and Bracing Members: Of same gauge, material and finish as studs, thickness to suit purpose.
- F. Clips, Brackets: Galvanized wire or sheet metal designed for attachment of framing, furring and bridging members.
 1. Deflection Clips: If acceptable to Building Official, VertiClip™ as manufactured by Signature Industries, LLC, P.O. Box 68005, Raleigh, NC 27613 (919) 844-0789 may be provided for attachment of framing to roof and floor construction at head and slide conditions. Provide sizes as required for stud depth(s). Clips shall be manufactured of steel conforming to ASTM A 653 Prime Certified G60 galvanized material or better, 50 ksi yield strength and 65 ksi ultimate strength. Deflection clips to have positive attachment to structure and stud material while allowing for frictionless movement.
 2. Bridging Clips: If acceptable to Building Official, BridgeClip™ as manufactured by Signature Industries, LLC, P.O. Box 68005, Raleigh, NC 27613 (919) 844-0789 may be provided for attachment of bridging to studs.
- G. Fasteners: GA 203, self-drilling, self-tapping screws.
- H. Anchorage Devices: Power driven, powder actuated, drilled expansion bolts or screws with sleeves as required for positive anchorage.
- I. Acoustic Sealant: As specified in Section 09 29 00.
- J. Primer: FS TT-P-645, for touch-up of galvanized surfaces.
- K. Backing: "Notch-Tite" and "Flush Mount" as manufactured by Metal Lite, Inc., 3070 E. Miraloma Avenue, Anaheim, CA 92806 (800) 886-6824.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that conditions are ready to receive Work.
- B. Verify field measurements are as shown on Drawings.
- C. Verify that rough-in utilities are in proper location.
- D. Beginning of installation means acceptance of substrate.

3.02 METAL STUD ERECTION

- A. Install stud framing in accordance with ASTM C 754.
- B. Align and secure top and bottom runners at 24 inches o.c. Place two beads of acoustic sealant between runners and substrate.
- C. Fit runners under and above openings; secure intermediate studs at spacing of wall studs.
- D. Install studs vertically at 16 inches on center; unless indicated otherwise on Drawings. Place two beads of acoustic sealant between studs and adjacent vertical surfaces. Install felt strips between wall and stud where studs abut exterior walls.
- E. Connect studs to tracks using fastener method.
- F. Door Opening Framing: Install double studs at door frame jambs. Install stud tracks on each side of opening, at frame head height, and between studs and adjacent studs.
- G. Backing and Blocking: Provide backing and blocking attached to studs. Bolt or screw steel channels to studs. Install backing and blocking for support of plumbing fixtures, toilet partitions, wall cabinets, toilet accessories, and hardware. If proprietary system is used, install in accordance with manufacturer's printed instructions.
- H. In areas where partitions are subject to severe impact loads, and in situations where fixtures and appurtenances are intended to be supported directly from partitions, require the installation of backing and/or blocking in the partitions. Describe the locations for all backing and blocking on the drawings. Considerations for blocking are as follows:
 - 1. Provide 20 gauge metal backing where numerous light weight fixtures are intended to be supported directly from the walls.
 - 2. Provide 3 ½ " blocking at the bottom of heavy duty partitions where resilient floors are scheduled to be installed (to protect walls from floor cleaning equipment impacts.)
 - 3. Provide 6" high minimum wood blocking or 20 gauge metal at points of attachment for small fixtures, toilet accessories and partitions, handrails, door stops, etc.
 - 4. Provide engineering for built up headers made of light gauge metal framing.
 - 5. Provide built up members at corners, jambs and other locations where stresses are enhanced.
- I. Coordinate installation of bucks, anchors, blocking, electrical and mechanical Work placed in or behind partition framing.

- J. Splice studs with 8 inch nested lap, secure each stud flange with flush head screw.
- K. Construct corners using minimum three studs.
- L. Brace stud framing system and make rigid.
- M. Coordinate erection of studs with requirements of door and window frame supports and attachments.
- N. Align stud web openings.
- O. Refer to Drawings for indication of partitions extending to ceiling only and for partitions extending through ceiling to structure above. Maintain clearance under structural building members to avoid deflection transfer to studs. Provide nested extended leg ceiling runners, deflection clips or proprietary slip track. Install fire rated proprietary slip track at fire rated partitions in accordance with applicable UL assembly and coordinate installation of additional gypsum board strips to comply with assembly requirements.
- P. Coordinate placement of insulation in multiple stud spaces made inaccessible after stud framing erection.

3.03 WALL FURRING INSTALLATION

- A. Erect wall furring for direct attachment to concrete masonry walls.
- B. Erect furring channels vertically. Secure in place on alternate channel flanges at maximum 24 inches.
- C. Space furring channels maximum 16 inches on center, not more than 4 inches from floor and ceiling lines, and butting walls.
- D. Install furring channels directly attached to concrete masonry walls, as applicable in accordance with Manufacturer's instructions.
- E. Erect free-standing metal stud framing tight to concrete, concrete and brick masonry walls, attached by adjustable furring brackets in accordance with Manufacturer's instructions.

3.04 ACOUSTICAL AND FIRE RATINGS

- A. Install framing and furring as required for indicated acoustical and fire ratings.

3.05 CEILING FRAMING INSTALLATION

- A. Install in accordance with ASTM C 754.
- B. Coordinate location of hangers with other Work.
- C. Install ceiling framing independent of walls, columns and above-ceiling Work.
- D. Reinforce openings in ceiling suspension system which interrupt main carrying channels or furring channels, with lateral channel bracing. Extend bracing minimum 24 inches beyond each end of openings.
- E. Laterally brace entire suspension system.

- F. No hanger support shall be allowed from roof deck.
- G. At steel beams, joists or other steel construction wrap hangers around, inset through, or clip or bolt to the supports, so as to develop the full strength of the hangers.
- H. At lights or other openings that interrupt the main runner or furring channels reinforce grillage with 3/4 inch cold-rolled channels, wire tied atop and parallel to the main runner channels.
- I. Do not bridge control and expansion joints with metal furring. Provide separate supports on each side of joint.

3.06 FIELD QUALITY CONTROL

- A. Testing: At Owner's request, Contractor shall provide spot testing of actual properties of steel framing to verify compliance with specifications.

3.07 CLEANING

- A. During the course of the Work and on completion, remove and dispose of excess materials, equipment and debris away from premises. Leave Work in clean condition.

3.08 STUD SCHEDULE

- A. Stud Table: Maximum limits based upon 5 psf deflection limit, 33 ksi yield stress, and composite wall sheathed both sides full height with 1/2 inch thick gypsum wallboard attached with No. 6 screws at 12 inches on center minimum, from the SSMA "Product Technical Information" - "Wall Height Tables for Composite Allowable Wall Heights." Maximum allowable deflection as follows:
 1. Walls receiving gypsum wallboard finishes: L/240.
 2. Walls receiving plaster and brittle finishes, including stucco, stone masonry, and mirrors: L/360.
 3. Walls receiving ceramic and stone tile finishes: L/360.
 4. ASTM C645 requires the stud members have a minimum flange of 31.75 mm (1 1/4 in.)

STUD WIDTH	DESIGN THICKNESS (Gauge)	STUD SPACING	PARTITION HEIGHT		BRACING SPACING WHERE OCCURS
			L/240	L/360	
1 5/8"	18 mils .0188 in. (25)	16	8' – 4"	---	4' – 0" O.C.
		24	7' – 11"	---	4' – 0" O.C.
	33 mils .0346 in. (20)	16	9' – 8"	8'-5"	4' – 0" O.C.
		24	8' – 9"	7'-8"	4' – 0" O.C.
2-1/2"	18 mils .0188 in. (25)	16	11' – 3"	9'-10"	6' – 0" O.C.
		24	10' – 7"	9'-3"	6' – 0" O.C.
	33 mils .0346 in. (20)	16	12' – 10"	11'-2"	6' – 0" O.C.
		24	11' – 7"	10'-0"	6' – 0" O.C.

STUD WIDTH	DESIGN THICKNESS (Gauge)	STUD SPACING	PARTITION HEIGHT		BRACING SPACING WHERE OCCURS
			L/240	L/360	
3-1/2"	18 mils .0188 in. (25)	16	14' – 4"	12'-4"	8' – 0" O.C
		24	13' – 5"	11'-7"	8' – 0" O.C
	33 mils .0346 in. (20)	16	16' – 5"	14'-3"	8' – 0" O.C
		24	14' – 9"	12'-9"	8' – 0" O.C
4"	18 mils .0188 in. (25)	16	15' – 4"	13'-4"	8' – 0" O.C
		24	14' – 2"	12'-4"	8' – 0" O.C
	33 mils .0346 in. (20)	16	18' – 4"	15'-11"	8' – 0" O.C
		24	16' – 5"	14'-3"	8' – 0" O.C
6"	18 mils .0188 in. (25)	16	19' – 9"	17'-11"	10' – 0" O.C
		24	16' – 9"	16'-9"	10' – 0" O.C
	33 mils .0346 in. (20)	16	24' – 6"	21'-4"	10' – 0" O.C
		24	21' – 7"	18'-10"	10' – 0" O.C

END OF SECTION

SECTION 09 29 00

GYPSUM BOARD

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. New partitions shall be gypsum wallboard over metal stud framing, extending full height between laboratories.
 - 2. Provide 5/8" Type X gypsum board on metal studs at 16" o.c. for the majority of interior partitions.
 - 3. Gypsum board shall be taped and sanded where finishes are to be applied or code required. Provide Level 4 finish in Lab, Level 5 in Offices (level 4 minimum overall).
 - 4. Areas exposed to moisture shall be treated with water resistant gypsum board. Fiberglass faced gypsum board to be provided where scheduled.
 - 5. Gypsum board ceilings shall consist of metal stud framing and 5/8 inch gypsum board.
 - 6. Gypsum board soffits shall consist of metal stud framing and 5/8" gypsum board.
 - 7. Provide gypsum board ceilings (plenums) in accordance with drawings and specifications.

1.02 SUBMITTALS

- A. Product Data: Submit data on gypsum board, joint, finish and accessories.
- B. Samples: Submit sample of textured finish prior to application.
- C. Reports: Submit fire test report for fire rated assemblies, and acoustical performance test reports for acoustically-rated assemblies.

1.02 QUALITY ASSURANCE

- A. Applicator Qualifications: Company specializing in Gypsum Board Systems Work with 2 years documented experience and approved by Manufacturer.
- B. Regulatory Requirements: Conform to applicable code for fire rated assemblies as shown on the Drawings.
- C. Comply with applicable specification recommendations of GA-216 and GA-600 as published by the Gypsum Association.

1.03 DELIVERY, STORAGE AND HANDLING

- A. Comply with GA-216 and Manufacturer's directions.

1.04 PROJECT CONDITIONS

- A. Physical Requirements for Proper Installation or Application:
 - 1. Maintain temperature of installed gypsum board spaces in range of 55 degrees F. to 90 degrees F. until building is entirely closed.
 - 2. Ventilate as required to eliminate excessive moisture.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Furnish products of one of the following Manufacturers, except as approved by the Architect, subject to compliance with Specification requirements:
1. G-P Gypsum www.gp.com/gypsum/
 2. Gold Bond Building Products Div., National Gypsum Co. www.nationalgypsum.com
 3. United States Gypsum Co. www.usg.com
 4. BPB Gypsum (formerly James Hardie Gypsum) www.us.bpb-na.com
 5. Pabco Gypsum www.pabco gypsum.com

2.02 GYPSUM BOARD MATERIALS

- A. Gypsum Wallboard - General:
1. Provide fire rated, insulating, water-resistant and exterior type board where required. Gypsum board in all areas of toilet rooms and other areas where moisture will be present in any form shall be mold resistant.
 2. Related type of hard board materials applied to metal studs shall be selected to adequately meet the requirements of the intended use and shall be used strictly in accordance with the manufacturer's recommendations. An example of this material is hard board cementitious-based tile backer.
- B. Gypsum Board (interior applications): U.S. Gypsum wallboard or equal, 5/8 inch thickness conforming to ASTM C-36; or FS SS-L-30, Type III, Grade X, Class I; tapered edge.
- C. Moisture Resistant Gypsum Board: ANSI/ASTM C630 or ASTM C1396; 1/2 inch or 5/8 inch thick (as noted on Drawings), maximum permissible length; ends square cut.
- D. Insulating Gypsum Board: ANSI/ASTM C36 or ASTM C1396; 1/2 inch or 5/8 inch thick, (as noted on Drawings), maximum permissible length; back surface laminated with aluminum foil; ends square cut edges.
- E. Cementitious Backer Units (Ceramic Tile Backer Board): Provide cementitious backer units (1/2 inch thickness) conforming to ANSI A118.9. Georgia-Pacific Dens-Shield, Modulars Inc. Wonder-Board, or USG Durabond Division Durock Tile Backer Board are acceptable products. Furnish with joint tape.

2.03 ACCESSORIES

- A. Adhesive: ASTM C557.
- B. Acoustical Sealant: Non-hardening, non-skinning, for use in conjunction with gypsum board, as recommended by Board Manufacturer.
- C. Corner Beads: GA216; Type CB; electro-galvanized steel.
- D. Edge Trim: GA216; Type L bead; electro-galvanized steel and Type LC rolled-formed zinc.
- E. Control Joint: U.S. Gypsum No. 093, roll-formed zinc.

- F. Joint Materials: ANSI/ASTM C475; reinforcing tape, joint compound, adhesive, water, and fasteners. For coated board and gypsum sheathing, use material recommended by Board Manufacturer.
- G. Screws: ASTM C1002 for steel drill screws. Type G for fastening to gypsum board, Type S for fastening to light gauge steel framing and Type W for fastening to wood framing.
- H. Wall and ceiling texture material: U.S. Gypsum Imperial QT and joints shall have tape embedded, filled and finished.
- I. Drywall Primer:
 - 1. Paint material specifically formulated to fill the pores and equalize the suction difference between gypsum board surface paper and the compound used on finished joints, angles, fastener heads and accessories and over skim coatings.
 - 2. Drywall primer which is applied to the finished surface of the work specified in this section shall be provided as specified under Section 09 91 00 as applicable.
 - 3. A good quality, white latex drywall primer formulated with high binder solids, applied undiluted, shall be applied to gypsum board surfaces prior to the application of texture materials.

PART 3 EXECUTION

3.01 INSPECTION

- A. Verify that site conditions are ready to receive Work and opening dimensions are as instructed by the Manufacturer.
- B. Beginning of installation means acceptance of substrate.

3.02 GYPSUM BOARD INSTALLATION

- A. Application of Gypsum Board shall adhere to "APPLICATION AND FINISHING OF GYPSUM PANEL PRODUCTS (GA-216-2004)" or "APPLICATION OF GYPSUM SHEATHING (GA-253-99)" publications of the Gypsum Association and all ASTM specification it refers to.
 - 1. Install wallboard with long dimension at right angles to framing and fasten with screws spaced a maximum of 12 inches on center.
 - 2. Erect single layer fire rated gypsum board vertically, with edges and ends occurring over firm bearing.
- B. Ceiling Boards:
 - 1. Install gypsum panels prior to wall/partition board application to the greatest extent possible and at right angles to framing, unless otherwise indicated.
 - 2. Install ceiling board panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in the central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.
- C. Use screws when fastening gypsum board to metal and wood furring or framing.
- D. Double Layer Applications:
 - 1. Use gypsum backing board for first layer, placed perpendicular to framing or furring members.
 - 2. Use fire rated gypsum backing board for fire rated partitions.

3. Place second layer perpendicular to first layer.
 4. Offset joints of second layer from joints of first layer.
 5. Secure second layer to first with adhesive and sufficient support to hold in place. Apply adhesive in accordance with Manufacturer's instructions.
- E. Treat cut edges and holes in moisture resistant gypsum board with sealant.
- F. Place control joints consistent with lines of building spaces as indicated on Drawings and as recommended by Board Manufacturer.
- G. Place corner beads at external corners. Use longest practical length. Place edge trim where gypsum board abuts dissimilar materials.

3.03 JOINT TREATMENT

- A. Tape, fill, and sand exposed joints, edges, and corners to produce smooth surface ready to receive finishes.
- B. Feather coats onto adjoining surfaces so that camber is maximum 1/32 inch.

3.04 ACOUSTICAL TREATMENT

- A. Install acoustical sealant in accordance with Manufacturer's instructions.
- B. Install acoustical sealant at gypsum board perimeter at:
1. Metal framing: Two beads.
 2. Base layer of double layer applications, if applicable.
 3. Face layer.
 4. Caulk partition penetrations by conduit, pipe, ductwork, and rough-in boxes.
- C. Install acoustical sealant where gypsum board joins other walls or surfaces at sound control partitions.

3.05 FINISHING OF GYPSUM BOARD SURFACES

- A. Finishing: Joints shall have tape embedded, filled and finished, ready for texture/paint. Gypsum Board finish levels shall adhere to "RECOMMENDED LEVELS OF GYPSUM BOARD FINISH (GA-214-96)" publication of the Gypsum Association and all ASTM specifications it refers to.
1. Level 0 (Temporary Construction): No taping, finishing, or accessories required.
 2. Level 1 (Fire Taping at plenum areas above ceiling, in attics, in areas where the assembly will be concealed or in building service corridors and other areas not normally open to public view):
 - a. Joints and interior angles shall have tape embedded in joint compound.
 - b. Surface shall be free of excess joint compound.
 - c. Tool marks and ridges are acceptable.
 3. Level 2 (Not Used)
 4. Level 3 (Not Used)
 5. Level 4 (Labs and minimum overall)
 - a. Joints and interior angles shall have tape embedded in joint compound and 2 separate coats of joint compound applied over flat joints and one separate coat of joint compound applied over interior angles.
 - b. Fastener heads and accessories shall be covered with 3 separate coats of joint compound..
 - c. Joint compound shall be smooth and free of tool marks and ridges.

- d. Surface to be coated with Drywall Primer as specified herein prior to application of texture.
 - e. Untextured surfaces to be coated with Drywall Primer prior to application of final finishes as specified in Section 09 91 00, as applicable.
 - 6. Level 5 (Offices)
 - a. Joints and interior angles shall have tape embedded in joint compound and 2 separate coats of joint compound applied over flat joints and one separate coat applied over interior angles.
 - b. Fastener heads and accessories shall be covered with 3 separate coats of joint compound.
 - c. A thin skim coat of joint compound, or a material manufactured especially for this purpose, shall be applied to the entire surface to fill imperfections in the joint work, smooth the paper texture and provide a uniform surface for decorating. Excess compound shall be immediately sheared off, leaving a film of skim coating compound completely covering the paper.
 - d. The surface shall be smooth and free of tool marks and ridges.
 - e. Surface to be coated with Drywall Primer as specified herein prior to application of texture.
 - e. Untextured surfaces to be coated with Drywall Primer prior to application of final finishes as specified in Section 09 91 00.
 - B. Surfaces shall be free of dust, dirt and oil and shall received Drywall Primer before application of texture or skim coat as required by the manufacturer of the texture or skim coat materials.
 - C. Surface Finish (Interior): Produce smooth surface finish (Level 4), unless otherwise noted or scheduled on Drawings) to match approved sample.
- 3.06 CLEANING
- A. After completion of wallboard installation, taping and texturing, remove rubbish, excess material and equipment from building and job site, leaving floors and other surfaces clean.
 - B. Remove overspray from adjoining construction.
 - C. During the course of the Work and on completion of the Work, remove excess materials, equipment and debris and dispose of away from premises. Leave Work in clean condition.

3.07 PROTECTION

- A. Protect Work from damage until acceptance.
- B. Repair or replace damaged Work.

END OF SECTION

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SECTION 09 51 13

ACOUSTICAL PANEL CEILINGS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Typical: Lay-in ceiling panels are typically 24-inch by 48-inch and supported by a wire-hung aluminum 'T' grid system. ACT systems allow for increased accessibility to HVAC systems and controls above the ceiling. ACT system shall be non-shedding mylar finish washable ceiling tile.
 - 2. Trace Metals Suite Construction: Due to the low detection level performance of the ICP-MS (or similar ICP-based instrumentation), the room environments for Sample Prep and Instrument are constructed as metals-free as possible in terms of what the room enclosure/environment "sees". Provide pultruded fiberglass lay-in ceiling grid with gasketed mylar-faced ceiling tiles.

1.02 SUBMITTALS

- A. Shop Drawings: Submit Drawings showing complete layout of systems including attachments, intersections of members and edge conditions.
- B. Product Data: Provide data on metal grid system components and acoustical units.
- C. Samples:
 - 1. Submit 2 samples of each type of unit specified, including color selection when applicable.
 - 2. Submit samples of Manufacturer's full color selection for selection by Architect.

1.03 QUALITY ASSURANCE

- A. Qualifications: Installer shall be approved by Manufacturer of material or system.
- B. Standards: Comply with the following:
 - 1. ASTM C635, "Standard Specification for Acoustical Tile and Lay-In Panel Ceilings."
 - 2. ASTM C636, "Recommended Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels."
 - 3. Ceilings and Interior Systems Construction Association (CISCA) "Recommendations for Direct-Hung Acoustical tile and Lay-in Panel Ceilings."
- C. Surface Burning Characteristics: Class A per ASTM E1264 and Fed. Spec. SS-S-118B, Flame Spread 25 or under, per ASTM E-84 (UL Label).
- D. Coordination of Work: Coordinate ceiling work with installers of related work including, but not limited to building insulation, gypsum board, light fixtures, mechanical systems, electrical systems, and sprinklers.

1.04 DELIVERY, STORAGE AND HANDLING

- A. Packing and Shipping: Deliver materials to site in Manufacturer's original unopened packaging with labels intact. Protect finished surfaces with removable wrapping or coating which will not bond when exposed to sunlight.
- B. Storage: Adequately protect against damage while stored at the site.
- C. Handling: Comply with Manufacturer's instructions.

1.05 MAINTENANCE

- A. Extra Materials:
 - 1. Provide a minimum of 2% additional material over actual material installed.
 - 2. Provide a minimum of one carton of each type of acoustical unit installed, in unopened labeled cartons, to the Owner at completion of Work, for his maintenance use, at no additional cost.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Furnish products of the following Manufacturers, except as approved otherwise by the Architect, subject to compliance with Specification requirements.
 - 1. USG Interiors, Inc. www.usg.com (Basis of Design)
 - 2. Ecophon (Saint Gobain) www.ecophon.com
 - 3. Armstrong World Industries www.ceiling.com
 - 4. Chicago Metallic Corporation (for suspension system) www.chicago-metallic.com
 - 5. Celotex Building Products Division www.bpb-celotex.com

2.02 CEILING FINISHES

- A, For Phase 1 (Lab Only), USG Mars Clean Room, Class 100 (ISO 5) Panels, Unperforated, 2x4. Square edge. Grid profile: USG AX. Standard Flat White 050.

2.03 SUSPENSION SYSTEM

- A. In accordance with Ceiling Systems specified above.
- B. Attachment Devices: Size for 5 times design load indicated in ASTM C635, Table 1, Direct Hung unless otherwise indicated.
- C. Hanger Wire: Galvanized steel conforming to Federal Specification FF-QQ-W-461, Finish 5, Class 1 annealed, and not less than 12 gage).
- D. Suspension system shall support the ceiling system specified with a maximum deflection of 1/360 of the span.
- E. Wall and Penetration Moldings: 24 MSG painted steel with a minimum one inch wide lower flange, finish and configuration to match grid. For circular penetrations provide edge molding manufactured to exact diameter of circular penetration.

2.04 ACCESSORIES

- A. Acoustical Batt Insulation: Specified in Section 07 21 00.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions: Examine subsurfaces to receive Work and report detrimental conditions in writing, with a copy to Architect. Commencement of Work will be construed as acceptance of subsurfaces.
- B. Verify, before proceeding with this Work, that required inspections of existing conditions have been completed.

3.02 INSTALLATION - SUSPENSION SYSTEM

- A. Install suspension system in accordance the following:
 - 1. ASTM C636 and as supplemented in this Section.
 - 2. CISCA's Recommendations for Acoustical Ceilings: Comply with CISCA's "Recommendations for Direct-Hung Acoustical tile and Lay-in Panel Ceilings- Seismic Zones 1-2" as modified by IBC Section 1621.2.5.
 - 3. Main and cross tees shall be installed in accordance with Architect's design indicated on reflected ceiling plan to accentuate a "linear" direction.
 - 4. Where walls run to the underside of the system, provide acoustical seal where they meet.
- B. Install system capable of supporting imposed loads to a deflection of 1/360 maximum.
- C. Locate system on room axis according to reflected ceiling plan.
- D. Install after major above-ceiling Work is complete. Coordinate the location of hangers with other Work.
- E. Supply hangers or inserts for installation in concrete with instructions for their correct placement.
- F. Provide hanger clips during steel deck erection. Provide additional hangers and inserts as required.
- G. Hang suspension system independent of walls, columns, ducts, pipes and conduit. Where carrying members are spliced, avoid visible displacement of face plane of adjacent members.
- H. Where ducts or other equipment prevent the regular spacing of hangers, reinforce the nearest affected hangers and related carrying channels to span the extra distance.
- I. Do not support components on main runners or cross runners if weight causes total dead load to exceed deflection capability. Support fixture loads by supplementary hangers located within 6 inches of each corner; or support components independently.
- J. Do not eccentrically load system, or produce rotation of runners.

- K. Install edge molding at intersection of ceiling and vertical surfaces, using longest practical lengths. Miter corners. Provide edge moldings at junctions with other interruptions.
- L. Form expansion joints as detailed. Form to accommodate plus or minus 1 inch movement. Maintain visual closure.

3.03 INSTALLATION - ACOUSTICAL LAY-IN UNITS

- A. Install acoustical units in accordance with Manufacturer's instructions.
- B. Fit acoustical units in place, free from damaged edges or other defects detrimental to appearance and function.
- C. Fit border trim neatly against abutting surfaces.
- D. Install units after above-ceiling Work is complete.
- E. Install acoustical units level in uniform plane, and free from twist, warp and dents.
- F. Cut panels to fit irregular grid and perimeter edge trim. Field rabbett panel edge. Double cut and field paint exposed edges of reveal edge units.
- G. Where round obstructions occur, provide preformed closers to match edge molding.

3.04 ERECTION TOLERANCES

- A. Maximum Variation from Flat and Level Surface: 1/4 inch in 10 feet.

3.05 ADJUSTING

- A. Remove damaged or soiled panels and replace with new units, as directed by Architect.

3.06 CLEANING

- A. During the course of the Work and on completion, remove and dispose of excess materials, equipment and debris away from premises. Leave Work in clean condition.

END OF SECTION

SECTION 09 65 19

RESILIENT FLOORING

PART 1 GENERAL

1.01 SUBMITTALS

- A. Product Data: Submit data on specific products, describing physical and performance characteristics, sizes, patterns and colors available.
- B. Samples: Submit 2 samples of each material specified illustrating color and pattern.
- C. Maintenance Data: Submit maintenance procedures, recommended maintenance materials, and suggested schedule for cleaning, stripping, and re-waxing.

1.02 QUALITY ASSURANCE

- A. Qualifications: Installation shall be by qualified installer approved by the Manufacturer of the materials.
- B. Regulatory Requirements:
 - 1. Critical Radiant Flux Classification: Class I (Not less than 0.45 Watts per sq./cm per ASTM E648).
 - 2. Slip resistance of floor surfaces and changes in level shall be in accordance with applicable law.

1.03 DELIVERY, STORAGE AND HANDLING

- A. Packing and Shipping: Deliver materials to site in Manufacturer's original unopened packaging with labels intact.
- B. Storage: Adequately protect against damage while stored at the site.
- C. Handling: Comply with Manufacturer's instructions.

1.04 PROJECT/SITE CONDITIONS

- A. Physical Requirements for Proper Installation or Application: Installation shall not begin until Work of other Trades is substantially completed and the area or rooms where flooring is to be installed has been maintained at a minimum temperature of 70 degrees F. for at least 48 hours.
- B. Moisture content and bondability of concrete sub-floors shall be determined by a field testing method recommended by the flooring manufacturer.
- C. Maintain ambient temperature required by Adhesive Manufacturer three days prior to, during, and 24 hours after installation of materials.

1.05 MAINTENANCE

- A. Extra Materials: Provide additional 5% (minimum) of flooring and 5% (minimum) of base of each material specified. Extra material shall be not less than one unopened box.

PART 2 PRODUCTS

2.01 FLOORING

- A. LVT
 1. Manufacturer: Shaw Contract
 2. Style Name / Number: Intricate 0692VF
 3. Color: As noted on Drawings or as selected by Architect from manufacturer's full color range. Color shall match color noted or selected, otherwise it shall be rejected, even if provided by an acceptable manufacturer.
 4. Installation method: Monolithic

2.03 BASE

- A. Base (Typical): ASTM F1861.
 1. Manufacturer: Armstrong
 2. Material: Type TS thermoset vulcanized rubber
 3. Height: 4 inch, unless otherwise indicated on Drawings.
 4. Thickness: 1/8 inch thick
 5. Type: Top set, coved.
 6. Color: As noted on Drawings or as selected by Architect from manufacturer's full color range. Color shall match color noted or selected, otherwise it shall be rejected, even if provided by an acceptable manufacturer.
- B. Base Accessories: Premolded end stops and external corners of same material, size, and color as base.

2.04 ACCESSORIES

- A. Adhesives - General:
 1. Suitable for the underfloor substrate conditions involved as recommended by the Manufacturer of the flooring materials.
 2. Adhesives shall be waterproof, stabilized type. Asphalt emulsions are not acceptable.
- B. Crack and Joint Filler: Waterproof type as recommended by the Manufacturer.
- C. Edge and Transition Strips:
 1. Provide 1" edge strips with beveled edge where tile abuts floor drains, concrete, or a different floor material.
 2. Other types as furnished or approved by Flooring Manufacturer.
 3. Color: As noted on Drawings or as selected by Architect from manufacturer's full color range. Color shall match color noted or selected, otherwise it shall be rejected, even if provided by an acceptable manufacturer.
- D. Sealer: Type recommended by Flooring Manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions: Examine subsurfaces to receive Work and report detrimental conditions in writing to Architect. Commencement of Work will be construed as acceptance of subsurfaces.

- B. Inspect the sub-floor to receive resilient flooring in accordance with ASTM F710. Do not lay floor covering until sub-floors are in proper condition to receive same. Sub-floors shall be broom clean, free of foreign matter and thoroughly clean before installation.
- C. Verify concrete floors are dry and bondable.

3.02 PREPARATION

- A. Remove sub-floor ridges and bumps.
- B. Verify that concrete floors are dry and bondable.
- C. Fill low spots, cracks, joints, holes, and other defects with subfloor filler.
 - 1. Apply, trowel, and float filler to leave a smooth, flat, hard surface.
 - 2. Prohibit traffic from area until filler is cured.
- D. Vacuum clean substrate.
- E. Apply primer to floor surfaces as recommended by Flooring Manufacturer.

3.03 INSTALLATION - TILE FLOORING

- A. Install in accordance with Manufacturers' instructions and in accordance with "Recommended Work Procedures for Resilient Floor Coverings" of the Resilient Floor Covering Institute.
- B. Mix tile from container to ensure shade variations are consistent.
- C. Spread only enough adhesive to permit installation of materials before initial set.
- D. Set flooring in place, press with heavy roller to attain full adhesion.
- E. Lay tile flooring with joints parallel to building lines and with symmetrical tile patterns.
- F. Install tile to square grid pattern with all joints aligned. Allow minimum 1/2 full size tile width at room or area perimeter.
- G. Terminate flooring at centerline of door openings where adjacent floor finish is dissimilar.
- H. Install edge strips at unprotected or exposed edges, and where flooring terminates.
- I. Scribe flooring to walls, columns, cabinets, floor outlets, and other appurtenances to produce tight joints.
- J. Install flooring under movable partitions without interrupting floor pattern.
- K. Install edge strips where indicated. Fit joints tightly.
- L. Installation of resilient tile flooring over the Vapor Reduction Floor Coating (as specified in Section 07 26 53): Install using flooring manufacturer's recommended adhesive for the vapor reduction system.

3.04 INSTALLATION - BASE

- A. Fit joints tight and vertical. Maintain minimum measurement of 18 inches between joints.
- B. Miter internal corners at typical base:
 - 1. At external corners, use premolded units.
 - 2. At exposed ends use premolded units.
 - 3. No cuts on inside or outside corners are acceptable.
- C. Install base on solid backing. Bond tight to wall and floor surfaces.
- D. Scribe and fit to door frames and other interruptions.

3.05 CLEANING

- A. After flooring has become well seated, minimum 72 hours, and just prior to opening it to traffic, thoroughly clean in accordance with Manufacturer's recommendations.
 - 1. Apply two coats of manufacturer's recommended wax to cleaned resilient flooring in accordance with manufacturer's published recommendations.
- B. Remove dirt, debris and adhesive from floor covering and adjacent surfaces using Manufacturers recommended methods and leave installation in a clean, undamaged condition.
- C. During the course of the Work and on completion, remove excess materials, equipment and debris and dispose of away from premises. Leave Work in clean condition.

3.06 PROTECTION

- A. Minimize traffic until flooring has become well seated, at least 72 hours, at a maintained temperature of not less than 70 degrees F., and do not permit fixtures, equipment, trucks, or similar items on flooring.
 - 1. Provide temporary protection materials of underlayment board or other suitable protection sheets over flooring where it is necessary to move heavy or sharp loads across the floor within 72 hours after installation.
 - 2. Protect installed flooring by providing protective coverings or other protection as recommended by manufacturer until time of final completion of Project.

END OF SECTION

SECTION 09 67 23
RESINOUS FLOORING

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: High-performance resinous flooring systems.

1.02 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Installer Certificates for Qualification: Signed by manufacturer stating that installers comply with specified requirements.
- C. Material Certificates: For each resinous flooring component, from manufacturer.
- D. Maintenance Data: For maintenance manuals.
- E. Samples: Submit two 6" X 6" samples of each resinous flooring system applied to a rigid backing. Provide sample which is a true representation of proposed field applied finish. Provide sample color and texture for approval from Owner in writing or approved by General Contractor prior to installation.
- F. Product Schedule: For resinous flooring.

1.03 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of flooring systems required for this Project.
 - 1. Engage an installer who is approved in writing by resinous flooring manufacturer as qualified to apply resinous flooring systems indicated.
 - 2. Installer Letter of Qualification: Installer to provide letter stating that they have been in business for at least 5 years and listing 5 projects in the last 2 years of similar scope. For each project provide: project name, location, date of installation, contact information, size of project, and manufacturer of materials with system information.
- B. Source Limitations: Obtain primary resinous flooring materials, including primers, resins, hardening agents, grouting coats, and topcoats, from single source from single manufacturer. Provide secondary materials, including patching and fill material, joint sealant, and repair materials, of type and from source recommended by manufacturer of primary materials.
- C. Pre-installation Conference: Conduct conference at Project site before work and mockups begin.
- D. Mockups: Apply mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution. Do not cover up mockup area.
 - 1. Apply full-thickness mockups on 16 square foot floor area selected by Architect.
 - 2. Finish surfaces for verification of products, color, texture, and sheen.
 - 3. Simulate finished lighting conditions for Architect's review of mockups.

- 4, Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
- 5, Mockup shall demonstrate desired slip resistance for review and approval by Owner's representative in writing.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in original packages and containers, with seals unbroken, bearing manufacturer's labels indicating brand name and directions for storage and mixing with other components.
 1. Maintain containers in clean condition, free of foreign materials and residue.
 2. Remove rags and waste from storage areas daily.

1.05 PROJECT CONDITIONS

- A. The Lab has existing epoxy flooring which will remain in place and will be the substrate for the new epoxy flooring.
 1. After construction demo is completed, Contractor shall clean the floor.
 2. The existing epoxy floor condition to be reviewed with the Architect and the Owner prior to installation of new flooring.
 3. Patch and repair existing floor (gaps, cracks, etc) before new flooring installation.
- B. Environmental Limitations: Comply with resinous flooring manufacturer's written instructions for substrate temperature, ambient temperature, moisture, ventilation, and other conditions affecting resinous flooring application.
- C. Lighting: Provide permanent lighting or, if permanent lighting is not in place, simulate permanent lighting conditions during resinous flooring application.
- D. Close spaces to traffic during resinous flooring application and for not less than 24 hours after application unless manufacturer recommends a longer period.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by:
 1. The Sherwin Williams Company, Cleveland, OH. Representative Contact: Michael Starner (484) 624-2360 michael.starner@sherwin.com.
 2. Or approved equal
- B. FasTop Deco Flake SL45, 3/16" – 1/4" nominal thickness.
 1. Cove Base FasTop Multi Cove Base, 15-20 linear feet per kit at 6" with 1" radius.
 2. Primer (Optional for outgassing): Resuflor Aqua 3477 at 250 sq. ft. per gallon.
 3. Slurry (1/4"): FasTop Multi SL45 32-34 sq. ft. per kit.
 4. Broadcast: 6750/6755 (1/4 inch flake) Decorative Flake at 100 lbs. per 1,000 sq. ft.
 5. Grout Coat: Resuflor 3746 at 200-300 sq. ft. per gallon.
 6. Seal Coat: 5190 anti-slip texture admixture to Resutile 4685 top coat at 250-400 sq. ft. per gallon. (2 coats)

2.02 MATERIALS

- A. VOC Content of Resinous Flooring: Provide resinous flooring systems, for use inside the weatherproofing system, that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24)].
 - 1. Resinous Flooring: 100 g/L.

2.03 HIGH-PERFORMANCE RESINOUS FLOORING

- A. Resinous Flooring: Abrasion-, impact- and chemical-resistant, high-performance, resin-based, monolithic floor surfacing designed to produce a seamless floor.
- B. System Characteristics:
 - 1. Color and Pattern: As indicated on color/finish schedule on Drawings
 - 2. Slip Resistance: Provide slip resistant finish.

PART 3 EXECUTION

3.01 PREPARATION

- A. Inspection: Prior to commencing Work, thoroughly examine all underlying and adjoining work, surfaces and conditions upon which Work is in any way dependent for perfect results. Report all conditions which affect Work. No "waiver of responsibility" for incomplete, inadequate or defective underlaying and adjoining work, surfaces and conditions will be considered, unless notice of such unsatisfactory conditions has been filed and agreed to in writing before Work begins. Commencement of Work constitutes acceptance of surfaces.
- B. Surface Preparation: Remove all surface contamination, loose or weakly adherent particles, laitance, grease, oil, curing compounds, paint, dust and debris by blast track method or approved mechanical means (acid etch not allowed). If surface is questionable try a test patch. Create a minimum surface profile for the system specified in accordance with the methods described in ICRI No. 03732 to achieve profile numbers as follows:

1. Thin film, to 10 mils	CSP-1 to CSP-3
2. Thin and medium films, 10 to 40 mils	CSP-3 to CSP-5
3. Self-leveling mortars, to 3/16"	CSP-4 to CSP-6
4. Mortars and laminates, to 1/4" or more	CSP-5 to CSP-10
- C. Verify that concrete substrates are dry and moisture-vapor emissions are within acceptable levels according to manufacturer's written instructions.
 - 1. Moisture Testing: Perform tests indicated below.
 - a. Calcium Chloride Test: Perform anhydrous calcium chloride test per ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. in 24 hours. Perform tests so that each test area does not exceed 1000 sq. ft. and perform 3 tests for the first 1000 sq. ft. and one additional test for every additional 1000 sq ft.
 - b. In-Situ Probe Test: Perform relative-humidity test using in-situ probes per ASTM F 2170. Proceed with installation only after substrates have a maximum 75 percent relative-humidity-level measurement.

3.02 ENVIRONMENTAL CONDITIONS

- A. All applicators and all other personnel in the area of the RF installation shall take all required and necessary safety precautions. All manufacturers' installation instructions shall be implicitly instructions shall be implicitly followed.
- B. Repair damaged and deteriorated concrete according to resinous flooring manufacturer's written instructions.
- C. Alkalinity and Adhesion Testing: Verify that concrete substrates have pH within acceptable range. Perform tests recommended by manufacturer. Proceed with application only after substrates pass testing.
- D. Resinous Materials: Mix components and prepare materials according to resinous flooring manufacturer's written instructions.
- E. Use patching and fill material to fill holes and depressions in substrates according to manufacturer's written instructions.
- F. Treat control joints and other nonmoving substrate cracks to prevent cracks from reflecting through resinous flooring according to manufacturer's written instructions.

3.03 APPLICATIONS

- A. Install resinous floor over properly prepared concrete surface in strict accordance with the manufacturer's directions.
 - 1. Install the primer and/or base coats over thoroughly cleaned and prepared concrete.
 - 2. Install topcoat over flooring after excess aggregate has been removed.
 - 3. Maintain a slab temperature of 60°F to 80°F for 24 hours minimum before applying floor topping, or as instructed by manufacturer.
- B. Apply components of resinous flooring system according to manufacturer's written instructions to produce a uniform, monolithic wearing surface of thickness indicated.
 - 1. Coordinate application of components to provide optimum adhesion of resinous flooring system to substrate, and optimum intercoat adhesion.
 - 2. Cure resinous flooring components according to manufacturer's written instructions. Prevent contamination during application and curing processes.
 - 3. At substrate expansion and isolation joints, comply with resinous flooring manufacturer's written instructions.
- C. Sealant: Saw cut resinous floor topping at expansion joints in concrete slab. Fill sawcuts with sealant prior to final seal coat application. Follow manufacturer's written recommendations.
- D. Apply primer over prepared substrate at manufacturer's recommended spreading rate.
- E. Slip Resistant Finish: Provide admixture for slip resistance.
- F. Apply topcoats in number indicated for flooring system and at spreading rates recommended in writing by manufacturer.

3.04 `COMPLETED WORK

- A. Cleaning: Upon completion of the Work, clean up and remove from the premises surplus materials, tools, appliances, empty cans, cartons and rubbish resulting from the Work. Clean off all spattering and drippings, and all resulting stains.
- B. Protection: Protect Work in accordance with manufacturer's directions from damage and wear during the remainder of the construction period. Use protective methods and materials, including temporary covering, recommended in writing by resinous flooring manufacturer.
- C. Contractor shall insure that coating is protected from any traffic until it is fully cured to the satisfaction of the coating manufacturer.

END OF SECTION

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SECTION 09 91 00

PAINTING

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Painting as specified and as noted on Drawings. Surfaces requiring finishing and left unfinished by the requirements of other Sections shall be painted or finished as part of the Work of this Section.
 - 2. For both lab areas and lab offices, generally, wall surfaces shall be smooth, non-shedding and cleanable with a durable paint finish. All penetrations through walls shall be sealed.

1.02 DEFINITIONS

- A. Touch-Up: Painting of items missed by painter at no additional cost to Owner.
- B. Re-Paint: Repairs to paint work for damages caused by other trades.
- C. Block Resistance (Non-Blocking): The capability of a coating to resist sticking to itself when used on 2 surfaces that come in contact with each other (e.g. door and jamb, window sash and sill).

1.03 SUBMITTALS

- A. Product Data: Submit schedule of manufacturers of products required for the Work, together with specifications recommended by each manufacturer.
- B. Samples: Submit samples of each type of finish specified.
 - 1. Architect will furnish Contractor a color schedule of colors selected either from manufacturer's stock colors or specially requested color mixes before Work is begun.
 - 2. Submit two 8 inch x 10 inch samples of each color, including the correct sheen and texture, on heavy cardboard or masonry. Submit sealer and stain finishes on material of the same quality and species of wood on which that particular finish shall be used. Rejected samples shall be resubmitted until approved.
 - 3. Samples shall be submitted at least 30 days prior to the start of painting work. Label and identify each sample as to location and application. Upon submittal of color samples, minor variations or changes in color selection may be requested by the Architect and new samples ordered, until final color approval.

1.04 QUALITY ASSURANCE

- A. General:
 - 1. Primers and other undercoat paint shall be supplied by the same manufacturer of the finish coats.
 - 2. All paint materials (whether primers, thinners or finish) must be a manufacturers standard, best grade product(s), with the manufacturer's product literature identifying the material or product as such.

3. Primers, back-primers, undercoats and finish coats must be provided as a total assembly, adhering to all manufacturer's directions and recommendations. Material types must be chosen considering the surface nature to be covered, location of the surface, and the environmental conditions the surface and materials will be in continual and occasional contact with.
 4. Painted surfaces shall have consistent color and sheen throughout any continuous, flat areas.
 5. Touch-ups or repainting required for punch lists needs to be indistinguishable. This most often would necessitate painting whole sections of a given surface where the finish can be squared off at a corner or other break in the surface.
 6. Finished surfaces shall comply with PDCA Industry Standards.
- B. Standards: Preparation, application and workmanship shall be in accordance with manufacturer's recommendations and applicable provisions of the following:
1. Painting and Decorating Contractors of America (PDCA) "Painting Specification Manual" and "Standards".
 - a. PDCA P1-09, "Touch-Up Painting and Damage Repair - Financial Responsibility and Definition of a Properly Painted Surface."
 - b. PDCA P2-09, "Third Party Inspections: Qualifications, Responsibilities and Procedures."
 - c. PDCA P3-09, "Designation of Paint Color."
 - d. PDCA P4-09, "Responsibility for Inspection and Acceptance of Surfaces Prior to Painting and Decorating."
 - e. PDCA P5-09, "Benchmark Sample Procedures for Paint and Other Decorative Coating Systems."
 2. Gypsum Association - GA210, "Gypsum Board for Walls and Ceilings."

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Packing and Shipping: Deliver materials to site in manufacturer's sealed containers, legends and labels, intact.
- B. Storage:
1. Adequately protect against damage while stored at site.
 2. In no case shall the amount or method of materials stored exceed the amount permitted or the manner allowed by local ordinances, state laws, or fire underwriter regulations.

1.06 PROJECT/SITE CONDITIONS

- A. Physical Requirements for Proper Installation or Application: Do not apply exterior paint in damp or rainy weather or until after the surface has dried thoroughly from the effects of such weather.
1. Do not apply varnish or paint when temperature is below 50 degrees F.. Avoid painting surfaces exposed to hot sunlight.
 2. During interior application, maintain minimum temperature of 65 degrees F. unless otherwise directed by Architect or manufacturer's printed instructions. Hold temperature as constant as possible.
 3. Provide adequate ventilation at all times so the humidity cannot rise above the dew point of the coldest surface to be painted.
 4. Moisture-containing surfaces, such as concrete, stucco and cement plaster shall have a moisture content of less than 8 percent as measured by moisture meter. Remove surface salt deposits prior to painting. Verify that pH is neutral, or within acceptable limits of Paint Manufacturer. Paint after thoroughly cured.

1.07 MAINTENANCE

- A. Extra Materials: Upon completion of the Work, furnish Owner with one fresh gallon of each type and color of paint and finish used on this Project. Label containers with manufacturer's name, batch, color, shelf life, instructions, and cautions.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Furnish products of one of the following manufacturers, except as otherwise approved by Architect, subject to compliance with specification requirements.
 - 1. Sherwin Williams (Basis of Design)
 - 2. Dunn-Edwards Corporation
 - 3. Glidden (formerly ICI Paints)
 - 4. Or equal in accordance with Section 01 60 00.

2.02 MATERIALS

- A. General:
 - 1. Brands of paint, varnish and stains shall be of highest quality, made by reputable manufacturers, have identifying labels on containers and shall be approved by Architect.
 - 2. All paint materials shall be factory fresh and low VOC.
 - 3. Compatibility of the paint with the substrate shall be verified prior to painting.
- B. Provide materials in accordance with the Schedule of Paint Products at the end of this Section as applicable to project and as follows:
 - 1. Block resistant (non-blocking) materials shall be used for doors, door jambs, railings and other locations subject to handling, or where surfaces will come into contact with other painted surfaces or belongings.
 - 2. Shall not be formulated or manufactured with formaldehyde, halogenated solvents, aromatic hydrocarbons, mercury, or mercury compounds, or tinted with pigments of lead, cadmium, chromium VI, and their oxides
 - 3. Materials used shall comply with applicable Federal and local air pollution regulations, lead content laws, and current VOC requirements. If products listed in Schedule of Paint Products located at the end of this Section are not in compliance with regulations, laws, or requirements, Contractor shall notify Architect and shall provide information regarding substitute products.
- C. Colors: As scheduled on Drawings.
- D. Basic painting materials such as linseed oil, shellac, turpentine, thinners, driers, and other similar products, shall be of highest quality, made by reputable, recognized manufacturers, and have identifying labels on containers. Paint materials shall be factory fresh.
- E. Alternate materials submitted for prior approval shall have qualities and materials equal to the other listed manufacturer's scheduled products. Materials selected for coating systems for each type of surface shall be the products of a single manufacturer, unless otherwise specified or scheduled.

- F. Standard Gloss Range: Provide paints in accordance with the following ranges in accordance with ASTM D523 and in accordance with Finish Schedules on drawings:

<u>Sheen</u>	<u>Geometry</u>	<u>Gloss Range</u>
Flat	85 degree	Below 15 (see also Paint Finishes herein)
Eggshell	60 degree	5-20
Lo Luster	60 degree	15-25
Satin	60 degree	15-35
Semi-Gloss	60 degree	30-65
Gloss	60 degree	Over 65

- G. Paints shall be ready mixed except for field catalyzed coatings.
- H. Transparent Finishes:
1. Urethane finishes: Water emulsion urethane
 2. Penetrating oil-based, waterborne finishes: Shall not contain lead acetate or cobalt manganese (drying agents)
 3. Stain: Vegetable oil-based, waterborne stain for exterior use with UV Protection
 4. Acrylic: Waterborne, urethane; VOC less than 100grams/liter
 5. Plant-based oil finish: Low odor, water reducible; interior use
 6. Polymerized linseed oil: Interior use
 7. Polymerized tung oil: Interior Use
- I. Paint Strippers - Low-Emitting: Shall not contain methylene chloride. Avoid products containing methanol and trichloroethane.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions: Examine subsurfaces to receive Work and report in writing with a copy to Architect, conditions detrimental to Work. Commencement of Work will be construed as acceptance of subsurfaces.

3.02 PROTECTION

- A. Before painting, remove hardware, hardware accessories, machined surfaces, accessories, electrical plates, lighting fixtures and similar items and protect or provide surface applied protection be provided for such items prior to the start of the work.
1. Provide "Wet-Paint" signs and other barricades and protections as required to protect adjacent surfaces and work of other trades, whether being painted or not.
 2. Mask permanent labels.
 3. Provide, distribute, and maintain a sufficient supply of clean drop cloths and other protective coverings.
 4. Protect foliage and other exterior finished surfaces from contact with cleaning materials and thoroughly flush with water after contact.
 5. On completion of each space, replace above items.

3.03 SURFACE PREPARATION

- A. General:
1. Surfaces requiring painting or finishing shall be thoroughly dry and cured, free of dirt, dust, rust, stains, scale, mildew, wax, grease, oil, deteriorated substrates, bond-breakers, efflorescence and other foreign matter detrimental to the coating's adhesion and performance. Repair voids, cracks, nicks and other surface defects with appropriate patching material. Finish flush with surrounding surfaces and match adjacent finish texture.
 2. Spot prime marred or damaged shop coats on metal surfaces with appropriate metal primer.
 3. Determine moisture content of plaster, stucco, cementitious materials, wood and other moisture-holding materials by use of a reliable electronic moisture meter.
 4. Determine alkalinity of plaster, stucco and other cementitious materials by performing appropriate tests.
 5. Do not paint surfaces where moisture content or alkalinity exceeds that which is allowed by paint manufacturer.
- B. Existing Surfaces:
1. Clean, sand, patch, repair and prepare existing surfaces to be painted so that such existing finished surfaces are indistinguishable from new surfaces.
 2. Surfaces which cannot be prepared or painted as specified shall be immediately brought to the attention of the Architect in writing.
 3. Remove loose peeling and checked paint.
 4. Remove mildew by washing the surface with a commercially available mildew killer/remover.
 5. Remove efflorescence by wire brushing, power brushing or washing. Thoroughly rinse surfaces wire brushed. After removal of efflorescence, wash the surface with a commercially available cleaner acceptable to the manufacturer of the substrate.
 6. Remove existing wallcovering and wash the surface to remove paste residue. Seal surface before making any surface repairs.
 7. Dull and roughen glossy surfaces to obtain proper adhesion by either sanding, washing with a tri-sodium phosphate solution, or treating with a liquid deglossing compound.
 8. Overlap and feather edge spot-primed areas.
- C. Wood:
1. Wood surfaces must be cleaned prior to priming, painting or staining with mineral spirits or light grit sandpaper (thoroughly dusted afterwards).
 2. Sandpaper to smooth and even surface and then dust off. After primer or stain coat has been applied, thoroughly fill nail holes and other surface imperfections with putty tinted with primer or stain to match wood color. Sand woodwork between coats to a smooth surface. Cover knots and sap streaks with a thin coat of shellac, or seal with a suitable stain blocking sealer.
 3. Finish door and window edges after final fitting. Finish interior of cabinets in the same manner as the exterior unless otherwise specified. Seal interior of drawers unless otherwise specified.
 4. Backpriming:
 - a. Backprime exterior woodwork, which is to receive paint finish, with exterior primer paint.
 - b. Backprime interior woodwork, which is to receive paint or enamel finish, with enamel undercoater paint.

- c. Backprime interior and exterior woodwork, which is to receive stain and/or varnish finish with VOC compliant varnish acceptable to the Architect.
 - d. Back-prime wood trim before installation.
 - 5. Where existing stained surfaces are indicated to be coated with a transparent stain, test apply stain to small area where directed by Architect and obtain Architects approval of color.
- D. Steel and Iron:
 - 1. Remove grease, oil, mill scale, rust and rust scale and touch-up chipped or abraded places on items that have been shop coated. Remove and reprime incompatible or damaged shop applied primers. Comply with the Steel Structures Painting Council's (SSPC) recommendations for cleaning of uncoated steel and iron surfaces.
 - 2. When area will be exposed to view, sandpaper the entire primed area smooth, feather the edge of surrounding undamaged prime coat and spot prime in a manner to eliminate evidence of repair.
 - 3. Where steel or iron at existing Work have a heavy coating of scale, remove by sand blasting, sanding, descaling, grinding or wire brushing, as necessary, to produce a satisfactory surface for painting.
- E. Galvanized Metal and Aluminum:
 - 1. Thoroughly clean by wiping surfaces with a non-hydrocarbon solvent that will not leave an oily residue. Apply surface conditioner or vinyl-wash pretreatment as required for proper adhesion if required by paint manufacturer. Prime galvanized metal with galvanized iron primer as recommended by paint manufacturer. A test sample of the complete painting system should be applied and checked for adhesion before final painting begins.
 - 2. Clean visible portions of throats of galvanized steel ductwork with solvent; wipe dry with clean rags and paint flat black.
- F. Concrete and cement plaster:
 - 1. The method of surface preparation shall be at Contractor's discretion, provided the results are satisfactory to the Architect, and the method is in compliance with applicable codes and requirements.
 - 2. Concrete and cement plaster must have all efflorescence, chalk, dust, dirt grease, oils, etc. removed by roughening prior to the application of primer or finish paint coats.
 - 3. Repair surfaces to be painted prior to application of prime and finish coat(s). Apply a tinted primer to the substrate to help identify surface imperfections. After the primer has thoroughly dried, patch, fill and repair surface imperfections to match and flush-out with adjacent finish texture and profile.
 - 4. Before first paint coat is applied, spot prime nails and other exposed metal occurring in the surfaces with a rust inhibitive primer as recommended by paint manufacturer.
- G. Plaster and Gypsum Board Surfaces:
 - 1. Fill cracks, holes or imperfections with compatible patching material and smooth off to match adjoining surfaces. Before painting, surfaces shall be first tested for dryness with a moisture testing device.
 - 2. Apply no paint or sealer on gypsum board or plaster when the moisture content exceeds 8 percent. Test sufficient areas in each space and as often as necessary to determine if the surface has the proper moisture content for painting. If the moisture content is between 8 percent and 12 percent, prime with alkali resistant primer.

3. If 8 percent or less, prime with specified primer. Remove the dry salt deposits from plaster surfaces by brushing with a stiff brush before painting.
- H. Acoustical Surfaces (Lay-in acoustical ceiling panels, acoustical wall panels, etc.):
1. Thoroughly vacuum clean surfaces to remove dust and debris from acoustical surface pores. Use a soft brush attachment that will not damage or loosen acoustical surface.
 2. Seal surface stains with a suitable stain blocking sealer that will not fill pores of acoustical surface.

3.04 WORKMANSHIP

- A. Apply products to achieve paint manufacturer's printed specifications for dry mil thickness
1. Surfaces to receive finish painting shall be primed if not primed by the manufacturer or shop, in accordance with the paint manufacturer's recommendations.
 2. Surfaces shall receive as a minimum two coats of finish paint, allowed to dry completely between coats, and applied to the manufacturer's recommendation per coat thickness and application rate.
 3. Recommended application techniques:
 - a. Metal: Spray applied.
 - b. Walls: Spray or rolled applied.
 - c. Doors and jambs: Spray or Brush applied.
- B. Apply each coat of paint evenly and comply with manufacturer's drying time before applying subsequent coats.
- C. Finished work shall be uniform, match approved color, texture and coverage, and free from runs, sags, clogging or excessive flooding. Make edges of paint adjoining other materials or colors sharp and clean, without overlapping. Where varnishes or enamel is used, lightly sand, dust and clean undercoats to obtain a smooth finish coat. Sand carefully between each coat of finish on smooth surfaces for good adhesion of subsequent coats.
- D. Where clear finishes are required, ensure tinted fillers match wood. Work fillers well into the grain before set. Wipe excess from the surface.
- E. Where specific mil thicknesses are required, check thickness by the following methods:
1. Over ferrous metal - Elecometer Film Gauge
 2. Other surfaces - Tooke Dry Mil Inspection Gauge

3.05 APPLICATION

- A. The number of coats scheduled is the minimum number of coats required. Additional coat(s) shall be applied, at no additional cost to the Owner, to completely hide base material, provide uniform color and to produce satisfactory finish results.
- B. Apply coatings without thinning except as specifically required by label directions, or required by these specifications. In such cases, thinning shall be the minimum reduction permitted.
- C. Priming will not be required on items delivered with prime or shop coats, unless otherwise specified. Touch up prime coats applied by others as required to ensure an even primed surface before applying finish coat.

- D. Block Fillers: Provide level of block fill as scheduled to conform with the following:
1. Level 1 – Regular Fill: Minimum block fill, reduces irregularity in masonry profile. One coat, spray applied.
 2. Level 2 – Medium Full Fill: Masonry profile slightly reduced. One coat, spray applied and back-rolled.
 3. Level 3 – Full Fill: Minimum block fill required for semi-gloss and gloss finishes. Use where conformance with health regulations is required. Number of coats as required to conceal most of masonry texture, spray applied and back-rolled.
- E. Plumbing, Mechanical and Electrical:
1. Exterior and interior exposed water, gas, waste piping, sprinkler piping, conduit, lighting and electrical panels, telephone terminal boxes, galvanized ducts and insulated ducts, shall be painted in areas other than mechanical rooms, unless otherwise scheduled.
 2. Paint exposed unfinished fixtures, metal ducts, switch boxes, control panels, devices, starters, junction boxes, vents, drains, and other similar items, as directed by Architect.
- F. Spray paint prime coated (not pre-finished) grilles and registers with enamel or lacquer to match walls and ceilings. Paint materials shall not sag, run or bind movable parts of grilles, registers, louvers, baffles and other similar items.
1. Throats of ducts shall be given one coat of flat black paint, wherever visibility of the interior of the duct is allowed through registers or other similar items. At fiber lined duct, use black latex paint.
 2. Examine the Mechanical and Electrical Drawings and Specifications to determine the amount of exposed work to be painted.
- G. Paint exposed surfaces of every member; paint items inaccessible after installation before installation, if required to be painted. Edges, tops and bottoms of wood doors shall be sealed and finished with the same finish as the door faces, to meet door manufacturer's warranty requirements. Verify edge color with Architect as different colors may be selected for each face.
- H. Paint items fitted with finish hardware after hardware has been temporarily removed.
- I. Heating and other equipment on or adjacent to walls or surfaces scheduled for painting, shall be disconnected, using workmen skilled in appropriate trades and moved temporarily to permit painting of surface. Following completion of painting, replace and reconnect items.
- J. Each succeeding pigmented coat shall be distinguishably lighter than the previous coat. Tint prime and undercoats to a color similar to finish coat. Each coat of material applied must be inspected and approved by the Architect before the application of the succeeding specified coat; otherwise no credit for the concealed coat will be given, and the Contractor shall assume the responsibility to recoat work in question. Contractor shall notify the Architect when each coat is completed.
- K. Brush, wipe or roll stain in 2 coat application. Avoid lap marks by maintaining "wet-edge" continually being merged with existing liquid coverage and stop only at natural edges, turns and breaking places.
- L. Do not paint over Underwriters' Laboratory labels, fusible links, exposed sprinkler heads and other similar items.
- M. Paint piping, electrical or other equipment, conduit, vents and other similar items, on roof or other exterior locations as directed by Architect.

- N. Finish closets and the interior of cabinets with same color as adjoining rooms, unless otherwise specified. Finish other surfaces same as nearest or adjoining surfaces, unless otherwise shown or scheduled.
- O. Paint surface of walls which will be concealed by cabinets, chalkboards and other items attached to wall.
- P. Finishes
 - 1. The use of flat paint finishes (whether field applied or factory) are not acceptable in areas or on surfaces that will be subject to human contact, direct sun exposure, exposure to water, solvents or cleaning materials, or frequent abrasions.
 - 2. High gloss finishes are not acceptable in areas where reflective glare may be a concern (areas that contain computer terminals) or on surfaces that are in continual human contact.
 - 3. Acceptable finishes for most areas, surfaces or features are velvet flat, eggshell, satin, and semi-gloss.
 - 4. Exterior exposed metal fabrications shall have a spray applied epoxy-polymide type primer (as described in 05 50 00), finish paint coat(s) shall also be spray applied- Kynar or equal. A color should be chosen that does not easily fade when exposed to sunlight.
 - 5. At the top and bottom of stair landings, a contrasting color and texture to the normal stair treads shall be used to facilitate the blind and visually impaired.

3.06 ADJUSTING

- A. At completion, do touch-up and re-paint work and leave finish surfaces in good condition.

3.07 CLEANING

- A. During the course of the Work, remove misplaced paint and stain spots or spills. Leave Work in clean condition acceptable to Architect.
- B. Remove oily rags and waste daily, taking precaution to prevent fire.

3.08 SCHEDULES

- A. Color Schedule:
 - 1. Architect will provide a complete schedule of colors. Colors may be selected from various manufacturer's color palettes. Manufacturer supplying paint shall match these colors. Contractor shall prepare duplicate set of samples of treatments for major surfaces. If a specific surface or item receiving a paint finish does not have a specific color indicated or selected by the Architect, obtain clarification from the Architect. Do not assume the confirmation of the same color on the adjacent surfaces.
 - 2. Final coat of paint shall be not be applied until colors have been approved by the Architect.
- B. Schedule of Finishes: Refer to the "Finish Schedule" on the Drawing for designated finishes of areas.
- C. Finishing of the following listed items and materials will not be required and shall be protected:
 - 1. Stainless Steel, brass, bronze, copper, monel, chromium, anodized aluminum; specially finished articles such as porcelain enamel, plastic coated fabrics, and baked enamel, unless otherwise indicated.

2. Finished products such as ceramic tile, glass, brick, resilient flooring and acoustical tiles, board and metal tees.
3. Pre-finished products such as wood folding partitions and doors, wood classroom and laboratory casework, bleachers and elevator cabs.

3.09 EXTERIOR PAINT FINISHES

- A. Not applicable to this project.

3.10 INTERIOR PAINT FINISHES

- A. This schedule uses the generic names listed in the Schedule of Paint Products.
- B. System 201 (Ferrous Metals): Apply to exposed metals such as steel doors, hollow metal frames, metal beam saddles, columns, grilles and registers, stair and hand railings, ladders, and other exposed miscellaneous metals.
1. 1st Coat: Ferrous Metal Primer (Red or White color as applicable to finish coats).
 2. 2nd Coat: Same material as 3rd Coat as recommended by manufacturer.
 3. 3rd Coat:
 - a. Eggshell: Enamel, Eggshell.
 - b. Semi-Gloss (if noted on Drawings): Enamel, Semi-Gloss.
 - c. Gloss (if noted on Drawings): Enamel Gloss.
- C. System 202 (Interior Wood Finishes - Enamel): Apply to wood door frames, columns, exposed and concealed casework and millwork, wood-window wall construction, medium density plywood surfaces, shelving, roll-up wood doors, perforated and plain type hardboard, particleboard and other exposed miscellaneous wood and trim, except wood specified for a transparent or stain finish.
1. 1st Coat: Enamel Undercoater.
 2. 2nd and 3rd Coat:
 - a. Semi-Gloss: Enamel, Semi-Gloss
 - b. Eggshell (if noted on Drawings): Enamel, Eggshell
 - c. Gloss (if noted on Drawings): Enamel, Gloss
- D. System 203 (Interior Wood Finish - Flat): Apply to plywood telephone backing boards and other miscellaneous softwood as noted, specified or scheduled.
1. 1st Coat: Enamel Undercoater/Primer.
 2. 2nd and 3rd Coat: Flat Paint, - Waterborne (Vinyl Acrylic)
- E. System 204 (Galvanized Metals): Apply to exposed galvanized metal.
1. Clean metal to remove foreign matter or any coating applied by the metal manufacturer. Apply Surface Conditioner or Vinyl Wash Pretreatment (if required by paint manufacturer)
 2. 1st Coat: Galvanized Metal Primer
 3. 2nd and 3rd Coats:
 - a. Eggshell: Enamel, Eggshell
 - b. Semi-Gloss (if noted on Drawings): Enamel, Semi-Gloss
 - c. Gloss (if noted on Drawings): Enamel Gloss

- F. System 205 (Aluminum): Apply to interior louvers and other miscellaneous exposed unfinished aluminum surfaces.
1. Clean metal to remove foreign matter or any coating applied by the metal manufacturer. Apply Surface Conditioner or Vinyl Wash Pretreatment.
 2. 1st Coat: Aluminum Primer
 3. 2nd and 3rd Coats:
 - a. Eggshell: Enamel, Eggshell
 - b. Semi-Gloss (if noted on Drawings): Enamel, Semi-Gloss
 - c. Gloss (if noted on Drawings): Enamel, Gloss
- G. System 206 (Gypsum Board, Plaster and Concrete - Wet Areas): Apply to gypsum board, plaster and concrete surfaces in toilet rooms, janitor rooms, kitchens, and other areas as scheduled.
1. 1st Coat: Enamel Undercoater
 2. 2nd and 3rd Coats:
 - a. Eggshell (if noted on Drawings): Enamel, Eggshell.
 - b. Semi-Gloss: Enamel, Semi-Gloss - Latex wall coating as scheduled on drawings.
- H. System 207 (Gypsum Board, Plaster and Concrete - Non-Wet Areas): Apply to gypsum board, plaster and concrete except for wet areas.
1. 1st Coat: Waterborne Primer/Sealer.
 2. 2nd and 3rd Coat:
 - a. Eggshell: Enamel, Eggshell
 - b. Semi-Gloss (if noted on Drawings): Enamel, Semi-Gloss
 - c. Flat (if noted on Drawings): Paint, Flat
- I. System 208 (Ferrous Metal - Chemical Resistant Finish): NOT USED
- J. System 209 (Interior Concrete Masonry - Wet Areas): Apply to concrete masonry block units in kitchen, toilet rooms, bathrooms, janitor rooms, vestibules and other walls noted for enamel finish.
1. 1st Coat: Block Filler, w/o Aggregate. Provide Level 3 Full Fill.
 2. 2nd Coat: Primer/Sealer or same material as 3rd Coat as recommended by manufacturer.
 3. 3rd and 4th Coats: Enamel, Semi-Gloss – Latex wall coating as scheduled on drawings. .
- K. System 210 (Interior Concrete Masonry or Plaster - Extremely Wet Areas): Not used.
- L. System 211 (Interior Concrete Masonry - Non-Wet Areas): Apply to exposed interior concrete masonry block units except areas specified above for enamel finish.
1. 1st Coat: Block Filler, w/o Aggregate. Provide Level 1, 2 or 3 Fill as required by gloss.
 2. 2nd Coat: Same material as 3rd Coat as recommended by manufacturer.
 3. 3rd Coat: Enamel, Semi-Gloss - Waterborne.

- M. System 212 (Acoustic Ceilings): Apply to existing acoustic panel or tile ceilings.
1. 1st and 2nd Coat: Acoustic Paint.

3.11 SCHEDULE OF PAINT PRODUCTS

- A. Only those products which are specifically required by this Section shall be provided. Products listed in the following Schedule that are not specified in this Section are for information only.

INTERIOR PRIMERS/UNDERCOATERS	System(s)	Dunn-	Glidden	Sherwin
		Edwards		Williams
Red Ferrous Metal Primer Waterborne	201	BRPR00- 1-RO	4020PF	B66W00310
White Ferrous Metal Primer Waterborne	201	BRPR00- 1-WH	4020PF	B66W00310
Solventborne		---	---	---
Galvanized Metal Primer Waterborne	204	UGPR00	4020PF	B66W00310
Solventborne		---	---	---
Aluminum Primer Waterborne	205	UGPR00	4020PF	B66W00310
Solventborne		---	---	---

continued

INTERIOR PRIMERS/UNDERCOATERS (continued)	System(s)	Dunn-	Glidden	Sherwin
		Edwards		Williams
Primer/Sealer (for drywall, etc.)	206,207,209			
Waterborne (Vinyl Acrylic)		VNSL00		B28W08601
Waterborne (Zero VOC)		ENSO00	LM911 6	B28W02600
Vinyl Acrylic Wall Sealer				
Waterborne	211	VNSL00	1030	B28W08601
Enamel Undercoater/Primer	201 - 203, 206			
Waterborne (100% Acrylic)		IKPR00	1020	B51W00020
Block Filler, w/ Aggregate				?
Waterborne		MBPR00	---	
Block Filler, w/out Aggregate	209, 211			
Waterborne		SBSL00	3010	B25W25
Waterborne (100% Acrylic)		SBPR00	4000	B42W00046
Vinyl Wash Pretreatment/Surface Conditioner	204, 205			
Waterborne		ME01	788T	---
Concrete and Masonry Primer	211			
Waterborne		ESPR00	3030	A24W08300

INTERIOR PAINT - FINISH COATS	System(s)	Dunn-	Glidden	Sherwin
		Edwards		Williams
Acoustic Paint	212			
Waterborne (Vinyl-Acrylic)		W615	---	---
Paint, Flat	207			
Waterborne (Vinyl Acrylic)	203	SWLL10	1201	B30W04651
Waterborne (Low Odor/Low VOC)		ENSO10	1250	B30W02651
Waterborne (Low Odor/Zero VOC)		ENSO10	LM910 0	B30W02651

continued

INTERIOR PAINT - FINISH COATS	System(s)	Dunn- Edwards	Glidden	Sherwin Williams
Enamel, Low Sheen				
Waterborne (100% Acrylic)		SPMA30	1414	B20W02651
Waterborne (Vinyl Acrylic)		SWLL30	1434	B20W04651
Waterborne (Low Odor/Zero VOC)		ENSO30	LM920 0	B20W02651
Enamel, Eggshell	201, 204, 205, 207			
Waterborne (100% Acrylic)		SPMA40	1403	
Waterborne (Vinyl-Acrylic)		SWLL40	1412	B20W04651
Waterborne (Low Odor/Zero VOC)		---	LM930 0	B20W02651
Waterborne (Non-Blocking - 100% Acrylic)	202	SPMA40	1403	B75W00051
Enamel, Semi-Gloss	201, 204, 205, 207			
Waterborne (100% Acrylic)?		SPMA50	1416	B31W02651
Waterborne (Non-Blocking - 100% Acrylic)	202, 211	SPMA50	1407	B76W00051
Waterborne (Low Odor/Low VOC)		ENSO50	1456	B31W02651
Waterborne (Low Odor/Zero VOC)		ENSO50	LM920 0	B31W02651
Enamel, Gloss	201, 204, 205			B21W00251
Waterborne (Non-Blocking - 100% Acrylic)	202	EVSH60-0	3028	A77W00051
Waterborne (Low Odor/Low VOC)		---	3038	A77W00051

END OF SECTION

SECTION 10 26 00

WALL AND DOOR PROTECTION

PART 1 GENERAL

1.01 SUBMITTALS

- A. Product Data: Include physical characteristics, such as durability, resistance to fading, and flame resistance, for each impact-resistant wall protection system component indicated.
- B. Shop Drawings: Show locations, extent, and installation details of each impact-resistant wall protection system component. Show methods of attachment to adjoining construction.
- C. Samples for Verification: For the following products, showing the full range of color and texture variations expected in each impact-resistant wall protection system component. Prepare Samples from the same material to be used for the Work.
 - 1. Corner Guards: 12-inch- (300-mm-) long Samples of each type of impact-resistant wall protection system component required. Include examples of joinery, corners, and field splices.

1.02 DELIVERY, STORAGE, AND HANDLING

- A. Store wall surface-protection materials in original undamaged packages and containers inside a well-ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.
 - 1. Maintain room temperature within the storage area at not less than 70 deg F (21 deg C) during the period plastic materials are stored. Keep sheet material out of direct sunlight to avoid surface distortion.
 - 2. Store rigid plastic corner-guard covers in a vertical position, and rigid plastic wall guard and handrail covers in a horizontal position for a minimum of 72 hours, or until the plastic material attains the minimum room temperature of 70 deg F (21 deg C).

1.03 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install wall surface-protection system components until the space is enclosed and weatherproof and ambient temperature within the building is maintained at not less than 70 deg F (21 deg C) for not less than 72 hours before beginning installation. Do not install rigid plastic wall surface-protection systems until that temperature has been attained and is stabilized.

PART 2 PRODUCTS

2.01 CORNER GUARDS

- A. Corner Guards:
 - 1. Surface mounted, clear polyester or metal; minimum 2-1/2 inch by 2-1/2 inch by 48 inch.
 - 2. Apply to exposed-to-view 90 degree outside corners of walls and columns.
 - 3. Finish to be compatible with adjacent finishes, but must be durable and highly resistant to scratches, nicks, gouges, etc.
 - 4. Corner guards are to be easily removable and reinstalled/replaced using common tools.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine areas and conditions in which impact-resistant wall protection system components and impact-resistant wall covering materials will be installed.
 - 1. Complete finishing operations, including painting, before installing impact-resistant wall protection system components.
- B. Impact-Resistant Wall Covering Materials: Wall surfaces to receive impact-resistant wall covering materials shall be dry and free from dirt, grease, loose paint, and scale.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. General: Before installation, clean substrate to remove dust, debris, and loose particles.

3.03 INSTALLATION

- A. Install impact-resistant wall protection system components level, plumb, and true to line without distortions.
 - 1. Do not use materials with chips, cracks, voids, stains, or other defects that might be visible in the finished Work.

3.04 CLEANING

- A. General: Immediately on completion of installation, clean plastic covers and accessories using a standard ammonia-based household cleaning agent. Clean metal components according to the manufacturer's written instructions.
- B. Remove excess adhesive using methods and materials recommended by the manufacturer.
- C. Remove surplus materials, rubbish, and debris, resulting from installation, on completion of work and leave installation areas in neat, clean condition.

END OF SECTION

SECTION 10 44 00

FIRE PROTECTION SPECIALTIES

PART 1 GENERAL

1.01 SUBMITTALS

- A. Product Data: Submit Manufacturer's data and installation instructions for each item, including dimensions and anchorage details.

1.02 QUALITY ASSURANCE

- A. Standards: Comply with ANSI/UL 92 and 711.
- B. Regulatory Requirements: Conform to ANSI/NFPA 10 and the following:
 - 1. 2010 ADA Standards for Accessible Design.
 - 2. Public Law 101-336 "The Americans with Disabilities Act of 1990 (ADA) revised September 15, 2012.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Furnish products of one of the following Manufacturers, except as approved by the Architect, subject to compliance with Specification requirements:
 - 1. Larsen's Manufacturing Co. www.larsensmfg.com
 - 2. J.L. Industries www.jlindustries.com
 - 3. General
 - 4. Knox
 - 5. Supra Products Co.

2.02 EQUIPMENT

- A. Extinguishers: Match existing and provide as indicated on Drawings.
- B. Wall Bracket: Manufacturer's standard J-type for wall hung extinguishers. Kitchen and other extinguishers as noted on drawings to be mounted on wall brackets.
- C. Fire Extinguisher Cabinet: Match existing and provide as indicated on Drawings.
 - 1. Inside box dimensions: As required for fire extinguisher.
 - 2. Cabinet Mounting Hardware: Appropriate to cabinet.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions: Examine subsurfaces to receive Work and report detrimental conditions in writing to Architect. Commencement of Work will be construed as acceptance of subsurfaces.
- B. Coordination: Coordinate with other Work which affects, connects with, or will be concealed by this Work.

3.02 INSTALLATION

- A. Install items in accordance with Manufacturer's directions. Install cabinets plumb and level at heights shown on Drawings.
- B. Comply with regulatory requirements and anchor securely.
- C. Verify that extinguishers are charged and tagged.
- D. Place extinguishers in cabinets and on wall brackets.

3.03 CLEANING

- A. During the course of the Work and on completion, remove and dispose of excess materials, equipment and debris away from premises. Leave Work in clean condition.

END OF SECTION

SECTION 11 53 13

LABORATORY FUME HOODS AND EXTRACTION ARMS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Furnishing and installing Chemical Fume Hoods, Fume Hood Base and Special Cabinets as shown on the drawings and as specified herein, including; but not limited to:
 - a. E04 and E07: General Purpose Bench Hoods
 - b. E63: ADA Hoods
 - c. E42: Polypropylene Hoods
 - 2. Furnishing and installing Extraction Arms as shown on the drawings and as specified herein.
 - 3. Fume hoods and extraction arms shall be installed in laboratory spaces.
 - a. All chemical fume hoods are to be provided by a single manufacturer (unless noted specifically otherwise) conforming to the requirements stated below.
- B. Related Sections:
 - 1. Section 05 50 00 – Metal Fabrications: Metal supports at ceiling to support mechanical equipment and ductwork.
 - 2. Section 12 35 53 - Laboratory Casework and Countertops.
 - 3. Division 22: Furnishing and installation of plumbing utilities and final connections to fume hoods.
 - 4. Division 23: Furnishing and installation of fume hood blowers, exhaust duct work and equipment, and final connection of fume hoods and extraction arms.
 - 5. Division 23: Furnishing and installation of exhaust controls and final connections to hoods and extraction arms.
 - 6. Division 23: Test and Balance.
 - 7. Division 23: Air Flow Alarm
 - 8. Division 26: Furnishing and installation of electrical utilities and final connections to fume hoods.

1.02 DESIGN REQUIREMENTS

- A. Fume hoods must be Underwriters Laboratories 1805 Classified.
- B. Fume hoods shall function as ventilated, enclosed work spaces, designed to capture and confine exhaust fumes, vapors and particulate matter produced or generated within the enclosure.
- C. Design fume hoods for consistent and safe air flow through the hood face. Negative variations of face velocity shall not exceed 10 % of the average face velocity at any designated measuring point as defined in this section.
- D. Fume hood shall be designed to minimize static pressure loss with adequate slot area and bell shaped exhaust collar configuration.
- E. Fume hoods shall be constructed in such a manner as to cause no perceptible increase in sound pressure level over the mechanical exhaust system.

- F. Provide seismic anchorage in accordance with the local governing structural codes.

1.03 SUBMITTALS

- A. Product Data: Submit manufacturer's data for each type of fume hood and extraction arm specified. Include component dimensions, configurations, construction details, joint details, and attachments. Indicate location, size, and service requirement for each utility connection.
- B. Shop Drawings:
 - 1. Submit shop and fabrication drawings stamped by a licensed Professional Engineer. This engineer shall perform and submit structural calculations to document the fume hood systems/ extraction arms and proper anchorage to building components.
 - 2. Provide 3/4 inch = 1'-0" (1:20) scale elevations of individual and battery of fume hoods and extraction arms showing cross sections, rough-in and anchor placements, tolerances, and clearances. Indicate relation to other laboratory equipment, surrounding walls, windows, doors, and other building components.
 - 3. Provide 1/4 inch = 1'-0" (1:50) rough-in plan drawings for coordination with trades.
 - 4. Provide 3 full size sets of black line shop drawing prints.
- C. Work Surface Samples: Submit 3 inch by 5 inch (75 mm by 125 mm) product sample of each color and type of work surface material.
- D. Finish Samples: Submit 3 inch by 5 inch (75 mm by 125 mm) samples of color of finish for fume hoods, and for other pre-finished equipment and accessories for selection by Owner's Representative.
- E. Test Reports: Submit test reports verifying conformance to specified performance tests.
- F. UL 1805: Submit written verification of compliance to UL 1805 for fume hoods.
- G. Life Cycle Tests: Provide independent test data for sash hardware components such as cables and pulleys for fume hoods.
- H. Manufacturer's Qualifications: Provide documentation from Fume Hood Manufacturer and Extraction Arm manufacturer indicating they have supplied for installation, the product described in this section on six (6) similar projects in the past three (3) years.
- I. Operations and maintenance manuals: Submit complete operating and maintenance manuals for each type of hood/extraction arm and size that describe proper operating procedures, maintenance and replacement schedules, components parts list, and nearest local factory representative for components and emergency repairs.

1.04 QUALITY ASSURANCE

- A. Single Source Responsibility: Fume hoods, casework, work surfaces, laboratory furnishings, and accessories shall be furnished by a single laboratory furniture company.
- B. Manufacturer's Qualifications: Modern plant with proper tools, dies, fixtures, and skilled production staff to produce high quality laboratory casework and equipment, and shall meet the following minimum requirements:
 - 1. Five years or more experience in manufacture of laboratory casework and equipment of type specified.
 - 2. Ten installations of equal or larger size and requirements in the previous three years.
- C. Installer's Qualifications: Factory trained and certified by the manufacturer.

- D. Flammable Liquid Storage: Where cabinets are indicated for solvent or flammable liquid storage, provide units that are listed and labeled as complying with requirements of Underwriters Laboratories (UL) or another testing and inspecting agency acceptable to authorities having jurisdiction.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Delivery: Schedule delivery of fume hoods/extraction arms and equipment so that spaces are sufficiently complete that material can be installed immediately following delivery.
- B. Storage: If fume hoods/extraction arms must be stored in other than installation areas, store only in areas where it will prevent damage or soiling of fume hoods/ extraction arms.
- C. Handling: Keep covered with polyethylene film or other protective coating as necessary to protect fume hood/ extraction arms from soiling or damage during handling and installation.

1.06 PROJECT CONDITIONS

- A. Do not deliver or install equipment until the following conditions have been met:
 - 1. Building areas requiring the installation of fume hoods/ extraction arms shall be dry and unexposed to adverse weather conditions which may damage finished materials.

1.07 SEQUENCING AND SCHEDULING

- A. All overhead mechanical, electrical and plumbing rough-in work shall be complete prior to fume hood/ extraction arms delivery.
- B. All mechanical, electrical and plumbing rough-in work required is to be complete prior to delivery of materials.
- C. Walls and partitions must be in place and finished with at least the primer coat of paint. If finish painting is to take place after laboratory furnishing installation, protect the fume hoods/ extraction arms by covering and masking prior to commencement.
- D. All necessary blocking or backing must be installed within wall partitions prior to delivery of extraction arms, casework and furnishings.
- E. Ceiling grid must be in place prior to fume hood installation.
- F. Overhead lighting must be installed and connected prior to casework installation.
- G. All flooring required to be placed under lab casework and furnishings must be installed prior to material delivery and casework installation.
- H. Wet operations to be performed must be complete prior to material deliveries.

1.08 WARRANTY

- A. Provide a 1-year warranty against defects in materials and workmanship.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Fume Hoods: Subject to compliance with requirements, provide products by one of the following:
1. Kewaunee Scientific Corporation - Laboratory Division, Statesville, North Carolina 28677, (704) 873-7202 www.kewaunee.com (Basis of Design – E04, E07 and E63)
 2. NuAire, Inc., Plymouth, Minnesota 55774, (763) 553-1270 www.nuaire.com (Basis of Design E42)
 3. Air Master Systems Corporation, Muskegon, Michigan 49441, (231) 789-1111 www.airmastersystems.com
 4. Bedco Lab, Laval, Quebec, Canada H7S 1N5, (604) 531-1525 www.bedcolab.com
 5. BMC, Muskegon, MI 49444, (231) 733-1206 www.bmclab.com
 6. Jamestown Metal Products, Inc., Jamestown, New York 14701, (701) 665-5313 www.Jamestown.com
 7. Labconco Corporation, Kansas City, Missouri 64132, (800) 821-5525 www.labconco.com
 8. Mott Manufacturing Limited, Brantford, Ontario, Canada N3T 5T3, (519) 752-7825 www.mott.com
 9. Hamilton Scientific, De Pere, Wisconsin 54115, (920) 793-1121 www.hamiltonlab.com
- B. Extraction Arms: Movex®, 104 Commerce Drive, Northampton, PA 18067, USA Phone: 610 440-0478, Fax: 610 440-0480 www.movexinc.com info@movexinc.com

2.02 MATERIALS

- A. Fume Hoods:
1. Sheet Steel: Metallic Furniture Stock, ASTM A-1008 mild steel, cold rolled, pickled, double annealed, and free from rust, scales, scratches, buckles, ragged edges, and other defects.
 2. Stainless Steel:
 - a. Type 304: ASTM A240; exposed surfaces ground and polished to a Number 4 finish.
 - b. Type 316: ASTM A240; exposed surfaces ground and polished to a Number 4 finish.
 - c. Welding: All stainless steel welding material shall be of type similar to sheet material. Welds shall be ground, polished, and a subsequent passivation process utilized to blend harmoniously with a Number 4 satin finish without discoloration.
- B. Extraction Arms:
1. Friction joints: Ball bearing-equipped adjustable friction joints in polypropylene (PP), with guide ring in low friction-treated rubber. Support springs and other component parts in zinc-plated steel or stainless steel.
 2. Tubes: Made from thin-walled anodized aluminum or from polypropylene. Air-tight damper supplied as standard.
 3. ME Standard: The standard ME version has polypropylene joints and anodized aluminum tubes. The standard ME version is suitable for evacuating most types of airborne contaminants, e.g. in laboratories, schools, hospitals, the pharmaceutical industry, nail salons and light industrial applications.
 4. ME PP: Polypropylene joints and tubes version. All metallic parts that are in contact with the air flow are made of stainless steel. The PP version of the ME is used primarily for evacuating very corrosive contaminants in high concentrations, e.g. in certain laboratories and in the pharmaceutical and chemical industries.

2.03 BENCHTOP CHEMICAL FUME HOODS

- A. Underwriters Laboratories 1805 Classified. Provide labeling affixed to the face of each fume hood indicating classification to the UL 1805 standard for laboratory fume hoods.
- B. General Use Chemical Fume Hood Type (E04 and E07)
1. Catalog Number:
 - a. E04: Kewaunee V05F282448GN-G1, F2, SK-L, U/U2, C,R1
 - b. E07: Kewaunee V05F282472GN-G1, F2, SK-L, U/U2, C,R1
 2. Fume Hood Type: Bench Fume Hood, Vertical Sash
 3. Hood Construction Style: Venturi Fume Hood
 4. Sash Opening Height: Bench Hood
 5. Hood Interior Depth: 24 inches
 6. Hood Length:
 - a. E04: 48 inches
 - b. E07: 72 inches
 7. Interior Liner Material: ¼ Kemglass (fiberglass reinforced polyester)
 8. Sash Frame: Frameless
 9. Sash Glass Type: Laminated Safety Glass
 10. Service Fitting Holes: Rod controlled Ball Valves
 11. Electrical Fixtures:
 - a. Receptacle Grade and Type: Specification Grade, 20 amp-120 VAC-GFCI
 - b. Receptacle Color: Black
 12. Airflow Safety: Sash Stop Label
 13. Fittings and Fixtures: Pre-wired/UL Listed
 14. Stainless Steel Parts: Stainless Steel Duct Collar (Type 316)
 15. Sash Operators: Auto Sash Return
 16. Provide minimum face velocity at the sash (18" height operating position) of 80 fpm, unless noted otherwise on Drawings.
- C. ADA Chemical Fume Hood Type (E63)
1. Catalog Number: Kewaunee V15F282472GN-G1, F2, SK-L, U/U2, C,R1
 2. Fume Hood Type: Bench Fume Hood, ADA Vertical Sash
 3. Hood Construction Style: Venturi Fume Hood
 4. Sash Opening Height: Bench Hood
 5. Hood Interior Depth: 24 inches
 6. Hood Length: 72 inches
 7. Interior Liner Material: ¼ Kemglass (fiberglass reinforced polyester)
 8. Sash Frame: Frameless
 9. Sash Glass Type: Laminated Safety Glass
 10. Service Fitting Holes: Rod controlled Ball Valves
 11. Electrical Fixtures:
 - a. Receptacle Grade and Type: Specification Grade, 20 amp-120 VAC-GFCI
 - b. Receptacle Color: Black
 12. Airflow Safety: Sash Stop Label
 13. Fittings and Fixtures: Pre-wired/UL Listed
 14. Stainless Steel Parts: Stainless Steel Duct Collar (Type 316)
 15. Sash Operators: Auto Sash Return
 16. Provide minimum face velocity at the sash (18" height operating position) of 80 fpm, unless noted otherwise on Drawings.

- D. ADA Vertical Laminar Flow Trace Metals Fume Hood (E42)
1. Trace Metals Suite Construction: Due to the low detection level performance of the ICP-MS (or similar ICP-based instrumentation), the room environments for Sample Prep and Instrument are constructed as metals-free as possible in terms of what the room enclosure/environment “sees”. Provide non-metallic bench-mounted / fume hood mounted service fittings & fixtures, as well as at bench mounted lab sink
 2. Basis of design is NuAire NU-S156-624.
 - a. Each fume hood shall have a completely welded shell assembly (case), which shall be rigid and self-supporting, requiring little or no field assembly.
 3. General Design Requirements:
 - a. Fume hoods required under this specification will be referenced as: Vertical Laminar Air Flow (VLAf), Type HA – High Acid use
 - b. Fume Hood Configurations: Provide in sizes and configurations with fume hood bases as shown on the drawings.
 4. Performance Characteristics
 - a. All cabinets of size and type as indicated on the hood schedule shall be a bench style, single pass flow-through design in which all HEPA filtered work zone (downflow) and work access inflow air, is drawn through the cabinet's internal exhaust plenums to a single exit point at the top.
 - b. Air shall be drawn into the HEPA filter by the internal supply blower from a prefilter at the top of the cabinet. The air shall exit the HEPA filter through a diffuser into the work zone in a laminar manner. The air shall split at the removable work surface with ½ being drawn into a rear inlet grill and ½ drawn into the front inlet grill along with the work access inflow. The combination of the downflow and inflow into the front inlet grill forms an “air barrier” that creates the “personnel protection factor”.
 - c. The area beneath the removable work surface shall form a leak-tight exhaust plenum that shall drain to a single, polypropylene, 3/8-inch, ball-type drain valve. The drain valve shall be plumbed to a polypropylene “p-trap” where a sink/cup sink has been specified or dead ended into a ball valve. 1½- inch vent holes shall be provided through the bottom of the plenum/cabinet to provide venting for the base cabinets below. One vent hole shall be provided for each base cabinet door and they shall be protected from plenum spills by 3-inch high “mushroom capped” stand pipes.
 - d. The supply HEPA filter shall be the full cabinets' work surface width and depth and removable from the front of the cabinet. The work zone shall be the same fixed cross sectional area as the HEPA filter.
 - e. The positive pressure supply plenum shall be surrounded by negative pressure, even down to the interface of the supply HEPA filter and the filter frame in order to absolutely preclude any gasket leaks from contaminating the HEPA filtered work zone air.
 - f. The downflow air velocity from a clean HEPA filter shall average from 55 to 65 LFPM with no single point more than 20% above or below the average velocity measured in a horizontal plane defined by the bottom of edge of the sash at nominal working height (10-inches).
 - g. Minimum average inflow velocity through the work access opening shall be 105 LFPM with a 10-inch nominal sash opening. Working sash heights shall vary between 8 and 12-inches without a loss of the “personnel protection factor”. The maximum non-working height shall be 20-inches [heights up to 30-inches may be specified].

- h. The exhaust volumes and negative static pressures required per cabinet size shall not exceed the following based on an average inflow velocity of 105 FPM at an work access opening height of 10-inches and an average internal downflow velocity of 60 LFPM.

Cabinet width	24-inch depth, CFM (CMH)
4-foot cabinet	759 (476) @ 0.8"w.g. (20mm)
5-foot cabinet	995 (1690) @ 0.8"w.g. (20mm)
6-foot cabinet	1232 (2093) @ 0.8"w.g. (20mm)
8-foot cabinet	1705 (2897) @ 1.5"w.g. (38mm)

- i. The supply HEPA filter shall be wood board framed and constructed from non-woven pleated fiberglass media with separatorless media. [Filter can be specified to use a non-boron, woven Gore-Tex™ media]. All media shall be a minimum of 99.99% efficient on 0.3-micron particles with greater efficiency on smaller and/or larger particles. [Efficiencies of 99.999% and 99.9999% on 0.12-micron particles may be specified].
- j. The internal downflow blower shall be a non-overloading, backward inclined, dynamically balanced, motorized impeller with the impeller and all hardware (i.e. nuts, bolts, screws, etc) TFE coated by a licensed coating manufacturer, for maximum corrosion resistance. The coating shall be a minimum thickness of 1.5 ml.
- k. All motors shall be permanent split capacitor type and sized to automatically compensate for airflow as the filter loads with particulate to achieve a fan delivery fall off of no more than 10% for an 80% increase in pressure drop across the filter. The Class B insulated motor shall be thermally protected, rated for 24-hour continuous operation, lubricated for life and speed controlled by a solid state, voltage regulated solid-state speed controller.
- l. Vibration, due to the motor, shall be minimized through the use of vibration isolators when mounting the motor/blower assembly to the internal frame.
- m. The work zone shall be illuminated by an externally mounted, polypropylene, fluorescent lamp fixture and shall provide an average of 100 foot-candles, as measured at the work surface. The lamp shall use two T8 bulbs and use a thermally protected, UL Listed electronic ballast with automatic reset. The fluorescent fixture shall be gas-tight and constructed from 1/2-inch polypropylene with a clear Lexan™ lens. All lamps shall be easily replaceable using simple tools.
- n. All electronic controls shall be housed in a separate gastight polypropylene enclosure and shall be accessible from the top of the cabinet.
- o. The polypropylene workspace shall be enclosed on both sidewalls by a 4-inch wide plumbing chase. The chase shall extend the full height and width of the cabinet's exterior sidewall. Access panels shall be provided on both the exterior and interior sides of the chase. All panels shall mount flush to the surrounding material, be fastened by #8-32 flat head polypropylene screws and provide sufficient access for maintenance and repair of plumbing, electrical and sash components.
5. Fume Hood Construction:
- a. The cabinets work space, plumbing chase, structural support members and bottom shall be constructed from 1/2-inch fully stress relieved, refrigerator white, polypropylene sheet stock. All sections are to be reinforced where necessary and continuously heat seam welded to form a rigid structure with all exterior welds finished flush with the surrounding surfaces. All access panels, rear exhaust duct, and the perforated reinforced and removable work surface shall use 1/4-inch material.

- b. The upper structure of the cabinet containing the HEPA filter, blower, supply plenum and electronics shall use 1/2-inch thick polypropylene material and shall be an integral extension of the work space sides and back walls (i.e. one-piece construction). Access panels shall be provided at the top of plumbing chase section for maintenance of sash pulleys, counterweight and polypropylene attachment rope.
- c. Access to the HEPA filters and motor blower assembly for maintenance and repair shall be through a flush mounted access panel in the upper portion of the hood face. Access to internal components shall NOT require disassembly of the window sash and glide system.
- d. Prefilter(s) shall be mounted on top of the motor/blower module and easily replaceable. Prefilter(s) shall be 1-inch thick non-woven fiberglass and shall be 40 percent efficient per the Atmospheric Dust Test.
- e. Closure panels, where specified, shall be constructed from materials to match VLAH hood AND shall use 1/4-inch polypropylene. The panels shall enclose the top of the cabinet to the ceiling and/or the plumbing chase to the wall in the rear. Panels shall be finished to match hood type. For ceiling enclosures, the panels shall be louvered (or slotted) to obtain supply air for the downflow, unless otherwise stipulated. The side panels shall fasten to the top of cabinet and the rear wall. The front panel shall fasten only to the side panels and easily removable to provide access to the top for maintenance purposes.
- f. The glazing material shall be 1/4-inch polycarbonate unframed, unless otherwise specified. The glazing is suspended within polypropylene glide channels by a 3/16-inch polypropylene cable routed over front and rear pulleys connected to a totally PVC enclosed counter balanced weight located in the plumbing chase. The counter balance weight shall ride within a close-tolerance outer PVC tube to control vertical motion.
- g. The diffuser below the HEPA filter shall fit snugly full width and length of the work zone and constructed from 1/16-inch thick, 22 percent open, perforated PVC and held in place with polypro screws. A vinyl wiper shall be installed between the sash and the interface of the diffuser and the upper workspace to provide a seal against the glazing material. The area above the wiper, but under the sash, shall be maintained under a negative pressure.
- h. All internal electrical wiring shall be enclosed in flexible, UL Listed or Recognized, non-metal corrosive-resistant, liquid-tight conduit with UL Listed fittings. All internal junction boxes and enclosures shall be constructed from polypropylene and shall be liquid-tight construction and gasketed where required. All exposed controls and visual indicators shall be constructed from non-metal corrosive-resistant materials or protected by non-metal, gas-tight enclosures with a clear viewing lens, where required.
- i. The work surface shall be removable and constructed from 1/4-inch thick polypropylene material, reinforced with polypropylene ribbing to maintain surface flatness. The perforated front and rear sections shall be 3/16-inch diameter holes on 1/4-inch alternate centers, whose width is suitable to provide both personnel and product protection per the testing methods of NSF/ANSI 49. Where sinks are called out, the work surface shall be segmented such that the sink section is fixed and separate from the rest of the removable work surface.
- j. Supply mains to the cabinet shall be connected to a UL Listed junction box of suitable size to accommodate required circuits as indicated on the hood schedule. The junction box shall be non-metallic and require non-metallic liquid-tight connections.

- k. Where required, all cabinets shall be provided with a separate support base constructed from ½-inch polypropylene as specified herein.
- 1) Fume hood bases shall have 1½-inch diameter adjustable levelers that are accessible from inside the base cabinet and protected from spills with a ½-inch high rim, covered with a removable cap. A minimum of two (front and rear) levelers shall be provided for each 2-foot section of fume hood. The levelers shall thread through a minimum of 1½-inches of material for stability and permit an adjustment of 2-inches.
 - 2) The top of the base cabinet shall have a 3-inch wide, full interior perimeter stretcher to facilitate assembly to the hood.
 - 3) Hood bases shall have at least one sealed compartment where sinks/cup sinks are scheduled. The remaining space shall contain a fixed shelf. Where sinks are scheduled on both sides of the workspace, each shall have a sealed compartment. Each sealed compartment shall have an access panel for connection to building utilities. Depending on hood size, any remaining space shall contain a fixed shelf.
 - 4) Each segmented compartment shall be vented to the exhaust duct via a stand pipe, plumbed through the base of the VLAFF cabinet to the exhaust duct.
 - 5) All base cabinet doors shall have four 1½- inch diameter vent holes, centered 4-inches above the bottom of the door and evenly spaced. An adjustable slide shall be located on the inside of the door, with an identical offset hole-pattern to control airflow through the compartment(s). For compartments with shelves, shelves shall permit air to pass through the front ½-inch of the shelf.
6. Hood Services
- a. Services shall be provided in each hood as per the hood schedule. Hood shall not have any pre-punched holes on the hood post except for services per the schedule. Where multiple services are scheduled, provide one each side.
 - b. Service fixtures and fittings mounted inside of hood shall consist of labeled hose nozzle outlets remotely controlled from the hood post with color-coded index handles. The fixtures (valves and nozzles) shall be constructed from polypropylene unless otherwise noted. The valve body shall be easily removed from the front for repair.
 - c. Service fixtures shall be provided with piping, from the outlet/valve to the exterior. Where services are scheduled on both sides of the hood, piping shall be connected for a coordinated single point connection to the building services.
 - d. Exhaust duct washdowns, where specified, shall consist of three, ¾-inch, schedule 80, polypropylene pipes (spray bars) extending horizontally across the rear exhaust duct, evenly spaced vertically and sealed on one end. Each spray bar shall consist of replaceable, 1/8-inch NPT, polypropylene spray heads, with a 110-degree spray angle and 0.28 GPM at 10 PSI, on evenly spaced centers (minimum of three), orientated down toward the floor. The spray bars shall be manifolded to a common point through a ball valve mounted on the hood post as shown on the drawings for operator control (on/off and flow rate). The valve shall be plumbed out the rear of the cabinet for connection to building utilities. A 1½-inch, NPT threaded drain hole shall be installed in the center of the floor of the exhaust duct to remove washdown water. The floor shall insure complete drainage of wash water. The rear divider panel shall be removable for inspection and maintenance of the spray bar

system. The panel shall be gasketed via inlaid 1/8-inch thick EPDM gasket material, around the entire periphery of the panel and fastened to the back via 1/4-inch-20 flat head screws on 4-inch centers to form a leak-tight seal.

- e. Sinks of size per the hood schedule and/or cup sinks (nominal 6" by 3") shall be flush with the work surface and be complete with strainer, tail piece and p-trap, plumbed to the rear of the hood base. Sinks and accessories shall be constructed from 1/4-inch polypropylene unless otherwise specified and shall have a slanted bottom to the drain. Cold/hot/DI water goosenecks where scheduled shall be positioned so that they discharge into the sink(s).
- f. Service for flammable gas shall be installed per local codes using approved piping methods. Where metallic (black pipe) is required, the pipe shall be epoxy coated, including the remote valve and all internal piping.
 - 1) Any external color-coded handles/rods shall be coated with a clear acid and solvent resistant plastic coating.
- g. Electrical services shall be three wire grounding type receptacles rated for 120 volt or 230 volt supply per the schedule. Outlets shall be provided on the hood post where noted. Each outlet shall have a non-metallic, corrosive resistant, vapor-tight gasketed cover capable of being sealed in place with a gasketed thumbscrew and shall have removable inserts of plastic to seal outlet contacts when not in use. Receptacles shall conform to NEMA standards.

- E. Monitor/Alarm: Local monitor to display sash opening airflow velocity, and provide local audible alarm. Controls/Alarms to be provided by Division 25 (Mechanical)
- F. Fume Hood Base Cabinets: See also Section 12 35 53 - Laboratory Casework and Countertops.
 - 1. Flammable (solvent) liquid storage cabinet, width/capacity depending on fume hood width and provision of lab sink or cup sink.
 - 2. Corrosive (acid or base) liquid storage cabinet, width/capacity depending on fume hood width and provision of lab sink or cup sink.
 - 3. Vertical Laminar Flow Trace Metals Fume Hood (E41): As noted above elsewhere, the corrosives base storage at the trace metals fume hood would be CP5 polypro, same manufacturer as the fume hood above it.

2.04 EXTRACTION ARMS

- A. Provide one of the following as indicated on Drawings, including individual control unit for each extraction arm:
 - 1. Standard version – suitable for evacuation most type of airborne contaminants: Movex® MET 1350-100 with MVK-125 wall bracket (provide custom horizontal and vertical lengths as may be required) and MEM251-100 metal hood.
 - 2. PP version – used primarily for evacuating very corrosive contaminants in high concentrations: Movex® MET 1350-100PP with MVK-125 wall bracket (provide custom horizontal and vertical lengths as may be required) and MEM251-100PP metal hood.

2.05 SOURCE QUALITY CONTROL TESTING OF FUME HOODS

- A. Submit a test report, for each type and size of hood, for the standard product previously tested, if the product is identical to equipment being provided for this project.

- B. Evaluation of standard product shall have been conducted in the manufacturer's test facility in accordance with the method prescribed in ANSI/ASHRAE 110-1995.

PART 3 EXECUTION

3.01 EXAMINATION:

- A. Prior to start of installation, verify that wall and ceiling construction conform to fume hood/extractor arms manufacturer's requirements. If required, extend wall construction above ceiling to allow for wall bracket construction for extractor arms.

3.02 INSTALLATION

- A. Installation:
 - 1. Install fume hoods/extractor arms and equipment in accordance with manufacturer's instructions.
 - 2. Install equipment plumb, square, and straight with no distortion and securely anchored as required.
 - 3. Secure work surfaces to casework and equipment components with material and procedures recommended by the manufacturer.
 - 4. Fume hoods and extractor arms shall be connected to mechanical, plumbing and electrical equipment to provide fully functioning equipment as intended for use.
 - 5. Vertical Laminar Flow Trace Metals Fume Hood (E41)
 - a. Fume Hood Base Installation: Temporarily set fume hood bases plumb, square, and straight with no distortion using the leg levelers adjustable from with the hood base. Use polypropylene shims as required for added support. (bases can be "tacked" in place via nails through the toe kick backer.
 - b. Fume Hood Installation: Set fume hood on base cabinet and using base cabinet leg levelers plumb, square and straight with no distortion. Fasten fume hood to bases from inside the base cabinet, through perimeter base cabinet strips, using TFE coated screws, recessed and plugged. Once the work surface is level and true, the bases shall be fastened to the floor via a treated wood backer installed behind the toe kick. Adjust levelers/shims. All screws shall be TFE coated, recessed and covered with a polypropylene plug.
- B. Accessory installation: Install accessories and fixtures in accordance with manufacturer's recommendations.
- C. Provide ductwork and other materials as required for installation.

3.03 FIELD QUALITY CONTROL TESTING

- A. Testing Requirements:
 - 1. Perform tests in field to verify proper operation of the fume hoods and extraction arms before they are put in use, using only qualified personnel.
 - 2. Perform tests after installation is complete, the building ventilation system has been balanced, all connections have been made, and written verification has been submitted that the above conditions have been met.
 - 3. Verify that the building makeup air system is in operation, the doors and windows are in normal operating position, and that all other hoods and exhaust devices are operating at designed conditions.
 - 4. Correct any unsafe conditions disclosed by these tests before request of test procedures.
 - 5. Provide written results of each fume hood / extraction arm test.

6. Testing Equipment (Fume Hoods):
 - a. Properly calibrated hot wire thermal anemometer.
 - b. Supply of 30 second smoke bombs.
7. Face Velocity Testing (Fume Hoods): Provide face velocity measurements as outlined in Articles 6.2, 6.3 and 6.4 of ANSI/ASHRAE 110-1995 or latest edition.
8. Smoke Testing (Fume Hoods):
 - a. With sash in the open position check airflow into the fume hood using a smoke source. Verify that airflow is into the fume hood over the entire face area by a complete traverse of the fume hood 6 inches (150 mm) inside the face. Reverse flow is evidence of unsafe conditions. Take necessary corrective actions and retest.
 - b. Move a lighted smoke bomb throughout the fume hood work area directing smoke across the work surface and against the side walls and baffle. Verify that smoke is contained within the fume hood and rapidly exhausted.
9. Testing of extraction arms shall be in accordance with extraction arm manufacturer's instructions.

3.04 ADJUSTING

- A. Repair or remove and replace defective work, as directed by The Architect upon completion of installation.
- B. Adjust sash, fixtures, extractor arms, accessories and other moving or operating parts to function smoothly.

3.04 CLEANING

- A. Clean equipment, touch up as required. Note: Polypropylene will carry a static charge and, as such, attract dirt and dust. Consult MSDS for precautions.

3.05 PROTECTION OF FINISHED WORK

- A. Provide all necessary protective measures to prevent damage to equipment from exposure to other construction activity. In Particular high concentrations of aerosols caused by spray painting or plaster dust can seriously shorten the lifetime of the HEPA filter.
- B. Advise Contractor of procedures and precautions for protection of material and installed fume hoods from damage by work of other trades.

END OF SECTION

SECTION 11 53 29.13

CHEMICAL STORAGE CABINETS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: Furnishing and installing Chemical Storage Cabinets as shown on the drawings and as specified herein.
- B. Related Sections:
 - 1. Section 11 53 13 – Laboratory Fume Hoods
 - 2. Section 12 35 53 – Laboratory Casework.
 - 3. Section 12 36 53 – Laboratory Countertops

1.02 DESIGN REQUIREMENTS

- A. Flammable Storage Cabinets: UL Listed and constructed in accordance with NFPA 30, Flammable and Combustible Liquids Code. Self-closing, self-latching.
- B. Under fume hoods within wet laboratory spaces. Fitted with bungs on vent openings. 12 gallons for a 30 inch wide cabinet, 15 gallons for a 36 inch wide cabinet.
- C. Flammable storage cabinet to be re-used in the new lab concept floor plan layout.
- D. Flammables storage cabinets shall not be vented, which is in alignment with NFPA 30, subsection 9.5 guidelines.
- E. Corrosive Storage Cabinets: Under fume hoods within wet laboratory spaces. Steel framed construction matching laboratory casework, with polypropylene liner. Steel shelves with polypropylene tray for spill control. Vented doors. Rear cabinet vent ports to route through to fume hood per fume hood manufacturer's standard detail. Each cabinet to be labeled for "Acids" or "Bases".
 - 1. The corrosives storage base cabinet in the Trace metals Sample Prep Lab shall be manufactured by the polypro vertical laminar flow trace metals fume hood, and also constructed of polypropylene (CP5 fireresistive type Polypro)

1.03 SUBMITTALS

- A. Product Data: Submit manufacturer's data for each type of cabinet specified. Include component dimensions, configurations, construction details, joint details, and attachments.
- B. Shop Drawings: Submit shop and fabrication drawings.
- C. Finish Samples: Submit 3 inch by 5 inch (75 mm by 125 mm) samples of color of finish for chemical storage cabinets for selection by Owner's Representative.
- D. Maintenance Manuals: Provide written instruction manuals outlining operating and safety instructions and proper maintenance procedures.

1.04 QUALITY ASSURANCE

- A. Flammable Liquid Storage: Where cabinets are indicated for solvent or flammable liquid storage, provide units that are listed and labeled as complying with requirements of Underwriters Laboratories (UL) or another testing and inspecting agency acceptable to authorities having jurisdiction.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Delivery: Schedule delivery of chemical storage cabinets so that spaces are sufficiently complete that material can be installed immediately following delivery.
- B. Storage: If chemical storage cabinets must be stored in other than installation areas, store only in areas where it will prevent damage or soiling of chemical storage cabinets.
- C. Handling: Keep covered with polyethylene film or other protective coating as necessary to protect chemical storage cabinets from soiling or damage during handling and installation.

1.06 PROJECT CONDITIONS

- A. Do not deliver or install equipment until the following conditions have been met:
 - 1. Building areas requiring the installation of chemical storage cabinets shall be dry and unexposed to adverse weather conditions which may damage finished materials.

1.07 SEQUENCING AND SCHEDULING

- A. All overhead mechanical, electrical and plumbing rough-in work shall be complete prior to chemical storage cabinet delivery.
- B. All mechanical, electrical and plumbing rough-in work required is to be complete prior to delivery of materials.
- C. Walls and partitions must be in place and finished with at least the primer coat of paint. If finish painting is to take place after laboratory furnishing installation, protect the chemical storage cabinets by covering and masking prior to commencement.
- D. All necessary blocking or backing must be installed within wall partitions prior to delivery of casework and furnishings.
- E. All flooring required to be placed under lab casework and furnishings must be installed prior to material delivery and casework installation.
- F. Wet operations to be performed must be complete prior to material deliveries.

1.08 WARRANTY

- A. Provide a 1-year warranty against defects in materials and workmanship.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Sheet Steel: Metallic Furniture Stock, ASTM A-1008 mild steel, cold rolled, pickled, double annealed, and free from rust, scales, scratches, buckles, ragged edges, and other defects.

- B. Stainless Steel:
 - 1. Type 304: ASTM A240; exposed surfaces ground and polished to a Number 4 finish.
 - 2. Type 316: ASTM A240; exposed surfaces ground and polished to a Number 4 finish.
 - 3. Welding: All stainless steel welding material shall be of type similar to sheet material. Welds shall be ground, polished, and a subsequent passivation process utilized to blend harmoniously with a Number 4 satin finish without discoloration.
- C. Epoxy Resin: As specified in Section 12 35 53.16 - Plastic Laminate Laboratory Casework

PART 3 EXECUTION

3.01 INSTALLATION

- A. Installation:
 - 1. Install chemical storage cabinets and equipment in accordance with manufacturer's instructions.
 - 2. Install equipment plumb, square, and straight with no distortion and securely anchored as required.
 - 3. Secure work surfaces to casework and equipment components with material and procedures recommended by the manufacturer.

3.02 ADJUSTING

- A. Repair or remove and replace defective work, as directed by The Architect upon completion of installation.
- B. Adjust sash, fixtures, accessories and other moving or operating parts to function smoothly.

3.03 CLEANING

- A. Clean equipment, touch up as required.

3.04 PROTECTION OF FINISHED WORK

- A. Provide all necessary protective measures to prevent damage to equipment from exposure to other construction activity.
- B. Advise Contractor of procedures and precautions for protection of material and installed chemical storage cabinets from damage by work of other trades.

END OF SECTION

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SECTION 11 53 33.13

SAFETY SHOWER / EYEWASH

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: Furnishing and installing Safety Shower and Eyewash as shown on the drawings and as specified herein.

1.02 SUBMITTALS

- A. Product Data: Submit manufacturer's data for each type of equipment specified. Include component dimensions, configurations, construction details, joint details, and attachments.
- B. Shop Drawings: Submit shop and fabrication drawings.
- C. Maintenance Manuals: Provide written instruction manuals outlining operating and safety instructions and proper maintenance procedures.

1.03 DELIVERY, STORAGE, AND HANDLING

- A. Delivery: Schedule delivery of equipment so that spaces are sufficiently complete that material can be installed immediately following delivery.
- B. Storage: If equipment must be stored in other than installation areas, store only in areas where it will prevent damage or soiling of equipment.
- C. Handling: Keep covered with polyethylene film or other protective coating as necessary to protect equipment from soiling or damage during handling and installation.

1.06 PROJECT CONDITIONS

- A. Do not deliver or install equipment until the following conditions have been met:
 - 1. Building areas requiring the installation of equipment shall be dry and unexposed to adverse weather conditions which may damage finished materials.

1.07 SEQUENCING AND SCHEDULING

- A. All overhead mechanical, electrical and plumbing rough-in work shall be complete prior to equipment delivery.
- B. All mechanical, electrical and plumbing rough-in work required is to be complete prior to delivery of materials.
- C. Walls and partitions must be in place and finished with at least the primer coat of paint. If finish painting is to take place after laboratory furnishing installation, protect the equipment by covering and masking prior to commencement.
- D. All necessary blocking or backing must be installed within wall partitions prior to delivery of equipment.
- E. Ceiling grid must be in place prior to equipment installation.
- F. Overhead lighting must be installed and connected prior to equipment installation.

- G. All flooring required to be placed under equipment must be installed prior to material delivery and equipment installation.
- H. Wet operations to be performed must be complete prior to material deliveries.

1.08 WARRANTY

- A. Provide a 1-year warranty against defects in materials and workmanship.

PART 2 PRODUCTS

2.01 EQUIPMENT

- A. Recessed metal eye wash and shower at Multi-Use lab and Main lab – Guardian Equipment GBF2170 Recessed Safety Station with Drain Pan and Wall Mounted Exposed Shower Head
- B. Recessed PVC Eye wash and shower at Metal Lab: GBF2170MOD Modified with Powder Coated Pipe/Fittings/Shower Head and Exterior of Cabinet. Color to be Gray to match architect's sample.
- C. Eye wash at Main Lab ADA Sink: **TBD**

PART 3 EXECUTION

3.01 INSTALLATION

- A. Installation:
 - 1. Install equipment in accordance with manufacturer's instructions.
 - 2. Install equipment plumb, square, and straight with no distortion and securely anchored as required.
 - 3. Secure equipment to floor, casework and wall construction in accordance with procedures recommended by the manufacturer.
 - 4. Coordinate and provide connections to water and sewer in accordance with Division 22 – Plumbing.

3.02 ADJUSTING

- A. Repair or remove and replace defective work, as directed by The Architect upon completion of installation.
- B. Adjust sash, fixtures, accessories and other moving or operating parts to function smoothly.

3.03 CLEANING

- A. Clean equipment, touch up as required.

3.04 PROTECTION OF FINISHED WORK

- A. Provide all necessary protective measures to prevent damage to equipment from exposure to other construction activity.
- B. Advise Contractor of procedures and precautions for protection of material and installed equipment from damage by work of other trades.

END OF SECTION

SECTION 11 53 43

SERVICE FIXTURES

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: Furnishing and installing service fixtures as shown on the drawings and as specified herein.

1.02 SUBMITTALS

- A. Product Data: Submit manufacturer's data for each type of equipment specified. Include component dimensions, configurations, construction details, joint details, and attachments.
- B. Shop Drawings: Submit shop and fabrication drawings.
- C. Maintenance Manuals: Provide written instruction manuals outlining operating and safety instructions and proper maintenance procedures.

1.03 DELIVERY, STORAGE, AND HANDLING

- A. Delivery: Schedule delivery of equipment so that spaces are sufficiently complete that material can be installed immediately following delivery.
- B. Storage: If equipment must be stored in other than installation areas, store only in areas where it will prevent damage or soiling of equipment.
- C. Handling: Keep covered with polyethylene film or other protective coating as necessary to protect equipment from soiling or damage during handling and installation.

1.06 PROJECT CONDITIONS

- A. Do not deliver or install equipment until the following conditions have been met:
 - 1. Building areas requiring the installation of equipment shall be dry and unexposed to adverse weather conditions which may damage finished materials.

1.07 SEQUENCING AND SCHEDULING

- A. All overhead mechanical, electrical and plumbing rough-in work shall be complete prior to equipment delivery.
- B. All mechanical, electrical and plumbing rough-in work required is to be complete prior to delivery of materials.
- C. Walls and partitions must be in place and finished with at least the primer coat of paint. If finish painting is to take place after laboratory furnishing installation, protect the equipment by covering and masking prior to commencement.
- D. All necessary blocking or backing must be installed within wall partitions prior to delivery of equipment.
- E. Ceiling grid must be in place prior to equipment installation.
- F. Overhead lighting must be installed and connected prior to equipment installation.

G. All flooring required to be placed under equipment must be installed prior to material delivery and equipment installation.

H. Wet operations to be performed must be complete prior to material deliveries.

1.08 WARRANTY

A. Provide a 1-year warranty against defects in materials and workmanship.

PART 2 PRODUCTS

2.01 EQUIPMENT

A. Laboratory dry compressed air and vacuum fittings to be needle valves with straight pattern serrated tip fitting, four-arm handle. Pressure rated for service. Epoxy clear coat finish on satin chrome valve bodies. Basis of design is Watersaver Faucets.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Installation:
1. Install equipment in accordance with manufacturer's instructions.
 2. Install equipment plumb, square, and straight with no distortion and securely anchored as required.
 3. Secure equipment to floor, casework and wall construction in accordance with procedures recommended by the manufacturer.
 4. Coordinate and provide connections to water and sewer in accordance with Division 22 – Plumbing.

3.02 ADJUSTING

- A. Repair or remove and replace defective work, as directed by The Architect upon completion of installation.
- B. Adjust sash, fixtures, accessories and other moving or operating parts to function smoothly.

3.03 CLEANING

A. Clean equipment, touch up as required.

3.04 PROTECTION OF FINISHED WORK

- A. Provide all necessary protective measures to prevent damage to equipment from exposure to other construction activity.
- B. Advise Contractor of procedures and precautions for protection of material and installed equipment from damage by work of other trades.

END OF SECTION

SECTION 123553.19

WOOD LABORATORY CASEWORK AND COUNTERTOPS

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Furnishing of materials, products, accessories, tools, equipment, services, scaffolding, ladders, transportation, supervision, labor, product protection, and other items that may not be specifically mentioned, but are necessary for the fabrication and installation of laboratory casework.
- B. Furnish and install laboratory casework including, but not limited to, work surfaces, adjustable shelves, tables, standards, slotted studs, filler panels, scribes, knee space panels, accessories, utility space framing, utility space closure panels between base cabinets and at exposed ends of utility spaces, laboratory sinks, cup sinks, cup drains, strainers, overflows and sink outlets with integral or separate pieces, and miscellaneous items of equipment as listed in these specifications and as shown on drawings, including delivery to the building, unpacking, installing, leveling and scribing to walls and floors as required.
- C. Furnish and deliver packed in boxes for receipt, handling and installation by others; electrical service fixtures, task lights including fluorescent bulbs, electrical receptacles and switches listed in these specifications and as shown on drawings as part of the laboratory casework. The above-defined items are to be supplied, not attached, and loose in boxes, properly marked for tailgate delivery.
- D. Furnish and set in place for final installation and connection by other trades; service fittings where part of the laboratory casework, listed in the specifications or shown on drawings. Tailpieces shall be furnished less couplings required to connect to the trap or drain piping system. Install service fittings "finger-tight".
- E. Furnish and mount plumbing and electrical fixtures on fume hood superstructure.

1.2 RELATED WORK BY OTHER SPECIFICATION SECTIONS

- A. Furnishing, installation and connection of "Service Lines" within and/or attached to equipment, slotted studs, partitions, service tunnels or service turrets, through, under or along backs of working surfaces as required for "Service Fixtures."
- B. Final installation, tightening and connecting "Service Fixtures" furnished by laboratory casework manufacturer including the pulling of wire and connecting of electrical fixtures in service lines.
- C. Receiving, handling, installing and connecting separate laboratory sinks, cup sinks or drains, overflows, sink outlets and tail-pieces furnished by the laboratory casework manufacturer.
- D. Furnishing, installing and connecting vents and drain lines.

- E. Furnishing, installing, setting and connecting special electrical and plumbing fixtures and piping to meet local codes, even though not specifically called for in specifications and shown on drawings.
- F. Furnishing, installing and connecting of ducts from fume hoods to blowers and from blowers to atmosphere.
- G. Furnishing, handling and installing fans with motors (blowers).
- H. Furnishing, and installation of framing or reinforcements for wall, floors and ceilings to adequately support laboratory equipment and brick, plaster, metal or wood grounds required for proper anchoring of the equipment.
- I. Furnishing and installation of pipe hangers.
- J. Furnishing and installation of resilient base on walls and fixed laboratory casework after laboratory casework installation is completed.
- K. Furnishing in-wall exhaust duct and connection to vented cabinets.
- L. Related Sections include the following:
 - 1. Division 6 Section "Rough Carpentry" for wood blocking for anchoring casework.
 - 2. Division 6 Section "Interior Architectural Woodwork".
 - 3. Division 9 Section "Gypsum Wallboard Assemblies" for reinforcements in gypsum board partitions for anchoring casework.
 - 4. Division 9 Section "Resilient Wall Base and Accessories" for resilient base applied to casework.
 - 5. Division 11 Section "Laboratory Fume Hoods"
 - 6. Division 22 and 26 Sections for installing service fittings specified in this section.
 - 7. Divisions 22 and 26 for connecting service utilities at indicated points. Piping and wiring for service fittings within casework up to point of connection are specified in this Section.
- M. Casework System: Laboratory casework components and assemblies shall meet local seismic restraint requirements.

1.3 DEFINITIONS

- A. "Laboratory Casework Contractor" is defined as the manufacturer and/or manufacturer's representative furnishing and installing the laboratory casework, equipment, and accessories listed under these specifications, laboratory equipment schedule and/or shown on drawings.
- B. "Service Fixtures" are defined as gas, air, and vacuum, hot, cold, reagent grade water faucets, remote control valves, electrical receptacles with necessary flush mounting boxes, conduits or pedestals and plates, fluorescent and/or incandescent light fixtures, light switches and/or motor switches for hoods and other items which serve as a functional part of the equipment.
- C. "Service Lines" are defined as gas, air, vacuum, hot, cold, reagent grade and reference grade water piping, drain lines, fittings and shut off valves necessary to carry respective services from building roughing-in floors or walls through equipment to "service fixture".

- D. "Service Lines" also include conduit, junction boxes, conduit fitting, wire disconnect switches and fuse or circuit breakers necessary to carry electrical services from building roughing-in outlets in floors or walls through equipment to "service fixtures."
- E. "Standards" are wall mounted, twin-tracked shelf supports.
- F. "Slotted Studs" are double-faced, twin-tracked studs comprising the frame spanning between the utility chase and the building wall or workstation at peninsula bench assemblies.
- G. Exposed Portions of Cabinets: Surfaces visible when doors and drawers are closed, including bottoms of cabinets more than 48 inches (1220 mm) above floor, and surfaces visible in open cabinets. This also includes tops and bottoms of shelving in open or glass doored units and open wall shelving.
- H. Semi-exposed Portions of Cabinets: Surfaces behind opaque doors, such as interiors of cabinets, shelves, dividers, interiors and sides of drawers, and interior faces of doors. Tops of cases 78 inches (1980 mm) or more above floor are defined as semi-exposed.
- I. Concealed Portions of Cabinets: Surfaces not usually visible after installation, including sleepers, web frames, dust panels, and ends and backs that are placed directly against walls or other cabinets.

1.4 STANDARDS

- A. REFERENCE Scientific Equipment & Furniture Association (SEFA)
 - 1. SEFA 1 Laboratory Fume Hoods
 - 2. SEFA 2.3 Scientific Laboratory Furniture And Equipment
 - 3. SEFA 7 Laboratory and Hospital Fixtures
 - 4. SEFA 8 Laboratory Furniture-Casework-Shelving and Tables – Recommended Practices.
- B. American Society for Testing and Materials (ASTM)
 - 1. A240-Heat Resistant Chromium and Chromium – Nickel Stainless Steel Plate, Sheet, and Strip for pressure Vessels
 - 2. A312-Seamless and Welded Austenitic Stainless Steel Pipe
 - 3. D260-Boiled Linseed Oil
 - 4. D570-Water Adsorption of Plastics
 - 5. D695-Compressive Properties of Rigid Plastics
 - 6. D790-Fluctural Properties of Un-reinforced and Reinforced Plastics and Electrical Insulating Materials
 - 7. E84-Test Method for Surface Burning Characteristics of Building Materials
- C. Builders Hardware Manufacturers Association (BHMA)
- D. National Electrical Manufacturers Association (NEMA)
- E. American National Standards Institute (ANSI) A208.1-Wood Products
- F. American National Standards Institute (ANSI) A135.4-Basic Hardboard

- G. American National Standards Institute (ANSI) HPVA HP-1-2000 American National Standard for Hardwood and Decorative Plywood.
- H. American Plywood Association (APA) Engineered Wood Association
- I. National Particleboard Association (NPA) 8-Voluntary Standard for Formaldehyde Emission from Particleboard
- J. United States Department of Commerce, Product Standard (PS) 1-Construction and Industrial Plywood
- K. United States Department of Commerce, Product Standard (PS) 51-Hardwood and Decorative Plywood
- L. National Fire Protection Association (NFPA) 30 Flammable Liquid Storage
- M. National Fire Protection Association (NFPA) 70 Electrical Components, Devices and Accessories.
- N. Architectural Woodwork Institute (AWI) Quality Standards, Guide Specifications, and Quality Certification Program, 8th Edition, version 1.0, 2003.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An authorized representative of the casework manufacturer for installation and maintenance of units required for this Project.
- B. Source limitations: Though products may be manufactured by different manufacturers, obtain and install all casework, including work surfaces, sinks, service fittings and accessories, and fume hoods through one source from a single Laboratory Furniture Contractor.
- C. Electrical components, Devices and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction and marked for intended use.
- D. Pre-installation Conference: Conduct a conference at the Project Site to comply with requirements in Division 1 Section "Project Management and Coordination.
- E. Product Standard: Comply with SEFA 8, "Laboratory Furniture-Casework, Shelving and Tables-Recommended Practices".

1.6 SUBMITTALS

- A. Refer to submittal section of the General and Supplementary Specification in Division 1 for requirements and procedures. Fabrication or purchase of any items prior to approval will be at the manufacturer's risk.

B. Samples: Laboratory casework manufacturer shall submit the following samples for approval by the Owner's Representative, prior to fabrication:

1. One (1) 24 inch (600mm) wide full height base cabinet consisting of one (1) drawer, one (1) door, one (1) cupboard with adjustable half/full depth shelf and related hardware (pulls, hinges, etc.), complete with finish.
2. One 36 inch wide by 36 inch high (900mm wide by 900mm high) wall cabinet with two internal adjustable shelves and one adjustable shelf below the cabinet, as well as related hardware and doors, complete with finish.
3. One (1) 24 inch (600mm) long standard, and one (1) end bracket, with specified finish.
4. Service Fixtures: one of each fixture type required for project.
5. Caster(s) and glides
6. Adhesives and sealants.
7. Work surface material (one of each specified): 12 inches by 12 inches by 1 inch (300mm x 300mm x 25mm) thick, showing top, front edge and backsplash construction.

C. Reviewed samples will be retained by the Owner's Representative.

D. Stain and Finish Samples for Wood Components.

1. Stain for casework and miscellaneous items, shall be selected by the Owner's Representative. The laboratory casework manufacturer shall furnish stain and finish samples on same material from which the casework and miscellaneous items will be constructed for approval before fabrication of casework starts. Samples shall be clearly identified.
2. Stain and finish samples will be retained by the Owner's Representative.

E. Shop Drawings. Fabrication or purchase of any equipment prior to approval will be at the manufacturer's own risk. The laboratory casework manufacturer shall furnish shop drawings showing enclosures, cabinets, hardware, and service banks complete with numbers and names of items and details including construction kinds and gages of materials for hood, cabinets, benches and other items necessary to complete the work. In addition, it is the responsibility of the casework manufacturer to flag any deviations in dimension, material, detail, etc. that is not exactly the same as shown on the contract documents. Those deviations not flagged will be considered "not reviewed", even if missed during the approval process and will have to be changed. Provide number of copies of drawings and data sheets in accordance with Division 1 requirements.

F. Shop drawings shall be stamped and signed by a registered engineer for conformance to structural and lateral requirements. Stamped and signed calculations shall also be provided.

1.7 EXCEPTIONS TO DRAWINGS AND SPECIFICATION

A. All exceptions shall be subject to written approval prior to receipt of bid. If no written communication is received prior to receipt of bid and approval indicated in an addendum, it is assumed that bidder will be in total compliance with specifications and will be held responsible for default or delay, regardless of any statement to the contrary in their written proposal.

B. Requests for a substitution must follow the requirements in Division 1 of the Specifications.

1.8 WARRANTY

- A. Furnish a written warranty that Work performed under this Section shall remain free from defects as to materials and workmanship for a period of one (1) year from date of acceptance. Defects in materials and workmanship that may develop within this time are to be replaced without cost or expense to the Owner. Defects include, but are not limited to:
1. Ruptured, cracked, or stained coating
 2. Discoloration or lack of finish integrity
 3. Cracking or peeling of finish
 4. Delamination of components or edge banding
 5. Slippage, shift, or failure of attachment to wall, floor, or ceiling
 6. Weld or structural failure (visible weld marks)
 7. Warping or unloaded deflection of components
 8. Failure of hardware

1.9 TESTING

- A. The laboratory casework manufacturer shall be required to include in their initial submittals, certified test reports indicating compliance of their laboratory casework finish and work surface materials with requirements specified for chemical and physical resistance; and confirmation of load performance for movable tables. The material test reports shall be performed by an independent testing agency qualified for testing indicated, as documented according to ASTM E548.

1.10 FIELD MEASUREMENTS

- A. It is the laboratory casework manufacturer's responsibility to verify field measurements and that equipment will fit through entryways, corridors and door openings enabling a smooth flow of equipment to its proper location in the building.

1.11 DELIVERY, STORAGE AND HANDLING

- A. Delivery: Deliver casework only after painting, utility rough-ins and similar operations that could damage, soil or deteriorate casework have been completed in installation areas.
- B. Storage: If casework must be stored in other than installation areas, store only in areas where environmental conditions meet requirements specified in "Project Conditions" Article of this specification section.
- C. Handling: Keep finished surfaces covered with polyethylene film or other protective covering during handling and installation.

1.12 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install casework until building is enclosed, wet work is complete and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.

- B. Field Measurements: Where casework is indicated to fit to other construction, verify dimensions by field measurements before fabrication and indicate measurements on Shop Drawings.
 - 1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating the casework without field measurements. Coordinate construction to ensure that actual dimensions correspond to established dimensions.

1.13 COORDINATION

- A. Coordinate layout of metal framing and reinforcements in wall assemblies for support of the casework.
- B. Coordinate installation of casework with installation of fume hoods and other laboratory equipment including rough-in locations and requirements.

1.14 EXTRA MATERIALS

- A. Furnish complete touch-up kit for each type and finish of the casework provided. Include scratch fillers, stains, finishes, and other materials necessary to perform permanent repairs to damages casework finish.

1.15 CERTIFIED WOOD PRODUCTS

- A. Wood products used in the fabrication of all wood components shall comply with the Forest Stewardship Council (FSC) "Percentage Based Claims Policy Green Rating System" and shall bear the Forest Conservation Program Label. Wood/fiber products shall come from FSC "certified" sustained managed forestry sources, complying with FSC 1.2, Principals and Criteria. Manufacturer shall submit documentation that the source of at least 70% of the wood/fiber material used in its products are certified for sustainability contents. A "chain-of-custody" certificate must be submitted at time of bid. Certificate shall provide a system for tracking certified wood from the forest, through each stage of production and distribution, to the point of sale. Certificates shall be by U.S. Based certifiers, Scientific Certification Systems, Emeryville, California, Woodmark or SmartWood.
- B. Wood products shall utilize an environmentally friendly, low VOC (under 2 lbs. Per gallon). Finish process, stains and finishes, shall be executed with the use of compression spray equipment capable of providing high-transfer efficiency and low waste generation. Finish material shall meet SEFA 8 chemical testing requirements.
- C. Adhesive manufacturer's product data sheets are to be provided indicating that the adhesive does not contain urea formaldehyde.
- D. All plywood cores are required to have no added urea formaldehyde. This means all veneer cores and/or cross banded panels must use PVA glue lines and all composite core binders must be formaldehyde free.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Fixed and movable (some with 3 inch casters and some movable without wheels) wood cabinetry with plain-sliced maple veneer, transparent finish. Basis of design manufacturer shall be Kewaunee "Signature Series", Style 5.
 - 1. Base cabinets to include full door units with adjustable shelves, door/drawer combinations, and full drawer units where applicable.
 - 2. Specialty base cabinets shall include knee spaces, vacuum pump cabinets, (if a central lab vacuum system not located in main mechanical room), flammable and corrosive storage cabinets, provided at fume hoods. Matching wood wall cabinets to be framed glass swing door type. Users to confirm inclusion/extent of any slope tops for upper cabinets to prevent storage of items on top of wall cabinets.
 - 3. Tall storage cabinets to be provided where required for materials storage and large equipment storage. For storage of glassware and reagents, doors to be (wood) framed glass swing doors, with solid wood door units for other storage needs as appropriate. (Any tall storage cabinets within the Metals Suite would be polypropylene and Lexan construction due to the non-metallic requirements of the room environments in those two rooms.
- B. Trace Metals Suite Construction: Due to the low detection level performance of the ICP-MS (or similar ICP-based instrumentation), the room environments for Sample Prep and Instrument are constructed as metals-free as possible in terms of what the room enclosure/environment "sees". Provide non-metallic bench-mounted / fume hood mounted service fittings & fixtures, as well as at bench mounted lab sink
- C. Laboratory Countertops: Phenolic, grey, 1" thickness, typically 30" deep front to back at base cabinets, with 4" backsplash. Basis of design shall be Durcon.
- D. Laboratory / Cup Sinks:
 - 1. Phenolic, Durcon Gray, inset (drop-in) mount at laboratories, typically 25" wide x 15" front to back x 12" deep.
 - 2. Each sink provided with hot and cold water mixing faucet and separate DI filtered water faucet. Finish shall be epoxy clear coat over satin chrome.
 - 3. Cup sinks where required at fume hoods and/or benchtops would be 3" x 6" oval. self-rimming. It is (currently) assumed that water service at cupsinks would be cold water only.
- E. One sink in each laboratory to have the DI filtered water line provided with tee/valve and adjacent GFCI receptacle for connection of a local water purifier (in addition to the DI water faucet).
 - 1. Provision of paper towel and soap dispenser(s) within labs TBD during detailed design phase
 - 2. Each sink provided with a 30" wide x 30" tall drying rack.

3. Utility columns (service chases) to be provided at each sink for water supplies, waste vent, power, and laboratory gases piping. Typical utility column to be metal housing, finished to match fume hoods, with removable front panel for service access.

2.2 ACCEPTABLE MANUFACTURERS

- A. Wood Casework: Subject to compliance with requirements, the basis of design for wood casework in this project is the following manufacturer:
 1. Kewaunee Scientific Corporation – Laboratory Division
Statesville, North Carolina 28677
(704)-873-7202
www.kewaunee.com
 2. Other Manufacturers will be considered as substitution requests pending Owner's review of qualifications, project bid cost, and submission of proposed sample cabinets to indicate construction quality based on the specification requirements in this section and as identified in paragraphs 1.7 B.1 and B.2.
- B. Composite Resin Work Surfaces, Troughs and Sinks: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:
 1. Chem Tops (Elgin, TX)
 2. Kewaunee (Statesville, NC)
- C. The naming of a manufacturer and designation of a product is for the purpose of identifying a basis of design. Other manufacturers capable of producing the same appearance and having the same quality, durability, and performance may be proposed for use on this project subject to approval of the Owner's Representative, prior to the receipt of bid.
- D. Qualified Bidders must submit with their bid evidence of the successful completion of at least five (5) projects using laboratory casework systems and furniture of the type specified for this project.
- E. Stainless Steel:
 1. Work surfaces, sinks, stainless steel accessories, shelves and shelf supports noted on drawings as "Stainless Steel" shall be type 302/304, austenitic chromium nickel stainless steel in accordance with A.I.S.I. specification containing 8% nickel and 18% chromium. Where noted as such, stainless steel components and shelf supports shall be constructed exactly as those fabricated of cold rolled sheet steel and the same gages. Exposed surfaces shall have #4 finish.
 2. Work surfaces and sinks noted on drawings as "Type 316 Stainless Steel" shall be similar to type 302/304 except molybdenum is added to improve the general corrosion and pitting resistance.
- F. Clear Float Glass: Complying with ASTM C 1036, Type I, Class 1, Quality q3 not less than 3.0mm thick.
- G. Clear Tempered Glass: Complying with ASTM C 1048, Kind FT, Condition A, Type I, Class 1, Quality q3, not less than 3.0mm thick.

- H. Clear Laminated Safety Glass: Complying with ASTM C1172, Kind LT, Condition A, Type 1, Class 1 with 2 lites not less than 3.0mm thick with clear, polyvinyl butyl interlayer.
- I. Movable Casework:
1. Four (4) removable 12 gauge tubing leg assemblies that include a 1-1/2" diameter non-marring floor glides that is interchangeable with casters.
 2. Four (4) removable 3 inch heavy-duty locking casters capable of supporting a 1200 lb dynamic load. Casters shall be interchangeable with a floor glide assembly.
- J. Solid Hardwood: AWI Grade I, solid hardwoods shall be properly air-dried, then kiln dried to 5% to 6% moisture content, and then tempered in inside storage to moisture content of 6% to 8%. Wood used in interior construction to match exterior in species, finish and grade. All semi and semi concealed areas to also use Grade I lumber.
- K. Core:
1. Maximum Moisture Content for Lumber: 7 percent for hardwood and 12 percent for softwood.
 2. Particle Core Plywood: ANSI A208.1-1999, Grade M-3-Exterior Glue, 45 lb (20.4kg) banded on vertical edge of the hinge side with 1-1/2 inch (38.1mm) solid hardwood. Doors shall be cross-banded with veneer then apply 1/42 inch -1/50 inch (.9mm) face veneer. If particle board is used for cabinet construction then cabinet side where doors hinge must also be constructed with 1-1/2 inch solid wood stile to receive hinges.
- L. Edge-banding for Wood-Veneered Construction: Minimum 5/32 inch (3 mm) thick, solid wood of same species as face veneer. Ease edge 1/32 inch maximum.
- M. Plywood. Plywood shall be veneer core construction glued with water resistant resin adhesives. Hardwood plywood for exposed surfaces shall have face veneers of selected hardwood species and shall conform to ANSI/HPVA HP1 product standards, latest edition. Plywood for interior and unexposed surfaces shall be hardwood plywood conforming to U.S. Department of Commerce Voluntary Product Standard PS-1.
- N. Hardboard. Hardboard shall meet or exceed ANSI/AHA A135.4-1995 Un-tempered hardboard 1/4 inch (6.35mm), S1S, nominal thickness, smooth exposed side.
- O. Exposed Materials:
1. General: Provide materials that are selected and arranged for uniformity of grain and color. Do not use materials adjacent to one another that are noticeably dissimilar in color, grain, figure, or natural character markings. No water stains, no sharp contrasts at veneer joints will be accepted.
 2. Wood Species and Veneer Cut: plain sliced Maple.
 3. Stain Colors and Finishes: No. 201 Natural Maple.
 4. Solid Wood: Clear hardwood lumber.
 5. Plywood: Hardwood plywood; Grade A exposed faces at least 1/50 inch thick, solid cross-bands. Backs of same species as faces; Grade A.

P. Semi-exposed Materials:

1. Solid Wood: AWI Grade I, Sound hardwood lumber, selected to eliminate appearance defects of same species as exposed solid wood.
2. Plywood: Hardwood plywood of same species as exposed plywood. Grade A faces, Grade J cross-bands.

Q. Concealed Materials:

1. Solid Wood: Any hardwood or softwood species, with no defects affecting strength or utility.
2. Plywood: Hardwood plywood. Grade 1, Concealed backs of plywood with exposed or semi-exposed faces shall be same species as faces.

R. Veneer, grain and color shall be as follows:

1. Exposed surfaces: Grade A with vertical matching grain on fronts of cabinets including doors and drawers.
 - a. Sides and backs to be Grade A with vertical grain.
2. Semi-Exposed surfaces, sides and backs of cabinets: Grade A vertical grain.
3. Concealed Surfaces: Grade 1
4. Door and drawer heads, within the same cabinet shall be cut and vertically matched from the same sheet of veneer. Sink cabinets or other cabinets with a single piece apron across the front shall also have veneers that are vertically aligned. Cabinet fronts shall be cut from the same sheet of veneer.
5. Grain direction on bottoms and tops of base, wall and tall cabinets and on shelves shall run lengthwise.

S. Epoxy Resin

1. Physical Properties:
 - a. Compressive Strength (ASTM D695): 38,400 psi (265,000 kPa)
 - b. Flexural Strength (ASTM D790): 14,900 psi (103,000 kPa)
 - c. Tensile Strength (ASTM D638): 14,000 psi (96,500 kPa)
 - d. Hardness (Rockwell M): Not less than 110
 - e. Heat Distortion (ASTM D648): 325 degrees Fahrenheit (163 degrees Celsius)
 - f. Water Absorption (ASTM D570): 0.008 %
 - g. Fire Resistance (ASTM D635): Self Extinguishing
2. Chemical Resistance: Epoxy-resin material has the following ratings when tested with indicated reagents according to NEMA LD 3, Test Procedure 3.4.5:
 - a. No Effect: Acetic acid (98 percent), acetone, ammonium hydroxide (28 percent), benzene, carbon tetrachloride, dimethyl formamide, ethyl acetate, ethyl alcohol, ethyl ether, methyl alcohol, nitric acid (70 percent), phenol, sulfuric acid (60 percent), and toluene.
 - b. Slight Effect: Chromic acid (60 percent) and sodium hydroxide (50 percent).

2.3 WORK SURFACES AND CURBS

- A. General: Laboratory work surfaces shall be 1 inch thick phenolic resin unless otherwise noted on the drawings. Curbs shall be 3/4 inch thick of the same material as the work surfaces and shall be provided at the rear of work surfaces and on end returns. Phenolic and stainless steel work surfaces to be installed without field cutting or drilling. The gap between the curb and wall is to be sealed with silicone sealant, color matched to the work surfaces. Sink work surfaces shall be fabricated in one piece and have a marine edge around the four sides to create a dished top. Provide work surfaces in maximum lengths as possible to minimize seams. Provide front and end overhang of 1 inch (25mm), with continuous drip groove on underside 1/2 inch (13mm) from edge.
- B. Phenolic Resin Work Surfaces: Phenolic resin work surfaces, curbs, service ledges and perimeter service ledges shall be molded from a phenolic resin especially compounded and cured to give optimum physical and chemical resistant properties. Material shall be a uniform mixture throughout the full thickness. Materials shall have a non-specular finish in grey color. Curbs shall typically be 4 inch (100mm) high, unless otherwise noted on Drawings, and shall be 3/4 inch (19mm) thick bonded to the surface of the top using adhesive compatible with phenolic resin to form a square joint. Phenolic resin work surfaces shall be 1 inch (25mm) thick except in fume hoods where they will be 1-1/4 inch (32 mm) thick. Joints between work surfaces shall be smooth, even, square, 1/8 inch (3mm) wide maximum.
1. Work Surface Fabrication: Fabricate with factory cutouts for sinks and with butt joints assembled with adhesive compatible with phenolic resin.
 - a. Work Surface Configuration: Flat, 1 inch thick, with beveled or rounded top, front edge and all corners, with drip groove. Ends shall be square.
- C. Stainless Steel Work Surfaces: Work surfaces and curbs noted on drawings as "Stainless Steel", Type 316 Stainless steel shall be constructed of 16 gage (1.6mm) nominal thickness, stainless steel sheet, ASTM A666. Exposed surfaces shall have #4 satin finish.
1. Extend top down 1 inch (25mm) at edges with a 1/2 inch (13mm) return flange under frame. Apply heavy coating of heat-resistant, sound-deadening mastic to undersurface.
 2. Form curb coved to and integral with top surface of one piece, without seams or joints. The top of the curb shall be chamfered 45 degrees.
 3. Provide raised (marine) edge around perimeter of work surface containing sinks; pitch two ways to sink to provide drainage without channeling or grooving.
 4. Reinforce underside of work surface with channels where necessary to insure rigidity without deflection and coat with a sound deadening material where not exposed to view.
 5. Work surfaces shall be as long as practical to permit access to the building and room. Where field-made joints are required, provide continuous channels welded to the underside of the work surface for reinforcing and aligning the butt-joints.
 6. Electrically weld shop and field made joints, and grind and polish surfaces to produce uniform, directionally textured finish, free of cross scratches. When polishing is completed rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
 7. Where stainless steel sinks or cup sinks occur in stainless-steel work surfaces, factory weld into one integral unit, grind welds smooth, polish and rinse. Work surfaces shall be adequately reinforced to accept sinks.

2.4 ADJUSTABLE SHELVES

- A. Wood Shelves: 1 inch (25mm) 9 ply veneer core plywood with 5/32 inch (4mm) thick hardwood [square] [eased] edge banding on all four edges. Grain is to run along the longest dimension of the shelf. Particle board is not acceptable for shelving.
 - 1. Adjustable wood shelves mounted on slotted studs shall be supplied with a continuous 3/4 inch (20 mm) thick, 2 inch (50 mm) high hardwood edge band to create a 1 inch (25 mm) high curb at the rear of the shelf. The hardwood edge banding along the back shall be replaced by this wood curb. Particle board is not acceptable for shelving.
- B. Adjustable shelves shall be 12 inch OR 15 inch deep, unless otherwise noted on the Drawings.
- C. Adjustable shelves shall be mounted to surface type steel standards at wall condition and slotted studs at movable tables and island bench conditions. Adjustable shelves shall be supported by steel shelf brackets not to exceed 48 inches on center. Brackets shall be cold rolled steel with epoxy powder coated finish, complying with BHMA A156.9, Types B04102 and B04112. Shelves shall be fastened to brackets with two stainless steel screws per bracket.
- D. Adjustable shelves mounted on slotted studs shall be supplied with edge-banding on all four sides with a continuous 2 inch (50mm) high band to create a 1 inch (25mm) high curb at the rear of the shelf. The curb along the back shall be of solid hardwood to match cabinet material.
- E. Exterior adjustable shelves, those not in cabinets, shall be equipped with a 1/4 inch (6 mm) diameter, 2 inch (50 mm) high anodized aluminum rail at the front of the shelf. Rail lengths shall not exceed 36 inch (914mm) in nominal length (provide tow 24 inch (610 mm) long nominal rails for 48 inch (1219 mm) shelves). Rails shall be fastened to the shelf in a similar manner as wire pulls are fastened to drawers and doors. Stainless steel screws to be accessible from underside of shelf. Press fit rails are acceptable.

2.5 CABINET DESIGN

- A. Casework shall be fabricated as sectional units, ready for placement in the laboratory as a complete integral rigid unit permitting relocation at any subsequent time. Equivalent to AWI Section 400 Wood Cabinets, Premium grade. Component parts of the unit shall be manufactured ensuring uniformity, interchangeability and accurate alignment. No staples will be permitted as fasteners on any cabinet components. All base cabinets to have integral enclosed bases.
- B. Where noted as such, provide wall-mounted casework that matches all other laboratory casework in design and material. The assembly must be capable of supporting an equipment load of at least 150 lb. (68.04kg) per running foot (304.8mm) above and beyond the weight of the assembly.
- C. Sides of all sectional units shall be considered exposed and shall be finished accordingly.

2.6 CABINET CONSTRUCTION

- A. Cabinet construction shall meet AWI, Flush Overlay requirements.
- B. Sectional units to be located on the laboratory floor shall be equipped with adjustable leveling devices.
- C. Adjustable Shelves located in cabinets shall be edge banded on all four edges of each shelf component.
- D. Fixed shelves located in cabinets shall be edge banded on front edge of each shelf component.
- E. Whenever a cabinet is adjacent to a partition, the laboratory casework contractor will install a minimum 1 inch filler panel to accommodate the over face design and avoid potential interference from partition erection tolerances.
- F. Units shall have backs with removable panels for access to the pipe spaces at the rear of the units. Removable panels shall be provided in sides of units where units occur in the corners of the rooms and access is required to the pipe spaces. These removable panels shall be designed to permit removal utilizing only a screwdriver through the fronts of the units and no intermediate rails between drawers are required.
 - 1. Ends of Cabinets: 3/4 inch (19mm) 7 ply veneer core plywood with front exposed edges faced with a 1/8 inch (3mm) solid hardwood with edges chamfered 1/32 inch. End panels shall be glued to horizontal frame units and to solid bottom panels. Joint construction shall be blind, not extended to face of cases. Joinery shall be blind mortise and tenon, multiple doweled, interlocking mechanical or stopped tongue and groove.
 - 2. Tops and bottoms of Wall Cabinets and tops of Tall Cabinets: 1 inch (25mm) thick 9-ply veneer core plywood with exposed edge faced with 1/8 inch (3mm) solid hardwood.
 - 3. Backs on Stationary Cabinets: 1/4 inch thick hardboard or veneer core plywood dadoed into sides, bottoms, and tops where not exposed. Removable backs shall be removable from inside the cabinet with a minimal use of tools. Provide 1 inch x 1 inch cleats, top, bottom and sides, at the rear corners of the cabinet to fasten the removable panel.
 - 4. Wall Mounted Cabinet Bottoms: 1 inch (25 mm) thick 9-ply veneer core plywood with exposed edge faced with 5/32 inch (4 mm) solid hardwood.
 - 5. Shelves: 1 inch (25 mm) thick 9-ply veneer core plywood with exposed edge faced with 5/32 inch (4 mm) solid hardwood. The shelves shall be full depth adjustable type.
 - 6. Drawer Fronts: 3/4 inch (19mm) thick particleboard with hardwood faced veneers, edge banded with 5/16 inch (4 mm) solid hardwood. Drawer fronts shall be fastened to the drawer bodies with screws.
 - 7. Drawer Bottoms: 1/4 inch (6mm) thick PVC-coated hardboard glued and dadoed into front, back, and sides of drawers. Use 1/2 inch (12.7mm) thick material for drawers more than 24 inches (600 mm) wide or add center support in drawer.
 - 8. All corners of cabinet box, doors, drawers and shelves shall be chamfered not greater than 1/32 inch. Radiused corners are not acceptable.

2.7 WALL MOUNTED CASEWORK

- A. Where noted on drawings, provide wall-mounted casework that matches all other laboratory casework in design and material. The assembly's construction however, must be modified to withstand the rigors of being mounted directly to the wall and suspended above the floor, without sagging or effecting the door or drawer operation. The assembly must be capable of supporting an equipment load of at least 150 lb. (68.04kg) per running foot (304.8mm) above and beyond the weight of the assembly.

2.8 WOOD FINISH

- A. Preparation: Exposed surfaces to receive finish shall be free of machine marks, carefully and smoothly sanded, prior to assembly, in preparation for finishing. Sand edges of doors, drawer fronts and molded shapes with profile-edge sander. Sand casework after assembling for uniform smoothness at least equivalent to that produced by 600 grit sanding.
- B. Staining: Remove fibers and dust before applying stain to exposed and semi-exposed surfaces as necessary to match approved samples. Apply stain in a manner that will produce a consistent appearance.
 - 1. Exposed and semi exposed surfaces shall be first coated with a stain or toner to secure the desired color. The color coat shall be thoroughly dried. Wood finish shall consist of two coats of a chemical resistant finish applied and thoroughly dried and cured providing a semi-gloss finish. When a natural finish is required, the color coat is omitted. Stain shall be as selected by the Owner's Representative.
 - 2. Concealed Surfaces shall receive a double pass coat of resinous sealer.
- C. Chemical Resistant Finish: Apply chemical resistant, transparent finish consisting of sealer and topcoat(s) complying with AWI TR-5 and SEFA chemical testing requirements. Finish shall be individually applied, sanded and allowed to individually dry. Top frames of drawer openings and toe spaces shall be sealed with clear sealer.
- D. Chemical Resistance Testing Criteria: Finish shall comply with acceptance levels of cabinet surface finish tests in SEFA 8. Acceptance levels for chemical spot test shall be no more than four Level 3 conditions and as follows: Level 0: no detectable change; Level 1: slight change in color; Level 2: Slight surface etching or severe staining; Level 3: Pitting, cratering, swelling or erosion of coating. Obvious and significant deterioration when tested in the following method
 - 1. Method A Test volatile chemicals by placing a cotton ball saturated with reagent in the mouth of a 1-oz. Bottle and inverting the bottle on the surface of the panel.
 - 2. Method B Test non-volatile chemicals by placing five drops of the reagent on the surface of the panel and covering with a 24mm watch glass, convex side down.
 - a. Acetate Acids: Amyl and Ethyl A
 - b. Acetic Acid: 98% B
 - c. Acetone A
 - d. Acid Dichromate, 5% B
 - e. Alcohols: Butyl, Ethyl or Methyl A
 - f. Ammonium Hydroxide, 28% B
 - g. Benzene A
 - h. Carbon Tetrachloride A
 - i. Chloroform A

j.	Chromic Acid: 60%	B
k.	Cresol	A
l.	Dichlor Acetic Acid	A
m.	Dimethylformamide	A
n.	Dioxane	A
o.	Ethyl Ether	A
p.	Formaldehyde, 37%	A
q.	Formic Acid: 90%	B
r.	Furfural	A
s.	Gasoline	A
t.	Hydrochloric Acid: 37%	B
u.	Hydrofluoric Acid: 48%	B
v.	Hydrogen Peroxide: 3%	B
w.	Iodine, Tincture of	B
x.	Methyl Ethyl Ketone	A
y.	Methylene Chloride	A
z.	Mono Chlorobenzene	A
aa.	Naphthalene	A
bb.	Nitric Acid: 20%	B
cc.	Nitric Acid: 30%	B
dd.	Nitric Acid: 70%	B
ee.	Phenol, 90%	A
ff.	Phosphoric Acid 85%	B
gg.	Silver Nitrate, Saturated	B
hh.	Sodium Hydroxide: 10%, 20% or 40%	B
ii.	Sodium Hydroxide, Flake	B
jj.	Sodium Sulfide, Saturated	B
kk.	Sulfuric Acid: 33%	B
ll.	Sulfuric Acid: 77%	B
mm.	Sulfuric Acid: 96%	B
nn.	Sulfuric Acid: 77% and Nitric Acid 70%	B
oo.	Toluene	A
pp.	Trichloroethylene	A
qq.	Xylene	A
rr.	Zinc Chloride, Saturated	B

E. Hot Water Test: SEFA 8; Hot water (190 degree F. to 205 degree F. (88Degree C. to 96 degree C.) shall be allowed to trickle (with a steady stream and at a rate of not less than 6 ounces (177.44cc) per minute) on the finished surface, which shall be set at an angle of 45 degrees, for a period of five minutes. After cooling, and wiping dry, the finish shall show no visible effect from the hot water.

F. Impact Resistance Test: There shall be no visual evidence to the naked eye of cracks or checks in the finish due to impact when an 2 inch (50 mm) diameter, one pound ball is dropped onto the finished surface from a height of 12 inch (305 mm) onto a flat horizontal surface, in accordance with testing as described in SEFA 8.

2.9 SOURCE QUALITY CONTROL TESTING OF PHENOLIC RESIN WORK SURFACE

1. Test procedure: Apply 5 drops of each reagent to surface and cover with 25 mm watch glass, convex side down; test volatiles using 1 ounce (28 ml) bottle stuffed with saturated cotton. After 24 hour exposure flush surface, clean, rinse and wipe dry.

2. Evaluation ratings: Change in surface finish and function shall be described by the following ratings:
 - a. No Effect: No detectable change in surface material.
 - b. Excellent: Slight detectable change in color or gloss, but no change to the function or life of the work surface material.
 - c. Good: Clearly discernible change in color or gloss, but no significant impairment of work surface function or life.
 - d. Fair: Objectionable change in appearance due to surface discoloration or etch, possibly resulting in deterioration of function over an extended period.
 - e. Failure: Pitting, cratering or erosion of work surface material; obvious and significant deterioration.

3. Test Results: Submit a report of the test results. The results shall be equal to or better than the following:

	<u>REAGENT</u>	<u>RATING</u>
a.	Hydrochloric Acid, 37 %	Excellent
b.	Sulfuric Acid, 33 %	No Effect
c.	Sulfuric Acid, 77 %	No Effect
d.	Sulfuric Acid, 96 %	Failure
e.	Formic Acid, 90 %	Excellent
f.	Nitric Acid, 20 %	Excellent
g.	Nitric Acid, 30 %	Excellent
h.	Nitric Acid, 70 %	Good
i.	Hydrofluoric Acid, 48 %	Fair
j.	Phosphoric Acid, 85 %	No Effect
k.	Chromic Acid, 60 %	Failure
l.	Acetic Acid, 98 %	Excellent
m.	3 & 8 Equal Parts	Excellent
n.	Ammonium Hydroxide, 28 %	No Effect
o.	Sodium Hydroxide, 10 %	No Effect
p.	Sodium Hydroxide, 20 %	No Effect
q.	Sodium Hydroxide, 40 %	No Effect
r.	Sodium Hydroxide Flake	No Effect
s.	Sodium Sulfide	Excellent
t.	Zinc Chloride	No Effect
u.	Tincture of Iodine	Excellent
v.	Silver Nitrate	No Effect
w.	Methyl Alcohol	No Effect
x.	Ethyl Alcohol	No Effect
y.	Butyl Alcohol	No Effect
z.	Benzene	Excellent
aa.	Xylene	No Effect
bb.	Toluene	Excellent
cc.	Gasoline	No Effect
dd.	Dichloroacetic Acid	Good
ee.	Dimethylformamide	Excellent
ff.	Ethyl Acetate	No Effect
gg.	Amyl Acetate	Excellent
hh.	Acetone	Excellent
ii.	Chloroform	Excellent

jj.	Carbon Tetrachloride	No Effect
kk.	Phenol	Excellent
ll.	Cresol	Excellent
mm.	Formaldehyde	No Effect
nn.	Trichlorethylene	Excellent
oo.	Ethyl Ether	Excellent
pp.	Furfural	Good
qq.	Methylene Chloride	Excellent
rr.	Monochlorobenzene	Good
ss.	Dioxane	Excellent
tt.	Methylethyl Ketone	Excellent
uu.	Acid Dichromate	Fair
vv.	Hydrogen Peroxide	No Effect
ww.	Naphthalene	Excellent

2.10 HARDWARE AND ACCESSORIES

- A. General: Provide laboratory casework manufacturer's standard satin-finish, commercial grade quality, heavy-duty hardware complying with requirements indicated for each type.
- B. Drawer and Door Pulls. Door and drawer pulls shall be 4 inch (101.6mm) wire type, satin chrome plated finish, fastened from the back with two screws. Drawer pulls shall be installed horizontally, door pulls shall be installed vertically. Wall cabinet and floor storage cabinet pulls should be located for reaching convenience and ADA accessibility guidelines. Two pulls shall be required on all drawers over 24 inches wide.
- C. Rollers and Sheaves: Rollers and sheaves shall be cadmium plated hardened steel or nylon, specifically designed for their application. Sliding door sheaves shall have a special contour for engagement with the one-piece double "V" stainless steel tracks. The positive ball bearing sliding door retainers shall be adjustable for removal of the doors when required.
- D. Hinges shall be 2-1/2 inch (65mm) high five knuckle institutional type, of stainless steel with #4 finish complying with BHMA A156.9, Grade 1 with antifriction bearings and rounded tips. The hinge leaves shall have special offsets for leaf concealment and attachment. Provide two (2) hinges for 36 inch high doors, three (3) for 48 inch high doors and (4) for 84 inch high doors. Hinge shall be capable of supporting a 150 lb. dynamic load, 100 lbs on each side of the door located 12" from the hinge. Provide (2) hinges for 36 inch high doors, (3) for 48 inch high doors and (4) for 84 inch high doors.
- E. Door Catches: 3-barrel hinges have integral door catch mechanism. Catches shall be provided on hinged doors and shall be spring-loaded nylon roller types with a steel strike plate. Double doors without locks shall have a catch on each door. Tall cases shall have latching devices located on the structurally fixed center shelf. The left hand door shall have a positive catch and the right hand door shall have roller type catch. Where locks are used, catches and strike plates shall be used on left hand doors of double door cases and shall be steel, cadmium plated.
- F. Toe space filler: At gap created between the cabinet or ledge static panel and the floor due to leveling conditions, mechanically fasten (flat head screw) a 4 inch (101mm) wide 18 gage (1.21mm) galvanized steel plate to the cabinet behind the base molding to support its application. Provide continuous clear silicone sealant at intersection of floor/wall and steel plate.

G. Drawer slides:

1. Drawer slides shall be self-closing, ball bearing, full extension zinc plated assembly that will allow the drawer body to be completely exposed and physically accessible. Drawer slides shall have an integral stop mechanism to avoid inadvertent removal. Assembly shall be typically rated for 100 lb. at full extension, dynamic load. Slides shall be equal to Acuride Model 3832-SC or equal as manufactured by Precision Slide or Waterloo.
2. Drawer slides for file or bin drawers shall be ball bearing, full extension zinc plated assembly that will allow the drawer body to be completely exposed and physically accessible. Drawer slides shall have an integral stop mechanism to avoid inadvertent removal. Assembly shall be typically rated for 150 lb. at full extension, dynamic load. Slides shall be equal to Acuride Model 4034 or equal as manufactured by Precision Slide or Waterloo.

H. Shelf Adjustment: Adjustable shelf support clips inside wall, floor and base cabinets shall be designed for adjusting shelves on 1-1/4 inch (32mm) centers and shall be nylon complying with BHMA A156.9, Type B04013. Clip shall be configured to clamp top and bottom of shelf to avoid movement. Clip may have one or two pins. In addition to shelf clips required for initial assembly, six (6) dozen additional clips to be provided to the owner. Clips shall be Hafele #282.47.402 clear to provide the "clamping" to avoid shelf movement.

I. Locks: Locks to be furnished on all cabinets except sink cabinets unless otherwise noted on the drawings or within this specification section. Drawer and door locks shall be brass, five-pin tumbler type, complying with BHMA A156.11, Type EO7281 having para-centric keys. The exposed face shall be chromium plated with satin finish. Locks shall be mounted in special housing so designed as to prevent removal when in locked position. The locks and lock housings shall be fully concealed within the drawer heads and doors. The lock tongues shall engage the rails or stiles when in locked position. Sliding door locks shall be push-type operating in sleeves and engaging both doors when in locked position and provided with positive door holding device. Install theft panels above each drawer or cupboard segment in order to isolate locked section. Locks shall be separately keyed (including cabinets with multiple locks and cabinets in the same room) and two (2) keys shall be furnished with each lock. Supply two (2) master keys for all locks.

J. Standards: Surface mounted adjustable shelves, shall be mounted to twin-tracked standards. Standards shall be coated with an epoxy powder coating complying with BHMA A156.9 Types B04102 with a nominal cross section of 1-1/2 inch x 1/2 inch (38.1mm x 12.7mm). Acceptable manufacturers shall be Reeve, Fixture Hardware Manufacturing Corporation, and Knappe and Vogt. Standards and slotted studs shall have a fully compatible slot pattern. Fasten standards to concrete masonry walls or properly blocked steel stud walls with appropriate flat head screws. Adjustable shelves, wall cabinets and drying racks will be furnished with integral mounting brackets or clips.

K. Slotted Studs: Adjustable shelves, wall cabinets and drying rack boards mounted above peninsula or island benches shall be mounted to a welded double-sided, twin tracked stud assembly. Assembly shall be fabricated of 14 gage, fully welded with welds concealed, steel tube with slots laser cut into uprights and be coated with an epoxy powder coat. Acceptable manufacturers shall be Reeve, Fixture Hardware Manufacturing Corporation, and Knappe and Vogt. Slotted studs and standards shall have a fully compatible slot pattern. Adjustable shelves, wall cabinets and drying racks shall be furnished with integral mounting brackets or clips to meet design load.

- L. Glazing in doors shall be installed on a foam cushion with the glazing tape installed on sides trimmed below the level of the frame and glazing stops. Glazing stops shall be of the same material and finish as the cabinet door.
- M. Levelers are 3/8 inch – 16 NC x 3.5 inch long, model # 23015T56 as distributed by McMaster-Carr Supply Company, New Brunswick, NJ or equal.

2.11 MECHANICAL SERVICE FITTINGS See Also Section 11 53 43

- A. Manufacturers. Service fittings shall be manufactured by:
 - 1. Water Saver Corporation
 - 2. Chicago Faucets
 - 3. Broen Corporation
- B. Mechanical service fixtures shall comply with SEFA 7, "Laboratory and Hospital Fixtures-Recommended Practices. Fixtures for liquids and gaseous mixtures shall have lettered and colored indexes for each service. Serrated hose ends shall have seven (7) serrations. Fixtures for gas, air and vacuum shall be needle valve, large type. Water fixtures shall be compression type. Drain fittings shall be polypropylene unless otherwise noted.
 - 1. Provide fittings complete with washers, locknuts, nipples and other installation accessories necessary for final connection. Include the deck flanges, escutcheons, handle extension rods and similar items.
- C. Materials: Plumbing fixtures, except for drain fixtures and fittings, shall be a forged red-brass composition containing at least 85% copper with washers and seats, of maximum wear resistant materials for the specific use. Reagent grade water fixture to be brass gooseneck type with an internal polypropylene lining.
- D. Needle Valves (Large): Provide large needle valves with a renewable valve seat and floating cone made of stainless steel or Monel metal with removable serrated outlet.
- E. Compression Water Valves: Provide units complying with ASME A112.18.1. Compression water valves shall have a renewable unit containing all working parts, including a stainless steel replaceable seat and valve disc. Unit shall be broached on the outside for permanent position in the valve body. The unit shall contain an integral control device for volume of water discharged by the faucet. The valve shall have a removable serrated hose unless otherwise noted. Valve shall be rated for 125 psi (857 kPa) operating pressure with a max of 190 psi (1303 kPa) for intermittent use.
- F. Faucet Accessories: Hot and cold water combination sink faucets shall have aerator tips unless otherwise noted. Cup sink and reagent grade water faucets to have serrated hose ends. Faucets are to be swivel type.
- G. Vacuum Breakers: ASSE 1035 Integral vacuum breakers, shall be supplied on all domestic water fixtures. The fume hood fixture shall have the vacuum breaker exposed 7 feet (2133.6mm) A.F.F. on face of hood (exposed vacuum breaker and piping to have same finish as other fixtures).

- H. Industrial Water Sign: 1/8 inch thick black laminated plastic with engraved white letters "INDUSTRIAL WATER DO NOT DRINK". Provide a sign at all industrial hot and industrial cold water valves. At panel mounted valves mount sign on panel above valve handle and at all gooseneck fixtures provide with 3/8 inch thick split ring mounting bracket.
- I. Hand Held Eye Wash: Where indicated with designation "EW" on floor plans, provide a unit that consists of a dual head eye wash assembly, 6 feet (1828.8mm) length of rubber hose, work surface mounting stand, slip ring mechanism to allow for hands free operation and in-line vacuum breaker. Unit's finish to match other service fittings.
- J. Service Identification. Index buttons mounted in fixture handles shall identify the following services. Buttons shall be color-coded and lettered.
- | | <u>SERVICE</u> | <u>LETTERING</u> | <u>DISC COLOR</u> |
|----|---------------------|------------------|-------------------|
| 1. | Hot Water | HW | Red |
| 2. | Cold Water | CW | Green |
| 3. | Gas | Gas | Blue |
| 4. | Air | Air | Orange |
| 5. | Vacuum | Vac | Yellow |
| 6. | Reagent Grade Water | RG | White |
- K. Service Fixture Finish. Laboratory brass service fixtures shall be ground smooth, coated with satin chromium plated finish with a clear epoxy coating except where corrosion resistant finish is indicated. Fixtures shall receive multiple applications of coating and are baked for polymerization. Units must be assembled before coating and pressure tested before shipment.
- L. Fixture Shipment. Fixtures shall be assembled in factory and supplied loose except for fume hood factory mounted fixtures.

2.12 SINKS

- A. General: Provide sinks and accessories as shown on the Drawings and as specified herein.
- B. Phenolic Resin Sinks: Molded in 1 piece with radiused corners, and bottom sloped to outlet with side mounted overflow; 1/2 inch (13mm) minimum thickness producing a smooth finish, the same color as the surrounding work surface.
- C. Provide each sink with an outlet, removable polypropylene disc strainer and tailpiece.
- D. Joint between sink and work surface shall not exceed 1/8 inch.
- E. Stainless Steel Sinks: Made not less than 0.050 inch (1.3mm) thick. Fabricate with corners rounded and coved to at least 5/8 inch (16mm) radius. Slope sink bottom to outlet. Provide double wall construction for sink partitions with top edge rounded to at least 1/2 inch (13mm) diameter. Provide continuous butt-welded joints, grind smooth and polish surfaces to produce non-directional #4 satin finish, free of scratches. When polishing is completed rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean. Provide factory punchings for fittings, stainless steel strainers and tailpieces.

- F. Overflow: Sinks shall be equipped with an overflow that is connected directly to the tailpiece. Overflow shall consist of an outlet located 2 inches (50.8mm) below the sink rim and 1/2 inch (25mm) diameter minimum flexible tygon or polypropylene tubing to connect overflow to tailpiece which shall be modified to accept tubing.
- G. Outlets and Tailpieces: Provide each sink with an outlet and tailpiece.
- H. Traps: Furnished under Division 22.
- I. Sink Sizes: As indicated on Drawings.
- J. Countertops adjacent to sinks shall be provided with parallel drip groves (approximately 20" long) on one side of the sinks routed into the tops that will drain water back into the sinks.

2.13 ELECTRICAL FIXTURES

- A. General. Provide electrical fixtures in accordance with requirements in Division 26, complete with metal enclosure boxes, receptacles, terminals, switches, pilot lights, device plates, accessories and grommets. Standard receptacles shall be black, receptacles connected to emergency power shall be red.
- B. Electrical Raceways.
 - 1. Electrical raceways mounted directly to partitions, reagent shelves or slotted studs will be supplied and installed under Division 26 Electrical.
- C. Pedestal Outlets. Pedestal outlets shall be provided where noted. They shall be fabricated of cast aluminum, sloped single face or two faces, as indicated, with neoprene gasket under base and with concealed mounting holes in base for attaching to laboratory casework.
- D. Receptacles: Comply with NEMA WD 1, NEMA WD6, FS W-596 and UL 498, duplex type, Configuration 5 20R. Casework manufacturer will be responsible for providing appropriate cutout in their equipment to accommodate the outlet.
 - 1. Receptacle Grade: General grade, unless otherwise noted.
 - 2. GFCI Receptacles: Comply with UL 943, General grade.
- E. Line Type Fittings: Provide with cast metal boxes with threaded holes for mounting on rigid steel conduit. Provide cover plates the same size as boxes.
- F. Cover Plates: Provide satin finish, chrome plated cover plates with formed, beveled edges.
- G. Cover Plate Identification: Use 1/4 inch (6mm) high letters. On stainless steel or chrome-plated metal, stamp or etch plate and fill in letters with black enamel. Provide at the following locations:
 - 1. Receptacles other than standard 120v duplex, grounding type. Indicate voltage and phase.
 - 2. Réceptacles, switches and other locations indicated.

PART 3 - EXECUTION

3.1 JOB SITE CONDITIONS

- A. Coordinate with the General Contractor to verify that required backing and reinforcements are in place, secure, and accurately located and that project is ready for installation of laboratory casework.
- B. Proceed with work when conditions permit Work to be installed in complete accordance with the original design, accepted submittals, and the manufacturer's written instructions.
- C. In the event of discrepancy, immediately notify the Architect in writing. Do not proceed with the installation in areas of discrepancy until issues have been resolved.

3.2 INSTALLATION

- A. Base Cabinet Casework shall be located in their designated positions, leveled, and plumbed true and straight by means of the micro-adjustment device located in each bottom corner of the cabinet. Adjust top rails and sub-tops within 1/16 inch (1.5mm) of a single plane. Fasten cabinets to utility space framing, partition framing, blocking or reinforcements in partitions with fasteners spaced not more than 24 inches (600mm) O.C. Align similar adjoining doors to a tolerance of 1/16 inch (1.5mm).
- B. Work surface lengths shall be fabricated as specified and indicated on the Drawings with ends abutting tightly, and sealed with corrosion resistant sealants. The horizontal surface shall be smooth and level with no raised edges at the joints. Work surfaces shall be anchored to base cabinets.
- C. Install miscellaneous filler panels and scribe as required for a continuous tight and accurate fitting installation with fasteners concealed where practical, without gaps or spaces between cabinet work or work surfaces and adjoining surfaces. All back splashes to be sealed at wall surfaces with corrosion resistant sealants.
- D. Assemblies are to be fastened together with devices of adequate strength to support cabinet or shelf fully loaded. Fully loaded will be defined as twenty-five (25) pounds per linear foot per shelf for enclosed wall cabinets or open adjustable shelves not inclusive of cabinet, shelf and bracket weight. Securely fasten wall-mounted items to solid supporting material only. Installation to meet local seismic requirements.
- E. Wall Cabinets: Adjust fronts and bottoms within 1/16 inch (1.5mm) of a single plane. Fasten to hanging strips, masonry, partition framing, blocking or reinforcements in partitions. Fasten each cabinet through back, near top, at not less than 24 inches (600mm) O.C. Align similar adjoining doors to a tolerance of 1/16 inch (1.5mm).
- F. Utility Space Framing: Secure to floor with two fasteners at each frame. Fasten to partition framing, wood blocking, or metal reinforcements in partitions and to base cabinets.
- G. Install hardware uniformly and precisely. Set hinges snug and flat in mortises.
- H. Adjust laboratory casework and hardware so doors and drawers align and operate smoothly without warp or bind and contact points meet accurately. Lubricate joints only where shown on Shop Drawings.

3.3 WORK SURFACE INSTALLATION

- A. Work surface lengths shall be fabricated as specified and indicated on the drawings with ends abutting tightly in hairline joints, single true plane, smooth and level with no raised edges at the joints with supports place to prevent deflection. All joints are to be sealed with corrosion resistant sealants. Wall-to-wall work surfaces are to be installed with a maximum 1/4 inch (6.35mm) gap.
- B. Make field jointing in same manner as factory jointing using dowels, splines, adhesives, and fasteners recommended by manufacturer. Locate field joints as shown on accepted submittal drawings. Joints shall be factory prepared requiring no job site processing of top and edge surfaces.
- C. Work surfaces shall be anchored to base cabinets. Secure work surfaces to cabinets/supports with concealed "Z" type angles or equal fastening devices spaced no more than 24 inches (610mm) on center, with one located within 6 inches (150mm) of front and back edge. Tighten according to manufacturer's written instructions to exert a uniform heavy pressure at joints. Countersink exposed heads approximately 1/8 inch (3mm) and plug flush with material equal in chemical resistant, color, harshness and texture to adjoining surface. Where work surface is intended to be moveable use a clamping device that is removable. Work surfaces to be installed with a maximum 1/8 inch gap. Secure phenolic work surfaces to cabinets with cement compatible with phenolic resin, applied at each corner and along perimeter edges at not more than 48 inches (1200mm) O.C.
- D. Provide holes and cutouts as required for equipment and service fittings and fixtures. Verify size of opening with actual size of item to be used, prior to making openings. Form inside corners to a radius of not less than 1/8 inch (3mm). After cutting, rout and file cutouts to ensure smooth, crack-free edges. Seal exposed edges after cutting with a chemical resistant sealer recommended by the manufacturer.
- E. Provide scribe moldings for closures at junctures of work surface, curb and splash with walls as recommended by manufacturer for materials involved. Match materials and finish to adjacent laboratory casework. Use chemical-resistant, permanently elastic sealing compound where recommended by manufacturer.
- F. Carefully dress joints smooth, remove surface scratches and clean entire surface.

3.4 INSTALLATION OF ACCESSORIES

- A. Install in accordance with manufacturer's directions. Turn screws to a flat seat; do not drive. Adjust moving parts to operate freely without excessive bind.
- B. Securely fasten adjustable shelving supports, shelves and drying rack to partition framing, blocking or reinforcements in partitions.
- C. Install shelf standards plumb and at heights to align shelf brackets for level shelves. Install shelving level and straight, closely fitted to other work where indicated.

3.5 CLEANING

- A. Repair or remove and replace defective, damaged or soiled work to match original factory finish.

- B. Clean finished surfaces, including wiping of drawers and cabinet shelves, touch up as required.
- C. Clean work surfaces leaving tops free of grease and streaks. Use no wax or oils.

3.6 PROTECTION

- A. Protect against soiling and deterioration during remainder of construction period.
- B. Protect work surfaces and ledges for the remainder of the construction period with 1/4 inch (6mm) corrugated cardboard or equal completely covering the top and securely taped to edges. Mark cardboard in large lettering "No Standing".

END OF SECTION

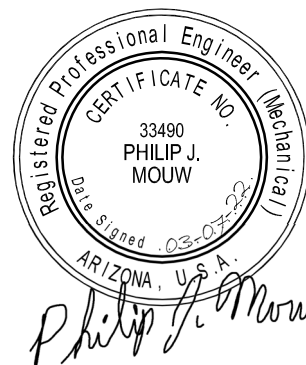
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DIVISION 22

PLUMBING

22 05 00	Common Work Results for Plumbing
22 05 00	General Provisions
22 05 13	Common Motor Requirements for Plumbing Equipment
22 05 17	Sleeves & Sleeve Seals for Plumbing Piping
22 05 18	Escutcheons for Plumbing Piping
22 05 19	Meters & Gages for Plumbing Piping
22 05 23	General Duty Valves for Plumbing Water Piping
22 05 29	Hangers & Supports for Plumbing Piping & Equipment
22 05 48	Vibration Controls for Plumbing Piping & Equipment
22 05 53	Identification for Plumbing Piping & Equipment
22 07 00	Plumbing Insulation
22 07 19	Plumbing Piping Insulation
22 11 00	Facility Water Distribution
22 11 16	Domestic Water Piping
22 11 19	Domestic Water Piping Specialties
22 13 00	Facility Sanitary Sewerage
22 13 16	Sanitary Waste & Vent Piping
22 13 19	Sanitary Waste Piping Specialties
22 14 00	Facility Storm Drainage
22 14 13	Storm Drainage Piping
22 14 23	Storm Drainage Piping Specialties
22 40 00	Plumbing Fixtures
22 40 00	Plumbing Fixtures
22 45 00	Emergency Plumbing Fixtures
22 45 00	Emergency Plumbing Fixtures
22 61 00	Compressed Air Systems for Laboratory & Healthcare Facilities
22 61 13.10	Compressed Air Piping for Laboratory Facilities
22 62 00	Vacuum Systems for Laboratory & Healthcare Facilities
22 62 13.10	Vacuum Piping for Laboratory Facilities
22 63 00	Gas Systems for Laboratory & Healthcare Facilities
22 63 13.10	Gas Piping for Laboratory Facilities
22 66 00	Chemical Waste Systems for Laboratory & Healthcare Facilities
22 66 00.10	Chemical Waste Systems for Laboratory Facilities
22 67 00	Processed Water Systems for Laboratory & Healthcare Facilities
22 67 00.10	Processed Water Systems for Laboratory Facilities

END OF INDEX



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SECTION 22 05 00

GENERAL PROVISIONS

PART 1 GENERAL

1.01 SCOPE

- A. Provisions of this section apply to all work specified in all sections under Division 22.
- B. In addition, work in Division 22 is governed by the provisions of the Bidding Requirements, Contract Forms, General Conditions, and all sections in Division 01, General Requirements.
- C. The Contract Documents do not specify exact installation means and methods or Contractor safety procedures. Installation means and methods and safety procedures are the responsibility of the Contractor. No instruction or statement made on the Contract Documents shall be interpreted to shift this responsibility away from the Contractor.
- D. These specifications contain statements which are more definitive or more restrictive than those contained in the General Conditions. Where these statements occur, they shall take precedence over the General Conditions.

1.02 DEFINITIONS

- A. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unconditioned shelters.
- B. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings, in duct shafts, and in utility chases.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations and mechanical yards.
- D. Exposed, Interior Installations: Exposed to view indoors. Examples include finished spaces and mechanical equipment rooms.
- E. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unconditioned spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspace, and utility tunnels.

1.03 EXAMINATION OF PREMISES

- A. Visit the site, verify all measurements and project conditions, and pay all costs necessary to perform the work.

1.04 PLUMBING CONTRACTOR

- A. The Plumbing Contractor shall hold a current contracting license that has been valid for a minimum of 2 years in the State of Arizona as a plumbing contractor.

1.05 REGULATIONS, PERMITS, FEES, CHARGES, INSPECTIONS

- A. Regulations: Comply with all applicable codes, rules and regulations.
- B. Fees and Permits: Pay all connection, installation, use, disposal, development, etc., fees and/or charges. Obtain and pay for all required permits and licenses. Refer to Division 01 specifications.
- C. Inspections: All work must be inspected and approved by local authorities. Prior to final approval, furnish the Architect with certificates of inspections and approvals by the local authorities in accordance with Division 01 specifications.

1.06 DRAWINGS AND SPECIFICATIONS

- A. Refer to Division 01 specifications for additional information on submittals and shop drawings.
- B. If a conflict exists on the drawings or between the drawings and specifications, promptly notify the Architect.

1.07 SUBMITTALS

- A. Submittals are for information and coordination only. The Engineer will diligently review the submittals and attempt to verify compliance with the project requirements. Such review, however, does not constitute approval or disapproval of obligation to comply with all project requirements. The submittals are not to be construed to be Contract Documents. Any failure by the Engineer to note a point of non-compliance shall not be construed to be acceptance or approval of the discrepancy.
- B. Product Information Sheets: Provide project specific manufacturer's literature which includes the information required by the Product Data paragraph of the applicable specification section. Where product information sheets show multiple models or options, clearly mark the model and options to be provided.
- C. Assembly: Assemble all required submittal information for each specification section and submit in PDF format.
 - 1. Assemble PDF submittals in one PDF file for each division. Separate and order sections within each file by corresponding specification number. Provide bookmarks at the first page of each section and label each bookmark with the specification number and name to allow for easy navigation of the submittal.
 - 2. Partial submittals and submittals that are not project specific will be returned without review.
- D. Identification and Information:
 - 1. Name the PDF file with the project name, division number and sequential submittal number (i.e., the first submittal shall be No. 1; the second submittal shall be No. 2).
 - 2. Provide a cover sheet at the front of each submittal with the following information:
 - a. Project name.
 - b. Date.
 - c. Name of Engineer.
 - d. Name of Contractor.
 - e. Name of subcontractor.
 - 3. Provide a cover sheet at the front of each submittal section with the following information:
 - a. Name of supplier.

- b. Name of manufacturer.
 - c. Number and title of appropriate specification section.
 - d. Drawing number and detail references, as appropriate.
 - e. Other necessary identification.
- E. Options:
 - 1. Identify options requiring selection by the Engineer.
 - 2. Identify options included with submittal item.
- F. Deviations: Identify deviations from the Contract Documents on submittals.
- G. Furnished by Others: This project is to provide a complete and functional system. Where material or labor is indicated in the submittal to be provided "by others" clearly indicated who is providing those items and include information to indicate proper coordination.

1.08 MATERIAL SAFETY DATA SHEETS

- A. Provide current Material Safety Data Sheets (MSDS) for all hazardous materials that are proposed for use at the project site.
 - 1. Provide one complete set to the Owner for review and approval a minimum of 1 week prior to the delivery of any hazardous materials to the site.
 - 2. Maintain a second complete set at the project location, readily accessible by both the Owner's personnel and the Contractor's personnel.

1.09 REQUEST FOR INFORMATION

- A. Request for Information (RFI):
 - 1. A document submitted by the Contractor requesting clarification of a portion of the Contract Documents, hereinafter referred to as an RFI.
 - 2. A properly prepared request for information shall include a detailed written statement of the clarification, apparent conflict, or information requested that indicates the specific drawings or specification in need of clarification and the nature of the clarification requested.
 - a. Drawings shall be identified by drawing number and location on the drawing sheet.
 - b. Specifications shall be identified by section number, page, and paragraph.
 - 3. Include a proposed solution, where appropriate, based upon the field conditions and best knowledge of the Contractor.
- B. Improper or Frivolous RFIs: RFIs which are not properly prepared or that request information which is clearly shown in the Contract Documents will be returned unanswered. Processing time for multiple submissions of improper or frivolous RFIs will be billed at the Engineer's standard hourly rate to the Owner who may deduct an equal amount from the monies due the Contractor.

1.10 AS-BUILT DRAWINGS

- A. As-Built Drawings: Maintain one set of marked-up paper copies of the Contract Drawings.
 - 1. Preparation: Mark As-Built Drawings to show the actual installation where installation varies from that shown originally. Include all equipment, and underground and overhead piping.
 - a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.

- b. Include dimensions both horizontally and vertically to permanent points of reference, accurate within 6 inches. Include descriptors such as “below slab,” “above ceiling,” etc.
 - c. Record data daily or as soon as possible after obtaining it.
 - d. Record and check the markup before enclosing concealed installations.
 - 2. Mark the As-Built Drawings completely and accurately. Utilize personnel proficient at recording graphic information in production of As-Built Drawings.
 - 3. Mark the As-Built Drawings with erasable, red colored pencil, or in a digital PDF format using an editor program such as Bluebeam, Adobe Acrobat Professional, or similar. Use other colors to distinguish between changes for different categories of the work at the same location.
 - 4. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.
 - 5. Update the As-Built Drawings weekly or daily as appropriate for the project size.
- B. Format: Identify and date each As-Built Drawing; include the designation “PROJECT AS-BUILT DRAWING” in a prominent location.
 - 1. Organize newly-prepared As-Built Drawings into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
 - 2. Identification, as follows:
 - a. Project name.
 - b. Date.
 - c. Designation “PROJECT AS-BUILT DRAWINGS.”
 - d. Name of Engineer.
 - e. Name of Contractor.
 - 3. Remove or obscure the Engineer’s seal and signature from As-Built Drawings.

1.11 OPERATION AND MAINTENANCE MANUAL

- A. Prior to completion of the project, compile a complete equipment, operation and maintenance manual for all equipment supplied under Division 22.
- B. Schedule:
 - 1. Submit a preliminary copy of the manual not less than 30 days prior to Substantial Completion for review and comment.
 - 2. Submit the final version the manual not more than 4 weeks after Substantial Completion of the project.
- C. Format: Submit manuals in both of the following formats:
 - 1. PDF Electronic Files: Assemble each manual into a single master directory with subdirectories for the individual PDF files for each system and piece of equipment. Provide a table of contents file with hyperlinks to each of the individual PDF files within the subdirectories. Submit on digital media acceptable to Engineer.
 - a. Name each directory, subdirectory, and document file with applicable item name.
 - b. Enable reviewer comments on draft submittals.
 - 2. Paper Copies: Assemble paper copies in 3-ring binders. Separate and order systems and equipment within each binder. Provide labeled tabs at each section with a table of contents at the front of the binder. The table of contents shall indicate the tab number and the information contained at that tab. Enclose title pages and directories in clear plastic sleeves.
- D. Provide operating and maintenance manuals for all systems, subsystems, and equipment that require operation and regular maintenance, or have replaceable parts.

- E. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, product data, manufacturer's maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranty and bond information, as described below. In addition to requirements in this section, include operation and maintenance data required in individual specification sections.
- F. Source Information: List each system, subsystem, and piece of equipment included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of installer or supplier and maintenance service agent, and cross-reference specification section number and title in Project Manual.
- G. Product Data: Include the following information:
1. System, subsystem, and equipment descriptions. Use designations for systems and equipment indicated on Contract Documents.
 2. Approved submittals.
 3. Include the following if not shown on approved submittals:
 - a. Product name and model number. Use designations for products indicated on Contract Documents.
 - b. Manufacturer's name.
 - c. Equipment identification with serial number of each component.
 - d. Equipment function.
 - e. Operating characteristics.
 - f. Limiting conditions.
 - g. Performance curves.
 - h. Engineering data and tests.
- H. Operating Procedures: Include the following, as applicable:
1. Startup procedures.
 2. Equipment or system break-in procedures.
 3. Routine and normal operating instructions.
 4. Regulation and control procedures.
 5. Instructions on stopping.
 6. Normal shutdown instructions.
 7. Seasonal and weekend operating instructions.
 8. Required sequences for electric or electronic systems.
 9. Special operating instructions and procedures. Including precautions against improper use.
 10. Operating logs.
- I. Wiring Diagrams: Diagram of factory-installed wiring including any options as well as any field modifications.
- J. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.
- K. Piped Systems: Diagram piping as installed, and identify color-coding where required for identification. Include valve locations and designations.
- L. Manufacturer's Maintenance Documentation: Provide manufacturer's maintenance documentation including the following information for each component part or piece of equipment:
1. Standard maintenance instructions and bulletins.
 2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.

3. Identification and nomenclature of parts and components.
 4. List of items recommended to be stocked as spare parts.
- M. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:
1. Test and inspection instructions.
 2. Troubleshooting guide.
 3. Precautions against improper maintenance.
 4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
 5. Aligning, adjusting, and checking instructions.
 6. Demonstration and training video recording, if available.
- N. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.
- O. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturer's maintenance documentation and local sources of maintenance materials and related services.
- P. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.
- Q. Licenses: Include copies of any licenses with requirements including inspection and renewal dates.
- R. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

1.12 WORK AND MATERIALS

- A. Unless otherwise specified, all materials must be new and of the quality specified. The workmanship shall be of a quality that is acceptable to the Architect, Engineer, and Owner, and is equal to the standards of the trades. Contractor must staff the project with sufficient skilled workmen, including a fully qualified construction superintendent, to complete the work in the time allotted. The superintendent must be qualified to supervise all of the work in his work category.
- B. Uniformity: Unless otherwise specified, provide all equipment and products of same type or classification by the same manufacturer.

1.13 APPROVALS OF MATERIALS AND EQUIPMENT

- A. Refer to Division 01 specifications for description of material and equipment for prior approvals and substitutions.

1.14 COOPERATIVE WORK

- A. Correct without charge any work requiring alteration due to lack of proper supervision or failure to make proper provision in time. Correct without charge any damage to adjacent work caused by the alteration. Refer to Division 01 specifications for additional requirements.

- B. Cooperative Work Includes:
 - 1. General supervision and responsibility for proper location, rough-in and size of work related to Division 22 but provided under other divisions of these specifications.
 - 2. Installation of sleeves, inserts and anchors bolts for work under sections in Division 22.

1.15 EXISTING MATERIALS AND EQUIPMENT

- A. Disposition: With the exception of items that are to be reused or retained by the Owner, all other materials indicated to be removed shall be removed and legally disposed of by the Contractor. Items that are indicated to be retained or returned to the Owner shall be delivered to a storage area designated by the Owner.
- B. Unused Materials: All unused piping, controls and miscellaneous materials shall be removed by the Contractor except where located within walls, below or above existing construction which is not being altered and would require removal and replacement of this existing construction. All visible piping, etc., shall be removed and sealed or capped within wall, below floor, or above ceiling unless noted otherwise.
- C. Exterior Services: The Contractor shall be responsible for maintaining plumbing services to the existing building during the construction period. Existing services are to be retained until such a time that the new services, if any, are completely installed and ready for use. Scheduling of service interruptions is to be coordinated with the Architect and Owner.
- D. Disconnect, demolish, and remove plumbing systems, equipment, and components that are indicated to be removed.
 - 1. Piping to be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material. Patch insulation, as required, to match adjacent areas.
 - 2. Piping to be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
 - 3. Equipment and Fixtures to be Removed: Disconnect and cap services and remove equipment and fixtures.
 - 4. Equipment and Fixtures to be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment and fixtures; when appropriate, reinstall, reconnect, and make equipment fixtures operational.
 - 5. Equipment and Fixtures to be Removed and Salvaged: Disconnect and cap services and remove equipment and fixtures, and deliver to Owner.
- E. Continuity of Services in Existing Building: Contractor shall permanently reroute existing plumbing services or provide temporary connection as required to maintain service to existing fixtures, equipment, and systems in building which are to remain in service.
- F. Rerouting and Relocation of Existing Plumbing Equipment and Services in Existing Building:
 - 1. General: Contractor shall reroute, relocate all existing materials which are in conflict with the building alterations and which are required to be maintained in use.
 - 2. Existing Piping: Where applicable, existing material may be reused in their original location unless otherwise indicated.
- G. Testing: All existing services affected by the new construction and which are modified, reused or are to remain in operation shall be returned to their original condition. The existing services shall be tested as new, as described in other sections of these

specifications. If for any reason these requirements cannot be met, the Contractor shall immediately notify the Architect.

1.16 CONSTRUCTION FACILITIES

- A. General: Under this division of the specifications, execute all work in a manner to provide safe and lawful ingress and egress to the Owner's establishment and such facilities shall be kept clear of materials or equipment. Refer to Division 01 specifications for additional requirements.
- B. Furnish and maintain from the beginning to the completion of all work all lawful and necessary security, guards, railings, fences, canopies, lights, fire protection, and warning signs. Take all necessary precautions required by city and state laws to avoid injury or damage to any and all persons and property.

1.17 GUARANTEE

- A. Guarantee all material, equipment, installation and workmanship for all sections under Division 22 in writing to be free from defects of material and workmanship for 1 year from date of final acceptance as outlined in Division 01 specifications. Equipment warranties shall be a minimum of 1 year from date of Substantial Completion or as specified elsewhere. Replace without charge any material or equipment proving defective during this period. The guarantee shall include performance of the equipment under all conditions.

1.18 ELECTRICAL WORK

- A. Electrical wiring, including power wiring and control wiring, except as otherwise specified under Division 22, all raceways, outlet and junction boxes, and labor for installation of the wiring and equipment shall be included in Division 26 of the specifications.
- B. All loose starters and control devices for equipment furnished under Division 22, except as otherwise specified under Division 22, are to be furnished under that particular section of Division 22 and installed under Division 26.
- C. Contractor shall be responsible for the checking and testing of all controls and the interlocks for a complete and satisfactory operating system.
- D. Before ordering any motors and equipment, verify the available voltage and phase for all motors with the Division 26 Contractor.
- E. Submit a complete list of all motors prior to final closeout of project indicating the location, horsepower, voltage, phase, and amperage draw of each motor.
- F. All field wiring and equipment must conform to the applicable Division 26 specification sections.

PART 2 PRODUCTS

2.01 EQUIPMENT DESIGN AND INSTALLATION

- A. Design: Design all equipment in accordance with latest edition of ASME, AGA, UL, and other applicable technical standards as follows:
 - 1. Pressure Vessels: ASME Code constructed and stamped.

2. Electric Appliances: UL labeled.

2.02 GROUT

- A. Description: ASTM C1107, Grade B, non-shrink and non-metallic, dry hydraulic-cement grout.
 1. Characteristics: Post-hardening, volume-adjusting, non-staining, non-corrosive, non-gaseous, and recommended for interior and exterior applications.
 2. Design Mix: 5,000-psi, 28-day compressive strength.
 3. Packaging: Premixed and factory packaged.

PART 3 EXECUTION

3.01 SUBMITTALS

- A. Prepare submittals as directed for review by the Contractor, Owner, Architect, and Engineer.
- B. Submit one copy of PDF submittals via email, project website or other electronic media.

3.02 AS-BUILT DRAWINGS AND RECORD DOCUMENTS

- A. Recording: Post changes and modifications to the As-Built Drawings as they occur; do not wait until the end of the project.
- B. Maintenance of As-Built Drawings and Record Documents: Store Record Documents in the field office, apart from the Contract Documents used for construction. Do not use project Record Documents for construction purposes. Maintain Record Documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to project Record Documents for the Engineer's reference during normal working hours. As-Built Drawings will be reviewed by the Architect, Owner, and Engineer at each pay request review.
- C. Submit As-Built Drawings to the Architect at completion of the project.

3.03 OPERATION AND MAINTENANCE MANUALS

- A. Prepare operation and maintenance manuals as directed.
- B. Submit a preliminary electronic copy of the operation and maintenance manual to the Engineer for review.
- C. Make any corrections noted from the Engineer's review upon receipt of comments and resubmit as required.
- D. Submit the final, corrected operation and maintenance manual in both paper and electronic format to the Architect.

3.04 VERIFICATION OF DIMENSIONS

- A. Scaled and figured dimensions are approximate only. Before proceeding with work, carefully check and verify dimensions at site, and be responsible for properly fitting equipment and materials together and to the structure in spaces provided.

- B. Drawings are essentially diagrammatic and many offsets, bends, special fittings and exact locations are not indicated. Carefully study drawings and premises in order to determine best sequence and installation methods, exact locations, routes, building obstructions, and install apparatus and equipment in available locations. Install apparatus and equipment in manner and in locations to avoid obstructions, preserve headroom, and keep openings and passageways clear.

3.05 CUTTING AND PATCHING

- A. Cut work and patch per Division 01 specifications as necessary to properly install the new work. As the work progresses, coordinate necessary openings, holes, chases, etc., in their correct location. If the required openings, holes and chases are not in their correct locations, make the necessary corrections at no cost to the Owner. Avoid excessive cutting and do not cut structural members without the consent of the Architect. Include as a part of the work all structural framing required by penetrations through the roof and necessary design and installation of steel to support equipment and pipes between structural steel unless shown on the structural drawings.

3.06 CLOSING-IN OF UNFINISHED WORK

- A. Cover no work until inspected, tested and approved. Where work is covered before inspection and test, uncover it, and when inspected, tested and approved, restore all work to original proper condition.

3.07 EXCAVATION AND BACKFILL

- A. Perform all necessary excavation, shoring and backfilling required for the proper laying of all pipes inside the building and premises, and outside as may be necessary. Remove all excess excavated materials from the site or dispose of on site as directed by General Contractor.
- B. Excavate all trenches open cut, keep trench banks as nearly vertical as practicable, and sheet and brace trenches where required for stability and safety. Excavate trenches true to line and make bottoms not less than 18 inches wide but no wider than necessary to provide ample work room. Excavate to provide continuous granular bedding as indicated. Do not cut any trench near or under footings without first consulting the Architect. Comply with OSHA requirements.
- C. Provide not less than 4 inches of granular material as pipe bedding. Grade and compact trench bedding accurately prior to laying pipe in trench to provide uniform bearing and support for each section of pipe along its entire length. Dig "bell" holes after the trench bottom has been graded and compacted. Granular material shall be pea gravel or sand per MAG Standards.
- D. Provide backfilling and compaction in accordance with provisions of these specifications and under the direction of the Architect to the required density.
- E. Provide not less than 4 inches of granular material, same as piping bedding, all around pipe. Make the first 2 feet of fill in 6-inch layers, each thoroughly compacted as directed with no puddling, and free from rocks, large clods of earth, leaves, branches, and debris. Compact the rest of the backfill as directed, using in the backfill no rocks larger than 4 inches in diameter, and using no rock in the top 12 inches.

3.08 ACCESSIBILITY

- A. Install valves, thermometers, gauges, traps, cleanouts, control devices or other specialties requiring reading, adjustment, inspection, repairs, removal or replacement conveniently and accessibly throughout the finished building. Where any of these devices are shown on the Contract Drawings to be installed above any inaccessible ceiling or behind any inaccessible wall, the Plumbing Contractor shall furnish access doors or panels as required.
- B. All access doors or panels in walls and ceilings required for access to control devices, traps, valves and similar devices are to be furnished and installed as part of the work under this section. Provide type as specified in Division 08 specifications.
- C. Refer to architectural drawings for type of wall and ceiling in each area and for rated construction.
- D. Coordinate work of various sections to locate valves, traps, etc., with others to avoid unnecessary duplication of access doors.
- E. The Contractor, along with the Owner's representative, shall complete the Plumbing Accessibility/Clearance Checklist at the end of this section for all plumbing equipment. The chart shall be submitted to the Architect for approval prior to Substantial Completion. All conflicts shall be resolved to the Architect's and Owner's satisfaction prior to submission.

3.09 FLASHINGS

- A. Flash and counterflash all piping penetrating roofing membrane with flashing per roofing manufacturer's recommendations. Refer to architectural drawings for detailing of pipe penetrations through roof.
- B. Flash and counterflash all piping penetrating exterior walls. Refer to architectural drawings for detailing of pipe penetrations through walls.

3.10 PRODUCT AND EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. All equipment, valves, sensors, etc., shall be installed in strict conformance with the manufacturer's recommendations and all codes.
- B. Install equipment to allow maximum possible headroom unless specific mounting heights are indicated.
- C. Install equipment and piping level and plumb, parallel and perpendicular to other building systems and components, unless otherwise indicated.
- D. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations.
- E. Install equipment and piping to allow right-of-way for piping installed at required slope.
- F. Do not install any equipment in an application not recommended by the manufacturer.

3.11 EQUIPMENT ROUGH-IN

- A. Rough in all equipment and fixtures as designated on the approved submittals and in the Construction Documents. The Contract Drawings indicate only the approximate location of rough-ins. The exact rough-in locations must be determined from large-scale certified drawings. The Contractor shall obtain all certified rough-in information before progressing with any work for rough-in.
- B. Be responsible for providing all outlets and services of proper size at the required locations.
- C. Minor changes in the Contract Drawings shall be anticipated and provided for under this contract.
 - 1. Rough-in only (unless otherwise designated on the drawings) shall include providing all services as indicated and required, including all piping, valves, and fittings. Valve and cap all piping stub-outs.

3.12 OWNER-FURNISHED AND OTHER EQUIPMENT

- A. Rough-in only for all Owner-furnished equipment refer to Division 01 specifications and all equipment furnished under other sections of the specifications, except as otherwise specified and/or noted on the drawings.
- B. Obtain rough-in drawings from the Owner or other contractors prior to roughing-in any services.
- C. Provide all services required. Valve and cap all piping, and leave in a clean and orderly manner.

3.13 EQUIPMENT FINAL CONNECTIONS

- A. Provide all piping final connections for all equipment under Division 22 and as indicated on the drawings.

3.14 EQUIPMENT SUPPORTS

- A. Erection of Metal Supports and Anchorages:
 - 1. Refer to Division 05 specifications for structural steel.
 - 2. Design, cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor plumbing materials and equipment. Neatly fabricate and erect steel work with burrs and welding spatter ground off. Paint after fabrication with a rust-inhibitive primer.
 - 3. Field Welding: Comply with AWS D1.1.
- B. Erection of Wood Supports and Anchorages:
 - 1. Design, cut, fit, and place wood grounds, nailers, blocking, and anchorages to support and anchor plumbing materials and equipment.
 - 2. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
 - 3. Attach to substrates as required to support applied loads.
- C. Where supports, foundations, stands, suspended platforms for machinery, tanks, or other equipment are indicated or specified, perform the following:
 - 1. Locate support members to avoid equipment strains and interference with piping connections and maintenance operations.

2. Where saddles are required, use cast-iron or welded-steel saddles with curvature to fit the tank shell.
 3. Mount power-driven equipment on common base with driver.
- D. Concrete Inserts: Furnish and install all concrete inserts required for all materials and equipment specified and/or shown on the drawings for Division 22.
- E. Concrete Housekeeping Pads and Isolation Bases: Work under this section includes coordination of construction of all concrete foundations indicated or required for equipment specified under Division 22. Materials and workmanship shall be described in Division 03 specifications. Anchor equipment to concrete housekeeping pads and isolation bases according to equipment manufacturer's written instructions and according to seismic codes at project.
1. Construct concrete housekeeping pads and isolation bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
 2. Install dowel rods to connect concrete pads to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the pad.
 3. Install epoxy-coated anchor bolts for supported equipment that extends through concrete pad, and anchor into structural concrete floor.
 4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 5. Install anchor bolts to elevations required for proper attachment to supported equipment.
 6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
- F. Grouting:
1. Grout under all equipment after leveling, filling completely the space between machinery base plate and foundation surface as specified in Division 03 specifications.
 2. Mix and install grout for plumbing equipment base bearing surfaces, pumps and other equipment base plates, and anchors.
 3. Clean surfaces that will come into contact with grout.
 4. Provide forms as required for placement of grout.
 5. Avoid air entrapment during placement of grout.
 6. Place grout, completely filling equipment bases.
 7. Place grout on concrete pads and isolation bases and provide smooth bearing surface for equipment.
 8. Place grout around anchors.
 9. Cure placed grout.
 10. Finish exposed surface of grout for a neat appearance.

3.15 CLEANUP

- A. In addition to cleanup specified in Division 01 specifications, thoroughly clean all parts of the equipment and fixtures. Where exposed parts are to be painted, thoroughly clean off any splattered construction materials and remove all oil and grease spots. Wipe the surface carefully and scrape out all cracks and corners.
- B. Thoroughly flush and clean all water systems.
- C. During the progress of the work, keep the premises clean and free of debris.

3.16 PAINTING

- A. Except as otherwise specified or indicated in the architectural drawings and/or specifications, paint all exposed unfinished metal with one coat of rust-inhibiting primer. Stainless-steel, aluminum, galvanized, and factory-painted equipment shall be considered as having primed surface.
- B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.
- C. Finished painting is specified in Division 09 specifications.

3.17 FIRESTOPPING

- A. Coordinate with the firestopping installer for sealing of all penetrations of fire and smoke barriers and other rated assemblies created during the installation of the Division 22 work.

3.18 CONNECTIONS TO SERVICES

- A. Provide all connections to sanitary sewer lines, storm water lines, gas lines, and water lines, except as otherwise specifically designated. Provide all necessary tees, taps and connections required to properly connect to all building services. Verify all requirements with civil drawings before making any piping connections to sanitary sewer, storm sewer, water or gas piping and conform to them during installation.

3.19 OBJECTIONABLE NOISE AND VIBRATION

- A. Construct and brace piping systems to prevent vibration or rattling when systems are in operation. Install connections to equipment so noise and vibration will not reach the conditioned area through piping, conduit, or the building structure.

3.20 WELDING

- A. Procedures:
 - 1. All procedures and welders must be qualified in accordance with the requirements of Section IX, ASME Boiler and Pressure Vessel Code and ANSI code for power piping B31.1. Procedure qualification test records and acceptance shall be submitted with the welding procedure prior to the start of fabrication.
 - 2. Architect's inspector or authorized representative will review performance qualification records of individual welders.

END OF SECTION

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SECTION 22 05 13

COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

- A. This section includes general requirements for single-phase and polyphase, general-purpose, horizontal and vertical, small and medium, squirrel-cage induction motors for use on AC power systems up to 600V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.02 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
 - 1. Motor controllers.
 - 2. Torque, speed, and horsepower requirements of the load.
 - 3. Ratings and characteristics of supply circuit and required control sequence.
 - 4. Ambient and environmental conditions of installation location.

PART 2 PRODUCTS

2.01 GENERAL MOTOR REQUIREMENTS

- A. Comply with requirements in this section except when stricter requirements are specified in plumbing equipment schedules or sections.
- B. Comply with NEMA MG 1 unless otherwise indicated.

2.02 MOTOR CHARACTERISTICS

- A. Duty: Continuous duty at ambient temperature of 104°F and at altitude of 3,300 feet above sea level.
- B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.03 POLYPHASE MOTORS

- A. Description: NEMA MG 1, Design B, medium induction motor.
- B. Efficiency: Energy efficient, as defined in NEMA MG 1.
- C. Service Factor: 1.15.
- D. Multi-Speed Motors: Variable-torque.
 - 1. For motors with 2:1 speed ratio, consequent pole, single winding.
 - 2. For motors with other than 2:1 speed ratio, separate winding for each speed.

- E. Rotor: Random-wound, squirrel-cage.
- F. Bearings: Regreasable, shielded, anti-friction ball bearings suitable for radial and thrust loading.
- G. Temperature Rise: Match insulation rating.
- H. Insulation: Class F.
- I. Code Letter Designation:
 - 1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
 - 2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.
- J. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.04 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

- A. Motors Used with Reduced-Voltage and Multi-Speed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
- B. Motors Used with Variable Frequency Controllers:
 - 1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
 - 2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
 - 3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
 - 4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
 - 5. Bearing Protection Device: Field- or factory-applied shaft grounding ring consisting of metal ring supporting carbon microfibers to provide grounding path between shaft and motor casing.

2.05 SINGLE-PHASE MOTORS

- A. Motors larger than 1/20 HP shall be one of the following, to suit starting torque and requirements of specific motor application:
 - 1. Permanent-split capacitor.
 - 2. Split phase.
 - 3. Capacitor start, inductor run.
 - 4. Capacitor start, capacitor run.
 - 5. Electronically commutated.
- B. Multi-Speed Motors: Variable-torque, permanent-split-capacitor type.
- C. Bearings: Prelubricated, anti-friction ball bearings or sleeve bearings suitable for radial and thrust loading.
- D. Motors 1/20 HP and Smaller: Shaded-pole type.
- E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor

insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

2.06 ELECTRONICALLY COMMUTATED MOTOR

- A. Description: Motor with integral electronics to convert incoming AC power to DC power along with controls to vary the speed of the motor based on an internal or external signal.
- B. Controls: Provide with internal controls and programming or external inputs, depending on the application, to allow for motor speed control.
- C. Motor Protection: Provide with integral safeties to limit motor speed or de-energize motor if operating in an over-temperature or overloaded condition.

PART 3 EXECUTION (NOT USED)

END OF SECTION

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SECTION 22 05 17

SLEEVES & SLEEVE SEALS FOR PLUMBING PIPING

PART 1 GENERAL

1.01 SUMMARY

- A. This section includes:
 - 1. Sleeves.
 - 2. Sleeve seal systems.

1.02 SUBMITTALS

- A. Product Data: For each type of product indicated.

PART 2 PRODUCTS

2.01 SLEEVES

- A. Cast-Iron Wall Pipes: Cast or fabricated of cast- or ductile-iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
- B. Galvanized-Steel Wall Pipes: ASTM A53/A53M, Schedule 40, with plain ends and welded steel collar; zinc coated.
- C. Galvanized-Steel-Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.
- D. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded or snap-lock longitudinal joint.

2.02 SLEEVE SEAL SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Advance Products & Systems, Inc.
 - 2. CALPICO, Inc.
 - 3. Link-Seal by GPT, an EnPro Industries Company.
 - 4. The Metraflex Company.
 - 5. Proco Products, Inc.
- B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
 - 1. Sealing Elements: EPDM-rubber or NBR interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 2. Pressure Plates: Stainless steel or reinforced nylon polymer.
 - 3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

PART 3 EXECUTION

3.01 SLEEVE INSTALLATION

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
 - 1. Sleeves are not required for core-drilled holes through exterior walls or slab-on-grade floors.
- B. For sleeves that will have sleeve seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and interior of sleeve.
 - 1. For core-drilled holes, size hole large enough to provide 1-inch annular space between piping and concrete wall or slab-on-grade floor.
- C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
 - 2. Using grout, seal the space outside of sleeves in slabs and walls.
- D. Install sleeves in core-drilled holes in concrete floors in mechanical equipment areas or other wet areas.
 - 1. Extend sleeves 2 inches above finished floor level.
 - 2. Using grout, seal the space outside of sleeves.
- E. Install sleeves for pipes passing through interior partitions.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - 2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
 - 3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Division 07 specifications.
- F. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Division 07 specifications.

3.02 SLEEVE SEAL SYSTEM INSTALLATION

- A. Install sleeve seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.
- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Center piping in penetration, assemble sleeve seal system components, and install in annular space between piping and sleeve or hole. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.03 SLEEVE AND SLEEVE SEAL SCHEDULE

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
 - 1. Exterior Concrete Walls Above Grade: Cast-iron wall sleeves, galvanized-steel wall sleeves or galvanized-steel-pipe sleeves.

2. Exterior Concrete Walls Below Grade:
 - a. Piping Smaller than NPS 4: Cast-iron wall sleeves with sleeve seal system, galvanized-steel wall sleeves with sleeve seal system or galvanized-steel-pipe sleeves with sleeve seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve seal system.
 - b. Piping NPS 4 and Larger: Cast-iron wall sleeves with sleeve seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve seal system.
3. Concrete Foundation or Stem Walls Below Grade:
 - a. Piping Smaller than NPS 4: Cast-iron wall sleeves.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve.
 - b. Piping NPS 4 and Larger: Cast-iron wall sleeves.
4. Concrete Slabs-on-Grade:
 - a. Piping Smaller than NPS 4: Cast-iron wall sleeves with sleeve seal system, galvanized-steel wall sleeves with sleeve seal system or galvanized-steel-pipe sleeves with sleeve seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve seal system.
 - b. Piping NPS 4 and Larger: Cast-iron wall sleeves with sleeve seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve seal system.
5. Concrete Slabs Above Grade: Galvanized-steel-pipe sleeves.
6. Interior Partitions:
 - a. Piping Smaller than NPS 6: Galvanized-steel-pipe sleeves.
 - b. Piping NPS 6 and Larger: Galvanized-steel-sheet sleeves.

END OF SECTION

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SECTION 22 05 18

ESCUTCHEONS FOR PLUMBING PIPING

PART 1 GENERAL

1.01 SUMMARY

- A. This section includes:
 - 1. Escutcheons.
 - 2. Floor plates.

1.02 SUBMITTALS

- A. Product Data: For each type of product indicated.

PART 2 PRODUCTS

2.01 ESCUTCHEONS

- A. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.
- C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.
- D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw and polished chrome-plated finish.

2.02 FLOOR PLATES

- A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.
- B. Split-Casting, Floor Plate Type: Cast brass with concealed hinge and set screw.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
- B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
 - 1. Escutcheons for New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Insulated Piping: One-piece, stamped-steel type.
 - c. Bare Piping: One-piece, cast-brass type.
 - 2. Escutcheons for existing piping shall be split-casting, cast-brass type.
- C. Install floor plates for piping penetrations of equipment-room floors.

- D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
 - 1. New Piping: One-piece, floor-plate type.
 - 2. Existing Piping: Split-casting, floor-plate type.

3.02 FIELD QUALITY CONTROL

- A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION

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SECTION 22 05 19

METERS & GAGES FOR PLUMBING PIPING

PART 1 GENERAL

1.01 SUMMARY

- A. This section includes:
 - 1. Liquid-in-glass thermometers.
 - 2. Thermowells.
 - 3. Dial-type pressure gages.
 - 4. Gage attachments.

1.02 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Product certificates.
- C. Operation and maintenance data.

PART 2 PRODUCTS

2.01 LIQUID-IN-GLASS THERMOMETER

- A. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Miljoco Corporation.
 - b. Palmer Wahl Instrumentation Group.
 - c. Trerice, H.O. Co.
 - d. Weiss Instruments, Inc.
 - e. Winters Instruments – U.S.
 - 2. Standard: ASME B40.200.
 - 3. Case: Cast aluminum, 9-inch nominal size unless otherwise indicated.
 - 4. Case Form: Adjustable angle unless otherwise indicated.
 - 5. Tube: Glass with magnifying lens and blue or red organic liquid.
 - 6. Tube Background: Non-reflective aluminum with permanently etched scale markings graduated in degrees F.
 - 7. Window: Glass.
 - 8. Stem: Bare aluminum and of length to suit installation.
 - 9. Connector: 1-1/4 inches, with ASME B1.1 screw threads.
 - 10. Accuracy: $\pm 1\%$ of scale range or one scale division, to a maximum of 1.5% of scale range.

2.02 THERMOWELLS

- A. Standard: ASME B40.200.

- B. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
- C. Material for Use with Copper Tubing: Brass.
- D. Material for Use with Steel Piping: Stainless Steel.
- E. Type: Stepped shank unless straight or tapered shank is indicated.
- F. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
- G. Internal Threads: 1-1/4 inch, with ASME B1.1 screw threads.
- H. Bore: Diameter required to match thermometer bulb or stem.
- I. Insertion Length: Length required to match thermometer bulb or stem.
- J. Lagging Extension: Include on thermowells for insulated piping and tubing.
- K. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

2.03 PRESSURE GAGES

- A. Metal-Case, Dial-Type Pressure Gages:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Marsh Bellofram.
 - b. Miljoco Corporation.
 - c. Palmer Wahl Instrumentation Group.
 - d. Trerice, H. O. Co.
 - e. Weiss Instruments, Inc.
 - f. Weksler.
 - 2. Standard: ASME B40.100.
 - 3. Case: Liquid-filled sealed type(s); cast aluminum or drawn steel; 4-1/2-inch nominal diameter.
 - 4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
 - 5. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
 - 6. Movement: Mechanical, with link to pressure element and connection to pointer.
 - 7. Dial: Non-reflective aluminum with permanently-etched scale markings graduated in psi.
 - 8. Pointer: Dark-colored metal.
 - 9. Window: Glass.
 - 10. Ring: Metal.
 - 11. Accuracy: Grade A, $\pm 1\%$ of middle half of scale range.

2.04 GAGE ATTACHMENTS

- A. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and surge-dampening device. Include extension for use on insulated piping.
- B. Valves: Brass or stainless-steel needle, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install thermowells with socket extending one-third of pipe diameter and in vertical position in piping tees.
- B. Install thermowells of sizes required to match thermometer and temperature sensor connectors. Include bushings if required to match sizes.
- C. Install thermowells as directed by the Building Automation System Contractor.
- D. Install thermowells with extension on insulated piping.
- E. Fill thermowells with heat-transfer medium.
- F. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
- G. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.
- H. Install valve and snubber in piping for each pressure gage for fluids.
- I. Install thermometers where indicated on the drawings and in the following locations:
 - 1. Outlet of each water heater.
 - 2. Two inlets and one outlet of each mixing valve.
 - 3. Inlet and outlet of each thermal-storage tank.
- J. Install pressure gages where indicated on the drawings and in the following locations:
 - 1. Discharge of each pressure-reducing valve.
 - 2. Each pump. Provide one gage per pump with tubing and valves to allow measurement at strainer inlet, pump inlet, and pump discharge.

3.02 CONNECTIONS

- A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

3.03 ADJUSTING

- A. After installation, calibrate meters according to manufacturer's written instructions.
- B. Adjust faces of meters and gages to proper angle for best visibility.

3.04 THERMOMETER SCALE-RANGE SCHEDULE

- A. Scale Range for Cold- and Hot-Water Piping: 0 to 250°F.

3.05 PRESSURE-GAGE SCALE-RANGE SCHEDULE

A. Scale Range: 0 to 100 psi.

END OF SECTION

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SECTION 22 05 23

GENERAL DUTY VALVES FOR PLUMBING WATER PIPING

PART 1 GENERAL

1.01 SUMMARY

- A. This section includes:
 - 1. Ball valves.
 - 2. Bronze swing check valves.
 - 3. Iron swing check valves.
 - 4. Iron swing check valves with closure control.
 - 5. Iron gate valves.
 - 6. Chainwheels.

1.02 SUBMITTALS

- A. Product Data: For each type of valve indicated.
- B. Warranty information.
- C. Operation and maintenance data.

1.03 QUALITY ASSURANCE

- A. ASME Compliance: ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
- B. NSF Compliance: NSF 61-G for valve materials for potable-water service.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS FOR VALVES

- A. Refer to Plumbing Valve Schedule articles for applications of valves.
- B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- C. Valve Sizes: The same as upstream piping unless otherwise indicated.
- D. Valve Actuator Types:
 - 1. Gear Actuator: For quarter-turn valves NPS 6 and larger.
 - 2. Handwheel: For valves other than quarter-turn types.
 - 3. Handlever: For quarter-turn valves NPS 4 and smaller except plug valves.
 - 4. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the Valve Installation article.
- E. Valves in Insulated Piping: With 2-inch stem extensions and the following features:
 - 1. Gate Valves: With rising stem.

2. Ball Valves in Chilled Drinking Water Service: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation. Assembly shall be UL 2043 Classified.
- F. Valve-End Connections:
1. Flanged: With flanges according to ASME B16.1 for iron valves.
 2. Solder Joint: With sockets according to ASME B16.18.
 3. Threaded: With threads according to ASME B1.20.1.
- G. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. American Valve.
 2. Conbraco Industries, Inc.; Apollo Valves.
 3. FNW.
 4. Hammond Valve.
 5. Kitz Corporation of America.
 6. Milwaukee Valve Company.
 7. NIBCO INC.
 8. Watts Regulator Co.; a Division of Watts Water Technologies, Inc.

2.02 BALL VALVES

- A. Two-Piece, Full-Port Ball Valves with Bronze Trim:
1. Standard: MSS SP-110.
 2. Compliance: ANSI/NSF 372 lead-free.
 3. SWP Rating: 150 psig.
 4. CWP Rating: 600 psig.
 5. Body Design: Two piece.
 6. Body Material:
 - a. Valves 2 Inches and Smaller: Forged bronze.
 - b. Valves 2-1/2 Inches and Larger: Forged bronze or brass.
 7. Ends: Soldered or threaded as indicated below.
 8. Seats: PTFE or TFE.
 9. Stem: Bronze or brass to match valve body.
 10. Ball: Chrome-plated brass.
 11. Port: Full.
- B. Two-Piece, Full-Port Cast-Iron Ball Valves:
1. Standard: ANSI B16.10.
 2. Compliance:
 - a. ANSI/NSF 61-8 drinking water safe.
 - b. ANSI/NSF 372 lead-free.
 3. SWP Rating: 125 psig.
 4. CWP Rating: 200 psig.
 5. Body Design: Two piece.
 6. Body Material: Epoxy-coated cast iron.
 7. Ends: Flanged.
 8. Seats: PTFE or TFE.
 9. Stem: Stainless steel, blowout proof design.
 10. Ball: Teflon fused cast iron or stainless steel.
 11. Port: Full.

2.03 CHECK VALVES

- A. Class 125, Bronze Swing Check Valves with Bronze Disc:
 - 1. Standard: MSS SP-80, Type 3.
 - 2. Compliance: ANSI/NSF 372 lead-free.
 - 3. CWP Rating: 200 psig.
 - 4. Body Design: Horizontal flow.
 - 5. Body Material: ASTM B62, bronze.
 - 6. Ends: Threaded.
 - 7. Disc: Bronze.
- B. Class 125, Iron Swing Check Valves with Metal Seats:
 - 1. Standard: MSS SP-71, Type I.
 - 2. CWP Rating: 200 psig.
 - 3. Body Design: Clear or full waterway.
 - 4. Body Material: ASTM A126, gray iron with bolted bonnet.
 - 5. Ends: Flanged.
 - 6. Trim: Bronze.
 - 7. Gasket: Asbestos-free.

2.04 CHECK VALVES WITH CLOSURE CONTROL

- A. Class 125, Iron Swing Check Valves with Lever- and Weight-Closure Control:
 - 1. Standard: MSS SP-71, Type I.
 - 2. CWP Rating: 200 psig.
 - 3. Body Design: Clear or full waterway.
 - 4. Body Material: ASTM A126, gray iron with bolted bonnet.
 - 5. Ends: Flanged.
 - 6. Trim: Bronze.
 - 7. Gasket: Asbestos-free.
 - 8. Closure Control: Factory-installed, exterior lever and weight.

2.05 GATE VALVES

- A. Class 125, Non-Rising Stem (NRS), Full-Port, Iron Gate Valves:
 - 1. Standard: MSS SP-70, Type I.
 - 2. CWP Rating: 200 psig.
 - 3. Body Material: ASTM A126, gray iron with bolted bonnet.
 - 4. Ends: Flanged.
 - 5. Trim: Bronze.
 - 6. Disc: Solid wedge.
 - 7. Packing and Gasket: Asbestos-free.

2.06 CHAINWHEELS

- A. Description: Valve actuation assembly with sprocket rim, brackets, and chain.
 - 1. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
 - 2. Attachment: For connection to valve stems.
 - 3. Sprocket Rim with Chain Guides: Ductile iron, of type and size required for valve. Include zinc coating.
 - 4. Chain: Hot-dip, galvanized steel, of size required to fit sprocket rim.

PART 3 EXECUTION

3.01 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem and handle movement.
- E. Install gear actuator with hand wheel axle in horizontal position to prevent accidental engagement or disengagement.
- F. Install chainwheels on operators for gate valves NPS 2 and larger and more than 96 inches above floor. Extend chains to 60 inches above finished floor.
- G. Install chainwheels on operators for all valves located more than 3 feet above a lay-in ceiling. Extend chains to 6 inches above ceiling.
- H. Install chainwheels on operators for all valves located more than 2 feet above a hard ceiling access opening. Extend chains to 6 inches above ceiling.
- I. Install swing check valves for proper direction of flow and in horizontal position with hinge pin level.

3.02 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.03 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valve applications are not otherwise indicated, use the following:
 - 1. Shutoff Service: Ball or gate valves.
 - 2. Throttling Service: Ball valves.
 - 3. Pump-Discharge Check Valves:
 - a. NPS 2 and Smaller: Bronze swing check valves with bronze disc.
 - b. NPS 2-1/2 and Larger for Domestic Water: Iron swing check valves with lever and weight.
 - c. NPS 2-1/2 and Larger for Sanitary Waste and Storm Drainage: Iron swing check valves with lever and weight or spring.
- B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP class or CWP ratings may be substituted.
- C. Select valves with the following end connections:
 - 1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
 - 2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
 - 3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
 - 4. For Steel Piping, NPS 2 and Smaller: Threaded ends.

5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
6. For Steel Piping, NPS 5 and Larger: Flanged ends.

3.04 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

- A. Pipe NPS 4 and Smaller:
 1. Brass and Bronze Valves: NPS 2-1/2 and smaller may be provided with solder-joint ends instead of threaded ends. NPS 3 and larger threaded or flanged ends.
 2. Ball Valves: Two piece, full port.
 3. Bronze Swing Check Valves: Class 125, bronze disc.
- B. Pipe NPS 5 through NPS 8:
 1. Ball Valves: Two piece, full-port, cast iron with flanged ends.
 2. Iron Swing Check Valves: Class 125, metal seats.
 3. Iron Swing Check Valves with Closure Control: Class 125, lever and weight.
- C. Pipe NPS 10 and Larger:
 1. Iron Swing Check Valves: Class 125, metal seats.
 2. Iron Swing Check Valves with Closure Control: Class 125, lever and weight.
 3. Iron Gate Valves: Class 125, NRS.

3.05 SANITARY-WASTE AND STORM-DRAINAGE VALVE SCHEDULE

- A. Pipe NPS 4 and Smaller:
 1. Brass and Bronze Valves: NPS 2-1/2 and smaller may be provided with solder-joint ends instead of threaded ends. NPS 3 and larger threaded or flanged ends.
 2. Ball Valves: Two piece, full port, bronze with bronze trim.
 3. Bronze Swing Check Valves: Class 125, bronze disc.
- B. Pipe NPS 5 and Larger:
 1. Iron Swing Check Valves: Class 125, metal seats.
 2. Iron Swing Check Valves with Closure Control: Class 125, lever and weight.
 3. Iron Gate Valves: Class 125, NRS.

END OF SECTION

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SECTION 22 05 29

HANGERS & SUPPORTS FOR PLUMBING PIPING & EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

- A. This section includes:
 - 1. Metal pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3. Thermal-hanger shield inserts.
 - 4. Fastener systems.
 - 5. Pipe positioning systems.
 - 6. Equipment supports.
 - 7. Non-penetrating rooftop bases.

1.02 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
 - 1. Design supports for multiple pipes capable of supporting combined weight of supported systems, system contents, and test water with no load transmitted to connected equipment.
 - 2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.03 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Show fabrication and installation details and include calculations for the following; include product data for components:
 - 1. Trapeze pipe hangers.
 - 2. Equipment supports.
- C. Delegated-Design Submittal: For trapeze hangers, include analysis data signed and sealed by a qualified professional engineer responsible for their preparation.

1.04 QUALITY ASSURANCE

- A. Surface-Burning Characteristics: For tapes, as determined by testing identical products according to ASTM E84, by a testing agency acceptable to Authorities Having Jurisdiction. Factory label tapes with appropriate markings of applicable testing agency.
 - 1. Tape Installed in Return Plenums: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Tape Installed Elsewhere: No testing requirement.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with requirements, manufacturers shall be one of the following unless noted otherwise:
 - 1. Anvil International.
 - 2. B-Line.
 - 3. Elcen.
 - 4. Grinnell.
 - 5. Kin-Ling.
 - 6. Michigan Hanger Co.
 - 7. National Pipe Hanger Corp.
 - 8. PHD Manufacturing.
 - 9. PHS Industries.
 - 10. Pipe Technology Products.
 - 11. Unistrut.

2.02 METAL PIPE HANGERS AND SUPPORTS

- A. Carbon-Steel Pipe Hangers and Supports:
 - 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
 - 2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
 - 3. Non-Metallic Coatings: Plastic coating, jacket, or liner.
 - 4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
 - 5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel or stainless steel.
- B. Stainless-Steel Pipe Hangers and Supports:
 - 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
 - 2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
 - 3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

2.03 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts. Pregalvanized components or hot dip galvanize entire assembly after fabrication where indicated.

2.04 THERMAL-HANGER SHIELD INSERTS

- A. Insulation-Insert Material for Hot or Cold Piping: ASTM C552, Type II cellular glass with 100-psig or ASTM C591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.
- B. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- C. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- D. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

- E. Shield: Shields shall be a minimum of 18 gauge galvanized steel, 12 inches long for piping 6 inches and smaller. Shields shall be a minimum of 16 gauge galvanized steel, 18 inches long for pipe over 6 inches.

2.05 PIPE POSITIONING SYSTEMS

- A. Description: IAPMO PS 42, positioning system of metal brackets, clips, and straps for positioning piping in pipe spaces; for plumbing fixtures in commercial applications.
- B. Bushings: Plastic, flame retardant bushings may be used at penetrations of steel stubs and steel clips.

2.06 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes. Pregalvanized components or hot dip galvanize entire assembly after fabrication where indicated.

2.07 NON-PENETRATING ROOFTOP BASES

- A. Subject to compliance with requirements, manufacturers shall be one of the following:
 - 1. Roof Top Blox.
 - 2. Miro Industries, Inc.
- B. Description: Stainless-steel or polycarbonate bases designed for direct placement on roofing membrane.
 - 1. General:
 - a. All edges and corners in contact with the roof surface shall be rounded to prevent damage to the roof membrane.
 - b. Drainage ports shall be provided to prevent ponding of water within the base.
 - c. The bottom of the base shall be solid and flat, free of voids and deformities to prevent concentrated loading of the roofing membrane.
 - d. Polycarbonate bases shall be UV stabilized with carbon black.
 - 2. Supports: Pipe and equipment supports mounted to roof bases shall be constructed as outlined above. Integral supports for small diameter piping and conduit may be integral with polycarbonate bases.
 - 3. Protective Pads: 1/8 inch thick, flexible, PVC with carbon black additive for UV stabilization, protective pad for placement beneath roof bases to protect roofing membrane.

2.08 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A36/A36M, carbon-steel plates, shapes, and bars; black and galvanized.
- B. Tape for Plenum Use:
 - 1. Polypropylene backing with acrylic adhesive, Hart & Cooley Part Number 011371.
 - 2. Polyethylene coated cloth backing with rubber adhesive, Uline Black Nashua 398 Duct Tape, Model Number S-17236BL.

PART 3 EXECUTION

3.01 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
 - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
 - 2. Field fabricate from ASTM A36/A36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- D. Pipe-Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture. Refer to Division 22 plumbing fixture sections for requirements for pipe positioning systems for plumbing fixtures.
- E. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- F. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- G. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- H. Install lateral bracing with pipe hangers and supports to prevent swaying.
- I. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- J. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- K. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- L. Insulated Piping:
 - 1. Attach clamps and spacers to piping.
 - a. Piping Operating Above Ambient Air Temperature: Clamp may not project through insulation except riser clamp.
 - b. Piping Operating Below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
4. Shield Dimensions for Pipe: Not less than the following:

	Length	Thickness
NPS 1/4 to NPS 3-1/2	12 inches	0.048 inch
NPS 4	12 inches	0.06 inch
NPS 5 & NPS 6	18 inches	0.06 inch
NPS 8 to NPS 14	24 inches	0.075 inch
NPS 16 to NPS 2	24 inches	0.105 inch

5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.02 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place non-shrink grout under supports for equipment and make bearing surface smooth.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.03 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 2. Obtain fusion without undercut or overlap.
 3. Remove welding flux immediately.
 4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.04 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.05 PAINTING

- A. Refer to General Provisions for rust inhibiting primer.
- B. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- C. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 specifications.
- D. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780.

3.06 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system sections.
- C. Wrap copper piping with not less than two layers of 10-mil-thick black plastic tape extending a minimum of 1 inch on each side of clamp for electrolytic protection where hangers or supports are in direct contact with copper piping.
- D. Use carbon-steel pipe hangers and supports and metal trapeze pipe hangers and attachments for general service applications. Provide galvanized coating on all hangers and supports outside the insulated building envelope.
- E. Use stainless-steel pipe hangers and stainless-steel or corrosion-resistant attachments for hostile environment applications.
- F. Use padded hangers for piping that is subject to scratching.
- G. Use thermal-hanger shield inserts for insulated piping and tubing.
- H. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system sections, install the following types:
 - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated, stationary pipes NPS 1/2 to NPS 30.
 - 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1,050°F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
 - 3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.

4. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
 5. Single-Pipe Rolls (MSS Type 43): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
 6. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
 7. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
- I. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.
- J. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system sections, install the following types:
1. Steel Turnbuckles (MSS Type 13).
 2. Steel Clevises (MSS Type 14): For 120 to 450°F piping installations.
- K. Building Attachments: Unless otherwise indicated and except as specified in piping system sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joint construction, to attach to top flange of structural shape. Include retaining clip.
 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes.
 7. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lbs.
 - b. Medium (MSS Type 32): 1,500 lbs.
 - c. Heavy (MSS Type 33): 3,000 lbs.
 8. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 9. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
- L. Saddles and Shields: Unless otherwise indicated and except as specified in piping system sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

- M. Roof Bases: Unless otherwise indicated, install roof bases for roof-mounted piping and equipment as follows:
1. Select roof base size based on expected load to prevent crushing of the roofing membrane and underlying insulation.
 2. Space roof bases as required to properly support pipes or more frequently to distribute the weight of the supported systems to prevent damage to the roofing membrane, underlying insulation, or roofing system.
 3. Provide protective pads between each roof base and the roofing membrane. Size pads to extend a minimum of 2 inches beyond each roof base.
- N. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system sections, install the following types:
1. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
 2. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
- O. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system sections.
- P. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

END OF SECTION

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SECTION 22 05 48

VIBRATION CONTROLS FOR PLUMBING PIPING & EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

- A. This section includes the following:
 - 1. Isolation pads.
 - 2. Isolation mounts.
 - 3. Freestanding spring isolators.
 - 4. Housed spring mounts.
 - 5. Elastomeric hangers.
 - 6. Spring hangers.
 - 7. Spring hangers with vertical-limit stops.
 - 8. Pipe riser resilient supports.
 - 9. Resilient pipe guides.

1.02 SUBMITTALS

- A. Product Data: For each product indicated.
 - 1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
 - 2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
- B. Welding certificates.
- C. Field quality-control test reports.

1.03 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, Structural Welding Code - Steel.

PART 2 PRODUCTS

2.01 VIBRATION ISOLATORS

- A. Manufacturers: The following products are based on Mason Industries. Subject to compliance with requirements, provide comparable products by one of the following:
 - 1. Amber/Booth Company, Inc.
 - 2. Kinetics Noise Control.
 - 3. Mason Industries.
 - 4. Vibration Mountings & Controls, Inc.
- B. Neoprene Pad: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a non-slip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.
 - 1. Resilient Material: Oil- and water-resistant neoprene.

- C. Style B - Spring Isolators: Freestanding, laterally stable, open-spring isolators.
1. Outside Spring Diameter: Not less than 80% of the compressed height of the spring at rated load.
 2. Minimum Additional Travel: 50% of the required deflection at rated load.
 3. Lateral Stiffness: More than 80% of rated vertical stiffness.
 4. Overload Capacity: Support 200% of rated load, fully compressed, without deformation or failure.
 5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch-thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig.
 6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.
- D. Style F - Spring Hangers: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.
1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
 2. Outside Spring Diameter: Not less than 80% of the compressed height of the spring at rated load.
 3. Minimum Additional Travel: 50% of the required deflection at rated load.
 4. Lateral Stiffness: More than 80% of rated vertical stiffness.
 5. Overload Capacity: Support 200% of rated load, fully compressed, without deformation or failure.
 6. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
 7. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.
- E. Style G - Spring Hangers with Vertical-Limit Stop: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.
1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
 2. Outside Spring Diameter: Not less than 80% of the compressed height of the spring at rated load.
 3. Minimum Additional Travel: 50% of the required deflection at rated load.
 4. Lateral Stiffness: More than 80% of rated vertical stiffness.
 5. Overload Capacity: Support 200% of rated load, fully compressed, without deformation or failure.
 6. Elastomeric Elements: Molded, oil-resistant rubber or neoprene.
 - a. Minimum 1-1/4-inch-thick element at top of hanger with steel-washer-reinforced rod support and bushing projecting through top of frame.
 - b. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
 7. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
 8. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

- F. Style L – Floating Concrete Base: Rectangular, welded or bolted, structural or formed, steel pouring form for field provided concrete. The depth of the base shall be a minimum of 1/12th the longest dimension of the base but no less than 6 inches. The maximum base depth is not required to be more than 12 inches. Bases shall include 1/2-inch reinforcing bars running in both directions welded in place at 6-inch centers located 1-1/2 inches above the bottom of the base. Forms shall be furnished with steel templates to secure the anchor bolts and anchor bolt sleeves during pouring activities. Bases shall be provided with height saving brackets to maintain a 1-inch clearance below the base. Bases for pumps shall be sized to support the suction and discharge elbows.
- G. Style Q – Wall, Floor, and Ceiling Seals: Minimum 3/4-inch-thick neoprene sponge cemented to inner face of split pipe halves. Seals shall extend 1 inch beyond both faces of the element being penetrated.

2.02 FACTORY FINISHES

- A. Finish: Manufacturer's standard paint applied to factory-assembled equipment before shipping.
 - 1. Powder coating on springs and housings.
 - 2. All hardware shall be zinc electroplated.
 - 3. Baked enamel or powder coat for metal components on isolators for interior use.
 - 4. Color-code or otherwise mark vibration isolation control devices to indicate capacity range.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Engage a factory-authorized representative to inspect the intended equipment locations for deficiencies and to instruct installers in correct equipment installation procedure and sequence.
- B. Examine areas and equipment to receive vibration isolation devices for compliance with requirements for installation tolerances and other conditions affecting performance.
- C. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 APPLICATIONS

- A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application.
- B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits.

- C. Select vibration isolation elements and deflections in accordance with the following table:

Equipment	Location	Vibration Isolation Element (Minimum Deflection)
Pump	Slab On-Grade (Sound Critical) OR Slab Not On-Grade	Style B or L (1.5 inches ≤ 60 HP) (2.5 inches > 60 HP)
	Suspended In-Line Type	Style F (1.5 inches)
Piping	Where connected to equipment with spring isolators.	Style G on first four hangers (Match equipment deflection)
	Building element penetrations between central plants & sound critical spaces.	Style Q

3.03 VIBRATION-CONTROL INSTALLATION

- A. Install bushing assemblies for mounting bolts for vibration isolated wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
- B. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
- C. Drilled-In Anchors:
1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the Structural Engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid pre-stressed tendons, electrical and telecommunications conduit, and gas lines.
 2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
 3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
 4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
 5. Set anchors to manufacturer's recommended torque, using a torque wrench.
 6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.
- D. Riser Isolation: Suspended risers with spring hangers or supported with spring mounts, anchored with piping anchors, and guided with sliding guides.
1. Suspend horizontal pipe runs and branches with spring hangers for the first three supports from the risers.
 2. Steel springs shall be selected to provide a minimum of 3/4-inch static deflection except in those expansion locations where additional deflection is required to limit load changes to plus 25% of the initial load.

- E. Short-Circuiting: Avoid short-circuiting to the building any vibration-isolated piece of equipment, pipe, duct or other component. Short-circuits with or via rigid conduits, drain lines, rigid braces, rigid sleeves, framing, etc., shall all be avoided. The Contractor shall oversee trades to prevent the short-circuiting of any vibration isolation system and shall bring any unresolved conflicts to the Architect's attention.
- F. Incidentals: Supply and install any incidental equipment or parts needed to meet the requirements stated, even if not specified or shown on the drawings.

3.04 ADJUSTING

- A. Adjust isolators after piping system is at operating weight.
- B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.
- C. Adjust active height of spring isolators.
- D. Adjust restraints to permit free movement of equipment within normal mode of operation.

END OF SECTION

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SECTION 22 05 53

IDENTIFICATION FOR PLUMBING PIPING & EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

- A. This section includes:
 - 1. Equipment labels.
 - 2. Warning signs and labels.
 - 3. Pipe labels.

1.02 SUBMITTAL

- A. Product Data: For each type of product indicated.

PART 2 PRODUCTS

2.01 EQUIPMENT LABELS

- A. Plastic Labels for Equipment:
 - 1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8-inch thick, and having predrilled holes for attachment hardware.
 - 2. Letter Color: Black.
 - 3. Background Color: White.
 - 4. Maximum Temperature: Able to withstand temperatures up to 160°F.
 - 5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2" x 3/4".
 - 6. Minimum Letter Size: 1/2 inch. Include secondary lettering 3/8 inch.
 - 7. Fasteners: Stainless-steel rivets or self-tapping screws.
 - 8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Label Content: Include equipment's drawing designation or unique equipment number, and area(s) served by equipment. Coordinate with Owner.

2.02 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8-inch thick, and having predrilled holes for attachment hardware.
- B. Letter Color: White.
- C. Background Color: Red.
- D. Maximum Temperature: Able to withstand temperatures up to 160°F.
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2" x 3/4".
- F. Minimum Letter Size: 1/2 inch. Include secondary lettering 3/8 inch.

- G. Fasteners: Stainless-steel rivets or self-tapping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Label Content: As indicated on drawings or required by local authority.

2.03 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
 - 1. Complying with latest edition of ANSI/ASME A13.1 unless specifically noted otherwise or directed by Owner.
- B. Pretensioned Pipe Labels: Precoiled, semi-rigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Strap-On Pipe Labels: Semi-rigid plastic formed to fit circumference of pipe and to attach to pipe with stainless-steel worm-drive clamps.
- D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on drawings, pipe size, and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
 - 2. Lettering Size: At least 1-1/2 inches high.

2.04 PAINTED PIPE LABELS

- A. Paint: Alkyd paint selected for use without a primer based on base material.
- B. Color: Match background color indicated in Label Color Schedules below.
- C. Application: Use stencils for paint application.
- D. Lettering Size: At least 3 inches high.
- E. Flow Arrows: To show flow direction.

PART 3 EXECUTION

3.01 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.02 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of plumbing equipment.
- B. Locate equipment labels where accessible and visible.

3.03 PIPE LABEL INSTALLATION

- A. Comply with requirements in latest edition of ASNI/ASME 13.1 unless noted otherwise.
- B. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Near each valve and control device.
 - 2. Near each branch connection, excluding short takeoffs for fixtures. Where flow pattern is not obvious, mark each pipe at branch.
 - 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.
 - 6. Spaced at maximum intervals of 20 feet along each run. Reduce intervals to 10 feet in areas of congested piping and equipment. Reduce spacing to 5 feet when required by code.
 - 7. Spaced at maximum 10 feet on piping above removable acoustical ceilings. Reduce spacing to 5 feet when required by code.
- C. Use painted pipe labels outside where piping is exposed to weather.
 - 1. Apply one or two coats using the same stencil as required for thorough coverage.
- D. Pipe Label Color Schedule:
 - 1. Low-Pressure, Compressed-Air Piping:
 - a. Background Color: Blue.
 - b. Letter Color: White.
 - 2. Domestic Water Piping:
 - a. Background Color: Green.
 - b. Letter Color: White.
 - 3. Sanitary Waste and Storm Drainage Piping:
 - a. Background Color: Green.
 - b. Letter Color: White.

3.04 ADJUSTING AND CLEANING

- A. Relocate plumbing identification materials and devices that have become visually blocked by other work.
- B. Clean faces of plumbing identification devices.

END OF SECTION

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SECTION 22 07 19

PLUMBING PIPING INSULATION

PART 1 GENERAL

1.01 SUMMARY

- A. This section includes insulating the following plumbing piping services:
 - 1. Domestic hot water piping.
 - 2. Domestic recirculating hot water piping.

1.02 SUBMITTALS

- A. Product Data: For each type of product indicated, include manufacturer's technical data with proposed thickness and R-value indicated as well as proposed application.

1.03 QUALITY ASSURANCE

- A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E84 by a testing agency acceptable to Authorities Having Jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.
- B. Comply with the following applicable standards and other requirements specified for miscellaneous components:
 - 1. Supply and Drain Protective Shielding Guards: ICC A117.1.

PART 2 PRODUCTS

2.01 INSULATION MATERIALS

- A. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- B. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C871.
- C. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C795.
- D. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- E. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C534, Type I for tubular materials.
 - 1. Manufacturers: Subject to compliance with requirements, provide product by one of the following manufacturers:
 - a. Armacell LLC.

- b. K-Flex USA.
- F. Mineral-Fiber, Pre-Formed Pipe Insulation:
 - 1. Manufacturers: Subject to compliance with requirements, provide product by one of the following manufacturers:
 - a. Certainteed Corp.
 - b. Johns Manville; Micro-Lok.
 - c. Knauf Insulation.
 - d. Owens Corning.
 - 2. Mineral-Fiber, Pre-Formed Pipe Insulation:
 - a. Type I, 850°F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C547, Type I, Grade A, with factory-applied ASJ or with factory-applied ASJ-SSL. Omit jacket on all but outermost layer where multiple insulation layers are required. Jacket shall comply with the following:
 - 1) ASJ: White, kraft paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
 - 2) ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.
- G. Removable Insulation Wrap:
 - 1. Manufacturers: Subject to compliance with requirements, provide product by No Sweat.
 - 2. Removable Insulation Wrap:
 - a. Insert: Mineral or glass fibers bonded with a thermosetting resin with a minimum k-factor of 0.26 suitable for use up to 450°F. Maximum flame spread index of 25 and maximum smoke developed index of 50 per ASTM E84. Insert thickness to match thickness of adjacent insulation.
 - b. Outer Jacket: Tychem wrap consisting of Tyvek fabric made of spunbonded polyolefin with a polyethylene coating to limit vapor permeability. Jacket shall be provided with elastic banding at the ends and a reclosable hook and loop closure system at the seam. Maximum flame spread index of 25 and maximum smoke developed index of 50 per ASTM E84.

2.02 INSULATING CEMENTS

- A. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C449.

2.03 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.
- B. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.
 - 1. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Flame-spread index shall be 25 or less and smoke-developed index shall be 50 or less as tested in accordance with ASTM E84.
 - 3. Wet Flash Point: Below 0°F.
 - 4. Service Temperature Range: 40 to 200°F.
 - 5. Color: Black.

- C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
 - 1. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- D. ASJ Adhesive and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
 - 1. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- E. PVC Jacket Adhesive: Compatible with PVC jacket.
 - 1. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.04 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
 - 1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.
 - 1. Water-Vapor Permeance: ASTM E96/E96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
 - 2. Service Temperature Range: -20 to +180°F.
 - 3. Solids Content: ASTM D1644, 58% by volume and 70% by weight.
 - 4. Color: White.
- C. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.
 - 1. Water-Vapor Permeance: ASTM F1249, 1.8 perms at 0.0625-inch dry film thickness.
 - 2. Service Temperature Range: -20 to +180°F.
 - 3. Solids Content: 60% by volume and 66% by weight.
 - 4. Color: White.

2.05 SEALANTS

- A. Joint Sealants:
 - 1. Materials shall be compatible with insulation materials, jackets, and substrates.
 - 2. Permanently flexible, elastomeric sealant.
 - 3. Service Temperature Range: -100 to +300°F.
 - 4. Color: White or gray.
 - 5. For indoor applications, use sealants that have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. FSK and Metal Jacket Flashing Sealants:
 - 1. Materials shall be compatible with insulation materials, jackets, and substrates.
 - 2. Fire- and water-resistant, flexible, elastomeric sealant.
 - 3. Service Temperature Range: -40 to +250°F.
 - 4. Color: Aluminum.
 - 5. For indoor applications, use sealants that have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. ASJ Flashing Sealants, and Vinyl, and PVC Jacket Flashing Sealants:
 - 1. Materials shall be compatible with insulation materials, jackets, and substrates.

2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: -40 to +250°F.
4. Color: To match jacket.
5. For indoor applications, use sealants that have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.06 FIELD-APPLIED FABRIC-REINFORCING MESH

- A. Woven Polyester Fabric: Approximately 1 oz./sq.yd. with a thread count of 10 strands x 10 strands/sq.in., in a Leno weave, for pipe.

2.07 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C921, Type I, unless otherwise indicated.
- B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
 1. Adhesive: As recommended by jacket material manufacturer.
 2. Color: As scheduled below.
 3. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
 - a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.
- C. Aluminum Jacket: Comply with ASTM B209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
 1. Finish and thickness are indicated in field-applied jacket schedules.
 2. Moisture Barrier for Indoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.
 3. Moisture Barrier for Outdoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.
 4. Factory-Fabricated Fitting Covers:
 - a. Same material, finish, and thickness as jacket.
 - b. Pre-formed two-piece or gore, 45- and 90-degree, short- and long-radius elbows.
 - c. Tee covers.
 - d. Flange and union covers.
 - e. End caps.
 - f. Beveled collars.
 - g. Valve covers.
 - h. Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.08 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.
 1. Width: 3 inches.
 2. Thickness: 11.5 mils.
 3. Adhesion: 90 ounces force/inch in width.
 4. Elongation: 2%.
 5. Tensile Strength: 40 lbf/inch in width.
 6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

- B. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
 - 1. Width: 2 inches.
 - 2. Thickness: 6 mils.
 - 3. Adhesion: 64 ounces force/inch in width.
 - 4. Elongation: 500%.
 - 5. Tensile Strength: 18 lbf/inch in width.
- C. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
 - 1. Width: 2 inches.
 - 2. Thickness: 3.7 mils.
 - 3. Adhesion: 100 ounces force/inch in width.
 - 4. Elongation: 5%.
 - 5. Tensile Strength: 34 lbf/inch in width.

2.09 SECUREMENTS

- A. Aluminum Bands: ASTM B209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing seal or closed seal.
- B. Staples: Outward-clinching insulation staples, nominal 3/4 inch wide, stainless steel or Monel.
- C. Wire: 0.062 inch, soft-annealed, stainless steel.

PART 3 EXECUTION

3.01 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.02 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Install insulation continuously through hangers and around anchor attachments.
 - 1. At pipe guides, secure spider to pipe and apply insulation through spider per the guide manufacturer's recommendations.
- K. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
- L. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- M. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
- N. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- O. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth.
 - 2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 - 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
 - a. For below-ambient services, apply vapor-barrier mastic over staples.
 - 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
 - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
- P. Cut insulation in a manner to avoid compressing insulation more than 75% of its nominal thickness.
- Q. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- R. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- S. For above-ambient services, do not install insulation to the following:
 - 1. Vibration-control devices.
 - 2. Testing agency labels and stamps.

3. Nameplates and data plates.
4. Cleanouts.

3.03 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
 1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends below roof surface. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
- C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
 1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends inside building. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
 4. Seal jacket to wall flashing with flashing sealant.
- D. Insulation Installation at Interior Wall and Partition Penetrations (that are not Fire Rated): Install insulation continuously through walls and partitions.
- E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
 1. Comply with requirements in Division 07 specifications for firestopping and fire-resistive joint sealers.
- F. Insulation Installation at Floor Penetrations:
 1. Pipe: Install insulation continuously through floor penetrations.
 2. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 specifications for firestopping and fire-resistive joint sealers.

3.04 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
 1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
 2. Insulate pipe elbows using pre-formed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams,

- voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with pre-formed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 4. Insulate valves using pre-formed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
 5. Insulate strainers using pre-formed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
 6. Insulate flanges and unions using a section of oversized pre-formed pipe insulation. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
 7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
 8. For services not specified to receive a field-applied jacket except for flexible elastomeric, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
 9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.
 10. Contractor's Option for Valves and Strainers: Removable insulation wrap system.
 - a. Below Ambient Systems or where a Vapor Barrier is Specified:
 - 1) Provide PVC tape around ends of wrap system to seal wrap to adjacent pipe insulation.
 - 2) Provide PVC tape closure along seam. Center tape to overlap seam.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
 2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union at least 2 times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.

3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.05 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- B. Insulation Installation on Pipe Flanges:
 1. Install pipe insulation to outer diameter of pipe flange.
 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
 4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- C. Insulation Installation on Pipe Fittings and Elbows:
 1. Install mitered sections of pipe insulation.
 2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- D. Insulation Installation on Valves and Pipe Specialties:
 1. Install pre-formed valve covers manufactured of same material as pipe insulation when available.
 2. When pre-formed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 3. Install insulation to flanges as specified for flange insulation application.
 4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.06 INSTALLATION OF MINERAL-FIBER PRE-FORMED PIPE INSULATION

- A. Insulation Installation on Straight Pipes and Tubes:
 1. Secure each layer of pre-formed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
 2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
 3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.

4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.
- B. Insulation Installation on Pipe Flanges:
1. Install pre-formed pipe insulation to outer diameter of pipe flange.
 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
 4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.
- C. Insulation Installation on Pipe Fittings and Elbows:
1. Install pre-formed sections of same material as straight segments of pipe insulation when available.
 2. When pre-formed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.
- D. Insulation Installation on Valves and Pipe Specialties:
1. Install pre-formed sections of same material as straight segments of pipe insulation when available.
 2. When pre-formed sections are not available, install mitered sections of pipe insulation to valve body.
 3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 4. Install insulation to flanges as specified for flange insulation application.

3.07 FIELD-APPLIED JACKET INSTALLATION

- A. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.
1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- B. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.08 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable pre-formed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
1. Drainage piping located in crawl spaces.
 2. Underground piping, except hot water return and hot water piping.
 3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.09 INDOOR PIPING INSULATION SCHEDULE

- A. Domestic Hot and Recirculated Hot Water, 140°F and Lower, Piping:
 - 1. Insulation shall have a maximum K-factor of 0.28 at a mean rating temperature of 100°F and be one of the following:
 - a. Flexible Elastomeric: 1 inch thick for piping less than 1-1/2 inches; Not permitted for piping 1-1/2 inches and larger.
 - b. Mineral-Fiber, Pre-Formed Pipe Insulation, Type I: 1 inch thick for piping less than 1-1/2 inches; 1-1/2 inches thick for piping 1-1/2 inches and larger.

3.10 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

- A. Domestic Hot and Recirculated Hot Water, 140°F and Lower, Piping:
 - 1. Mineral-Fiber, Pre-Formed Pipe Insulation, Type I shall have a maximum K-factor of 0.28 at a mean rating temperature of 100°F and be the following:
 - a. Mineral-Fiber, Pre-Formed Pipe Insulation, Type I: 1-1/2 inches thick for piping less than 1-1/2 inches; 2 inches thick for piping 1-1/2 inches and larger.
- B. Domestic Hot and Recirculated Hot Water, Above 140°F, Piping:
 - 1. Mineral-Fiber, Pre-Formed Pipe Insulation, Type I shall have a maximum K-factor of 0.29 at a mean rating temperature of 125°F and be the following:
 - a. Mineral-Fiber, Pre-Formed Pipe Insulation, Type I: 2 inches thick.

3.11 UNDERGROUND PIPING INSULATION SCHEDULE

- A. Domestic Hot and Recirculated Hot Water, 140°F and Less, Piping:
 - 1. Flexible Elastomeric Insulation with a Maximum K-Factor of 0.28 at a Mean Rating Temperature of 100°F: 1 inch thick for piping less than 1-1/2 inches; 1-1/2 inches thick for piping 1-1/2 inches and larger.

3.12 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Piping, Concealed: None.
- D. Piping, Exposed:
 - 1. PVC: 20 mils thick.
 - a. Color: White.
 - 2. Aluminum, Smooth or Corrugated: 0.016 inch thick.

3.13 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Piping, Concealed: None.

- D. Piping, Exposed: Aluminum, smooth or corrugated with Z-shaped locking seam,
0.020 inch thick.

END OF SECTION

Edition 0908-03/21

SECTION 22 11 16

DOMESTIC WATER PIPING

PART 1 GENERAL

1.01 SUMMARY

- A. This section includes:
 - 1. Under-building slab and aboveground domestic water pipes, tubes, fittings, and specialties inside the building.
 - 2. Specialty valves.
 - 3. Flexible connectors.

1.02 DEFINITIONS

- A. Domestic Water: Includes softened and un-softened domestic hot and cold water.

1.03 SUBMITTALS

- A. Product Data: For each type of pipe and joining material, and for method for joining piping intended for the project.
- B. Field quality-control reports.

1.04 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 61 Annex G or NSF 372 for low-lead potable domestic water piping and components.

PART 2 PRODUCTS

2.01 PIPING MATERIALS

- A. Comply with requirements in Piping Schedule article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.02 COPPER TUBE AND FITTINGS

- A. Hard Copper Tube: ASTM B88, Type L water tube, drawn temper.
 - 1. Cast-Copper Solder-Joint Fittings: ASME B16.18, pressure fittings.
 - 2. Wrought-Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
 - 3. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
 - 4. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
- B. Soft Copper Tube: ASTM B88, Type K and ASTM B88, Type L water tube, annealed temper.
 - 1. Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.

2.03 PIPING JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick or ASME B16.2.1, non-metallic and asbestos-free, unless otherwise indicated; full-face or ring type unless otherwise indicated.
- B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- C. Solder Filler Metals: ASTM B32, lead-free alloys. Include water-flushable flux according to ASTM B813.
- D. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

2.04 TRANSITION FITTINGS

- A. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

2.05 DIELECTRIC FITTINGS

- A. Dielectric Nipples: Galvanized- or electroplated-steel, or ductile iron nipple with inert and non-corrosive thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225°F.
- B. General Requirements: Assembly of copper alloy and ferrous materials or ferrous material body with separating non-conductive insulating material suitable for system fluid, pressure, and temperature.
 - 1. Dielectric Flanges:
 - a. Factory-fabricated, bolted, companion-flange assembly.
 - b. Pressure Rating: 150 psig.
 - c. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
 - 2. Dielectric-Flange Kits:
 - a. Non-conducting materials for field assembly of companion flanges.
 - b. Pressure Rating: 150 psig.
 - c. Gasket: Neoprene or phenolic.
 - d. Bolt Sleeves: Phenolic or polyethylene.
 - e. Washers: Phenolic with steel backing washers.

2.06 FLEXIBLE CONNECTORS

- A. Bronze-Hose Flexible Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.
 - 1. Working-Pressure Rating: Minimum 200 psig.
 - 2. End Connections NPS 2 and Smaller: Threaded copper pipe or plain-end copper tube.
 - 3. End Connections NPS 2-1/2 and Larger: Flanged copper alloy.

PART 3 EXECUTION

3.01 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved.
- B. Install copper tubing under building slab according to CDA's Copper Tube Handbook.
- C. Install piping buried below the building slab a minimum of 24 inches below slab.
- D. Install underground piping outside of the building footprint a minimum of 24 inches below finished grade or minimum of 12 inches below the local frostline, whichever is deeper.
- E. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve, inside the building at each domestic water service entrance.
- F. Install shutoff valve immediately upstream of each dielectric fitting.
- G. Install water-pressure-reducing valves downstream from shutoff valves where facility incoming water pressure exceeds 80 psi.
- H. Install domestic water piping level and plumb.
- I. Rough-in domestic water piping for water-meter installation according to utility company's requirements.
- J. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- K. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- L. Do not install piping within electrical rooms, elevator equipment rooms, MDF or IDF rooms, or stairwells. Exception: Pipe supplying equipment serving the room. Maintain all required clearances to other equipment.
- M. Do not install piping above electrical equipment such as transformers, panels, motor control centers, etc., in other rooms.
- N. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
- O. Install piping adjacent to equipment and specialties to allow service and maintenance.
- P. Install piping to permit valve servicing.
- Q. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than system pressure rating used in applications below unless otherwise indicated.

- R. Install piping free of sags and bends.
- S. Install factory fabricated fittings for changes in direction and branch connections.
- T. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.
- U. Install pressure gages on suction and discharge piping from each plumbing pump and packaged booster pump. Comply with requirements in Specification Section 22 05 19, Meters and Gages for Plumbing Piping, for pressure gages.
- V. Install thermostats in hot-water circulation piping. Comply with requirements in Specification Section "Domestic Water Pumps" for thermostats.
- W. Install thermometers on outlet piping from each water heater. Comply with requirements in Specification Section 22 05 19, Meters and Gages for Plumbing Piping, for thermometers.
- X. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Specification Section 22 05 17, Sleeves and Sleeve Seals for Plumbing Piping.
- Y. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Specification Section 22 05 17, Sleeves and Sleeve Seals for Plumbing Piping.
- Z. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Specification Section 22 05 18, Escutcheons for Plumbing Piping.

3.02 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- D. Brazed Joints: Join copper tube and fittings according to CDA's Copper Tube Handbook, Brazed Joints Chapter.
- E. Soldered Joints: Apply ASTM B813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B828 or CDA's Copper Tube Handbook.
- F. Flanged Joints: Select appropriate asbestos-free, non-metallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.

- G. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.03 VALVE INSTALLATION

- A. General-Duty Valves: Comply with requirements in Specification Section 22 05 23, General-Duty Valves for Plumbing Piping, for valve installations.
- B. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures that do not have supply stops. Use ball valves for piping NPS 4 and smaller. Use gate valves for piping NPS 5 and larger.
- C. Install drain valves for equipment at base of each water riser, at low points in horizontal piping, and where required to drain water piping. Drain valves are specified in Specification Section 22 11 19, Domestic Water Piping Specialties.
 - 1. Hose-End Drain Valves: At low points in water mains, risers, and branches.
 - 2. Stop-and-Waste Drain Valves: Instead of hose-end drain valves where indicated.
- D. Install balancing valve in each hot-water circulation return branch and where indicated on the drawings. Set balancing valves partly open to restrict but not stop flow. Comply with requirements in Specification Section 22 11 19, Domestic Water Piping Specialties, for balancing valves.

3.04 TRANSITION FITTING INSTALLATION

- A. Install transition couplings at joints of dissimilar piping.

3.05 DIELECTRIC FITTING INSTALLATION

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric nipples.
- C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges.
- D. Dielectric Fittings for NPS 5 to NPS 6: Use dielectric flange kits.

3.06 FLEXIBLE CONNECTOR INSTALLATION

- A. Install flexible connectors in suction and discharge piping connections to each domestic water booster pump.

3.07 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements in Specification Section 22 05 29, Hangers and Supports for Plumbing Piping and Equipment, for pipe hanger and support products and installation.
 - 1. Vertical Piping: MSS Type 8 or 42, clamps.
 - 2. Individual, Straight, Horizontal Piping Runs: MSS Type 1, adjustable, steel clevis hangers.
 - 3. Multiple, Straight, Horizontal Piping Runs: Trapeze hangers with pipe clamps.
- B. Support vertical piping and tubing at base and at each floor.

- C. Support horizontal piping and tubing within 12 inches of each fitting, valve, and coupling.
- D. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.
- E. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

	Maximum Horizontal Spacing	Minimum Rod Diameter
NPS 3/4 & Smaller	60 inches	3/8-inch rod
NPS 1 & NPS 1-1/4	72 inches	3/8-inch rod
NPS 1-1/2 & NPS 2	96 inches	3/8-inch rod
NPS 2-1/2	108 inches	1/2-inch rod
NPS 3 to NPS 5	10 feet	1/2-inch rod
NPS 6	10 feet	5/8-inch rod

- F. Install supports for vertical copper tubing every 10 feet.
- G. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

3.08 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment and machines to allow service and maintenance.
- C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.
- D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
 1. Domestic Water Booster Pumps: Cold-water suction and discharge piping.
 2. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
 3. Plumbing Fixtures: Cold- and hot-water supply piping in sizes indicated, but not smaller than required by plumbing code. Comply with requirements in Division 22 plumbing fixture sections for connection sizes.
 4. Equipment: Cold- and hot-water supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.
 5. Install automatic trap primers on the cold water supply at the nearest fixture (or where indicated on the drawings) and run drain to trap seal being protected. Provide wall access panel when primers are installed in walls.

3.09 IDENTIFICATION

- A. Identify system components. Comply with requirements in Specification Section 22 05 53, Identification for Plumbing Piping and Equipment, for identification materials and installation.
- B. Label pressure piping with system operating pressure.

3.10 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Piping Inspections:
 - 1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by Authorities Having Jurisdiction (AHJ).
 - 2. During installation, notify the AHJ at least 1 day before inspection must be made. Perform tests specified below in presence of the AHJ:
 - a. Roughing-In Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - b. Final Inspection: Arrange final inspection for the AHJ to observe tests specified below and to ensure compliance with requirements.
 - 3. Re-Inspection: If the AHJ finds that piping will not pass tests or inspections, make required corrections and arrange for re-inspection.
 - 4. Reports: Prepare inspection reports and have them signed by the AHJ.
- C. Piping Tests:
 - 1. Fill domestic water piping using clean, potable water. Check components to determine that they are not air bound and that piping is full of water.
 - 2. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
 - 3. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - 4. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for 4 hours. Leaks and loss in test pressure constitute defects that must be repaired.
 - 5. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
 - 6. Prepare reports for tests and for corrective action required.
- D. Domestic water piping will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

3.11 CLEANING

- A. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.
- B. Clean and disinfect potable domestic water piping prior to putting into service as follows:
 - 1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before use with clean, potable water.
 - 2. Use purging and disinfecting procedures prescribed by the AHJ; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Fill and isolate system according to either of the following:
 - 1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.

- 2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for 3 hours.
 - c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
 - d. Submit water samples in sterile bottles to the AHJ for testing of piping cleanliness. Repeat procedures if biological examination shows contamination.
- C. Prepare and submit reports of purging and disinfecting activities to Architect/Engineer. Include a copy of final report in Operation and Maintenance Manual.

3.12 PIPING SCHEDULE

- A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
- B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.
- C. Underground, domestic water, building service piping shall be:
1. Piping NPS 2 and Smaller: Soft copper tube, ASTM B88, Type K; wrought-copper solder-joint fittings; and brazed joints.
 2. Piping NPS 2-1/2 and Larger: Hard copper tube, ASTM B88, Type K; wrought-copper solder-joint fittings; and brazed joints.
- D. Under-building-slab, domestic water piping shall be:
1. Piping NPS 2 and Smaller: Soft copper tube, ASTM B88, Type L; without joints.
 2. Piping NPS 2-1/2 and Larger: Hard copper tube, ASTM B88, Type L; wrought-copper solder-joint fittings; and brazed joints.
 3. All under slab copper tube shall be protected with 20-mil plastic sleeving. Use blue sleeving on cold water piping and red sleeving for hot water piping. Sleeving shall extend a minimum of 2 inches above slab.
- E. Aboveground domestic water piping, NPS 2 and smaller shall be the following:
1. Hard copper tube, ASTM B88, Type L; cast- or wrought- copper solder-joint fittings; and soldered joints.
- F. Aboveground domestic water piping, NPS 2-1/2 to NPS 4 shall be the following:
1. Hard copper tube, ASTM B88, Type L; cast- or wrought- copper solder-joint fittings; and soldered joints.
- G. Aboveground domestic water piping, NPS 5 and NPS 6 shall be the following:
1. Hard copper tube, ASTM B88, Type L; cast- or wrought- copper solder-joint fittings; and brazed joints.

3.13 VALVE SCHEDULE

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
1. Shutoff Duty: Use ball valves for piping NPS 4 and smaller. Use gate valves with flanged ends for piping NPS 5 and larger.
 2. Throttling Duty: Use ball valves for piping NPS 4 and smaller. Use butterfly valves with flanged ends for piping NPS 5 and larger.
 3. Hot-Water Circulation Piping, Balancing Duty: Memory-stop balancing valves.
 4. Drain Duty: Hose-end drain valves.

- B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

END OF SECTION

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SECTION 22 11 19

DOMESTIC WATER PIPING SPECIALTIES

PART 1 GENERAL

1.1 SUMMARY

- A. This section includes the following domestic water piping specialties:
 - 1. Balancing valves.
 - 2. Temperature-actuated water mixing valves.
 - 3. Strainers.
 - 4. Hose bibbs.
 - 5. Wall hydrants.
 - 6. Roof hydrants.
 - 7. Drain valves.
 - 8. Water hammer arresters.

1.2 PERFORMANCE REQUIREMENTS

- A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig, unless otherwise indicated.

1.3 SUBMITTALS

- A. Product Data: For each type of water piping specialty proposed for this project. Include manufacturer, model number, materials of construction, options and accessories, etc.
 - 1. For thermostatic mixing valves include a copy of the piping diagram.
- B. Field quality-control test reports.
- C. Operation and maintenance data.

1.4 QUALITY ASSURANCE

- A. NSF Compliance:
 - 1. Comply with NSF 14, Plastics Piping Components and Related Materials, for plastic domestic water piping components.
 - 2. Comply with NSF 61 Annex G for low-lead requirements.

PART 2 PRODUCTS

2.1 BALANCING VALVES

- A. Temperature Actuated, Automatic Balancing Valves:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. ThermOmegaTech.
 - 2. Body: Type 303 stainless steel.
 - 3. Plug: Type 303 stainless steel.
 - 4. Thermal Actuator: Type 303 stainless steel.
 - 5. Spring: Type 302 stainless steel.
 - 6. End Connections: Threaded.

7. CWP Rating: Minimum 200 psig.
8. Maximum Operating Temperature: 250°F.
9. Valve Selection: Select automatic balancing valve closing temperature to match the mixing station outlet temperature indicated on the drawings rounded down to the nearest 5°F increment. Valve size is indicated on the drawings.
10. Options: Provide the following factory options:
 - a. Stainless-steel union connection with O-ring to allow for valve removal and integrated check valve.
 - b. Inlet and outlet full-port, lead-free, bronze ball valves with threaded ends.
 - c. Integrated strainer.

2.2 TEMPERATURE-ACTUATED WATER MIXING VALVES

- A. Point-of-Use, Water-Temperature Limiting Devices:
 1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on the drawings or a comparable product by one of the following:
 - a. Bradley.
 - b. Conbraco Industries, Inc.
 - c. Lawler Manufacturing Company, Inc.
 - d. Powers.
 - e. Symmons Industries, Inc.
 - f. Watts Industries, Inc.
 - g. Wilkins.
 2. Standard: ASSE 1070.
 3. Pressure Rating: 125 psig.
 4. Type: Thermostatically controlled, pressure balanced water mixing valve.
 5. Material: Bronze body with corrosion-resistant interior components.
 6. Connections: Threaded or union inlets and outlet.
 7. Accessories: Check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
 8. Tempered-Water Setting: 110°F.
 9. Tempered-Water Design Flow Rate: 0.5 gpm to 2.5 gpm.
 10. Valve Finish: Chrome plated where exposed, rough bronze where concealed.

2.3 STRAINERS FOR DOMESTIC WATER PIPING

- A. Y-Pattern Strainers:
 1. Pressure Rating: 125 psig minimum, unless otherwise indicated.
 2. Body: Bronze for NPS 2 and smaller; cast iron for NPS 2-1/2 and larger.
 3. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
 4. Screen: Stainless steel with round perforations, unless otherwise indicated.
 5. Perforation Size:
 - a. Strainers NPS 2 and Smaller: 0.020 inch.
 - b. Strainers NPS 2-1/2 to NPS 4: 0.045 inch.
 - c. Strainers NPS 5 and Larger: 0.10 inch.
 6. Drain: Pipe plug.

2.4 HOSE BIBBS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Chicago.
 2. MIFAB, Inc.
 3. Prier Product, Inc.
 4. Jay R. Smith Manufacturing Co.

5. Watts Drainage Products Inc.
 6. Woodford Manufacturing Company.
 7. Zurn.
- B. Standard: ASME A112.18.1 for lawn and sediment faucets.
 - C. Body Material: Bronze.
 - D. Seat: Bronze, replaceable.
 - E. Supply Connections: NPS 1/2 or NPS 3/4 threaded or solder-joint inlet as indicated on the drawings.
 - F. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
 - G. Pressure Rating: 125 psig.
 - H. Vacuum Breaker: Integral non-removable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
 - I. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
 - J. Finish for Service Areas: Rough bronze.
 - K. Finish for Finished Rooms: Chrome or nickel plated.
 - L. Operation for Equipment Rooms: Wheel handle or operating key.
 - M. Operation for Service Areas: Operating key.
 - N. Operation for Finished Rooms: Operating key.
 - O. Include operating key with each operating-key hose bibb.
 - P. Include integral wall flange with each chrome- or nickel-plated hose bibb.

2.5 WALL HYDRANTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Chicago.
 2. MIFAB, Inc.
 3. Prier Product, Inc.
 4. Jay R. Smith Manufacturing Co.
 5. Watts Drainage Products Inc.
 6. Woodford Manufacturing Company.
 7. Zurn.
- B. Moderate-Climate Wall Hydrants:
 1. Standard: ASME A112.21.3M for concealed-outlet, self-draining wall hydrants.
 2. Pressure Rating: 125 psig.
 3. Operation: Loose key.
 4. Inlet: NPS 3/4 or NPS 1 as indicated on the drawings.
 5. Outlet: Concealed, with integral vacuum breaker or non-removable hose-connection and garden-hose thread complying with ASME B1.20.7.

6. Box: Deep, flush mounting with cover.
7. Lock: Quarter-turn matched to operating key.
8. Box and Cover Finish: Polished nickel bronze
9. Operating Keys(s): One with each wall hydrant.

2.6 ROOF HYDRANTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Chicago.
 2. MIFAB, Inc.
 3. Prier Product, Inc.
 4. Jay R. Smith Manufacturing Co.
 5. Watts Drainage Products Inc.
 6. Woodford Manufacturing Company.
 7. Zurn.
- B. Non-Freeze Roof Hydrants:
 1. Pressure Rating: 100 psig.
 2. Operation: Lift handle.
 3. Casing and Operating Rod: Galvanized casing approximately 50 inches long with bronze interior parts. Include coated, cast-iron roof sleeve with anchoring flange and clamp collar.
 4. Inlet: NPS 3/4 or NPS 1 as indicated on the drawings.
 5. Head: Coated cast iron with bronze interior parts.
 6. Outlet: Vacuum breaker with garden-hose thread complying with ASME B1.20.7.

2.7 DRAIN VALVES

- A. Ball-Valve-Type, Hose-End Drain Valves:
 1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
 2. Pressure Rating: 400-psig minimum CWP.
 3. Size: NPS 3/4.
 4. Body: Copper alloy.
 5. Ball: Chrome-plated brass.
 6. Seats and Seals: Replaceable.
 7. Handle: Vinyl-covered steel.
 8. Inlet: Threaded or solder joint.
 9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

2.8 WATER HAMMER ARRESTERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. MIFAB, Inc.
 2. PPP Inc.
 3. Sioux Chief Manufacturing Company, Inc.
 4. Jay R. Smith Manufacturing Co.
 5. Watts Drainage Products Inc.
 6. Zurn.
- B. Standard: ASSE 1010 or PDI-WH 201.
- C. Type: Metal bellows or copper tube with piston.

- D. Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install backflow preventers in each water supply to equipment and water systems that may be sources of contamination. Comply with the AHJ.
1. Locate backflow preventers in same room as connected equipment or system.
 2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe to floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are not acceptable for this application.
 3. Do not install bypass piping around backflow preventers.
- B. Install water pressure-reducing valves where supply water pressure exceeds 80 psig and where indicated on the drawings. Install water pressure-reducing valves with inlet and outlet shutoff valves, and full size bypass with isolation valve. Install pressure gages on inlet and outlet.
- C. Install balancing valves where indicated on the drawings in locations where they can be easily accessed.
- D. Install temperature-actuated water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.
1. Install thermometers and water regulators if specified.
 2. Install cabinet-type units recessed in or surface mounted on wall as specified.
- E. Install Y-pattern strainers for water on supply side of each water pressure-reducing valve, backflow preventer without integral strainer, solenoid valve, and pump.
1. Install shut-off valve upstream and downstream of each strainer
- F. Install wall hydrants in exterior walls and other locations as noted on the drawings.
- G. Install wall hydrants in interior locations susceptible to vandalism or damage such as student areas in schools, loading docks, etc., and other locations as noted on the drawings.
- H. Install hose bibbs in interior locations not susceptible to vandalism and other locations as noted on the drawings.
- I. Install roof hydrants where indicated on the drawings. Secure hydrant to roof structure to prevent movement during operation and use. Coordinate flashing with roofing contractor. Route drain to location indicated on the drawings, or to nearest mop sink, floor sink, or landscaping area exterior to the building. Terminate 1 inch above flood level of mop or floor sink, or 6 inches above grade for landscape areas.
- J. Install water hammer arresters in water piping according to PDI-WH 201.
- K. Install trap-seal primer valves with outlet piping pitched down toward drain trap a minimum of 1%, and connect to floor-drain or floor-sink body, trap, or inlet fitting. Adjust valve for proper flow.
1. Trap-seal primer valves are not required where barrier-type trap sealers are provided.

2. Install trap primer valves at all floor drains or floor sinks where indicated on the drawings.
 - a. Install supply-type valves where floor drains and floor sinks are in close proximity to flush valves.
 - b. Install electronic valves where floor drains and floor sinks are not in close proximity to flush valves.
- L. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
 1. Reduced-pressure-principle backflow preventers.
 2. Water pressure-reducing valves.
 3. Primary, thermostatic, water mixing valves.
- M. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Specification Section 22 05 53, Identification for Plumbing Piping and Equipment.

3.2 FIELD QUALITY CONTROL

- A. Perform the following tests and prepare test reports:
 1. Test each reduced-pressure-principle backflow preventer assembly according to the AHJ and the device's reference standard.
- B. Remove and replace malfunctioning domestic water piping specialties and retest as specified above.

3.3 ADJUSTING

- A. Set field-adjustable pressure setpoints of water pressure-reducing valves.
- B. Set field-adjustable temperature setpoints of water mixing valves.
- C. Set temperature limiting devices to a maximum of 120°F unless noted otherwise.

END OF SECTION

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SECTION 22 13 16

SANITARY WASTE & VENT PIPING

PART 1 GENERAL

1.01 SUMMARY

- A. This section includes:
 - 1. Pipe, tube, and fittings.
 - 2. Specialty pipe fittings.

1.02 DEFINITIONS

- A. Grease Waste Piping: Waste piping upstream of grease interceptor or grease trap.

1.03 SUBMITTALS

- A. Product Data: For each type of pipe and joining material, and for method for joining piping intended for the project.

1.04 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF/ANSI 14, Plastics Piping System Components and Related Materials, for plastic piping components. Include marking with "NSF-drain" for plastic drain piping and "NSF-sewer" for plastic sewer piping.

PART 2 PRODUCTS

2.01 PIPING MATERIALS

- A. Comply with requirements in the Piping Schedule article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.02 EPOXY-COATED, HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A888 or CISPI 301, coated inside and out with a fusion bonded epoxy coating complying with Sections 4.6 and 5.7 of European Standard EN 877.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Charlotte Pipe and Foundry.
 - b. NewAge Casting.
- B. Epoxy Tape: Butyl rubber tape with polypropylene fleece cover. Furnished by the pipe manufacturer, used to cover uncoated ends of pipe after cutting.
- C. Heavy-Duty, Hubless-Piping Couplings:
 - 1. Product: Subject to compliance with requirements, provide one of the following products:
 - a. ANACO-Husky, SD 4000.
 - b. Ideal Clamp Products, Ideal Tridon Heavy Duty HD Coupling.

- c. Mission, HeavyWeight Coupling.
 - 2. Standards: ASTM C1540.
 - 3. Description: Type 304 stainless-steel shield with minimum four stainless-steel bands and tightening devices; and ASTM C564, rubber sleeve with integral, center pipe stop.
- D. Standard-Duty, Hubless-Piping Couplings:
- 1. Product: Subject to compliance with requirements, provide one of the following products:
 - a. ANACO, No Hub Coupling.
 - b. Ideal Clamp Products, Ideal Tridon Standard Duty Coupling.
 - c. Mission, No Hub Coupling.
 - 2. Standards: ASTM C1277.
 - 3. Description: Type 301 stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C564, rubber sleeve with integral, center pipe stop.

2.03 COPPER TUBE AND FITTINGS

- A. Copper DWV Tube: ASTM B306, drainage tube, drawn temper.
- B. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought-copper, solder-joint fittings.
- C. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.
 - 1. Flange Gasket Materials: ASME B16.21, full-face, flat, non-metallic, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
 - 2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- D. Solder: ASTM B32, lead-free with ASTM B813, water-flushable flux.

2.04 HUB-AND-SPIGOT, STAINLESS-STEEL SOIL PIPE AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Blucher.
 - 2. Josam Company.
- B. Standard: ANSI/ASME A112.3.1.
- C. Description: Type 316L, lightweight, welded-seam, stainless-steel push-fit pipe and fittings.
- D. Gaskets: EPDM rubber fit in hub end of pipe and fittings.
- E. Fittings: DWV pattern to match piping.

2.05 PVC PIPE AND FITTINGS

- A. Solid-Wall PVC Pipe: ASTM D2665, drain, waste, and vent.
- B. PVC Socket Fittings: ASTM D2665, made to ASTM D3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

- C. Adhesive Primer: ASTM F656.
 - 1. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- D. Solvent Cement: ASTM D2564.
 - 1. PVC solvent cement shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.06 SPECIALTY PIPE FITTINGS

- A. Transition Couplings:
 - 1. General Requirements: Fitting or device for joining piping with small differences in ODs or of different materials. Include end connections same size as and compatible with pipes to be joined.
 - 2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
 - 3. Standard: ASTM C1460.
 - 4. Description: Rubber sleeve with full-length, stainless-steel shield and stainless-steel bands with tightening mechanism.
 - 5. Shielded, Non-Pressure Transition Couplings:
 - a. Copper Piping to Plastic Piping:
 - 1) Product: Subject to compliance with requirements, provide the following product:
 - a) Fernco Proflex.
 - b) Mission Band-Seal.
 - b. Cast Iron Piping to Plastic Piping:
 - 1) Product: Subject to compliance with requirements, provide the following product:
 - a) ANACO-Husky, SD 4200.
 - c. Cast Iron Piping to Copper Piping:
 - 1) Product: Subject to compliance with requirements, provide the following product:
 - a) Fernco Proflex.
 - b) Mission Band-Seal.

PART 3 EXECUTION

3.01 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved.
- B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Do not install piping within electrical rooms, elevator equipment rooms, MDF or IDF rooms, or stairwells. Exception: Pipe supplying equipment serving the room. Maintain all required clearances to other equipment.

- E. Do not install piping above electrical equipment such as transformers, panels, motor control centers, etc., in other rooms.
- F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back-to-back or side-by-side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees.
- J. Use standard pipe increasers and reducers if pipes of different sizes are connected. Do not use bushings. Reducing size of drainage piping in direction of flow is prohibited.
- K. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
- L. Install soil and waste drainage and vent piping at the following minimum slopes unless otherwise indicated:
 - 1. Horizontal Sanitary Drainage Piping: 1/4 inch per foot, 2% downward in direction of flow unless noted otherwise.
 - 2. Vent Piping: 1/8 inch per foot, 1% down toward vertical fixture vent or toward vent stack.
- M. Install cast-iron soil piping according to CISPI's Cast Iron Soil Pipe and Fittings Handbook, Chapter IV, Installation of Cast Iron Soil Pipe and Fittings.
- N. Install aboveground copper tubing according to CDA's Copper Tube Handbook.
- O. Install stainless-steel piping in accordance with the manufacturer's written instructions.
- P. Install aboveground PVC piping according to ASTM D2665.
- Q. Install underground PVC piping according to ASTM D2321.
- R. Plumbing Specialties:
 - 1. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary drainage gravity-flow piping. Comply with requirements for cleanouts specified in Specification Section 22 13 19, Sanitary Waste Piping Specialties.
 - 2. Install drains in sanitary drainage gravity-flow piping. Comply with requirements for drains specified in Specification Section 22 13 19, Sanitary Waste Piping Specialties.
- S. Do not enclose, cover, or put piping into operation until it is inspected and approved by Authorities Having Jurisdiction (AHJ).

- T. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Specification Section 22 05 17, Sleeves and Sleeve Seals for Plumbing Piping.
- U. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Specification Section 22 05 17, Sleeves and Sleeve Seals for Plumbing Piping.
- V. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Specification Section 22 05 18, Escutcheons for Plumbing Piping.

3.02 JOINT CONSTRUCTION

- A. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's Cast Iron Soil Pipe and Fittings Handbook for hubless-piping coupling joints.
 - 1. In corrosive applications such as: grease waste; dialysis treatment waste; bar, liquor, or soda waste; food processing waste; healthcare waste; or were noted on the drawings, cover cut ends with epoxy tape to cover exposed cast iron per the pipe manufacturer's written instructions.
- B. Join copper tube and fittings with soldered joints according to ASTM B828. Use ASTM B813, water-flushable, lead-free flux and ASTM B32, lead-free-alloy solder.
- C. Join hub-and-spigot, stainless-steel soil piping with gasket joints according to the manufacturer's written instructions and the following:
 - 1. Make all cuts square.
 - 2. Remove burrs.
 - 3. Confirm gasket is in place and not damaged before making joints.
 - 4. Apply lubricant as recommended by the manufacturer.
- D. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.
- E. Plastic, Non-Pressure-Piping, Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - 1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.
 - 2. PVC Piping: Join according to ASTM D2855 and ASTM D2665 Appendixes.

3.03 SPECIALTY PIPE FITTING INSTALLATION

- A. Transition Couplings:
 - 1. Install transition couplings at joints of piping with small differences in ODs.
 - 2. In Drainage Piping: Non-pressure transition couplings.

3.04 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for pipe hanger and support devices and installation specified in Specification Section 22 05 29, Hangers and Supports for Plumbing Piping and Equipment.
 - 1. Install carbon-steel pipe hangers for horizontal piping in non-corrosive environments.
 - 2. Install stainless-steel pipe hangers for horizontal piping in corrosive environments.

3. Install carbon-steel pipe support clamps for vertical piping in non-corrosive environments.
 4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
 5. Vertical Piping: MSS Type 8 or Type 42, clamps.
 6. Individual, Straight, Horizontal Piping Runs: MSS Type 1, adjustable, steel clevis hangers.
 7. Multiple, Straight, Horizontal Piping Runs: Trapeze hangers with pipe clamps.
 8. Base of Vertical Piping: MSS Type 52, spring hangers.
- B. Support each section of horizontal piping and tubing within 12 inches of each fitting and coupling.
- C. Support vertical piping and tubing at base and at each floor.
- D. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.
- E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

	Maximum Horizontal Spacing	Minimum Rod Diameter
NPS 1-1/2 & NPS 2	60 inches	3/8-inch rod
NPS 3	60 inches	1/2-inch rod
NPS 4 & NPS 5	60 inches	5/8-inch rod
NPS 6 & NPS 8	60 inches	3/4-inch rod

Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.

- F. Install supports for vertical cast-iron soil piping every 15 feet.
- G. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

	Maximum Horizontal Spacing	Minimum Rod Diameter
NPS 1-1/4	72 inches	3/8-inch rod
NPS 1-1/2 & NPS 2	96 inches	3/8-inch rod
NPS 2-1/2	108 inches	1/2-inch rod
NPS 3 & NPS 5	10 feet	1/2-inch rod
NPS 6	10 feet	5/8-inch rod
NPS 8	10 feet	3/4-inch rod

- H. Install supports for vertical copper tubing every 10 feet.

- I. Install hangers for stainless-steel soil piping with the following maximum horizontal spacing and minimum rod diameters:

	Maximum Horizontal Spacing	Minimum Rod Diameter
NPS 1-1/2 & NPS 4	120 inches	3/8-inch rod
NPS 5 & NPS 8	120 inches	1/2-inch rod
NPS 10 & NPS 12	120 inches	5/8-inch rod

- J. Install supports for vertical stainless-steel piping every 10 feet.

- K. Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:

	Maximum Horizontal Spacing	Minimum Rod Diameter
NPS 1-1/2 & NPS 2	48 inches	3/8-inch rod
NPS 3	48 inches	1/2-inch rod
NPS 4 & NPS 5	48 inches	5/8-inch rod
NPS 6 & NPS 8	48 inches	3/4-inch rod
NPS 10 & NPS 12	48 inches	7/8-inch rod

- L. Install supports for vertical PVC piping every 48 inches.

- M. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.05 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect drainage and vent piping to the following:
1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
 2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by the AHJ.
 3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
 4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
 5. Comply with requirements for cleanouts and drains specified in Specification Section 22 13 19, Sanitary Waste Piping Specialties.
 6. Equipment: Connect drainage piping as indicated. Provide shutoff valve if indicated and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 and larger.
- D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

- E. Make connections according to the following unless otherwise indicated:
 - 1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
 - 2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.06 IDENTIFICATION

- A. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Specification Section 22 05 53, Identification for Plumbing Piping and Equipment.

3.07 FIELD QUALITY CONTROL

- A. During installation, notify the AHJ at least 24 hours before inspection must be made. Perform tests specified below in the presence of the AHJ.
 - 1. Roughing-In Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - 2. Final Inspection: Arrange for final inspection by the AHJ to observe tests specified below and to ensure compliance with requirements.
- B. Reinspection: If the AHJ finds that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Reports: Prepare inspection reports and have them signed by the AHJ.
- D. Test sanitary drainage and vent piping according to the procedures of the AHJ or, in absence of published procedures, as follows:
 - 1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 - 2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - 3. Roughing-In Plumbing Test Procedure: Test drainage and vent piping except outside leaders on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. Water level must not drop for 4 hours. Inspect joints for leaks and make all necessary repairs.
 - 4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1 inch wg. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection but no less than 30 minutes. Inspect plumbing fixture connections for gas and water leaks.
 - 5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 - 6. Prepare reports for tests and required corrective action.

3.08 CLEANING AND PROTECTION

- A. Clean interior of piping. Remove dirt and debris as work progresses.

- B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.

3.09 PIPING SCHEDULE

- A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.
- B. Aboveground soil and waste piping NPS 4 and smaller shall be any of the following:
 - 1. Epoxy-coated, hubless, cast-iron soil pipe and fittings; heavy-duty, 4-band hubless-piping couplings; and coupled joints.
 - 2. Copper DWV tube, copper drainage fittings, and soldered joints.
 - 3. Dissimilar Pipe-Material Couplings: Shielded, non-pressure transition couplings.
- C. Aboveground vent piping NPS 4 and smaller shall be any of the following:
 - 1. Epoxy-coated, hubless, cast-iron soil pipe and fittings; standard-duty hubless-piping couplings; and coupled joints.
 - 2. Copper DWV tube, copper drainage fittings, and soldered joints.
 - 3. Dissimilar Pipe-Material Couplings: Shielded, non-pressure transition couplings.
- D. Aboveground soil and waste piping NPS 5 and larger shall be any of the following:
 - 1. Epoxy-coated, hubless, cast-iron soil pipe and fittings; heavy-duty, 6-band hubless-piping couplings; and coupled joints.
 - 2. Dissimilar Pipe-Material Couplings: Shielded, non-pressure transition couplings.
- E. Aboveground vent piping NPS 5 and larger shall be any of the following:
 - 1. Epoxy-coated, hubless, cast-iron soil pipe and fittings; standard-duty hubless-piping couplings; and coupled joints.
 - 2. Dissimilar Pipe-Material Couplings: Shielded, non-pressure transition couplings.
- F. Underground soil, waste, and vent piping NPS 4 and smaller shall be any of the following:
 - 1. Epoxy-coated, hubless, cast-iron soil pipe and fittings; heavy-duty, 4-band hubless-piping couplings; and coupled joints.
 - 2. Stainless-steel soil pipe and fittings; gaskets; and gasketed joints.
 - 3. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 - 4. Dissimilar Pipe-Material Couplings: Shielded, non-pressure transition couplings.
- G. Underground soil, waste, and vent piping NPS 5 and larger shall be any of the following:
 - 1. Epoxy-coated, hubless, cast-iron soil pipe and fittings; heavy-duty, 6-band hubless-piping couplings; and coupled joints.
 - 2. Stainless-steel soil pipe and fittings; gaskets; and gasketed joints.
 - 3. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 - 4. Dissimilar Pipe-Material Couplings: Shielded, non-pressure transition couplings.
- H. Aboveground soil and waste piping serving a kitchen or area where drain water temperatures will reach 140°F or above shall be:
 - 1. Epoxy-coated, hubless, cast-iron soil pipe and fittings; heavy-duty, 4-band hubless-piping couplings; and coupled joints.
 - 2. Extend to grease interceptor or 50 feet beyond boundary of kitchen or area.

- I. Underground soil and waste piping serving a kitchen or area where drain water temperatures will reach 140°F or above shall be:
 1. Epoxy-coated, hubless, cast-iron soil pipe and fittings; heavy-duty, 4-band hubless-piping couplings; and coupled joints.
 2. Stainless-steel soil pipe and fittings; gaskets; and gasketed joints.
 3. Extend to grease interceptor or 50 feet beyond boundary of kitchen or area.

END OF SECTION

Edition 0608-0721

SECTION 22 13 19

SANITARY WASTE PIPING SPECIALTIES

PART 1 GENERAL

1.01 SUMMARY

- A. This section includes the following sanitary drainage piping specialties:
 - 1. Cleanouts.
 - 2. Floor drains.
 - 3. Floor sinks.
 - 4. Roof flashing assemblies.
 - 5. Miscellaneous sanitary drainage piping specialties.
 - 6. Flashing materials.

1.02 SUBMITTALS

- A. Product Data: For each type of product indicated, include manufacturer, model number, materials of construction, and options and accessories.

1.03 QUALITY ASSURANCE

- A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with requirements, provide products by one of the following:
 - 1. Jay R. Smith Manufacturing Co.
 - 2. Josam Company; Josam Division.
 - 3. Sioux Chief Manufacturing Company, Inc.
 - 4. Watts Drainage Products Inc.
 - 5. Zurn Plumbing Products Group.

2.02 CLEANOUTS

- A. Exposed Cast-Iron Cleanouts:
 - 1. Standard: ASME A112.36.2M for cast iron for cleanout test tee.
 - 2. Size: Same as connected drainage piping.
 - 3. Body Material: Hub-and-spigot, cast-iron soil pipe T-branch or hubless, cast-iron soil pipe test tee as required to match connected piping.
 - 4. Closure: Countersunk, plastic plug, except provide brass plug in return air plenums.
 - 5. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
- B. Cast-Iron Floor Cleanouts:
 - 1. Standard: ASME A112.36.2M for adjustable housing cleanout.
 - 2. Size: Same as connected branch.
 - 3. Type: Adjustable housing.
 - 4. Body or Ferrule: Cast iron.

5. Clamping Device: Not required.
6. Outlet Connection: Spigot.
7. Closure: Plastic plug.
8. Adjustable Housing Material: Cast iron with threads.
9. Frame and Cover Material and Finish: Nickel-bronze, copper alloy
10. Frame and Cover Shape: Round in concrete floors, square in tiled floors.
11. Top Loading Classification: Heavy Duty.
12. Riser: ASTM A74, Service class, cast-iron drainage pipe fitting and riser to cleanout.

C. Cast-Iron Wall Cleanouts:

1. Standard: ASME A112.36.2M. Include wall access.
2. Size: Same as connected drainage piping.
3. Body: Hub-and-spigot, cast-iron soil pipe T-branch or hubless, cast-iron soil pipe test tee as required to match connected piping.
4. Closure: Countersunk, plastic plug.
5. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
6. Wall Access: Round, flat, chrome-plated brass or stainless-steel cover plate with screw.

2.03 FLOOR DRAINS

A. Cast-Iron Floor Drains:

1. Standard: ASME A112.6.3.
2. Pattern: Floor drain.
3. Body Material: Gray iron.
4. Seepage Flange: Required for slabs above grade.
5. Anchor Flange: Required for slabs on grade.
6. Clamping Device: Required, where floor has waterproofing membrane.
7. Outlet: Bottom or Side as required.
8. Backwater Valve: Not required.
9. Coating on Interior and Exposed Exterior Surfaces: Acid-resistant enamel when located in equipment rooms.
10. Sediment Bucket: Slotted type when located in equipment rooms.
11. Top or Strainer Material: Gray iron in unfinished floors, Nickel bronze in finished floors.
12. Top of Body and Strainer Finish: Nickel bronze in unfinished floors, polished bronze in finished floors.
13. Top Shape: Round in concrete floors, Square in tiled floors.
14. Top Loading Classification: Extra heavy-duty in areas with vehicle traffic, heavy duty in equipment rooms, light duty in finished areas.
15. Funnel: Required, where indicated on drawings.
16. Trap Material: Cast iron or copper to match adjacent piping.
17. Trap Pattern: Standard P-trap unless noted otherwise.
18. Trap Features: Trap-seal primer valve connection and cleanout where trap primers are indicated.

B. Stainless-Steel Floor Drains for use with Stainless-Steel Waste Piping:

1. Pattern: Floor drain.
2. Body Material: Type 304 stainless steel.
3. Seepage Flange: Required for slabs above grade.
4. Anchor Flange: Required for slabs on grade.
5. Clamping Device: Required, where floor has waterproofing membrane.
6. Outlet: Bottom or Side as required.
7. Backwater Valve: Not required.
8. Top or Strainer Material: Type 304 stainless steel.

9. Top of Body and Strainer Finish: Type 304 stainless steel.
10. Top Shape: Round in concrete floors, Square in tiled floors.
11. Top Loading Classification: Extra heavy-duty in areas with vehicle traffic, heavy duty in equipment rooms, light duty in finished areas.
12. Funnel: Required, where indicated on drawings.
13. Trap Material: Type 304 stainless steel to match adjacent piping.
14. Trap Pattern: Standard P-trap unless noted otherwise.
15. Trap Features: Trap-seal primer valve drain connection and cleanout where trap primers are indicated.

2.04 FLOOR SINKS

- A. Cast-Iron Floor Sinks:
 1. Standard: ASME A48-83.
 2. Pattern: Floor sink.
 3. Body Material: Gray iron.
 4. Seepage Flange: Required for slabs above grade.
 5. Anchor Flange: Required for slabs on grade.
 6. Clamping Device: Required, where floor has waterproofing membrane.
 7. Outlet: Bottom.
 8. Coating on Interior and Exposed Exterior Surfaces: Acid-resistant enamel.
 9. Sediment Bucket: Aluminum slotted type when located in kitchen area
 10. Dome Strainer: Anti-splash with acid-resistant enamel coating for non-kitchen areas.
 11. Top or Grate Material: Acid-resistant enamel, fully coated.
 12. Grate: Full, three-quarters, or half as required for application.
 13. Top Shape and Size: Square, 12" x 12" unless noted otherwise.
 14. Basin Depth: 8 inches unless noted otherwise.
 15. Funnel: Required, where indicated on drawings.
 16. Trap Material: Cast iron or copper to match adjacent piping.
 17. Trap Pattern: Standard P-trap unless noted otherwise.
 18. Trap Features: Trap-seal primer valve drain connection where trap primers are indicated.
- B. Stainless-Steel Floor Sinks for use with Stainless-Steel Waste Piping:
 1. Pattern: Floor sink.
 2. Body Material: Stainless steel.
 3. Seepage Flange: Required for slabs above grade.
 4. Anchor Flange: Required for slabs on grade.
 5. Clamping Device: Required, where floor has waterproofing membrane.
 6. Outlet: Bottom.
 7. Sediment Bucket: Stainless-steel slotted type when located in kitchen area.
 8. Dome Strainer: Anti-splash for non-kitchen areas.
 9. Top or Grate Material: Type 304 stainless steel.
 10. Grate: Full, three-quarters, or half as required for application.
 11. Top Shape and Size: Square, 12" x 12" unless noted otherwise.
 12. Basin Depth: Minimum of 8 inches unless noted otherwise.
 13. Funnel: Required, where indicated on drawings.
 14. Trap Material: Type 304 stainless steel to match adjacent piping.
 15. Trap Pattern: Standard P-trap unless noted otherwise.
 16. Trap Features: Trap-seal primer valve drain connection where trap primers are indicated.

2.05 ROOF FLASHING ASSEMBLIES

- A. Description: Manufactured assembly made of 4.0-lb./sq.ft., 0.0625-inch-thick, lead flashing collar and skirt extending at least 6 inches from pipe, with galvanized-steel boot reinforcement and counterflashing fitting.
1. Open-Top Vent Cap: Without cap.

2.06 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

- A. Open Drains:
1. Description: Shop or field fabricate from ASTM A74, Service class, hub-and-spigot, cast-iron, soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C564, rubber gaskets.
 2. Size: Same as connected waste piping.
- B. Deep-Seal Traps:
1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
 2. Size: Same as connected waste piping.
 - a. NPS 2: 4-inch minimum water seal.
 - b. NPS 2-1/2 and Larger: 5-inch minimum water seal.
- C. Floor-Drain, Trap-Seal Primer Fittings:
1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
 2. Size: Same as floor drain outlet with NPS 1/2 side inlet.
- D. Barrier-Type Trap Sealer:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. IPS Corporation.
 - b. Jay R. Smith Manufacturing Co.
 - c. MIFAB, Inc.
 - d. Precision Plumbing Products.
 - e. Sioux Chief Manufacturing Company, Inc.
 - f. RectorSeal.
 2. Description: Device that is installed at the drain body outlet to prevent sewer gases from escaping the waste piping into the building while allowing water and other materials to flow into the waste system. User replaceable from above.
 3. Materials: Flexible elastomeric material such as PVC, EPDM, etc.
 4. Conformance: ASSE 1072 or other standard acceptable to the Authority Having Jurisdiction.
- E. Air-Gap Fittings:
1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
 2. Body: Bronze or cast iron.
 3. Inlet: Opening in top of body.
 4. Outlet: Larger than inlet.
 5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.
- F. Sleeve Flashing Device:
1. Description: Manufactured, cast-iron fitting, with clamping device that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend 1 inch above finished floor and

- galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.
- 2. Size: As required for close fit to riser or stack piping.
- G. Stack Flashing Fittings:
 - 1. Description: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
 - 2. Size: Same as connected stack vent or vent stack.

2.07 FLASHING MATERIALS

- A. Lead Sheet: ASTM B749, Type L51121, copper bearing, with the following minimum weights and thicknesses, unless otherwise indicated:
 - 1. General Use: 4.0-lb./sq.ft., 0.0625-inch thickness.
 - 2. Vent Pipe Flashing: 3.0-lb./sq.ft., 0.0469-inch thickness.
 - 3. Burning: 6-lb./sq.ft., 0.0938-inch thickness.
- B. Fasteners: Metal compatible with material and substrate being fastened.
- C. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.
- D. Solder: ASTM B32, lead-free alloy.
- E. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
 - 1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
 - 2. Locate at each change in direction of piping greater than 45 degrees.
 - 3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
 - 4. Locate at base of each vertical soil and waste stack.
- B. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- C. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- D. Install a two-way cleanout at the waste piping exit of the building.
- E. Extend surface cleanouts up to grade.
 - 1. For cleanouts terminating in paved or other finished surfaces, install cleanout deck plate with top flush with finished surface.
 - 2. For cleanouts terminating in landscaping or other unfinished surface, install cleanout deck plate flush with top of (and centered in) minimum 12" x 16" x 4" concrete pad. Pad to be flush with adjacent surfaces.

- F. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
 - 1. Position floor drains for easy access and maintenance.
 - 2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:
 - a. Radius, 30 Inches or Less: Equivalent to 1% slope, but not less than 1/4-inch total depression.
 - b. Radius, 30 to 60 Inches: Equivalent to 1% slope.
 - c. Radius, 60 Inches or Larger: Equivalent to 1% slope, but not greater than 1-inch total depression.
 - 3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
 - 4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.
- G. Install floor sinks where indicated on drawings. Set grates of sinks flush with finished floor, unless otherwise indicated.
 - 1. Position floor sinks for easy access and maintenance.
 - 2. Install floor-sink flashing collar or flange so no leakage occurs between sink and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
 - 3. Install individual traps for floor sinks connected to sanitary building drain, unless otherwise indicated.
- H. Install trench drains at low points of surface areas to be drained. Set grates of drains flush with finished surface unless otherwise indicated.
- I. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.
- J. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.
- K. Assemble open drain fittings and install with top of hub 2 inches above floor.
- L. Install deep-seal traps on floor drains and other waste outlets where indicated.
- M. Install barrier-type trap sealers on all floor sinks and floor drains in accordance with the manufacturer's installation instructions unless indicated otherwise on the drawings.
- N. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.
 - 1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
 - 2. Size: Same as floor drain inlet.
- O. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.
- P. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.
- Q. Install vent caps on each vent pipe passing through roof.
- R. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

3.02 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.

3.03 FLASHING INSTALLATION

- A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:
 - 1. Lead Sheets: Burn joints of lead sheets 6.0-lb./sq.ft., 0.0938-inch thickness or thicker. Solder joints of lead sheets 4.0-lb./sq.ft., 0.0625-inch thickness or thinner.
- B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
 - 1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
 - 2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
 - 3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.
- C. Set flashing on floors and roofs in solid coating of bituminous cement.
- D. Secure flashing into sleeve and specialty clamping ring or device.
- E. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Division 07 specifications.
- F. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.

3.04 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION

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SECTION 22 14 13
STORM DRAINAGE PIPING

PART 1 GENERAL

1.01 SUMMARY

- A. This section includes:
 - 1. Pipe, tube, and fittings.
 - 2. Specialty pipe fittings.

1.02 SUBMITTALS

- A. Product Data: For each type of pipe and joining material, and for method for joining piping intended for the project.

1.03 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

PART 2 PRODUCTS

2.01 PIPING MATERIALS

- A. Comply with requirements in Piping Schedule article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.02 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A74, Service class.
- B. Gaskets: ASTM C564, rubber.

2.03 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A888 or CISPI 301.
- B. Heavy-Duty, Hubless-Piping Couplings:
 - 1. Product: Subject to compliance with requirements, provide one of the following products:
 - a. ANACO-Husky, SD 4000.
 - b. Ideal Clamp Products, Ideal Tridon Heavy Duty HD Coupling.
 - c. Mission, HeavyWeight Coupling.
 - 2. Standards: ASTM C1277 and ASTM C1540.
 - 3. Description: Stainless-steel shield with minimum four stainless-steel bands and tightening devices; and ASTM C564, rubber sleeve with integral, center pipe stop.

2.04 EPOXY-COATED, HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A888 or CISPI 301, coated inside and out with a fusion bonded epoxy coating complying with Sections 4.6 and 5.7 of European Standard EN 877.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Charlotte Pipe and Foundry.
 - b. NewAge Casting.
- B. Epoxy Tape: Butyl rubber tape with polypropylene fleece cover. Furnished by the pipe manufacturer, used to cover uncoated ends of pipe after cutting.
- C. Heavy-Duty, Hubless-Piping Couplings:
 1. Product: Subject to compliance with requirements, provide one of the following products:
 - a. ANACO-Husky, SD 4000.
 - b. Mission, HeavyWeight Coupling.
 2. Standards: ASTM C1277 or ASTM C1540.
 3. Description: Type 304 stainless-steel shield with minimum four stainless-steel bands and tightening devices; and ASTM C564, rubber sleeve with integral, center pipe stop.

2.05 COPPER TUBE AND FITTINGS

- A. Copper DWV Tube: ASTM B306, drainage tube, drawn temper.
- B. Copper Drainage Fittings: ASME B16.23, cast-copper fittings or ASME B16.29, wrought-copper, solder-joint fittings.
- C. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.
 1. Flange Gasket Materials: ASME B16.21, full-face, flat, non-metallic, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
 2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- D. Solder: ASTM B32, lead-free with ASTM B813, water-flushable flux.

2.06 SPECIALTY PIPE FITTINGS

- A. Transition Couplings:
 1. General Requirements: Fitting or device for joining piping with small differences in ODs or of different materials. Include end connections same size as and compatible with pipes to be joined.
 2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified-piping-system fitting.
 3. Standard: ASTM C1460.
 4. Description: Rubber sleeve with full-length, stainless-steel shield and stainless-steel bands with tightening mechanism.
 5. Shielded, Non-Pressure Transition Couplings:
 - a. Copper Piping to Plastic Piping:
 - 1) Product: Subject to compliance with requirements, provide the following product:
 - a) Fernco Proflex.
 - b) Mission Band-Seal.
 - b. Cast Iron Piping to Plastic Piping:
 - 1) Product: Subject to compliance with requirements, provide the following product:
 - a) ANACO-Husky, SD 4200.

- c. Cast Iron Piping to Copper Piping:
 - 1) Product: Subject to compliance with requirements, provide the following product:
 - a) Fernco Proflex.
 - b) Mission Band-Seal.

PART 3 EXECUTION

3.01 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations from layout are approved.
- B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Do not install piping within electrical rooms, elevator equipment rooms, MDF or IDF rooms, or stairwells. Exception: Pipe supplying equipment serving the room. Maintain all required clearances to other equipment.
- E. Do not install piping above electrical equipment such as transformers, panels, motor control centers, etc., in other rooms.
- F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Make changes in direction for storm drainage piping using appropriate branches, bends, and long-sweep bends. Do not change direction of flow more than 90 degrees.
- J. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Do not use bushings. Reducing size of drainage piping in direction of flow is prohibited.
- K. Lay buried building storm drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
- L. Install storm drainage piping at the following minimum slopes unless otherwise indicated:
 - 1. Building Storm Drain: 1/4 inch per foot, 2%, downward in direction of flow.
 - 2. Horizontal Storm-Drainage Piping: 1/4 inch per foot, 2%, downward in direction of flow.
- M. Install cast-iron soil piping according to CISPI's Cast Iron Soil Pipe and Fittings Handbook, Chapter IV, Installation of Cast Iron Soil Pipe and Fittings.

- N. Install aboveground copper tubing according to CDA's Copper Tube Handbook.
- O. Plumbing Specialties:
 - 1. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers in storm drainage gravity-flow piping. Install cleanout fitting with closure plug inside the building in storm drainage force-main piping. Comply with requirements for cleanouts specified in Specification Section 22 14 23, Storm Drainage Piping Specialties.
 - 2. Install drains in storm drainage gravity-flow piping. Comply with requirements for drains specified in Specification Section 22 14 23, Storm Drainage Piping Specialties.
- P. Do not enclose, cover, or put piping into operation until it is inspected and approved by the Authorities Having Jurisdiction (AHJ).
- Q. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Specification Section 22 05 17, Sleeves and Sleeve Seals for Plumbing Piping.
- R. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Specification Section 22 05 17, Sleeves and Sleeve Seals for Plumbing Piping.
- S. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Specification Section 22 05 18, Escutcheons for Plumbing Piping.

3.02 JOINT CONSTRUCTION

- A. Join hub-and-spigot, cast-iron soil piping with gasketed joints according to CISPI's Cast Iron Soil Pipe and Fittings Handbook for compression joints.
 - 1. In corrosive applications such as: parking garage drainage or were noted on the drawings, cover cut ends with epoxy tape to cover exposed cast iron per the pipe manufacturer's written instructions.
- B. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's Cast Iron Soil Pipe and Fittings Handbook for hubless-piping coupling joints.
- C. Join copper tube and fittings with soldered joints according to ASTM B828 procedure. Use ASTM B813, water-flushable, lead-free flux and ASTM B32, lead-free-alloy solder.
- D. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.

3.03 SPECIALTY PIPE FITTING INSTALLATION

- A. Transition Couplings:
 - 1. Install transition couplings at joints of piping with small differences in ODs.
 - 2. In Drainage Piping: Shielded, non-pressure transition couplings.

3.04 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for pipe hanger and support devices and installation specified in Specification Section 22 05 29, Hangers and Supports for Plumbing Piping and Equipment.
 1. Install carbon-steel pipe hangers for horizontal piping in non-corrosive environments.
 2. Install stainless-steel pipe hangers for horizontal piping in corrosive environments.
 3. Install carbon-steel pipe support clamps for vertical piping in non-corrosive environments.
 4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
 5. Vertical Piping: MSS Type 8 or Type 42, clamps.
 6. Individual, Straight, Horizontal Piping Runs: MSS Type 1, adjustable, steel clevis hangers.
 7. Multiple, Straight, Horizontal Piping Runs: Trapeze hangers with pipe clamps.
 8. Base of Vertical Piping: MSS Type 52, spring hangers.
- B. Support each section of horizontal piping and tubing within 12 inches of each fitting and coupling.
- C. Support vertical piping and tubing at base and at each floor.
- D. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.
- E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

	Maximum Horizontal Spacing	Minimum Rod Diameter
NPS 1-1/2 & NPS 2	60 inches	3/8-inch rod
NPS 3	60 inches	1/2-inch rod
NPS 4 & NPS 5	60 inches	5/8-inch rod
NPS 6 & NPS 8	60 inches	3/4-inch rod
NPS 10 & NPS 12	60 inches	7/8-inch rod

Spacing for 10-foot pipe lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.

- F. Install supports for vertical cast-iron soil piping every 15 feet.
- G. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

	Maximum Horizontal Spacing	Minimum Rod Diameter
NPS 1-1/4	72 inches	3/8-inch rod
NPS 1-1/2 & NPS 2	96 inches	3/8-inch rod
NPS 2-1/2	108 inches	1/2-inch rod
NPS 3 to NPS 5	10 feet	1/2-inch rod
NPS 6	10 feet	5/8-inch rod
NPS 8	10 feet	3/4-inch rod

- H. Install supports for vertical copper tubing every 10 feet.
- I. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.05 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect storm drainage piping to roof drains and storm drainage specialties.
 - 1. Install test tees (wall cleanouts) in conductors near floor, and floor cleanouts with cover flush with floor.
 - 2. Comply with requirements for cleanouts and drains specified in Specification Section 22 14 23, Storm Drainage Piping Specialties.
- D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

3.06 IDENTIFICATION

- A. Identify exposed storm drainage piping. Comply with requirements for identification specified in Specification Section 22 05 53, Identification for Plumbing Piping and Equipment.

3.07 FIELD QUALITY CONTROL

- A. During installation, notify the AHJ at least 24 hours before inspection must be made. Perform tests specified below in the presence of the AHJ.
 - 1. Roughing-In Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.
 - 2. Final Inspection: Arrange for final inspection by the AHJ to observe tests specified below and to ensure compliance with requirements.
- B. Reinspection: If the AHJ finds that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Reports: Prepare inspection reports and have them signed by the AHJ.
- D. Test storm drainage piping according to the procedures of the AHJ or, in absence of published procedures, as follows:
 - 1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 - 2. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - 3. Test Procedure: Test storm drainage piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. Water level must not drop for 4 hours. Inspect joints for leaks.
 - 4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.

5. Prepare reports for tests and required corrective action.

3.08 CLEANING

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.

3.09 PIPING SCHEDULE

- A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.
- B. Aboveground storm drainage piping NPS 4 and smaller shall be any of the following:
 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 2. Hubless, cast-iron soil pipe and fittings; heavy-duty, 4-band hubless-piping couplings; and coupled joints.
 3. Epoxy-coated, hubless, cast-iron soil pipe and fittings; heavy-duty, 4-band hubless-piping couplings; and coupled joints.
 4. Copper DWV tube, copper drainage fittings, and soldered joints.
 5. Dissimilar Pipe-Material Couplings: Shielded, non-pressure transition couplings.
- C. Aboveground storm drainage piping NPS 5 and larger shall be any of the following:
 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 2. Hubless, cast-iron soil pipe and fittings; heavy-duty, 6-band hubless-piping couplings; and coupled joints.
 3. Epoxy-coated, hubless, cast-iron soil pipe and fittings; heavy-duty, 6-band hubless-piping couplings; and coupled joints.
 4. Copper DWV tube, copper drainage fittings, and soldered joints.
 5. Dissimilar Pipe-Material Couplings: Shielded, non-pressure transition couplings.
- D. Underground storm drainage piping NPS 4 and smaller shall be any of the following:
 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 2. Hubless, cast-iron soil pipe and fittings; heavy-duty, 4-band hubless-piping couplings; and coupled joints.
 3. Epoxy-coated, hubless, cast-iron soil pipe and fittings; heavy-duty, 4-band hubless-piping couplings; and coupled joints.
 4. Dissimilar Pipe-Material Couplings: Shielded, non-pressure transition couplings.
- E. Underground storm drainage piping NPS 5 and larger shall be any of the following:
 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 2. Hubless, cast-iron soil pipe and fittings; heavy-duty, 4-band hubless-piping couplings; and coupled joints.
 3. Epoxy-coated, hubless, cast-iron soil pipe and fittings; heavy-duty, 4-band hubless-piping couplings; and coupled joints.
 4. Dissimilar Pipe-Material Couplings: Shielded, non-pressure transition couplings.

END OF SECTION

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SECTION 22 14 23

STORM DRAINAGE PIPING SPECIALTIES

PART 1 GENERAL

1.01 SUMMARY

- A. This section includes:
 - 1. Roof drains.
 - 2. Miscellaneous storm drainage piping specialties.
 - 3. Cleanouts.
 - 4. Flashing materials.

1.02 SUBMITTALS

- A. Product Data: For each type of product indicated, include manufacturer, model number, accessories and options.

1.03 QUALITY ASSURANCE

- A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

PART 2 PRODUCTS

2.01 METAL ROOF AND OVERFLOW DRAINS

- A. Manufacturers: Subject to compliance with requirements. Provide products by one of the following:
 - 1. Jay R. Smith Manufacturing Co.
 - 2. Josam Company; Josam Division.
 - 3. Sioux Chief Manufacturing Company, Inc.
 - 4. Wade.
 - 5. Watts Drainage Products Inc.
 - 6. Zurn Plumbing Products Group.
- B. Cast-Iron, Large-Sump, General-Purpose Roof Drains:
 - 1. Standard: ASME A112.6.4, for general-purpose roof drains.
 - 2. Body Material: Cast iron.
 - 3. Dimension of Body: Nominal 14-inch diameter.
 - 4. Combination Flashing Ring and Gravel Stop: Required.
 - 5. Outlet: Bottom or side.
 - 6. Extension Collars: Adjustable.
 - 7. Underdeck Clamp: Required.
 - 8. Sump Receiver Plate: Required.
 - 9. Dome Material: Cast iron.
 - 10. Vandalproof Dome: Required.
 - 11. Water Dam: 2 inches high, required on overflow drains.
- C. Metal, Parapet Roof Drains:
 - 1. Standard: ASME A112.6.4, for parapet roof drains.
 - 2. Body Material: Cast iron or bronze.

3. Outlet: Back or angle as required.
 4. Grate Material: Bronze or cast iron.
 5. Vandalproof Grate: Required.
- D. Metal, Large-Sump, Area Drains:
1. Standard: ASME A112.6.4, for area drains.
 2. Body Material: Cast iron.
 3. Dimension of Body: Nominal 14-inch diameter.
 4. Dimension of Frame and Grate: Nominal 14 inches square.
 5. Outlet: Bottom.
 6. Grate Material: Nickel-bronze alloy.
 7. Vandalproof Grate: Required.
 8. Extension Collars: As required.
 9. Sump Receiver: Required.
 10. Sediment Bucket: Required.

2.02 MISCELLANEOUS STORM DRAINAGE PIPING SPECIALTIES

- A. Conductor Nozzles:
1. Description: Nickel bronze body with threaded or hubless inlet and bronze wall flange with mounting holes. Designed to discharge water away from building and to prevent wall staining.
 2. Size: Same as connected conductor.

2.03 CLEANOUTS

- A. Floor Cleanouts:
1. Standard: ASME A112.36.2M, for adjustable housing cleanouts.
 2. Size: Same as connected branch.
 3. Type: Adjustable housing.
 4. Body or Ferrule Material: Cast iron.
 5. Clamping Device: As required.
 6. Outlet Connection: Spigot.
 7. Closure: Plastic.
 8. Adjustable Housing Material: Cast iron with threads.
 9. Frame and Cover Material and Finish: Nickel-bronze, copper alloy.
 10. Frame and Cover Shape: Round or square.
 11. Top-Loading Classification: Medium Duty.
 12. Riser: ASTM A74, service class, cast-iron drainage pipe fitting and riser to cleanout.
- B. Test Tees:
1. Standard: ASME A112.36.2M and ASTM A74, ASTM A888, or CISPI 301, for cleanout test tees.
 2. Size: Same as connected drainage piping.
 3. Body Material: Hub-and-spigot, cast-iron soil-pipe T-branch or hubless, cast-iron soil-pipe test tee as required to match connected piping.
 4. Closure Plug: Countersunk, brass.
 5. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
- C. Wall Cleanouts:
1. Standard: ASME A112.36.2M, for cleanouts. Include wall access.
 2. Size: Same as connected drainage piping.
 3. Body Material: Hub-and-spigot, cast-iron soil-pipe T-branch or Hubless, cast-iron soil-pipe test tee as required to match connected piping.
 4. Closure: Countersunk brass plug.

5. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
6. Wall Access: Round, flat, chrome-plated brass or stainless-steel cover plate with screw.

2.04 FLASHING MATERIALS

- A. Copper Sheet: ASTM B152/B152M, 12 oz./sq.ft.
- B. Zinc-Coated Steel Sheet: ASTM A653/A653M, with 0.20% copper content and 0.04-inch minimum thickness unless otherwise indicated. Include G90 hot-dip galvanized, mill-phosphatized finish for painting if indicated.
- C. Elastic Membrane Sheet: ASTM D4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.
- D. Fasteners: Metal compatible with material and substrate being fastened.
- E. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.
- F. Solder: ASTM B32, lead-free alloy.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions. Roofing materials are specified in Division 07 specifications.
 1. Install flashing collar or flange of roof drain to prevent leakage between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
 2. Install expansion joints, if indicated, in roof drain outlets.
 3. Position roof drains for easy access and maintenance.
- B. Install conductor nozzles at exposed bottom of conductors where they spill onto grade.
- C. Install cleanouts in aboveground piping and building drain piping according to the following instructions unless otherwise indicated:
 1. Use cleanouts the same size as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
 2. Locate cleanouts at each change in direction of piping greater than 45 degrees.
 3. Locate cleanouts at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
 4. Locate cleanouts at base of each vertical drain stack.
- D. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- E. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- F. Extend surface cleanouts up to grade.
 1. For cleanouts terminating in paved or other finished surfaces, install cleanout deck plate with top flush with finished surface.

2. For cleanouts terminating in landscaping or other unfinished surface, install cleanout deck plate flush with top of (and centered in) minimum 12" x 12" x 4" concrete pad. Pad to be flush with adjacent surfaces.
- G. Install test tees in vertical conductors and near floor.
- H. Install wall cleanouts in vertical conductors. Install access door in wall if indicated.
- I. Install trench drains at low points of surface areas to be drained. Set grates of drains flush with finished surface unless otherwise indicated.
- J. Install sleeve flashing device with each conductor passing through floors with waterproof membrane.

3.02 CONNECTIONS

- A. Comply with requirements for piping specified in Division 22 sections. Drawings indicate general arrangement of piping, fittings, and specialties.

3.03 FLASHING INSTALLATION

- A. Fabricate flashing from single piece of metal unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:
 1. Lead Sheets: Burn joints of 6.0-lb./sq.ft. lead sheets, 0.0938-inch thickness or thicker. Solder joints of 4.0-lb./sq.ft. lead sheets, 0.0625-inch thickness or thinner.
 2. Copper Sheets: Solder joints of copper sheets.
- B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
 1. Pipe Flashing: Sleeve type, matching the pipe size, with a minimum length of 10 inches and with skirt or flange extending at least 8 inches around pipe.
 2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
 3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.
- C. Set flashing on floors and roofs in solid coating of bituminous cement.
- D. Secure flashing into sleeve and specialty clamping ring or device.
- E. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.04 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION

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SECTION 22 40 00

PLUMBING FIXTURES

PART 1 GENERAL

1.01 SUMMARY

- A. This section includes standard plumbing fixtures and accessories.

1.02 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene-styrene plastic.
- B. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.
- C. FRP: Fiberglass-reinforced plastic.
- D. PMMA: Polymethyl methacrylate (acrylic) plastic.
- E. PVC: Polyvinyl chloride plastic.
- F. Solid Surface: Non-porous, homogeneous, cast-polymer-plastic material with heat-, impact-, scratch-, and stain-resistance qualities.

1.03 SUBMITTALS

- A. Product Data: For each type of product indicated, include manufacturer, model number, options and accessories. Label each data submittal with fixture designation shown on drawings.
- B. Warranty information.
- C. Operation and maintenance data.

1.04 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to the Authorities Having Jurisdiction, and marked for intended use.
- B. Regulatory Requirements:
 - 1. Comply with requirements in ICC A117.1, Accessible and Usable Buildings and Facilities; Public Law 90-480, Architectural Barriers Act; and Public Law 101-336, Americans with Disabilities Act; for plumbing fixtures for people with disabilities.
 - 2. Comply with requirements in Public Law 102-486, Energy Policy Act, about water flow and consumption rates for plumbing fixtures.
- C. NSF Standard: Comply with NSF 61, Drinking Water System Components--Health Effects, for fixture materials that will be in contact with potable water.
- D. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible and of the same manufacturer for all like items.

- E. Comply with the following applicable standards and other requirements specified for plumbing fixtures:
1. Enameled, Cast-Iron Fixtures: ASME A112.19.1M.
 2. Plastic Laundry Trays: ANSI Z124.6.
 3. Plastic Shower Enclosures: ANSI Z124.2.
 4. Plastic Sinks: ANSI Z124.6.
 5. Porcelain-Enameled, Formed-Steel Fixtures: ASME A112.19.4M.
 6. Slip-Resistant Bathing Surfaces: ASTM F462.
 7. Solid-Surface-Material Lavatories and Sinks: ANSI/ICPA SS-1.
 8. Stainless-Steel Residential Sinks: ASME A112.19.3.
 9. Vitreous-China Fixtures: ASME A112.19.2M.
 10. Water-Closet, Flush Valve, Tank Trim: ASME A112.19.5.
 11. Water-Closet, Flushometer Tank Trim: ASSE 1037.
- F. Comply with the following applicable standards and other requirements specified for lavatory and sink faucets:
1. Backflow Protection Devices for Faucets with Side Spray: ASME A112.18.3M.
 2. Backflow Protection Devices for Faucets with Hose-Thread Outlet: ASME A112.18.3M.
 3. Diverter Valves for Faucets with Hose Spray: ASSE 1025.
 4. Faucets: ASME A112.18.1.
 5. Hose-Connection Vacuum Breakers: ASSE 1011.
 6. Hose-Coupling Threads: ASME B1.20.7.
 7. Integral, Atmospheric Vacuum Breakers: ASSE 1001.
 8. NSF Potable-Water Materials: NSF 61.
 9. Pipe Threads: ASME B1.20.1.
 10. Sensor-Actuated Faucets and Electrical Devices: UL 1951.
 11. Supply Fittings: ASME A112.18.1.
 12. Brass Waste Fittings: ASME A112.18.2.
 13. Components shall be lead-free as defined by the Safe Drinking Water Act Amendments of 1986 and the Lead Contamination Control Act of 1988.
- G. Comply with the following applicable standards and other requirements specified for shower faucets:
1. Backflow Protection Devices for Hand-Held Showers: ASME A112.18.3M.
 2. Combination, Pressure-Equalizing- and Thermostatic-Control Anti-Scald Faucets: ASSE 1070.
 3. Faucets: ASME A112.18.1.
 4. Hand-Held Shower Backflow Prevention Devices: ASSE 1014.
 5. High-Temperature-Limit Controls for Thermal-Shock-Preventing Devices: ASTM F445.
 6. Hose-Coupling Threads: ASME B1.20.7.
 7. Manual-Control Anti-Scald Faucets: ASTM F444.
 8. Pipe Threads: ASME B1.20.1.
 9. Pressure-Equalizing-Control Anti-Scald Faucets: ASTM F444 and ASSE 1070.
 10. Sensor-Actuated Faucets and Electrical Devices: UL 1951.
 11. Thermostatic-Control Anti-Scald Faucets: ASTM F444 and ASSE 1070.
- H. Comply with the following applicable standards and other requirements specified for miscellaneous fittings:
1. Atmospheric Vacuum Breakers: ASSE 1001.
 2. Brass and Copper Supplies: ASME A112.18.1.
 3. Dishwasher Air-Gap Fittings: ASSE 1021.
 4. Manual-Operation Flushometers: ASSE 1037.
 5. Plastic Tubular Fittings: ASTM F409.

6. Brass Waste Fittings: ASME A112.18.2.
 7. Sensor-Operation Flushometers: ASSE 1037 and UL 1951.
- I. Comply with the following applicable standards and other requirements specified for miscellaneous components:
1. Disposers: ASSE 1008 and UL 430.
 2. Dishwasher Air-Gap Fittings: ASSE 1021.
 3. Flexible Water Connectors: ASME A112.18.6.
 4. Grab Bars: ASTM F446.
 5. Hose-Coupling Threads: ASME B1.20.7.
 6. Hot-Water Dispensers: ASSE 1023 and UL 499.
 7. Off-Floor Fixture Supports: ASME A112.6.1M.
 8. Pipe Threads: ASME B1.20.1.
 9. Plastic Toilet Seats: ANSI Z124.5.
 10. Supply & Drain Protective Shielding Guards: ICC A117.1, ASTM E84-07.

PART 2 PRODUCTS

2.01 LAVATORY AND SINK FAUCETS

- A. Standard Lavatory and Sink Faucets:
1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated or a comparable product by one of the following:
 - a. American Standard Brands.
 - b. Bradley Corporation.
 - c. CHG Component Hardware Group.
 - d. Chicago Faucets.
 - e. Delany Products.
 - f. Delta Commercial Faucet Company.
 - g. Elkay Manufacturing Co.
 - h. Grohe America, Inc.
 - i. Just Manufacturing Company.
 - j. Kohler Co.
 - k. Moen, Inc.
 - l. Powers; a Watts Water Technologies Co.
 - m. Speakman Company.
 - n. T & S Brass and Bronze Works, Inc.
 - o. Zurn Plumbing Products Group; Commercial Brass Operation.
- B. Metering Lavatory Faucets:
1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated or a comparable product by one of the following:
 - a. American Standard Brands.
 - b. CHG Component Hardware Group.
 - c. Chicago Faucets.
 - d. Moen, Inc.
 - e. Powers; a Watts Water Technologies Co.
 - f. Sloan Valve Company.
 - g. Symmons Industries, Inc.
 - h. Zurn Plumbing Products Group; Commercial Brass Operation.

2.02 PROTECTIVE SHIELDING GUARDS

- A. Protective Shielding Pipe Covers:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. McGuire Manufacturing Co., Inc.
 - b. Plumberex Specialty Products Inc.
 - c. TRUEBRO, Inc.
 - d. Zurn Plumbing Products Group; Tubular Brass Plumbing Products Operation.
 - 2. Description: Manufactured plastic wraps for covering plumbing fixture hot-water, cold-water, and tempered-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements. Product shall meet ADA and ICC/ANSI A117.1. Insulation material shall comply with ASTM E84-07/UL 723 Class A and shall be listed and meet UPC/IAPMO.

2.03 FIXTURE SUPPORTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Jay R. Smith Manufacturing Co.
 - 2. MIFAB Manufacturing Inc.
 - 3. Sun Drainage Products.
 - 4. Tyler Pipe; Wade Division.
 - 5. Watts Drainage Products; a Division of Watts Water Technologies.
 - 6. Zurn Plumbing Products Group; Specification Drainage Operation.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Assemble plumbing fixtures, trim, fittings, and other components according to manufacturer's written instructions.
- B. Install off-floor supports, affixed to building substrate, for wall-mounting fixtures.
 - 1. Use carrier supports with waste fitting and seal for back-outlet fixtures.
 - 2. Use carrier supports without waste fitting for fixtures with tubular waste piping.
 - 3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.
- C. Install back-outlet, wall-mounting fixtures onto waste fitting seals and attach to supports.
- D. Install floor-mounting fixtures on closet flanges or other attachments to piping or building substrate.
- E. Install wall-mounting fixtures with tubular waste piping attached to supports.
- F. Install fixtures level and plumb according to roughing-in drawings.
- G. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.

- H. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.
- I. Install tubular waste piping on drain outlet of each fixture to be indirectly connected to drainage system.
- J. Install flush valves for accessible water closets and urinals with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.
- K. Install tanks for accessible, tank-type water closets with lever handle mounted on wide side of compartment.
- L. Install toilet seats on water closets.
- M. Install faucet-spout fittings with specified flow rates and patterns. If faucets are not available with required rates and patterns, include adapters as required.
- N. Install gooseneck faucets to spill into sink or lavatory basin.
- O. Install water-supply flow-control fittings with specified flow rates in fixture supplies at stop valves.
- P. Install faucet flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.
- Q. Install shower flow-control fittings with specified maximum flow rates in shower arms.
- R. Install traps on fixture outlets.
 - 1. Exception: Omit trap on fixtures with integral traps.
 - 2. Exception: Omit trap on indirect wastes, unless otherwise indicated.
- S. Install disposer in outlet of each sink indicated to have disposer.
- T. Install dishwasher air-gap fitting at each sink indicated to have air-gap fitting. Connect inlet hose to dishwasher and outlet hose to disposer.
- U. Install hot-water dispensers in back top surface of sink or in countertop with spout over sink as indicated.
- V. Install escutcheons at piping wall and ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Escutcheons are specified in Specification Section 22 05 18, Escutcheons for Plumbing Piping.
- W. Set bathtubs and showers in leveling bed of cement grout. Grout is specified in Specification Section 22 05 00, General Provisions.
- X. Seal joints between fixtures and walls, floors, and countertops using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 07 specifications.
- Y. Install protective shielding guards per the manufacturer's written instructions to cover all exposed piping and valves below handicap accessible sinks and lavatories.

3.02 CONNECTIONS

- A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

3.03 FIELD QUALITY CONTROL

- A. Verify that installed plumbing fixtures are categories and types specified for locations where installed.
- B. Check that plumbing fixtures are complete with trim, faucets, fittings, and other specified components.
- C. Inspect installed plumbing fixtures for damage. Replace damaged fixtures and components.
- D. Flush and replace all lavatory and sink aerators, and shower heads after water systems are pressurized, cleaned, and sanitized.
- E. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.
- F. Set temperature limiting devices to a maximum of 120°F unless noted otherwise on the drawings.
- G. Install fresh batteries in sensor-operated mechanisms.

3.04 PROTECTION

- A. Provide protective covering for installed fixtures and fittings.
- B. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by the Owner.

END OF SECTION

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SECTION 22 45 00

EMERGENCY PLUMBING FIXTURES

PART 1 GENERAL

1.01 SUBMITTALS

- A. Product Data: For each type of product indicated, include manufacturer, model number, options, and accessories.
- B. Field quality-control test reports.
- C. Operation and maintenance data.

1.02 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ANSI Standard: Comply with ANSI Z358.1, Emergency Eyewash and Shower Equipment.
- C. NSF Standard: Comply with NSF 61, Drinking Water System Components - Health Effects, for fixture materials that will be in contact with potable water.
- D. Regulatory Requirements: Comply with requirements in ICC/ANSI A117.1, Accessible and Usable Buildings and Facilities; Public Law 90-480, Architectural Barriers Act; and Public Law 101-336, Americans with Disabilities Act; for plumbing fixtures for people with disabilities.

PART 2 PRODUCTS

2.01 EMERGENCY PLUMBING FIXTURES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated or comparable product by one of the following:
 - 1. Acorn Safety; a Division of Acorn Engineering Company.
 - 2. Bradley Corporation.
 - 3. Chicago Faucets.
 - 4. Encon Safety Products.
 - 5. Guardian Equipment Co.
 - 6. Haws Corporation.
 - 7. Sellstrom Manufacturing Company.
 - 8. Speakman Company.
 - 9. WaterSaver Faucet Co.

2.02 WATER-TEMPERING EQUIPMENT

- A. Hot- and Cold-Water, Water-Tempering Equipment:
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated or comparable product by one of the following:
 - a. Acorn Safety; a Division of Acorn Engineering Company.
 - b. Armstrong International, Inc.

- c. Bradley Corporation.
 - d. Encon Safety Products.
 - e. Guardian Equipment Co.
 - f. Haws Corporation.
 - g. Leonard Valve Company.
 - h. Powers; a Division of Watts Water Technologies, Inc.
 - i. Speakman Company.
2. Description: Factory-fabricated equipment with thermostatic mixing valve.
- a. Thermostatic Mixing Valve: Designed to provide 85°F tepid, potable water at emergency plumbing fixtures, to maintain temperature at $\pm 5^{\circ}\text{F}$ throughout required 15-minute test period, and in case of unit failure to continue cold-water flow, with union connections, controls, metal piping, and corrosion-resistant enclosure.

2.03 EMERGENCY PLUMBING FIXTURE ACCESSORIES

- A. Provide the accessories indicated on the drawings.
- B. Flow Switch Alarm System: Automatic, audible and visual alarm system complete with flow switch that is activated by water flow at the emergency fixture. Include silence button for audible alarm. System shall be NEMA 3R for installation in wet environments. Include dry contacts to allow for monitoring by the building automation system.
- C. Privacy Curtain: Vinyl laminate, high visibility curtain with stainless-steel curtain rail and mounting brackets designed to surround shower to allow for disrobing during rinsing activities.
- D. Test Equipment:
 - 1. Drench Shower Tester: Watertight, minimum 80-inch-long, chemical-resistant funnel with telescoping handle designed to direct drench shower discharge into bucket or floor drain.
 - 2. Eye and Eye/Face Wash Test Gauge: Clear plastic gauge designed to allow evaluation of spray pattern and height.
- E. Scald Protection Valve: Temperature actuated brass valve designed to bleed water from the emergency fixture to maintain a water temperature of less than 105°F.
- F. Freeze Protection Valve: Temperature actuated brass valve designed to bleed water from the emergency fixture to prevent pipe bursting in freezing conditions.

2.04 SOURCE QUALITY CONTROL

- A. Certify performance of emergency plumbing fixtures by an independent testing organization acceptable to the Authorities Having Jurisdiction (AHJ).

PART 3 EXECUTION

3.01 EMERGENCY PLUMBING FIXTURE INSTALLATION

- A. Assemble emergency plumbing fixture piping, fittings, control valves, accessories, and other components.
- B. Install fixtures level and plumb.

- C. Fasten fixtures to substrate.
- D. Install shutoff valves in water-supply piping to fixtures. Use ball valve if specific type valve is not indicated. Install valves chained or locked in open position if permitted. Install valves in locations where they can easily be reached for operation. Comply with requirements for valves specified in Specification Section 22 05 23, General Duty Valves for Plumbing Piping.
 - 1. Exception: Omit shutoff valve on supply to group of plumbing fixtures that includes emergency equipment.
 - 2. Exception: Omit shutoff valve on supply to emergency equipment if prohibited by the AHJ.
- E. Install dielectric fitting in supply piping to emergency equipment if piping and equipment connections are made of different metals. Comply with requirements for dielectric fittings specified in Specification Section 22 11 16, Domestic Water Piping.
- F. Install thermometers in supply and outlet piping connections to water-tempering equipment. Comply with requirements for thermometers specified in Specification Section 22 05 19, Meters and Gages for Plumbing Piping.
- G. Install trap and waste piping on drain outlet of emergency equipment receptors that are indicated to be directly connected to drainage system. Comply with requirements for waste piping specified in Specification Section 22 13 16, Sanitary Waste and Vent Piping.
- H. Install indirect waste piping on drain outlet of emergency equipment receptors that are indicated to be indirectly connected to drainage system. Comply with requirements for waste piping specified in Specification Section 22 13 16, Sanitary Waste and Vent Piping.
- I. Install escutcheons on piping wall and ceiling penetrations in exposed, finished locations. Comply with requirements for escutcheons specified in Specification Section 22 05 18, Escutcheons for Plumbing Piping.
- J. Fill self-contained fixtures with flushing fluid.

3.02 CONNECTIONS

- A. Connect cold-water-supply piping to plumbed emergency plumbing fixtures not having water-tempering equipment. Comply with requirements for cold-water piping specified in Specification Section 22 11 16, Domestic Water Piping.
- B. Connect hot- and cold-water-supply piping to water-tempering equipment. Connect output from water-tempering equipment to emergency plumbing fixtures. Comply with requirements for hot- and cold-water piping specified in Specification Section 22 11 16, Domestic Water Piping.
- C. Directly connect emergency plumbing fixture receptors with trapped drain outlet to sanitary waste and vent piping. Comply with requirements for waste piping specified in Specification Section 22 13 16, Sanitary Waste and Vent Piping.
- D. Indirectly connect emergency plumbing fixture receptors without trapped drain outlet to sanitary waste or storm drainage piping.
- E. Where installing piping adjacent to emergency plumbing fixtures, allow space for service and maintenance of fixtures.

- F. Connect drain piping from scald and freeze protection drains and route to an acceptable location away from the fixture.

3.03 IDENTIFICATION

- A. Install equipment nameplates or equipment markers on emergency plumbing fixtures and equipment and equipment signs on water-tempering equipment. Comply with requirements for identification materials specified in Specification Section 22 05 53, Identification for Plumbing Piping and Equipment.

3.04 FIELD QUALITY CONTROL

- A. Mechanical-Component Testing: After plumbing connections have been made, test for compliance with requirements. Verify ability to achieve indicated capacities.
- B. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection.
 - 2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Emergency plumbing fixtures and water-tempering equipment will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

3.05 ADJUSTING

- A. Adjust or replace fixture flow regulators for proper flow.
- B. Adjust equipment temperature settings.

END OF SECTION

Edition 0908-1115

SECTION 22 61 13.10

COMPRESSED AIR PIPING FOR LABORATORY FACILITIES

PART 1 GENERAL

1.01 SUMMARY

- A. This section includes gas-powered-tool air piping and specialties, designated "instrument air," operating at 100 psig.

1.02 SUBMITTALS

- A. Product Data: Provide manufacturer's product data for each piece of equipment indicated on the drawings. Include product data for service connections, valves and valve boxes. Data to be specific to the equipment proposed for the project with all options and accessories indicated. Include the following as a minimum:
 - 1. Manufacturer and model number.
 - 2. Rated capacity based on scheduled conditions.
 - 3. Equipment dimensions.
 - 4. Required clearances.
 - 5. Electrical Data:
 - a. Voltage/Phase/Hz.
 - b. Full load ampacity, minimum circuit ampacity and maximum overcurrent protection device requirements.
 - c. Electrical service point(s) of connection.
 - d. AIC rating of the equipment.
 - 6. Materials of construction.
 - 7. Accessories and options.
 - 8. Controls.
 - 9. Wiring diagrams for power signal and control wiring.
- B. Field quality-control test reports.
- C. Warranty information.
- D. Operation and maintenance data.

PART 2 PRODUCTS

2.01 PIPES, TUBES, AND FITTINGS

- A. Copper Medical Gas Tube: ASTM B819, Types K and L, seamless, drawn temper that has been manufacturer-cleaned, -purged, and -sealed for medical gas service or according to CGA G-4.1 for oxygen service.
 - 1. General Requirements for Copper Fittings: Manufacturer-cleaned, -purged, and -bagged for oxygen service according to CGA G-4.1.
 - 2. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure-type or MSS SP-73, with dimensions for brazed joints.
 - 3. Copper Unions: ASME B16.22 or MSS SP-123, wrought-copper or cast-copper alloy.

- B. Copper Water Tube: ASTM B88, Type M, seamless, drawn temper.
 - 1. Copper Fittings: ASME B16.18, cast copper or ASME B16.22, wrought copper, solder-joint pressure-type.

2.02 JOINING MATERIALS

- A. Solder Filler Metals: ASTM B32, lead-free alloys. Include water-flushable flux according to ASTM B813.
- B. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.
- C. Threaded-Joint Tape: PTFE.

2.03 VALVES

- A. General Requirements for Valves: Manufacturer-cleaned, -purged, and -bagged according to CGA G-4.1 for oxygen service.
- B. Ball Valves: MSS SP-110, 3-piece body, brass or bronze.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allied Healthcare Products, Inc.; Chemetron Division.
 - b. Allied Healthcare Products, Inc.; Oxequip Health Industries.
 - c. Amico Corporation.
 - d. BeaconMedaes.
 - e. Conbraco Industries, Inc.
 - f. NIBCO INC.
 - g. Squire-Cogswell/Aeros Instruments, Inc.
 - h. Tri-Tech Medical.
 - 2. Pressure Rating: 300 psig minimum.
 - 3. Ball: Full-port, chrome-plated brass.
 - 4. Seats: PTFE or TFE.
 - 5. Handle: Lever type with locking device.
 - 6. Stem: Blowout proof with PTFE or TFE seal.
 - 7. Ends: Manufacturer-installed ASTM B819, copper-tube extensions.
- C. Check Valves: In-line pattern, bronze.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allied Healthcare Products, Inc.; Chemetron Division.
 - b. Amico Corporation.
 - c. BeaconMedaes.
 - d. Conbraco Industries, Inc.
 - e. Squire-Cogswell/Aeros Instruments, Inc.
 - f. Tri-Tech Medical.
 - 2. Pressure Rating: 300 psig minimum.
 - 3. Operation: Spring loaded.
 - 4. Ends: Manufacturer-installed ASTM B819, copper-tube extensions.
- D. Safety Valves: Bronze-body, ASME-construction, poppet, pressure-relief type with settings to match system requirements.

- E. Pressure Regulators: Bronze body and trim; spring-loaded, diaphragm-operated relieving type; manual pressure-setting adjustment; rated for 250-psig minimum inlet pressure; and capable of controlling delivered air pressure within 0.5 psig for each 10-psig inlet pressure.
- F. Automatic Drain Valves: Stainless-steel body and internal parts, rated for 200-psig minimum working pressure, capable of automatic discharge of collected condensate. Include mounting bracket where wall mounting is indicated.

2.04 QUICK COUPLINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Aeroquip Corporation; Eaton Corp.
 - 2. Hansen Coupling Division.
 - 3. Parker Hannifin Corp.
 - 4. Schrader-Bridgeport; Amflo Division.
 - 5. Snap-Tite, Inc.
 - 6. TOMCO Products Inc.
- B. General Requirements for Quick Couplings: Assembly with locking-mechanism feature for quick connection and disconnection of compressed-air hose.
- C. Automatic-Shutoff Quick Couplings: Straight-through brass body with O-ring or gasket seal and stainless-steel or nickel-plated-steel operating parts.
 - 1. Socket End: With one-way valve and threaded inlet for connection to piping or threaded hose fitting.
 - 2. Plug End: Straight-through type with barbed outlet for attaching hose.

2.05 FLEXIBLE PIPE CONNECTORS

- A. Description: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.
 - 1. Working-Pressure Rating: 200 psig minimum.
 - 2. End Connections: Threaded copper pipe or plain-end copper tube.

2.06 NITROGEN

- A. Description: Comply with USP 28 - NF 23 for oil-free dry nitrogen.

PART 3 EXECUTION

3.01 PREPARATION

- A. Cleaning of Laboratory Gas Tubing: If manufacturer-cleaned and -capped fittings or tubing are not available or if precleaned fittings or tubing must be recleaned because of exposure, have supplier or separate agency perform the following procedures:
 - 1. Clean laboratory gas tube and fittings, valves, gages, and other components of oil, grease, and other readily oxidizable materials as required for oxygen service according to CGA G-4.1, Cleaning Equipment for Oxygen Service.
 - 2. Wash laboratory gas tubing and components in hot, alkaline-cleaner-water solution of sodium carbonate or trisodium phosphate in proportion of 1 lb. of chemical to 3 gallons of water.
 - a. Scrub to ensure complete cleaning.
 - b. Rinse with clean, hot water to remove cleaning solution.

3.02 PIPING APPLICATIONS

- A. Instrument Air Piping: Use Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.
- B. Drain Piping: Use copper water tube, cast- or wrought-copper fittings, and soldered joints.

3.03 PIPING INSTALLATION

- A. Comply with ASSE Standard #6010 for installation of compressed-air piping.
- B. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and coordinate with other services occupying that space.
- E. Install piping adjacent to equipment and specialties to allow service and maintenance.
- F. Install air and drain piping with 1% slope downward in direction of flow.
- G. Install nipples, unions, special fittings, and valves with pressure ratings same as or higher than system pressure rating used in applications below unless otherwise indicated.
- H. Install eccentric reducers, if available, where compressed-air piping is reduced in direction of flow, with bottoms of both pipes and reducer fitting flush.
- I. Install branch connections to compressed-air mains from top of main. Provide drain leg and drain trap at end of each main and branch and at low points.
- J. Install thermometer and pressure gage on discharge piping from each air compressor and on each receiver. Comply with requirements in Specification Section 22 05 19, Meters and Gages for Plumbing Piping.
- K. Install piping to permit valve servicing.
- L. Install piping free of sags and bends.
- M. Install fittings for changes in direction and branch connections.
- N. Install compressed-air service connections recessed in walls. Attach roughing-in assembly to substrate; attach finishing assembly to roughing-in assembly.
- O. Connect compressed-air piping to air compressors and to compressed-air outlets and equipment requiring compressed-air service.
- P. Install unions in copper compressed-air tubing adjacent to each valve and at final connection to each piece of equipment, machine, and specialty.

- Q. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Specification Section 22 05 17, Sleeves and Sleeve Seals for Plumbing Piping.
- R. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Specification Section 22 05 17, Sleeves and Sleeve Seals for Plumbing Piping.
- S. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Specification Section 22 05 18, Escutcheons for Plumbing Piping.

3.04 VALVE INSTALLATION

- A. Install shutoff valve at each connection to and from compressed-air equipment and specialties.
- B. Install check valves to maintain correct direction of compressed-air flow from compressed-air equipment.
- C. Install valve boxes recessed in wall and anchored to substrate. Single boxes may be used for multiple valves that serve same area or function.
- D. Install safety valves on compressed-air receivers where required by NFPA 99 and where recommended by specialty manufacturers.
- E. Install pressure regulators on compressed-air piping where reduced pressure is required.
- F. Install automatic drain valves on equipment, specialties, and piping with drain connection. Run drain piping to floor sink so contents spill over or into it.
- G. Install flexible pipe connectors in discharge piping and in inlet air piping from remote air-inlet filter of each air compressor.

3.05 JOINT CONSTRUCTION

- A. Ream ends of pipes and remove burrs.
- B. Remove scale, slag, dirt, and debris from outside of cleaned tubing and fittings before assembly.
- C. Threaded Joints: Apply appropriate tape to external pipe threads.
- D. Brazed Joints: Join copper tube and fittings according to CDA's Copper Tube Handbook, Brazed Joints Chapter. Continuously purge joint with oil-free dry nitrogen during brazing.
- E. Soldered Joints: Apply ASTM B813, water-flushable flux to tube end. Join copper tube and fittings according to ASTM B828.

3.06 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements in Specification Section 22 05 29, Hangers and Supports for Plumbing Piping and Equipment, for pipe hanger and support devices.

- B. Vertical Piping: MSS Type 8 or Type 42, clamps.
- C. Individual, Straight, Horizontal Piping Runs: MSS Type 1, adjustable, steel, clevis hangers.
- D. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze. Comply with requirements in Specification Section 22 05 29, Hangers and Supports for Plumbing Piping and Equipment, for trapeze hangers.
- E. Base of Vertical Piping: MSS Type 52, spring hangers.
- F. Support horizontal piping within 12 inches of each fitting and coupling.
- G. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.
- H. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

	Maximum Horizontal Spacing	Minimum Rod Diameter
NPS 1/4	60 inches	3/8-inch rod
NPS 3/8 & NPS 1/2	72 inches	3/8-inch rod
NPS 3/4	84 inches	3/8-inch rod
NPS 1	96 inches	3/8-inch rod
NPS 1-1/4	108 inches	3/8-inch rod
NPS 1-1/2	10 feet	3/8-inch rod
NPS 2	11 feet	3/8-inch rod
NPS 2-1/2	13 feet	1/2-inch rod
NPS 3	14 feet	1/2-inch rod
NPS 3-1/2	15 feet	1/2-inch rod
NPS 4	16 feet	1/2-inch rod

- I. Install supports for vertical copper tubing every 10 feet.

3.07 LABELING AND IDENTIFICATION

- A. Install identifying labels and devices for laboratory compressed-air piping systems. Comply with requirements in Specification Section 22 05 53, Identification for Plumbing Piping and Equipment. Use the following or similar captions and color-coding for piping products:
 - 1. Laboratory Air: Black letters on yellow and white checkerboard background.

3.08 FIELD QUALITY CONTROL

- A. Perform field tests and inspections.
- B. Tests and Inspections:
 - 1. Initial Cleaning: Purge the piping system with oil-free dry air or oil-free dry nitrogen to remove any contaminants that may have been introduced into the piping system during construction.

2. Piping Leak Tests: Test new and modified parts of existing piping. Cap and fill laboratory compressed-air piping with oil-free dry air or gaseous nitrogen to pressure of 50 psig above system operating pressure, but not less than 150 psig. Isolate test source and let stand for 4 hours to equalize temperature. Refill system, if required, to test pressure; hold for 2 hours with no drop in pressure.
3. Repair leaks and retest until no leaks exist.
4. Inspect filters and pressure regulators for proper operation.
5. Piping Particulate Test: Performing a piping particulate test similar to the requirements listed in NFPA 99 for a medical air system.

END OF SECTION

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SECTION 22 62 13.10

VACUUM PIPING FOR LABORATORY FACILITIES

PART 1 GENERAL

1.01 SUMMARY

- A. This section includes laboratory vacuum piping and specialties operating at 15 inches mercury.

1.02 SUBMITTALS

- A. Product Data: Provide manufacturer's product data for each piece of equipment indicated on the drawings. Include product data for service connections, valves and valve boxes, vacuum bottle brackets, pressure control panels, manifolds, and alarm system components. Data to be specific to the equipment proposed for the project with all options and accessories indicated. Include the following as a minimum:
 - 1. Manufacturer and model number.
 - 2. Rated capacity based on scheduled conditions.
 - 3. Equipment dimensions.
 - 4. Required clearances.
 - 5. Electrical Data:
 - a. Voltage/Phase/Hz.
 - b. Full load ampacity, minimum circuit ampacity and maximum overcurrent protection device requirements.
 - c. Electrical service point(s) of connection.
 - d. AIC rating of the equipment.
 - 6. Materials of construction.
 - 7. Accessories and options.
 - 8. Controls.
 - 9. Wiring diagrams for power signal and control wiring.
- B. Field quality-control test reports.
- C. Operation and maintenance data.

PART 2 PRODUCTS

2.01 PIPES, TUBES, AND FITTINGS

- A. Copper Tube: ASTM B88, Type L or M seamless, drawn-temper, water tube.
 - 1. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure-type or MSS SP-73, wrought copper with dimensions for brazed joints.
 - 2. Cast-Copper-Alloy Flanges: ASME B16.24, Class 150 or 300.
 - 3. Copper Unions: ASME B16.22 or MSS SP-123.

2.02 JOINING MATERIALS

- A. Solder Filler Metals: ASTM B32, lead-free alloys. Include water-flushable flux according to ASTM B813.

- B. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.
- C. Threaded-Joint Tape: PTFE.
- D. Pipe-Flange Gasket Materials: ASME B16.21, non-metallic, flat, asbestos-free, 1/8-inch maximum thickness, full-face type.
- E. Flange Bolts and Nuts: ASME B18.2.1, carbon steel.

2.03 VALVES

- A. Metal Ball, Butterfly, and Check Valves: Comply with requirements in Specification Section 22 05 23, General Duty Valves for Plumbing Piping.
- B. Safety Valves: Bronze-body, ASME-construction, pressure-relief type with settings to match system requirements.
- C. Automatic Drain Valves: Stainless-steel body and internal parts, rated for 200-psig minimum working pressure, capable of automatic discharge of collected condensate. Include mounting bracket where wall mounting is indicated.

2.04 QUICK COUPLINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Aeroquip Corporation; Eaton Corp.
 - 2. Hansen Coupling Division.
 - 3. Parker Hannifin Corp.
 - 4. Schrader-Bridgeport; Amflo Division.
 - 5. Snap-Tite, Inc.
 - 6. TOMCO Products Inc.
- B. General Requirements for Quick Couplings: Assembly with locking-mechanism feature for quick connection and disconnection of compressed-air hose.
- C. Automatic-Shutoff Quick Couplings: Straight-through brass body with O-ring or gasket seal and stainless-steel or nickel-plated-steel operating parts.
 - 1. Socket End: With one-way valve and threaded inlet for connection to piping or threaded hose fitting.
 - 2. Plug End: Straight-through type with barbed outlet for attaching hose.

2.05 FLEXIBLE PIPE CONNECTORS

- A. Description: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.
 - 1. Working-Pressure Rating: 200 psig minimum.
 - 2. End Connections: Threaded copper pipe or plain-end copper tube.

PART 3 EXECUTION

3.01 PIPING APPLICATIONS

- A. Laboratory Vacuum Piping: Use the following piping materials:
 - 1. Type L, copper; wrought-copper fittings; and brazed joints.
- B. Drain Piping: Use the following piping materials:
 - 1. Copper water tube, cast- or wrought-copper fittings, and soldered joints.

3.02 PIPING INSTALLATION

- A. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- B. Install piping at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- C. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and coordinate with other services occupying that space.
- D. Install piping adjacent to equipment and specialties to allow service and maintenance.
- E. Install vacuum and drain piping with 1% slope downward in direction of flow.
- F. Install nipples, unions, and special fittings, and valves with pressure ratings same as or higher than piping pressure rating used in applications below unless otherwise indicated.
- G. Install eccentric reducers, if available, where vacuum piping is reduced in direction of flow, with bottoms of both pipes and reducer fitting flush.
- H. Provide drain leg and drain trap at end of each main and branch and at low points.
- I. Install thermometer and vacuum gage on inlet piping to each vacuum producer and on each receiver. Comply with requirements in Specification Section 22 05 19, Meters and Gages for Plumbing Piping.
- J. Install piping to permit valve servicing.
- K. Install piping free of sags and bends.
- L. Install fittings for changes in direction and for branch connections.
- M. Connect vacuum piping to vacuum producers and to equipment requiring vacuum service.
- N. Install unions, in copper vacuum tubing adjacent to each valve and at final connection to each piece of equipment, machine, and specialty.
- O. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Specification Section 22 05 17, Sleeves and Sleeve Seals for Plumbing Piping.

- P. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Specification Section 22 05 17, Sleeves and Sleeve Seals for Plumbing Piping.
- Q. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Specification Section 22 05 18, Escutcheons for Plumbing Piping.

3.03 VALVE APPLICATIONS

- A. Valves for Copper Vacuum Tubing: Use copper alloy ball and bronze check types.

3.04 VALVE INSTALLATION

- A. Install shutoff valve at each connection to and from vacuum equipment and specialties.
- B. Install check valves to maintain correct direction of vacuum flow to vacuum-producing equipment.
- C. Install safety valves on vacuum receivers where recommended by specialty manufacturers.
- D. Install automatic drain valves on equipment, specialties, and piping with drain connection. Run drain piping to floor sink, so contents spill over or into it.
- E. Install flexible pipe connectors in suction inlet piping to each vacuum producer.

3.05 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs.
- B. Remove scale, slag, dirt, and debris from outside of cleaned tubing and fittings before assembly.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Threaded Joints: Apply appropriate tape to external pipe threads.
- E. Brazed Joints: Join copper tube and fittings according to CDA's Copper Tube Handbook, Brazed Joints Chapter.
- F. Soldered Joints: Apply ASTM B813, water-flushable flux to tube end. Join copper tube and fittings according to ASTM B828.
- G. Flanged Joints:
 - 1. Copper Tubing: Install flange on copper tubes. Use pipe-flange gasket between flanges. Join flanges with gasket and bolts according to ASME B31.9 for bolting procedure.

3.06 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements in Specification Section 22 05 29, Hangers and Supports for Plumbing Piping and Equipment, for pipe hanger and support devices.

- B. Vertical Piping: MSS Type 8 or Type 42, clamps.
- C. Individual, Straight, Horizontal Piping Runs: MSS Type 1, adjustable, steel, clevis hangers.
- D. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: Support pipe rolls on trapeze. Comply with requirements in Specification Section 22 05 29, Hangers and Supports for Plumbing Piping and Equipment, for trapeze hangers.
- E. Base of Vertical Piping: MSS Type 52, spring hangers.
- F. Support horizontal piping within 12 inches of each fitting and coupling.
- G. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.
- H. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

	Maximum Horizontal Spacing	Minimum Rod Diameter
NPS 1/4	60 inches	3/8-inch rod
NPS 3/8 & NPS 1/2	72 inches	3/8-inch rod
NPS 3/4	84 inches	3/8-inch rod
NPS 1	96 inches	3/8-inch rod
NPS 1-1/4	108 inches	3/8-inch rod
NPS 1-1/2	10 feet	3/8-inch rod
NPS 2	11 feet	3/8-inch rod
NPS 2-1/2	13 feet	1/2-inch rod
NPS 3	14 feet	1/2-inch rod
NPS 3-1/2	15 feet	1/2-inch rod
NPS 4	16 feet	1/2-inch rod

- I. Install supports for vertical copper tubing every 10 feet.

3.07 LABELING AND IDENTIFICATION

- A. Install identifying labels and devices for laboratory vacuum piping, valves, and specialties. Comply with requirements in Specification Section 22 05 53, Identification for Plumbing Piping and Equipment. Use the following or similar captions and color-coding for piping products:
 - 1. Laboratory Vacuum: Black boxed letters on white and black checkerboard background.

3.08 FIELD QUALITY CONTROL

- A. Perform field tests and inspections.
- B. Tests and Inspections:
 - 1. Initial Cleaning: Purge the piping system with oil-free dry air or oil-free dry nitrogen to remove and contaminants that may have been introduced into the piping system during construction.

2. Piping Leak Tests: Test new and modified parts of existing piping. Cap laboratory vacuum piping and subject to a minimum 12 inches mercury vacuum. Isolate test source; hold for 24 hours with no change in pressure.
3. Repair leaks and retest until no leaks exist.

END OF SECTION

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SECTION 22 63 13.10

GAS PIPING FOR LABORATORY FACILITIES

PART 1 GENERAL

1.01 SUMMARY

- A. This section includes:
 - 1. Nitrogen piping and specialties designated “nitrogen” operating at 160 psig to 185 psig.
 - 2. Helium piping and specialties designated “helium” operating at 50 psig to 55 psig.
 - 3. Argon piping and specialties designated “argon” operating at 160 psig to 185 psig.

1.02 SUBMITTALS

- A. Product Data: Provide manufacturer’s product data for the following:
 - 1. Valves and valve boxes.
 - 2. Laboratory gas service connections.
 - 3. Gas manifolds.
 - 4. Data to be specific to the equipment proposed for the project with all options and accessories indicated. Include the following as a minimum:
 - a. Manufacturer and model number.
 - b. Equipment dimensions.
 - c. Required clearances.
 - d. Electrical Data:
 - 1) Voltage/Phase/Hz.
 - 2) Electrical service point(s) of connection.
 - 3) Materials of construction.
 - 4) Accessories and options.
 - 5) Controls.
- B. Field quality-control test reports.
- C. Warranty information.
- D. Operation and maintenance data.

1.03 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to the Authorities Having Jurisdiction (AHJ), and marked for intended use.

PART 2 PRODUCTS

2.01 PIPES, TUBES, AND FITTINGS

- A. Stainless Steel Tubing: ASTM A632 (for sizes under 1/2 inch diameter) Type 316L seamless stainless steel tubing.
 - 1. Approved Manufacturer: Valex
 - 2. Tubing shall meet requirements of VALEX specification No. 401, or 301 where noted with deionized water cleaning and nitrogen drying, except where

requirements noted herein dictate more stringent measures. Such requirements shall include material, manufacturing, electropolishing, cleaning, inspection, certification, and packaging. Do not acid pickle after cold working or final annealing.

3. Wall thickness' for tubing shall be as follows:
 - a. 1/4 inch O.D. and 3/8 inch O.D.: 0.035"
 - b. 1/2 inch O.D.: 0.049"
4. Tubing shall be in exact 20 ft. lengths, with sulfur content from 0.003 to 0.010 percent, and no sulfur strings visible at the surface. Surface shall be chrome enriched, and average oxide depth (as determined by Auger or ESCA measurement) shall be greater than 50 angstroms. Hardness on the Rockwell B scale shall be between a value of 70 and a value of 90. Tube to be bright annealed in 100 percent dry hydrogen.
5. Weldability: Either provide each tube lot from the same heat batch, or provide test results demonstrating satisfactory cross-heat weldability.
6. Tubing shall be internally electropolished to a maximum of 10 micro-inches as specified herein. The electropolished surface shall be free of imperfections. Mechanical polishing to achieve finish requirements is not acceptable. Pitting shall be limited to 100 pits or defects per field of view in a SEM at 1000 X magnification.
7. Factory electropolishing shall consist of the following:
 - a. Inside surface electropolishing and flushout;
 - b. Nitric acid "pickling" flush to remove remaining contamination;
 - c. Deionized water flush series, until flushed water measures a resistance of 16 Megohm/cm or more;
 - d. Wad Cleaning: For 3/8 inch diameter and larger tube, blow a clean, lint-free wipe thoroughly wetted with deionized water through a tube and inspect a 10 X magnification for contamination. Repeat until the wad is clean, or the tubing is rejected. Each tube pass shall require use of a clean (new) wipe. For 1/4 inch tubing, the tube shall be flushed with deionized water at high velocity, and the water filtered through a cleanroom compatible (non-shedding) filter paper. The tubing shall pass if the filter shows no contamination at 10 X magnification.
 - e. Dry the tubing to a 5 PPM or less moisture content using nitrogen gas filtered to 0.01 microns.
 - f. Cap and seal tubing using an Aclar film cover and plastic cap.
8. Mechanical Joint Fittings:
 - a. 316L stainless steel Crawford type VCR or Parker Vacuseal, factory cleaned to VLSI standards and double bagged in polyethylene bags. Fittings shall be internally electropolished to 10 micro-inches and shall have a helium leak rate of less than 10-10 cc/sec. Gaskets shall be polished soft nickel type with retainer clip; plated gaskets are not acceptable.

2.02 VALVES

- A. General Requirements for Valves: Manufacturer-cleaned, -purged, and -bagged according to CGA G-4.1 for oxygen service.
- B. Stainless Steel Tubing Valves:
 1. Valves Under 1/2 inch O.D.:
 - a. Approved Manufacturers: Carten SPD, or Nupro (ELD series).
 2. Valves shall be springless packless diaphragm type, ultraclean 316L stainless steel with Kel-F seats and male VCR (or equivalent) end connections. "Wetted" surfaces shall not contain brass, bronze or other copper containing material. Valves shall be rated for a maximum working pressure of 250 psig. Valves shall not have purge ports.

3. Helium leak rates shall be as follows:
 - a. Components: Inboard $<2 \times 10^{-10}$ cc/sec for general nitrogen service; $< 10^{-10}$ cc/sec for other services.
 - b. Across the Seat: $<4 \times 10^{-8}$ cc/sec.
 - c. Outboard: $<2 \times 10^{-9}$ cc/sec.
 4. Finish shall be 15 Ra average or better for general nitrogen service and 10 Ra average or better for other services.
 5. Cleaning: Solvent based cleaning of valves shall not be done after the electropolishing step. Valves will be factory cleaned to Carten SWP 0003 and 800001 Specifications and double bagged.
- C. Pressure Regulators: Stainless-steel body and trim; spring-loaded, diaphragm-operated, relieving type; manual pressure-setting adjustment; rated for 250-psig minimum inlet pressure; and capable of controlling delivered gas pressure within 0.5 psig for each 10-psig inlet pressure.
1. Approved Manufacturers: Tescom.
 - a. Flows < 1 SCFM – No. 74-2400 series.
 - b. Flows > 1 SCFM – No. 74-38000 series.
 2. Regulators shall be manufactured from ultraclean 316L stainless steel with Kel-F seats and male VCR (or equivalent) ends for under 1/2 inch size. Wetted surfaces shall not contain brass, bronze, or other copper containing materials. Regulator shall be service rated for full cylinder pressure of regulated gas.
 3. Regulators shall be provided without pressure gages. (Pressure gages will be installed in-line upstream and downstream of regulator to permit tighter “racking” of parallel specialty gas tubing services.)
 4. Finish requirements, cleaning, and packaging shall be the same as specified for valves under 1/2 inch size, Tescom spec ES500.

2.03 POINT-OF-USE FILTERS:

- A. Approved Manufacturers: Mott (GasShield Series) No. POU-05 series – flows < 2 SCFM, No. POU-10-2 CFM.
- B. Filters shall be manufactured from ultraclean 316L stainless steel with female VCR (or equivalent) upstream end and male VCR (or equivalent) on downstream end, size to match tubing. Filter media shall be 100 percent fully sintered porous metal, with no shedding or outgassing. Filters shall be rated to a pressure of 2500 psi maximum and a temperature of 450 degrees C.
- C. Filter shall be rate to remove 99.999999 percent (9 log) of all particles over 0.005 microns at a flow rate of 30 SLPM, at a pressure drop not to exceed 9 psig.
- D. Filters shall be baked and cooled in clean dry nitrogen, capped with metal cap fittings, and sealed in clean polyethylene bags in a class 100 environment per Fed. Spec. 209B.

2.04 PRESSURE GAGES:

- A. For gas systems, use SPAN model No. S12230-0-100 VCRSM compound pressure gage. Install in locations indicated on drawings.

2.05 PURGE, TEST, SHIELD AND DRYING GASES:

- A. Argon For Purge: To have a minimum purity of 99.999% with a maximum of 1.0 ppm O₂ 0.5 ppm hydrocarbons, and 0.5 ppm moisture. Gas shall be filtered to 0.02 microns absolute.

- B. Nitrogen For Test: To have a minimum purity of 99.999% with a maximum of 1.0 ppm O₂, 0.5 ppm CO and CO₂ and 0.5 ppm hydrocarbons and a dewpoint of –100 degrees or lower and shall be filtered to 0.02 microns.
- C. Helium For Test: To have a minimum purity of 99.999% with a maximum of 1.0 ppm O₂ and moisture, 0.5 ppm CO and CO₂ and shall be filtered to 0.02 microns absolute.
- D. Argon For Shield Gas Use: To have a minimum purity of 99.999%. This can be supplied from pressurized cylinders. Filter at the weld machine outlet to 0.02 microns.
- E. Nitrogen used for drying components shall be of the same quality as that required for testing.

2.06 NITROGEN

- A. Description: Comply with USP 28 - NF 23 for oil-free dry nitrogen.

PART 3 EXECUTION

3.01 PREPARATION

- A. Cleaning of Laboratory Gas Tubing: If manufacturer-cleaned and -capped fittings or tubing are not available or if precleaned fittings or tubing must be re-cleaned because of exposure, have the supplier or a separate agency acceptable to the AHJ perform the following procedures:
 - 1. Clean laboratory gas tube and fittings, valves, gages, and other components of oil, grease, and other readily oxidizable materials as required for oxygen service according to CGA G-4.1, Cleaning Equipment for Oxygen Service.
 - 2. Tubing shall be tested for cleanliness after cutting but prior to installation. Testing, drying and sealing shall be the same as the wad cleaning, drying and sealing procedures described under the factory electropolishing in Section 2.

3.02 PIPING INSTALLATION

- A. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- B. Install piping at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- C. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and coordinate with other services occupying that space.
- D. Install piping adjacent to equipment and specialties to allow service and maintenance.
- E. Install nipples, unions, and special fittings, and valves with pressure ratings same as or higher than system pressure rating used in applications below unless otherwise indicated.
- F. Install piping to permit valve servicing.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.

- I. Install laboratory gas piping to medical gas service connections specified in this section and to equipment specified in other sections requiring laboratory gas service.
- J. Install laboratory gas service connections recessed in walls. Attach roughing-in assembly to substrate; attach finishing assembly to roughing-in assembly.
- K. Connect gas piping to gas sources and to gas outlets and equipment requiring gas service.
- L. Install unions, in stainless steel tubing adjacent to each valve and at final connection to each piece of equipment and specialty.
- M. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Specification Section 22 05 17, Sleeves and Sleeve Seals for Plumbing Piping.
- N. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Specification Section 22 05 17, Sleeves and Sleeve Seals for Plumbing Piping.
- O. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Specification Section 22 05 18, Escutcheons for Plumbing Piping.

3.03 VALVE INSTALLATION

- A. Install shutoff valve at each connection to gas laboratory equipment and specialties.
- B. Install check valves to maintain correct direction of gas flow from laboratory gas supplies.
- C. Install valve boxes recessed in wall and anchored to substrate. Single boxes may be used for multiple valves that serve same area or function.
- D. Install pressure regulators on gas piping where reduced pressure is required.

3.04 JOINT CONSTRUCTION

- A. Install systems using orbital arc welded joints.
- B. Orbital arc welding machine shall make autogenous welds using a tungsten-inert gas process.
- C. All cleaning and deburring and all shop welding shall be done in a Class 100 clean room per Federal Sec. 209B. Fitters and welders shall wear white lint-free gloves while fabricating and installing.
- D. Argon gas purge shall be continuously kept on all uncapped tubing. This shall include both tubing on the fabrication bench and installed tubing not yet in service. Purge gas connections to tubing or weld assemblies must be hard stainless steel tubing connections. Compression fittings are acceptable for this temporary use, but plastic tubing (Teflon, nylon, etc.) is unacceptable due to moisture infiltration through the wall.
- E. Prepare Joints as follows:
 - 1. Cut ends will be faced to be square to a tolerance of 0.003 inch. Tubing shall be cut and faced using a portable facing tool (Tri-tool or equal) or a lathe. No cutting

fluid shall be used. The tubing shall not be scratched during deburring. Abrasive wheels or saws shall not be used.

2. Set up the fabrication on the work bench or field fit. Verify that the argon gas purge is connected to one end of the assembly. Test for quality of the argon backing purge with an oxygen analyzer.

F. Quality Assurance:

1. Welding will be in accordance with a qualified welding procedure. A sample weld shall be made before each series of welding operations. A sample weld shall be made:
 - a. At the beginning of the day.
 - b. After lunch breaks.
 - c. After changing power sources or shut down of power.
 - d. After changing weld heads.
 - e. After changing tube sizes.
 - f. After any change in weld program.
 - g. After changing purge gas source.
 - h. After any other change that might affect the weld.All sample welds shall be approved by the Testing Agency.
2. All welding must meet the requirements of the American Standard Code for Pressure Piping, ANSI B31.3, and ASME Boiler Pressure Vessel Code. The Contractor shall provide certification that the welding procedure and welding operators have been qualified by the Owner's engineer (or designated representative) responsible for compliance with the specification.
3. Completed construction welds will be inspected by Contractor's superintendent as part of contractors Quality Assurance program. In addition, the Construction Manager and the Engineer will inspect welds wherever practical. The following defects will be cause for weld rejection:
 - a. Oxidation levels dark brown to black in surface appearance or "rainbowing", as compared to acceptable samples.
 - b. Skips (lack of fusion). Internal areas of the joint which have not been properly consumed.
 - c. Undercut of base material, interior or exterior.
 - d. Poor alignment of joint, or out of tolerance with joint preparation specified previously.
 - e. Evidence of any heat cracking, internal or external.
 - f. Pinholes of any sort.
 - g. Excessive internal crevice.
 - h. Weld current fluctuation causing irregular bead appearance and tracking.
 - i. Surface oxidation products or excessive silicone inclusion on interior weld surface.
 - j. Evidence of leaking during final test.

G. Welding Requirements:

1. During welding, all "high purity" lines shall be purged with clean, dry gas as specified herein. The purge gas shall be allowed to escape to atmosphere through a perforated plug or purge port at the end of pipe run.
2. Fittings shall be round, true and new. Fittings, once used, shall not be reused.
3. The minimum purge flow rates will be in accordance with the following table:

PURGE FLOW RATE TABLE		
Nom. Pipe/Tube Size	SCFH	Liters/Min.
1/4" & 3/8"	1.5	0.75

3.05 FIELD BENDING LIMITATIONS

- A. Bending ultrapolished 316L stainless steel, to too tight a radius will result in deterioration of the inner surface. Not only does this provide an increased potential for contamination, but it also weakens the tubing strength considerably. Since the tubing is used for containment of gasses that can be under high pressure and/or toxic or corrosive, it is imperative that field bending limitations be observed. Failure to meet field bending limitations will be considered to be not only cause for automatic replacement, but is considered an unsafe work practice as well.
- B. Field bending for 1/4" and 3/8" diameter tubing may be done only where a minimum of 10 tube diameters is used as the bending radius.

3.06 GAS SERVICE COMPONENT INSTALLATION

- A. Install gas manifolds on concrete base anchored to substrate.
- B. Install gas cylinders and connect to manifold piping.

3.07 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements in Specification Section 22 05 29, Hangers and Supports for Plumbing Piping and Equipment, for pipe hanger and support devices.
- B. Vertical Piping: MSS Type 8 or Type 42 clamps.
- C. Individual, Straight, Horizontal Piping Runs: MSS Type 1, adjustable, steel, clevis hangers.
- D. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: Trapeze hangers with pipe clamps. Comply with requirements in Specification Section 22 05 29, Hangers and Supports for Plumbing Piping and Equipment, for trapeze hangers.
- E. Base of Vertical Piping: MSS Type 52, spring hangers.
- F. Support horizontal piping within 12 inches of each fitting and coupling.
- G. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.
- H. Install hangers for stainless steel tubing with the following maximum horizontal spacing and minimum rod diameters:

	Maximum Horizontal Spacing	Minimum Rod Diameter
NPS 1/4	60 inches	3/8-inch rod
NPS 3/8 & NPS 1/2	60 inches	3/8-inch rod
NPS 3/4	72 inches	3/8-inch rod
NPS 1	84 inches	3/8-inch rod
NPS 1-1/4	84 inches	3/8-inch rod
NPS 1-1/2	9 feet	3/8-inch rod
NPS 2	10 feet	3/8-inch rod
NPS 2-1/2	10 feet	1/2-inch rod

	Maximum Horizontal Spacing	Minimum Rod Diameter
NPS 3	10 feet	1/2-inch rod
NPS 3-1/2	10 feet	1/2-inch rod
NPS 4	10 feet	1/2-inch rod

- I. Install supports for vertical stainless steel tubing every 10 feet.

3.08 LABELING AND IDENTIFICATION

- A. Install identifying labels and devices for laboratory gas piping, valves, and specialties. Comply with requirements in Specification Section 22 05 53, Identification for Plumbing Piping and Equipment.

3.09 FIELD QUALITY CONTROL

- A. Perform field tests and inspections.
- B. Tests and Inspections:
 1. Initial Cleaning: Purge the piping system with oil-free dry air or oil-free dry nitrogen to remove any contaminants that may have been introduced into the piping system during construction.
 2. Piping Leak Tests: Pressurize the completed system to 150 psig with helium. Check all connections and fittings with a portable leak detector such as a Varian Porta-Test leak detector. Do not use leak detection fluid such as "Snoop" or "Leaktec". Repair any defect, taking care to minimize system contamination. After completion of outboard leak test, repeat procedure using a vacuum inside the tubing (inboard leak test), again repairing any defects. Isolate test source and let stand for 4 hours to equalize temperature. Refill system, if required, to test pressure; hold for 2 hours with no drop in pressure
 3. Repair leaks and retest until no leaks exist.
 4. Inspect filters and pressure regulators for proper operation.
 5. Piping Particulate Test: Performing a piping particulate test similar to the requirements listed in NFPA 99 for a medical air system.

3.10 PIPING SCHEDULE

- A. Nitrogen gas piping shall be: Stainless Steel Tubing.
- B. Helium gas piping shall be: Stainless Steel Tubing.
- C. Argon gas piping shall be: Stainless Steel Tubing.

END OF SECTION

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SECTION 22 66 00.10

CHEMICAL WASTE SYSTEMS FOR LABORATORY FACILITIES

PART 1 GENERAL

1.01 SUMMARY

- A. This section includes:
 - 1. Single-wall piping.
 - 2. Neutralization tanks.

1.02 PERFORMANCE REQUIREMENTS

- A. Single-Wall Piping Pressure Rating: 10 feet head of water.

1.03 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Field quality-control test reports.
- C. Operation and Maintenance Data: For chemical-waste specialties and neutralization tanks to include in emergency, operation, and maintenance manuals.

1.04 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Neutralization-Tank Limestone: Equal to 200% of amount required for each tank sump initial charge. Furnish limestone in 50-lb. bags.

PART 2 PRODUCTS

2.01 SINGLE-WALL PIPE AND FITTINGS

- A. PP Drainage Pipe and Fittings: ASTM F1412, pipe extruded and drainage-pattern fittings molded, with Schedule 40 dimensions, from PP resin with fire-retardant additive complying with ASTM D4101; with mechanical-joint ends.
 - 1. Exception: Pipe and fittings made from PP resin without fire-retardant additive may be used for underground installation.
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Georg Fischer Sloane, LLC.
 - b. IPEX Inc.
 - c. Orion Fittings, Inc.; a Division of Watts Water Technologies, Inc.
 - d. Town & Country Plastics, Inc.
 - e. Watts Industries (Canada) Inc.
 - f. Zurn Plumbing Products Group; Chemical Drainage Systems.
- B. PVDF Drainage Pipe and Fittings: ASTM F1673, Schedule 40, pipe and drainage-pattern fittings. Include fittings with mechanical-joint ends.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Orion Fittings, Inc.; a Division of Watts Water Technologies, Inc.
 - b. Watts Industries (Canada) Inc.
 - c. Zurn Plumbing Products Group; Chemical Drainage Systems.
- C. Adapters and Transition Fittings: Assemblies with combination of clamps, couplings, adapters, and gaskets; compatible with piping and system liquid; made for joining different piping materials.

2.02 JOINING MATERIALS

- A. Couplings: Assemblies with combination of clamps, gaskets, sleeves, and threaded or flanged parts; compatible with piping and system liquid; and made by the piping manufacturer for joining system piping.
- B. Adapters and Transition Fittings: Assemblies with combination of clamps, couplings, adapters, gaskets, and threaded or flanged parts; compatible with piping and system liquid; and made for joining different piping materials.
- C. Flanges: Assemblies of companion flanges and gaskets complying with ASME B16.21 and compatible with system liquid, and bolts and nuts.

2.03 NEUTRALIZATION TANKS

- A. Plastic Neutralization Tanks:
 1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on the drawings or a comparable product by one of the following:
 - a. Chem-Tainer Industries.
 - b. Georg Fischer Sloane, LLC.
 - c. IPEX Inc.
 - d. Orion Fittings, Inc.; a Division of Watts Water Technologies, Inc.
 - e. Schier Products Company.
 - f. Town & Country Plastics, Inc.
 - g. Watts Industries (Canada) Inc.
 2. Description: Corrosion-resistant plastic materials; with removable, gastight cover; interior, sidewall, inlet; outlet; vent; and threaded or flanged, sidewall pipe connections.
 - a. Material: ASTM D1248, PE.
 - b. Limestone: Chips or lumps, with more than 90% calcium carbonate content and 1 to 3-inch diameter.

PART 3 EXECUTION

3.01 PIPING INSTALLATION

- A. Chemical-Waste Piping Inside the Building:
 1. Install piping next to equipment, accessories, and specialties to allow service and maintenance.
 2. Transition and special fittings with pressure ratings at least equal to piping pressure rating may be used unless otherwise indicated.
 3. Flanges may be used on aboveground piping unless otherwise indicated.
 4. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

5. Install piping at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
6. Install piping at indicated slopes.
7. Install piping free of sags and bends.
8. Install fittings for changes in direction and branch connections.
9. Verify final equipment locations for roughing-in.
10. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Specification Section 22 05 18, Escutcheons for Plumbing Piping.

3.02 JOINT CONSTRUCTION

- A. Chemical-Waste Piping Inside the Building:
 1. Dissimilar-Material Piping Joints: Make joints using adapters compatible with both system materials.

3.03 NEUTRALIZATION TANK INSTALLATION

- A. Install interior neutralization tanks on smooth and level floor surface. Include full initial charge of limestone.

3.04 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Make connections to existing piping so finished work complies as nearly as practical with requirements specified for new work.
- C. Protect existing piping to prevent concrete or debris from entering while making connections. Remove debris or other extraneous material that may accumulate.
- D. Install piping adjacent to equipment to allow service and maintenance.

3.05 LABELING AND IDENTIFICATION

- A. Comply with requirements in Specification Section 22 05 53, Identification for Plumbing Piping and Equipment, for labeling of equipment and piping.

3.06 FIELD QUALITY CONTROL

- A. Inspect interior of sewerage piping to determine whether line displacement or other damage has occurred.
 1. Defects requiring correction include the following:
 - a. Alignment: Less than full diameter of inside of pipe is visible between inspection points.
 - b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5% of piping diameter.
 - c. Crushed, broken, cracked, or otherwise damaged piping.
 - d. Hydrostatic Tests for Drainage Piping:
 - 1) Close openings in system and fill with water.
 - 2) Purge air and refill with water.
 - 3) Disconnect water supply.
 - 4) Test and inspect joints for leaks.
 - e. Air Tests for Drainage Piping: Comply with UNI-B-6.

2. Leaks and loss in test pressure constitute defects that must be repaired.
 3. Submit separate reports for each test.
- B. Replace leaking sewerage piping using new materials, and repeat testing until leakage is within allowances specified.
 - C. Chemical-waste piping will be considered defective if it does not pass tests and inspections.
 - D. Prepare test and inspection reports.

3.07 CLEANING

- A. Use procedures prescribed by the Authorities Having Jurisdiction or, if not prescribed, use procedures described below:
 1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
 2. Clean piping by flushing with potable water.

3.08 PIPING SCHEDULE

- A. Transition and special fittings with pressure ratings at least equal to piping pressure rating may be used in applications below unless otherwise indicated.
- B. Aboveground Chemical-Waste Piping: Use any of the following piping materials for each size range:
 1. NPS 1-1/2 to NPS 6: PP drainage piping and mechanical joints.
 2. NPS 1-1/2 to NPS 6: PVDF drainage piping and mechanical joints.

END OF SECTION

Edition 0310-1115

SECTION 22 67 00.10

PROCESSED WATER SYSTEMS FOR LABORATORY FACILITIES

PART 1 GENERAL

1.01 SUMMARY

- A. This section includes piping for the following systems:
 - 1. Deionized-water.
 - 2. Reverse-osmosis-water.

1.02 PERFORMANCE REQUIREMENTS

- A. Minimum Working-Pressure Ratings:
 - 1. Deionized-Water Piping: 75 psig unless otherwise indicated.
 - 2. Reverse-Osmosis-Water Piping: 75 psig unless otherwise indicated.
- B. Seismic Performance: Water piping shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1.03 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Field quality-control reports.

1.04 QUALITY ASSURANCE

- A. ASME Compliance: Comply with ASME B31.3, Process Piping, for piping conveying fluid at a pressure of 15 psig or greater.

PART 2 PRODUCTS

2.01 PLASTIC PIPE AND FITTINGS

- A. Schedule 40, CPVC Pipe and Fittings: ASTM F441/F441M pipe; with plain ends for solvent-cemented joints and ASTM F438, socket-type fittings. Piping and fittings used in return air plenums shall have a flame spread rating of 25 or less and a smoke development rating of 50 or less when tested in accordance with ASTM E84.
- B. Solvent Cements for Joining CPVC Piping and Tubing: ASTM F493.
 - 1. Use CPVC solvent cement that has a VOC content of 490 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. PP Pipe and Fittings for Heat-Fusion Joints: Made from ASTM D4101, PP resin.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Asahi/America.
 - b. Georg Fischer LLC.

- c. IPEX Inc.
 - d. NIBCO INC.
 - e. Orion Fittings; a Division of Watts Water Technologies Inc.
 - f. Town & Country Plastics, Inc.
- 2. Schedule 40, Pipe and Fittings: Pipe made to ASTM D2447, Schedule 40 or SDR 11 dimensions; with socket- or butt-fusion fittings matching pipe dimensions.
- D. PP Pipe and Fittings for Electro-Fusion Joints: Made from ASTM D4101, PP resin.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Georg Fischer LLC.
 - 2. Schedule 80, Pipe and Fittings: Pipe made to ASTM D2447, Schedule 80 dimensions; with socket fittings matching pipe dimensions.
 - 3. Electro-Fusion Fitting: Electrical-resistance heating coil for PP piping joints.
- E. Schedule 40, PVC Pipe and Fittings: ASTM D1785 pipe; with plain ends for solvent-cemented joints and ASTM D2466, socket-type fittings.
- F. Solvent Cements for Joining PVC Piping: ASTM D2564. Include primer complying with ASTM F656.
 - 1. Use PVC solvent cement that has a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- G. PVDF Pipe and Fittings: Made from ASTM D3222, PVDF resin.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Asahi/America.
 - b. Georg Fischer LLC.
 - c. NIBCO INC.
 - d. Orion Fittings; a Division of Watts Water Technologies Inc.
 - 2. Schedule 40, Pipe and Fittings: Pipe made to ASTM D2447, Schedule 40 or SDR 11 dimensions; with socket- or butt-fusion fittings matching pipe dimensions.

2.02 TRANSITION FITTINGS

- A. Couplings, flanges, or other manufactured fittings; same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

2.03 CPVC VALVES

- A. CPVC Ball Valves:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Valve, Inc.
 - b. Asahi/America.
 - c. Colonial Engineering, Inc.
 - d. Georg Fischer LLC.
 - e. Hayward Flow Control Systems.
 - f. IPEX Inc.
 - g. NIBCO INC.
 - h. Plast-O-Matic Valves, Inc.
 - i. Spears Manufacturing Company.
 - j. Thermoplastic Valves, Inc.

2. Description:
 - a. Standards: MSS SP-122 and comply with ASTM F1970.
 - b. Pressure Rating: 150 psig at 73°F.
 - c. Body Material: ASTM D1784, CPVC compound.
 - d. Body Design: Union type.
 - e. End Connections: Detachable, socket.
 - f. Ball: ASTM D1784, CPVC compound.
 - g. Port: Full.
 - h. Seats: PTFE.
 - i. Stem: ASTM D1784, CPVC compound.
 - j. Stem Seals: EPDM or FKM-rubber O-rings.
 - k. Handle: Tee shaped.
- B. CPVC Ball-Check Valves:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Valve, Inc.
 - b. Asahi/America.
 - c. Colonial Engineering, Inc.
 - d. Georg Fischer LLC.
 - e. Hayward Flow Control Systems.
 - f. IPEX Inc.
 - g. NIBCO INC.
 - h. Thermoplastic Valves, Inc.
 2. Description:
 - a. Standard: Comply with ASTM F1970.
 - b. Pressure Rating: 150 psig at 73°F.
 - c. Body Material: ASTM D1784, CPVC compound.
 - d. Body Design: Union type.
 - e. End Connections: Detachable, socket.
 - f. Ball: ASTM D1784, CPVC compound.
 - g. Seat and Seals: EPDM or FKM-rubber O-rings.

2.04 PP VALVES

- A. PP Ball Valves:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Asahi/America.
 - b. Georg Fischer LLC.
 - c. IPEX Inc.
 - d. NIBCO INC.
 - e. Orion Fittings; a Division of Watts Water Technologies Inc.
 - f. Plast-O-Matic Valves, Inc.
 - g. Thermoplastic Valves, Inc.
 2. Description:
 - a. Standard: MSS SP-122.
 - b. Pressure Rating: 150 psig at 73°F.
 - c. Body Material: ASTM D4101, PP resin.
 - d. Body Design: Union type.
 - e. End Connections: Detachable, butt or socket.
 - f. Ball: ASTM D4101, PP resin.
 - g. Port: Full.
 - h. Seats: PTFE.
 - i. Stem: ASTM D4101, PP resin.

- j. Stem Seals: FKM-rubber O-rings.
 - k. Handle: Tee shaped.
- B. PP Ball-Check Valves:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Valve, Inc.
 - b. Asahi/America.
 - c. Georg Fischer LLC.
 - d. Hayward Flow Control Systems.
 - e. NIBCO INC.
 - f. Thermoplastic Valves, Inc.
 - 2. Description:
 - a. Pressure Rating: 150 psig at 73°F.
 - b. Body Material: ASTM D4101, PP resin.
 - c. Body Design: Union type.
 - d. End Connections: Detachable, socket.
 - e. Ball: ASTM D4101, PP resin.
 - f. Seat and Seals: FKM-rubber O-rings.

2.05 PVC VALVES

- A. PVC Ball Valves:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Valve, Inc.
 - b. Asahi/America.
 - c. Colonial Engineering, Inc.
 - d. Georg Fischer LLC.
 - e. Hayward Flow Control Systems.
 - f. IPEX Inc.
 - g. Legend Valve.
 - h. NIBCO INC.
 - i. Plast-O-Matic Valves, Inc.
 - j. Spears Manufacturing Company.
 - k. Thermoplastic Valves, Inc.
 - 2. Description:
 - a. Standards: MSS SP-122 and comply with ASTM F1970.
 - b. Pressure Rating: 150 psig at 73°F.
 - c. Body Material: ASTM D1784, PVC compound.
 - d. Body Design: Union type.
 - e. End Connections: Detachable, socket.
 - f. Ball: ASTM D1784, PVC compound.
 - g. Port: Full.
 - h. Seats: PTFE.
 - i. Stem: ASTM D1784, PVC compound.
 - j. Seals: EPDM or FKM-rubber O-rings.
 - k. Handle: Tee shaped.
- B. PVC Ball-Check Valves:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Valve, Inc.
 - b. Asahi/America.
 - c. Colonial Engineering, Inc.

- d. Georg Fischer LLC.
- e. Hayward Flow Control Systems.
- f. IPEX Inc.
- g. Legend Valve.
- h. NIBCO INC.
- i. Thermoplastic Valves, Inc.
- 2. Description:
 - a. Standard: Comply with ASTM F1970.
 - b. Pressure Rating: 150 psig at 73°F.
 - c. Body Material: ASTM D1784, PVC compound.
 - d. Body Design: Union type.
 - e. End Connections: Detachable, socket.
 - f. Ball: ASTM D1784, PVC compound.
 - g. Seat and Seals: EPDM or FKM-rubber O-rings.

2.06 PVDF VALVES

- A. PVDF Ball Valves:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Asahi/America.
 - b. Georg Fischer LLC.
 - c. NIBCO INC.
 - d. Orion Fittings; a Division of Watts Water Technologies Inc.
 - e. Plast-O-Matic Valves, Inc.
 - f. Thermoplastic Valves, Inc.
 - 2. Description:
 - a. Standard: MSS SP-122.
 - b. Pressure Rating: 150 psig at 73°F.
 - c. Body Material: ASTM D3222, PVDF resin.
 - d. Body Design: Union type.
 - e. End Connections: Detachable, butt or socket.
 - f. Ball: ASTM D3222, PVDF resin.
 - g. Port: Full.
 - h. Seats: PTFE.
 - i. Stem: ASTM D3222, PVDF resin.
 - j. Stem Seals: FKM-rubber O-rings.
 - k. Handle: Tee shaped.
- B. PVDF Ball-Check Valves:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Asahi/America.
 - b. Georg Fischer LLC.
 - c. Legend Valve.
 - d. NIBCO INC.
 - e. Thermoplastic Valves, Inc.
 - 2. Description:
 - a. Pressure Rating: 150 psig at 73°F.
 - b. Body Material: ASTM D3222, PVDF resin.
 - c. Body Design: Union type.
 - d. End Connections: Detachable, socket.
 - e. Ball: ASTM D3222, PVDF resin.
 - f. Seat and Seals: FKM-rubber O-rings.

PART 3 EXECUTION

3.01 PIPING INSTALLATION

- A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of water piping. Location and arrangement of piping layout take design considerations into account. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.
- B. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for removal of ceiling panel, and coordinate with other services occupying that space.
- E. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.
- F. Install piping to permit valve servicing.
- G. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than system pressure ratings unless otherwise indicated.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Specification Section 22 05 17, Sleeves and Sleeve Seals for Plumbing Piping.
- K. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Specification Section 22 05 17, Sleeves and Sleeve Seals for Plumbing Piping.
- L. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Specification Section 22 05 18, Escutcheons for Plumbing Piping.

3.02 JOINT CONSTRUCTION

- A. Where specific joint construction is not indicated, follow piping manufacturer's written instructions.
- B. CPVC Piping Solvent-Cemented Joints: Comply with ASTM F402 for handling solvent cements, primers, and cleaners; make joints according to ASTM D2846/D2846M Appendix.
- C. PP Piping Electro-Fusion Joints: Make according to ASTM F1290.
- D. PP Piping Heat-Fusion Joints: Make according to ASTM D2657.

- E. PVC Piping Solvent-Cemented Joints: Comply with ASTM F402 for handling solvent cements, primers, and cleaners; make joints according to ASTM D2672.
- F. PVDF Piping Heat-Fusion Joints: Make according to ASTM D2657.
- G. Join dissimilar pipe materials with transition fittings compatible with pipe materials being joined.

3.03 VALVE INSTALLATION

- A. Install sectional valves close to mains on each branch and riser serving equipment.
- B. Install shutoff valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- C. Locate valves for easy access and provide separate support where necessary.
- D. Install valves of same size as the pipe or tube in which they are installed unless otherwise indicated.
- E. Install plastic valves of the same material as the plastic pipe in which they are installed.
- F. Install valves in horizontal piping with stem at or above center of pipe.
- G. Install valves in position to allow full movement of stem and lever handle.
- H. Install ball-check valves in horizontal or vertical position so ball will unseat during normal flow.

3.04 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for seismic-restraint devices specified in Specification Section 22 05 48, Vibration Controls for Plumbing Piping & Equipment.
- B. Comply with requirements for pipe hanger and support devices and installation specified in Specification Section 22 05 29, Hangers and Supports for Plumbing Piping and Equipment.
 - 1. Install carbon-steel pipe hangers for horizontal piping in non-corrosive environments.
 - 2. Install stainless-steel pipe hangers for horizontal piping in corrosive environments.
 - 3. Install carbon-steel pipe support clamps for vertical piping in non-corrosive environments.
 - 4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
 - 5. Clamps for Vertical Piping: MSS Type 8 or Type 42.
 - 6. Individual, Straight, Horizontal Piping Runs:
 - a. 100 Feet and Less: MSS Type 1, adjustable clevis hangers.
 - b. Longer than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
 - 7. Multiple, Straight, Horizontal Piping Runs, 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 - 8. Base of Vertical Piping: MSS Type 52, spring hangers.
- C. Support horizontal piping and tubing within 12 inches of each fitting, valve, and coupling.

- D. Support vertical piping and tubing at base and at each floor.
- E. Rod diameter may be reduced one size for double-rod hangers, to minimum 3/8 inch.
- F. Install padded hangers for CPVC piping with the following maximum horizontal spacing and minimum rod diameter:
 - 1. 36 inches with 3/8-inch rod.
- G. Install padded supports for vertical CPVC piping at mid-story for NPS 2 and smaller.
- H. Install padded hangers for PP piping with the following maximum horizontal spacing and minimum rod diameter:
 - 1. 32 inches with 3/8-inch rod.
- I. Install padded supports for vertical PP piping at mid-story for NPS 2 and smaller.
- J. Install padded hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameter:
 - 1. 48 inches with 3/8-inch rod.
- K. Install padded supports for vertical PVC piping at mid-story for NPS 2 and smaller.
- L. Install padded hangers for PVDF piping with the following maximum horizontal spacing and minimum rod diameter:
 - 1. 30 inches with 3/8-inch rod.
- M. Install padded supports for vertical PVDF piping at mid-story for NPS 2 and smaller.
- N. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.05 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.
- C. Connect deionized-water and reverse-osmosis-water piping to equipment and service outlets with unions or flanges.

3.06 IDENTIFICATION

- A. Comply with requirements for identification specified in Specification Section 22 05 53, Identification for Plumbing Piping and Equipment.

3.07 FIELD QUALITY CONTROL

- A. Test new piping, and parts of existing piping that have been altered, extended, or repaired, for leaks and defects.
 - 1. Schedule tests and their inspections by the Authorities Having Jurisdiction (AHJ) and Owner, with at least 24 hours advance notice.
 - 2. Do not cover piping or put into service before inspection and approval.

3. Test completed piping according to the AHJ and/or Owner. If the AHJ or Owner do not have published procedures, perform tests as follows:
 - a. Hydrostatic Tests: Test piping at pressure not less than 1.5 times the maximum system operating pressure, but not less than 100 psig.
4. Replace leaking joints with new materials and retest until no leaks exist.
5. Submit separate reports for each test.

3.08 CLEANING

- A. Use procedures prescribed by the AHJ and/or Owner or, if not prescribed, use procedures described below:
 1. Before using, purge new piping and parts of existing piping that have been altered, extended, or repaired.
 2. Clean piping by flushing with system deionized and reverse-osmosis water.

3.09 PIPING SCHEDULE

- A. Transition and special fittings with pressure ratings at least equal to piping, and of same or compatible material, may be used in applications below.
- B. Deionized-Water Piping: Use any of the following piping materials for each pipe size range:
 1. PP pipe and fittings and heat-fusion joints.
 2. PP pipe and fittings and electro-fusion joints.
 3. PVDF pipe and fittings and heat-fusion joints.
- C. Reverse-Osmosis-Water Piping: Use any of the following piping materials for each pipe size range:
 1. PP pipe and fittings and heat-fusion joints.
 2. PP pipe and fittings and electro-fusion joints.
 3. PVDF pipe and fittings and heat-fusion joints.

3.10 VALVE SCHEDULE

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
 1. Shutoff Duty: Install ball valves in piping NPS 2 and smaller.
 2. Throttling Duty: Install ball valves in piping NPS 2 and smaller.

END OF SECTION

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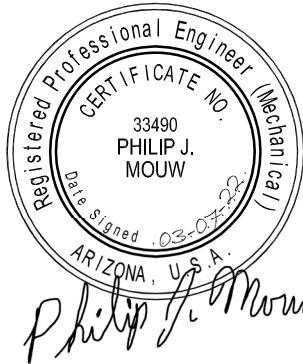
DIVISION 23

HEATING, VENTILATING & AIR CONDITIONING

23 05 00	Common Work Results for HVAC
23 05 00	General Provisions
23 05 13	Common Motor Requirements for HVAC Equipment
23 05 14	Variable Frequency Motor Drives
23 05 15	Enclosed Motor Controllers
23 05 17	Sleeves & Sleeve Seals for HVAC Piping
23 05 18	Escutcheons for HVAC Piping
23 05 19	Meters & Gages for HVAC Piping
23 05 20	Electrical & Control Wiring for Mechanical Systems
23 05 23	General Duty Valves for HVAC Hydronic Piping
23 05 29	Hangers & Supports for HVAC Piping & Equipment
23 05 48.13	Vibration Controls for HVAC Piping & Equipment
23 05 53	Identification for HVAC Piping & Equipment
23 05 93	Testing, Adjusting & Balancing for HVAC
23 07 00	HVAC Insulation
23 07 13	Duct Insulation
23 07 19	HVAC Piping Insulation
23 08 00	Commissioning of HVAC
23 08 00	Commissioning of HVAC
23 09 00	Instrumentation & Control for HVAC
23 09 00	Building Automation System for HVAC
23 09 00.10	Laboratory Air Valve Controls
23 21 00	Hydronic Piping & Pumps
23 21 13	Hydronic Piping
23 21 15	HVAC Drain Piping
23 21 23	Hydronic Pumps
23 25 00	HVAC Water Treatment
23 25 00	HVAC Water Treatment
23 25 01	Glycol Feed System
23 31 00	HVAC Ducts & Casings
23 31 13	Metal Ducts
23 31 16.10	Corrosion Resistant Ductwork
23 33 00	Air Duct Accessories
23 33 00	Air Duct Accessories
23 34 00	HVAC Fans
23 34 16	Centrifugal HVAC Fans
23 34 23	HVAC Power Ventilators
23 37 00	Air Outlets & Inlets
23 37 13	Diffusers, Registers & Grilles

23 41 00	Particulate Air Filtration
23 41 00	Particulate Air Filtration
23 74 00	Packaged Outdoor HVAC Equipment
23 74 33	Packaged, Outdoor, Heating & Cooling Makeup Air Conditioners
23 82 00	Convection Heating & Cooling Units
23 82 16.11	Hydronic Air Coils

END OF INDEX



SECTION 23 05 00

GENERAL PROVISIONS

PART 1 GENERAL

1.01 SCOPE

- A. Provisions of this section apply to all work specified in all sections under Division 23.
- B. In addition, work in Division 23 is governed by the provisions of the Bidding Requirements, Contract Forms, General Conditions, and all sections in Division 01 specifications.
- C. The Contract Documents do not specify exact installation means and methods or Contractor safety procedures. Installation means and methods and safety procedures are the responsibility of the Contractor. No instruction or statement made on the Contract Documents shall be interpreted to shift this responsibility away from the Contractor.
- D. These specifications contain statements which are more definitive or more restrictive than those contained in the General Conditions. Where these statements occur, they shall take precedence over the General Conditions.

1.02 DEFINITIONS

- A. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unconditioned shelters.
- B. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings, in duct shafts, and in utility chases.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations and mechanical yards.
- D. Exposed, Interior Installations: Exposed to view indoors. Examples include finished spaces and mechanical equipment rooms.
- E. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unconditioned spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspace, and utility tunnels.

1.03 EXAMINATION OF PREMISES

- A. Visit the site, verify all measurements and project conditions, and pay all costs necessary to perform the work.

1.04 MECHANICAL CONTRACTOR

- A. The Mechanical Contractor shall hold a current contracting license that has been valid for a minimum of 2 years in the State of Arizona as a mechanical contractor.

1.05 REGULATIONS, PERMITS, FEES, CHARGES, INSPECTIONS

- A. Regulations: Comply with all applicable codes, rules and regulations.
- B. Fees and Permits: Pay all connection, installation, use, disposal, development, etc., fees and/or charges. Obtain and pay for all required permits and licenses. Refer to Division 01 specifications.
- C. Inspections: All work must be inspected and approved by the local authorities. Prior to final approval, furnish the Architect with certificates of inspections and approvals by the local authorities in accordance with Division 01 specifications.

1.06 DRAWINGS AND SPECIFICATIONS

- A. Refer to Division 01 specifications for additional information on submittals and shop drawings.
- B. If a conflict exists on the drawings or between the drawings and specifications, promptly notify the Architect.

1.07 SUBMITTALS

- A. Submittals are for information and coordination only. The Engineer will diligently review the submittals and attempt to verify compliance with the project requirements. Such review, however, does not constitute approval or disapproval of obligation to comply with all project requirements. The submittals are not to be construed to be contract documents. Any failure by the Engineer to note a point of non-compliance shall not be construed to be acceptance or approval of the discrepancy.
- B. Product Information Sheets: Provide project-specific manufacturer's literature which includes the information required by the Product Data paragraph of the applicable specification section. Where Product Information Sheets show multiple models or options, clearly mark the model and options to be provided.
- C. Assembly: Assemble all required submittal information for each specification section and submit in Portable Document Format (PDF).
 - 1. Assemble PDF submittals in one PDF file for each division. Separate and order sections within each file by corresponding specification number. Provide bookmarks at the first page of each section and label each bookmark with the specification number and name to allow for easy navigation of the submittal.
 - 2. Partial submittals and submittals that are not project specific will be returned without review. Submittals for Building Automation System may be submitted separately.
- D. Identification and Information:
 - 1. Name the PDF file with the project name, division number and sequential submittal number (i.e., the first submittal shall be No. 1; the second submittal shall be No. 2).
 - 2. Provide a cover sheet at the front of each submittal with the following information:
 - a. Project name.
 - b. Date.
 - c. Name of Engineer.
 - d. Name of Contractor.
 - e. Name of subcontractor.

3. Provide a cover sheet at the front of each submittal section with the following information:
 - a. Name of supplier.
 - b. Name of manufacturer.
 - c. Number and title of appropriate specification section.
 - d. Drawing number and detail references, as appropriate.
 - e. Other necessary identification.
- E. Options:
 1. Identify options requiring selection by the Engineer.
 2. Identify options included with submittal item.
- F. Deviations: Identify deviations from the Contract Documents on submittals.
- G. Furnished by Others: This project is to provide a complete and functional system. Where material or labor is indicated in the submittal to be provided "by others" clearly indicated who is providing those items and include information to indicate proper coordination.

1.08 MATERIAL SAFETY DATA SHEETS

- A. Provide current, Material Safety Data Sheets (MSDS), for all hazardous materials that are proposed for use at the project site.
 1. Provide one complete set to the Owner for review and approval a minimum of 1 week prior to the delivery of any hazardous materials to the site.
 2. Maintain a second complete set at the project location, readily accessible by both the Owner's personnel and the Contractor's personnel.

1.09 REQUEST FOR INFORMATION

- A. Request for Information (RFI):
 1. A document submitted by the Contractor requesting clarification of a portion of the Contract Documents, hereinafter referred to as RFI.
 2. A properly prepared request for information shall include a detailed written statement of the clarification, apparent conflict, or information requested that indicates the specific drawings or specification in need of clarification and the nature of the clarification requested.
 - a. Drawings shall be identified by drawing number and location on the drawing sheet.
 - b. Specifications shall be identified by section number, page, and paragraph.
 3. Include a proposed solution, where appropriate, based upon the field conditions and best knowledge of the Contractor.
- B. Improper or Frivolous RFIs: RFIs which are not properly prepared or that request information which is clearly shown in the Contract Documents will be returned unanswered. Processing time for multiple submissions of improper or frivolous RFIs will be billed at the Engineer's standard hourly rate to the Owner who may deduct an equal amount from the monies due the Contractor.

1.10 AS-BUILT DRAWINGS

- A. As-Built Drawings: Maintain one set of marked-up paper copies of the Contract Drawings.
 1. Preparation: Mark As-Built Drawings to show the actual installation where installation varies from that shown originally. Include all equipment, and underground and overhead piping.

- a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
 - b. Include dimensions both horizontally and vertically to permanent points of reference, accurate within 6 inches. Include descriptors such as “below slab,” “above ceiling,” etc.
 - c. Record data daily or as soon as possible after obtaining it.
 - d. Record and check the markup before enclosing concealed installations.
- 2. Mark the As-Built Drawings completely and accurately. Utilize personnel proficient at recording graphic information in production of As-Built Drawings.
- 3. Mark As-Built Drawings with erasable, red colored pencil, or in a digital PDF format using an editor program such as Bluebeam, Adobe Acrobat Professional, or similar. Use other colors to distinguish between changes for different categories of the work at the same location.
- 4. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.
- 5. Update the As-Built Drawings weekly or daily as appropriate for the project size.
- B. Format: Identify and date each As-Built Drawing; include the designation “PROJECT AS-BUILT DRAWING” in a prominent location.
 - 1. Organize newly-prepared As-Built Drawings into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
 - 2. Identification, as follows:
 - a. Project name.
 - b. Date.
 - c. Designation “PROJECT AS-BUILT DRAWINGS.”
 - d. Name of Engineer.
 - e. Name of Contractor.
 - 3. Remove or obscure the Engineer’s seal and signature from As-Built Drawings.

1.11 OPERATION AND MAINTENANCE MANUAL

- A. Prior to completion of the project, compile a complete Equipment, Operation and Maintenance Manual for all equipment supplied under Division 23.
- B. Schedule:
 - 1. Submit a preliminary copy of the manual not less than 30 days prior to Substantial Completion for review and comment.
 - 2. Submit the final version of the manual not more than 4 weeks after Substantial Completion of the project.
- C. Format: Submit manuals in both of the following formats:
 - 1. PDF Electronic Files: Assemble each manual into a single master directory with sub-directories for the individual PDF files for each system and piece of equipment. Provide a table of contents file with hyperlinks to each of the individual PDF files within the sub-directories. Submit on digital media acceptable to the Engineer.
 - a. Name each directory, sub-directory, and document file with applicable item name.
 - b. Enable reviewer comments on draft submittals.
 - 2. Paper Copies: Assemble paper copies in 3-ring binders. Separate and order systems and equipment within each binder. Provide labeled tabs at each section with a table of contents at the front of the binder. The table of contents shall indicate the tab number and the information contained at that tab. Enclose title pages and directories in clear plastic sleeves.
- D. Provide Operation and Maintenance Manuals for all systems, subsystems, and equipment that require operation and regular maintenance, or have replaceable parts.

- E. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, product data, manufacturer's maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranty and bond information, as described below. In addition to requirements in this section, include operation and maintenance data required in individual specification sections.
- F. Source Information: List each system, subsystem, and piece of equipment included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of installer or supplier and maintenance service agent, and cross-reference specification section number and title in Project Manual.
- G. Product Data: Include the following information:
 - 1. System, subsystem, and equipment descriptions. Use designations for systems and equipment indicated on Contract Documents.
 - 2. Approved submittals.
 - 3. Include the following if not shown on approved submittals:
 - a. Product name and model number. Use designations for products indicated on Contract Documents.
 - b. Manufacturer's name.
 - c. Equipment identification with serial number of each component.
 - d. Equipment function.
 - e. Operating characteristics.
 - f. Limiting conditions.
 - g. Performance curves.
 - h. Engineering data and tests.
- H. Operating Procedures: Include the following, as applicable:
 - 1. Startup procedures.
 - 2. Equipment or system break-in procedures.
 - 3. Routine and normal operating instructions.
 - 4. Regulation and control procedures.
 - 5. Instructions on stopping.
 - 6. Normal shutdown instructions.
 - 7. Seasonal and weekend operating instructions.
 - 8. Required sequences for electric or electronic systems.
 - 9. Special operating instructions and procedures. Including precautions against improper use.
 - 10. Operating logs.
- I. Wiring Diagrams: Diagram of factory-installed wiring including any options as well as any field modifications.
- J. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.
- K. Piped Systems: Diagram piping as installed, and identify color-coding where required for identification. Include valve locations and designations.
- L. Manufacturer's Maintenance Documentation: Manufacturer's maintenance documentation including the following information for each component part or piece of equipment:
 - 1. Standard maintenance instructions and bulletins.
 - 2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
 - 3. Identification and nomenclature of parts and components.

4. List of items recommended to be stocked as spare parts.
- M. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:
 1. Test and inspection instructions.
 2. Troubleshooting guide.
 3. Precautions against improper maintenance.
 4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
 5. Aligning, adjusting, and checking instructions.
 6. Demonstration and training video recording, if available.
- N. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.
- O. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturer's maintenance documentation and local sources of maintenance materials and related services.
- P. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.
- Q. Licenses: Include copies of any licenses with requirements including inspection and renewal dates.
- R. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
- S. Test and Balance Report: Include a final approved copy of the Test and Balance Report.

1.12 WORK AND MATERIALS

- A. Unless otherwise specified, all materials must be new and of the quality specified. The workmanship shall be of a quality that is acceptable to the Architect, Engineer, and Owner, and is equal to the standards of the trades. The Contractor must staff the project with sufficient skilled workmen, including a fully qualified construction superintendent, to complete the work in the time allotted. The superintendent must be qualified to supervise all of the work in his work category.
- B. Uniformity: Unless otherwise specified, provide all equipment and products of the same type or classification by the same manufacturer.

1.13 APPROVALS OF MATERIALS AND EQUIPMENT

- A. Refer to Division 01 specifications for description of material and equipment for prior approvals and substitutions.

1.14 COOPERATIVE WORK

- A. Correct without charge any work requiring alteration due to lack of proper supervision or failure to make proper provision in time. Correct without charge any damage to adjacent work caused by the alteration. Refer to Division 01 specifications for additional requirements.

- B. Cooperative work Includes:
1. General supervision and responsibility for proper location, rough-in and size of work related to Division 23 but provided under other divisions of these specifications.
 2. Installation of sleeves, inserts and anchor bolts for work under sections in Division 23.
 3. Sealing of penetrations through fire and smoke barriers caused by work installed as part of Division 23.

1.15 EXISTING MATERIALS AND EQUIPMENT

- A. Disposition: With the exception of items that are to be reused or retained by the Owner, all other materials indicated to be removed shall be removed and legally disposed of by the Contractor. Items that are indicated to be retained or returned to the Owner shall be delivered to a storage area designated by the Owner.
- B. Unused Materials: All unused piping, ductwork, controls and miscellaneous materials shall be removed by the Contractor except where located within walls, below or above existing construction which is not being altered and would require removal and replacement of this existing construction. All visible piping, ductwork, etc., shall be removed and sealed or capped within wall, below floor, or above ceiling unless noted otherwise.
- C. Exterior Services: The Contractor shall be responsible for maintaining mechanical and control service to the existing building during the construction period. Existing services are to be retained until such a time that the new services, if any, are completely installed and ready for use. Scheduling of service interruptions is to be coordinated with the Architect and Owner.
- D. Disconnect, demolish, and remove mechanical systems, equipment, and components that are indicated to be removed.
1. Piping to be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with the same or compatible piping material. Patch insulation, as required, to match adjacent areas.
 2. Piping to be Abandoned In Place: Drain piping and cap or plug piping with the same or compatible piping material.
 3. Ducts to be Removed: Remove portion of ducts indicated to be removed and cap remaining ducts with the same or compatible ductwork material. Patch insulation, as required, to match adjacent areas.
 4. Ducts to be Abandoned In Place: Cap ducts with the same or compatible ductwork material.
 5. Equipment to be Removed: Disconnect and cap services and remove equipment.
 6. Equipment to be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
 7. Equipment to be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to the Owner.
- E. Continuity of Services in Existing Building: The Contractor shall permanently reroute existing mechanical and control services or provide temporary connection as required to maintain service to existing equipment and systems in building which are to remain in service.

- F. Rerouting and Relocation of Existing Mechanical Equipment and Services in Existing Building:
1. General: The Contractor shall reroute, relocate all existing materials which are in conflict with the building alterations and which are required to be maintained in use.
 2. Existing Piping and Ductwork: Where applicable, existing material may be reused in their original location unless otherwise indicated.
- G. Testing: All existing services affected by the new construction and which are modified, reused or are to remain in operation shall be returned to their original condition. The existing services shall be tested as new, as described in other sections of these specifications. If for any reason these requirements cannot be met, the Contractor shall immediately notify the Architect.

1.16 CONSTRUCTION FACILITIES

- A. General: Under this division of the specifications, execute all work in a manner to provide safe and lawful ingress and egress to the Owner's establishment and such facilities shall be kept clear of materials or equipment. Refer to Division 01 specifications for additional requirements.
- B. Furnish and maintain from the beginning to the completion of all work all lawful and necessary security, guards, railings, fences, canopies, lights, fire protection, and warning signs. Take all necessary precautions required by city and state laws to avoid injury or damage to any and all persons and property.

1.17 GUARANTEE

- A. Guarantee all material, equipment, installation and workmanship for all sections under Division 23 in writing to be free from defects of material and workmanship for 1 year from date of final acceptance as outlined in Division 01 specifications. Equipment warranties shall be a minimum of 2 years from date of Substantial Completion or as specified elsewhere. Replace without charge any material or equipment proving defective during this period. The guarantee shall include performance of the equipment under all conditions of load, installing any additional items of control and/or protective devices as required and the replacing of any refrigerant lost.

1.18 MECHANICAL WIRING

- A. Provide all temperature control wiring, interlock wiring, and equipment control wiring for the equipment that is to be provided under Division 23 unless wiring is specifically shown on the electrical drawings.
- B. The following schedule is intended to summarize the division of work and material responsibilities between the Mechanical Contractor, Controls Contractor and Electrical Contractor.

Item	Furn. By	Set By	Power Wiring	Control Wiring
Equipment Motors	MC	MC	EC	--
Motor Control Center	EC	EC	EC	CC
Motor Starters, Controllers, Contactors & Overload Heaters	MC*	EC**	EC	CC
Fused & Non-Fused Disconnect Switches	EC**	EC**	EC	--

Item	Furn. By	Set By	Power Wiring	Control Wiring
Manual Operating Switches, Multi-Speed Switches, Pushbutton Stations & Pilot Lights	CC	CC	CC	CC
Control Relays & Transformers	CC	CC	CC	CC
Line Voltage Thermostats & Time Switches***	MC	MC	EC	EC
Low-Voltage Thermostats	MC	MC	-	MC
Temperature Control Panels	MC	MC	EC	CC
Smoke Detectors (Duct Mounted)	EC	MC	EC	MC or CC
Motor & Solenoid Valves, Damper Motors, PE & EP Switches	CC	MC	CC	CC
Water Treatment Equipment	MC	MC	EC	CC
MC = Mechanical Contractor CC = Controls Contractor EC = Electrical Contractor *Except where such devices are located in MCCs. **Unless required by these specifications to be provided as part of a factory- furnished assembly (i.e., fan coils, air handlers, chillers, etc.). ***Motor-drive units which are controlled from line voltage automatic controls such as line voltage thermostats, float switches or time switches which conduct full load current of the motor shall be wired for both power and control circuit under the electrical contract.				

PART 2 PRODUCTS

2.01 MACHINERY DRIVES

- A. Unless otherwise specified in Division 23 equipment sections, use V-belts designed for 150% of capacity for all belt drives. For multiple belt drives, use matched sets, so marked at the factory.
- B. On drives with not more than two belts, provide adjustable pitch motor sheaves with the midpoint of the adjustment range equal to that required to achieve the specified fan capacity.
- C. On motors with drives with more than two belts, furnish non-adjustable sheaves, providing the specified fan capacity.

2.02 MACHINERY ACCESSORIES

- A. Guards: Provide totally enclosed OSHA-type belt guards for all rotating equipment. Design guards to be readily removable for access to belt drives.

2.03 GROUT

- A. Description: ASTM C1107, Grade B, non-shrink and non-metallic, dry hydraulic-cement grout.

1. Characteristics: Post-hardening, volume-adjusting, non-staining, non-corrosive, non-gaseous, and recommended for interior and exterior applications.
 2. Design Mix: 5,000-psi, 28-day compressive strength.
- B. Packaging: Premixed and factory packaged.

PART 3 EXECUTION

3.01 SUBMITTALS

- A. Prepare submittals as directed for review by the Contractor, Owner, Architect, and Engineer.
- B. Submit one copy of PDF submittals via email, project website or other electronic media.

3.02 REFRIGERANT HANDLING AND DOCUMENTATION

- A. Refrigerant Handling: Handle, contain and dispose of refrigerant in compliance with local, federal, and EPA regulations and requirements.
- B. Documentation: Maintain documentation for all refrigerant brought onto or removed from project location in compliance with local, federal, and EPA regulations and requirements. Submit documentation to the Owner and Architect.

3.03 AS-BUILT DRAWINGS AND RECORD DOCUMENTS

- A. Recording: Post changes and modifications to the As-Built Drawings as they occur; do not wait until the end of the project.
- B. Maintenance of As-Built Drawings and Record Documents: Store Record Documents in the field office, apart from the Contract Documents used for construction. Do not use project Record Documents for construction purposes. Maintain Record Documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to project Record Documents for the Engineer's reference during normal working hours. As-Built Drawings will be reviewed by the Architect, Owner, and Engineer at each pay request review.
- C. Submit As-Built Drawings to the Architect at completion of the project.

3.04 OPERATION AND MAINTENANCE MANUALS

- A. Prepare Operation and Maintenance Manuals as directed.
- B. Submit a preliminary electronic copy of the Operation and Maintenance Manual to the Engineer for review.
- C. Make any corrections noted from the Engineer's review upon receipt of comments and resubmit as required.
- D. Submit the final, corrected Operation and Maintenance Manual in both paper and electronic format to the Architect.

3.05 VERIFICATION OF DIMENSIONS

- A. Scaled and figured dimensions are approximate only. Before proceeding with work, carefully check and verify dimensions at site, and be responsible for properly fitting equipment and materials together and to the structure in spaces provided.
- B. Drawings are diagrammatic and many offsets, bends, special fittings and exact locations are not indicated. Carefully study drawings and premises in order to determine best sequence and installation methods, exact locations, routes, building obstructions, and install apparatus and equipment in available locations. Install apparatus and equipment in manner and in locations to avoid obstructions, preserve headroom, and keep openings and passageways clear.

3.06 CUTTING AND PATCHING

- A. Cut work and patch per Division 01 specifications as necessary to properly install the new work. As the work progresses, coordinate necessary openings, holes, chases, etc., in their correct location. If the required openings, holes and chases are not in their correct locations, make the necessary corrections at no cost to the Owner. Avoid excessive cutting and do not cut structural members without the consent of the Architect. Include as a part of the work all structural framing required by penetrations through the roof and necessary design and installation of steel to support equipment, ducts and pipes between structural steel unless shown on the structural drawings.

3.07 CLOSING-IN OF UNFINISHED WORK

- A. Cover no work until inspected, tested and approved. Where work is covered before inspection and test, uncover it, and when inspected, tested and approved, restore all work to original proper condition.

3.08 EXCAVATION AND BACKFILL

- A. Perform all necessary excavation, shoring and backfilling required for the proper laying of all pipes, ducts, and conduits inside the building and premises, and outside as may be necessary. Remove all excess excavated materials from the site or dispose of onsite as directed by the General Contractor.
- B. Excavate all trenches open cut, keep trench banks as nearly vertical as practicable, and sheet and brace trenches where required for stability and safety. Excavate trenches true to line and make bottoms not less than 18 inches wide but no wider than necessary to provide ample work room. Excavate to provide continuous granular bedding as indicated. Do not cut any trench near or under footings without first consulting the Architect. Comply with OSHA requirements.
- C. Provide not less than 4 inches of granular material as duct or pipe bedding. Grade and compact trench bedding accurately prior to laying duct or pipe in trench to provide uniform bearing and support for each section of pipe along its entire length. Dig "bell" holes after the trench bottom has been graded and compacted. Granular material shall be pea gravel or sand per MAG Standards.
- D. Provide backfilling and compaction in accordance with provisions of these specifications and under the direction of the Architect to the required density.
- E. Provide not less than 4 inches of granular material, the same as duct or piping bedding, all around duct or pipe. Make the first 2 feet of fill in 6-inch layers, each thoroughly compacted

as directed with no puddling, and free from rocks, large clods of earth, leaves, branches, and debris. Compact the rest of the backfill as directed, using in the backfill no rocks larger than 4 inches in diameter, and using no rock in the top 12 inches.

3.09 ACCESSIBILITY

- A. Install valves, dampers, thermometers, gauges, traps, cleanouts, control devices or other specialties requiring reading, adjustment, inspection, repairs, removal or replacement conveniently and accessibly throughout the finished building. Where any of these devices are shown on the Contract Drawings to be installed above any inaccessible ceiling or behind any inaccessible wall, the Mechanical Contractor shall furnish access doors or panels as required.
- B. All access doors or panels in walls and ceilings required for access to control devices, traps, valves and similar devices are to be furnished and installed as part of the work under this section. Provide type as specified in Division 08 specifications.
- C. Where any duct-mounted access doors or other items requiring access or maintenance are installed above an inaccessible ceiling or behind an inaccessible wall, the Mechanical Contractor shall furnish access doors or panels as required unless noted otherwise. Provide type as specified in Division 08 specifications.
- D. Refer to architectural drawings for type of wall and ceiling in each area and for rated construction.
- E. Coordinate work of various sections to locate valves, traps, and dampers with others to avoid unnecessary duplication of access doors.
- F. The Contractor, along with the Owner's representative, shall complete the Mechanical Accessibility/Clearance Checklist at the end of this section for all mechanical equipment. The chart shall be submitted to the Architect for approval prior to Substantial Completion. All conflicts shall be resolved to the Architect's and Owner's satisfaction prior to submission.

3.10 FLASHINGS

- A. Flash and counterflash all piping, conduits and ductwork penetrating roofing membrane with flashing per roofing manufacturer's recommendations. Refer to architectural drawings for detailing of duct and pipe penetrations through roof.
- B. Flash and counterflash all piping, conduits and ductwork penetrating exterior walls. Refer to architectural drawings for detailing of duct and pipe penetrations through walls.

3.11 PRODUCT AND EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. All equipment, valves, sensors, dampers, detectors, etc., shall be installed in strict conformance with the manufacturer's recommendations and all codes.
- B. Install equipment to allow maximum possible headroom unless specific mounting heights are indicated.
- C. Install equipment, ductwork, and piping level and plumb, parallel and perpendicular to other building systems and components, unless otherwise indicated.

- D. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- E. Install equipment, ductwork, and piping to allow right-of-way for piping installed at required slope.
- F. Do not install any equipment in an application not recommended by the manufacturer.

3.12 EQUIPMENT ROUGH-IN

- A. Rough in all equipment and fixtures as designated on the approved submittals and in the Construction Documents. The Contract Drawings indicate only the approximate location of rough-ins. The exact rough-in locations must be determined from large-scale certified drawings. The Contractor shall obtain all certified rough-in information before progressing with any work for rough-in.
- B. Be responsible for providing all outlets and services of proper size at the required locations.
- C. Minor changes in the Contract Drawings shall be anticipated and provided for under this Contract.
 - 1. Rough-in only (unless otherwise designated on the drawings) shall include providing all services as indicated and required, including all ductwork, piping, valves, and fittings. Valve and cap all piping stub-outs. Cap all ductwork stub-outs in a manner suitable for future extension.

3.13 OWNER-FURNISHED AND OTHER EQUIPMENT

- A. Rough-in only for all Owner-furnished equipment (refer to Division 01 specifications) and all equipment furnished under other sections of the specifications, except as otherwise specified and/or noted on the drawings.
- B. Obtain rough-in drawings from the Owner or other contractors prior to roughing-in any services.
- C. Provide all services required. Valve and cap all piping, cap all ductwork, and leave in a clean and orderly manner.

3.14 EQUIPMENT FINAL CONNECTIONS

- A. Provide all piping and duct final connections for all equipment under Division 23 and as indicated on the drawings.

3.15 MACHINERY DRIVES

- A. After tests have been performed on the air-conditioning and air-handling systems, make without cost, not more than one change in the size of non-adjustable sheaves to obtain the required air quantities as direct by the Test and Balance Contractor.

3.16 EQUIPMENT SUPPORTS

- A. Erection of Metal Supports and Anchorages:
 - 1. Refer to Division 05 specifications for structural steel.
 - 2. Design, cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and

- equipment. Neatly fabricate and erect steel work with burrs and welding spatter ground off. Paint after fabrication with a rust-inhibitive primer.
3. Field Welding: Comply with AWS D1.1.
- B. Erection of Wood Supports and Anchorages:
1. Design, cut, fit, and place wood grounds, nailers, blocking, and anchorages to support and anchor mechanical materials and equipment.
 2. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
 3. Attach to substrates as required to support applied loads.
- C. Where supports, foundations, stands, suspended platforms for machinery, tanks, or other equipment are indicated or specified, perform the following:
1. Locate support members to avoid equipment strainers and interference with piping connections, tube pulling or other maintenance operations.
 2. Where saddles are required, use cast-iron or welded-steel saddles with curvature to fit the tank shell.
 3. Mount power-driven equipment on common base with driver.
- D. Concrete Inserts: Furnish and install all concrete inserts required for all materials and equipment specified and/or shown on the drawings for Division 23.
- E. Concrete Housekeeping Pads and Isolation Bases: Work under this section includes coordination of construction of all concrete foundations indicated or required for equipment specified under Division 23. Materials and workmanship shall be described in Division 03 specifications. Anchor equipment to concrete housekeeping pads and isolation bases according to equipment manufacturer's written instructions and according to seismic codes at project.
1. Construct concrete housekeeping pads and isolation bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
 2. Install dowel rods to connect concrete pads to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the pad.
 3. Install epoxy-coated anchor bolts for supported equipment that extends through concrete pads, and anchor into structural concrete floor.
 4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 5. Install anchor bolts to elevations required for proper attachment to supported equipment.
 6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
- F. Grouting:
1. Grout under all equipment after leveling, filling completely the space between machinery bed plate and foundation surface as specified in Division 03 specifications.
 2. Mix and install grout for mechanical equipment base bearing surfaces, pumps and other equipment base plates, and anchors.
 3. Clean surfaces that will come into contact with grout.
 4. Provide forms as required for placement of grout.
 5. Avoid air entrapment during placement of grout.
 6. Place grout, completely filling equipment bases.
 7. Place grout on concrete pads and isolation bases and provide smooth bearing surface for equipment.
 8. Place grout around anchors.

9. Cure placed grout.
10. Finish exposed surface of grout for a neat appearance.

3.17 CLEANUP

- A. In addition to cleanup specified in Division 01 specifications, thoroughly clean all parts of the equipment. Where exposed parts are to be painted, thoroughly clean off any splattered construction materials and remove all oil and grease spots. Wipe the surface carefully and scrape out all cracks and corners.
- B. Thoroughly flush and clean out all water circulating systems. Remove, clean and replace all strainer elements.
- C. During the progress of the work, keep the premises clean and free of debris.

3.18 PAINTING

- A. Except as otherwise specified or indicated in the architectural drawings and/or specifications, paint all exposed unfinished metal pipe, duct, hangers, supports, rods, hardware, and equipment with one coat of rust-inhibiting primer. Galvanized, stainless-steel, or aluminum ductwork, pipe, supports, hangers, rods and hardware, and factory-painted equipment shall be considered as having primed surface.
- B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.
- C. Finished painting is specified in Division 09 specifications.

3.19 FIRESTOPPING

- A. Coordinate with the firestopping installer for sealing of all penetrations of fire and smoke barriers and other rated assemblies created during the installation of the Division 23 work.

3.20 OBJECTIONABLE NOISE AND VIBRATION

- A. Design, construct and brace the metal partitions, ducts and sheet metal housings to prevent vibration or rattling when systems are in operation. Install connections to equipment so noise and vibration will not reach the conditioned area through ducts, piping, conduit, sheet metal work, or the building structure.

3.21 WELDING

- A. Procedures:
 1. All procedures and welders must be qualified in accordance with the requirements of Section IX, ASME Boiler and Pressure Vessel Code and ANSI code for power piping B31.1. Procedure qualification test records and acceptance shall be submitted with the welding procedure prior to the start of fabrication.
 2. The Architect's inspector or authorized representative will review performance qualification records of individual welders.

END OF SECTION

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SECTION 23 05 13

COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

- A. This section includes general requirements for single-phase and polyphase, general-purpose, horizontal and vertical, small and medium, squirrel-cage induction motors for use on AC power systems up to 600 volts and installed at equipment manufacturer's factory or shipped separately by the equipment manufacturer for field installation.

1.02 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
 - 1. Motor controllers.
 - 2. Torque, speed, and horsepower requirements of the load.
 - 3. Ratings and characteristics of supply circuit and required control sequence.
 - 4. Ambient and environmental conditions of installation location.
 - 5. Variable frequency and variable speed drives.

PART 2 PRODUCTS

2.01 GENERAL MOTOR REQUIREMENTS

- A. Comply with requirements in this section except when stricter requirements are specified in HVAC equipment schedules or sections.
- B. Comply with NEMA MG 1 unless otherwise indicated.
- C. Motors 3/4 HP and larger, except as otherwise noted, shall be designed for 3 phase, 60 Hz power supply.
- D. Motors 1/2 HP and smaller, except as otherwise noted, shall be designed for 120 volt, single phase, 60 Hz power supply.
- E. Motors not directly exposed to weather and located in non-hazardous spaces shall be in dripproof enclosures or as indicated on the drawings.
- F. Motors shall be totally enclosed, fan cooled where directly exposed to weather or as indicated on the drawings.
- G. High-starting torque, totally enclosed or explosion-proof motors to be used in all hazardous areas or as indicated on the drawings.

2.02 MOTOR CHARACTERISTICS

- A. Duty: Continuous duty at ambient temperature of 104°F and at an altitude of 3,300 feet above sea level.

- B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.03 POLYPHASE MOTORS

- A. Description: NEMA MG 1, Design B, medium induction motor.
- B. Efficiency: Premium efficient, as defined in NEMA MG 1.
- C. Service Factor: 1.15.
- D. Multi-Speed Motors: Variable torque.
 - 1. For motors with 2:1 speed ratio, consequent pole, single winding.
 - 2. For motors with other than 2:1 speed ratio, separate winding for each speed.
- E. Rotor: Random-wound, squirrel cage.
- F. Bearings: Regreasable, shielded, anti-friction ball bearings suitable for radial and thrust loading.
- G. Temperature Rise: Match insulation rating.
- H. Insulation: Class F.
- I. Code Letter Designation:
 - 1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
 - 2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.
- J. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.04 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

- A. Motors Used with Reduced-Voltage and Multi-Speed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
- B. Motors Used with Variable Frequency Controllers:
 - 1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
 - 2. Premium-Efficient Motors: Class B temperature rise; Class F insulation.
 - 3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
 - 4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
 - 5. Bearing Protection Device: Field- or factory-applied shaft grounding ring consisting of metal ring supporting carbon microfibers to provide grounding path between shaft and motor casing.

2.05 SINGLE-PHASE MOTORS

- A. Motors larger than 1/20 HP shall be one of the following, to suit starting torque and requirements of specific motor application:
 - 1. Permanent-split capacitor.
 - 2. Split phase.
 - 3. Capacitor start, inductor run.
 - 4. Capacitor start, capacitor run.
 - 5. Electronically commutated.
- B. Multi-Speed Motors: Variable-torque, permanent-split-capacitor type.
- C. Bearings: Prelubricated, anti-friction ball bearings or sleeve bearings suitable for radial and thrust loading.
- D. Insulation: Class F where motors are installed on roofs outside the airstream.
- E. Motors 1/20 HP and Smaller: Shaded-pole type.
- F. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

2.06 ELECTRONICALLY COMMUTATED MOTOR

- A. Description: Motor with integral electronics to convert incoming AC power to DC power to drive motor shaft along with controls to vary the speed of the motor based on an internal or external signal.
- B. Controls: Provide with internal controls and programming or external inputs, depending on the application, to allow for motor speed control.
- C. Motor Protection: Provide with integral safeties to limit motor speed or de-energize motor if operating in an over-temperature or overloaded condition.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Arrange and set motors.
- B. Line up motors on direct drive equipment using dial-type gauges.
- C. Connections and testing of motor for proper rotation/phasing shall be under Division 26.

END OF SECTION

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SECTION 23 05 14

VARIABLE FREQUENCY MOTOR DRIVES

PART 1 GENERAL

1.01 SUMMARY

- A. This section includes separately enclosed, pre-assembled, combination VFDs, rated 600 volts and less, for speed control of 3-phase, squirrel-cage induction motors.

1.02 DEFINITIONS

- A. BAS: Building automation system.
- B. CE: Conformité Européenne (European Compliance).
- C. CPT: Control power transformer.
- D. EMI: Electromagnetic interference.
- E. IEC: International Electrical Commission.
- F. IEEE: Institute of Electrical and Electronics Engineers.
- G. IGBT: Insulated-gate bipolar transistor.
- H. LAN: Local area network.
- I. LED: Light-emitting diode.
- J. MCP: Motor-circuit protector.
- K. NC: Normally closed.
- L. NECA: National Electrical Contractors Association.
- M. NEMA: National Electrical Manufacturers Association.
- N. NETA: National Electrical Testing Association.
- O. NFPA: National Fire Protection Association.
- P. NO: Normally open.
- Q. OCPD: Overcurrent protective device.
- R. PID: Control action, proportional plus integral plus derivative.
- S. PWM: Pulse-width modulated.
- T. RFI: Radio-frequency interference.
- U. VFD: Variable-frequency drive.

1.03 SUBMITTALS

- A. Product Data: For each type and rating of VFD indicated.
- B. Shop Drawings: For each VFD indicated. Include dimensioned plans, elevations, and sections; and conduit entry locations and sizes, mounting arrangements, and details, including required clearances and service space around equipment.
 - 1. Show tabulations of installed devices, equipment features, and ratings.
 - 2. Schematic and Connection Wiring Diagrams: For power, signal, and control wiring.
- C. Product certificates.
- D. Source quality-control reports.
- E. Field quality-control reports.
- F. Operation and maintenance data.

1.04 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.

1.05 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace VFDs that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: 2 years from date of Substantial Completion or beneficial use.

PART 2 PRODUCTS

2.01 MANUFACTURED UNITS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide ABB ACH 580 drive.
- B. General Requirements for VFDs: Comply with NEMA ICS 7, NEMA ICS 61800-2, and UL 508C.
- C. Application: variable torque.
- D. VFD Description: Variable-frequency power converter (rectifier, DC bus, and IGBT, PWM inverter) factory packaged in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by a nationally recognized testing laboratory (NRTL) as a complete unit; arranged to provide self-protection, protection, and variable-speed control of one or more 3-phase induction motors by adjusting output voltage and frequency.
 - 1. Units suitable for operation of NEMA MG 1, Design A and Design B motors as defined by NEMA MG 1, Section IV, Part 30, Application Considerations for Constant Speed Motors Used on a Sinusoidal Bus with Harmonic Content and

- General Purpose Motors Used with Adjustable-Voltage or Adjustable-Frequency Controls or Both.
2. Units suitable for operation of inverter-duty motors as defined by NEMA MG 1, Section IV, Part 31, Definite-Purpose Inverter-Fed Polyphase Motors.
 3. Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to the Authorities Having Jurisdiction.
- E. Design and Rating: Match load type, such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.
- F. Output Rating: 3-phase; 10 to 60 Hz, with voltage proportional to frequency throughout voltage range; maximum voltage equals input voltage.
- G. Unit Operating Requirements:
1. Input AC Voltage Tolerance: +20 and -20% of VFD input voltage rating.
 2. Input AC Voltage Unbalance: Not exceeding 5%.
 3. Input Frequency Tolerance: $\pm 3\%$ of VFD frequency rating.
 4. Minimum Efficiency: 97% at 60 Hz, full load.
 5. Minimum Displacement Primary-Side Power Factor: 98% under any load or speed condition.
 6. Minimum Short-Circuit Current (Withstand) Rating: 100 kA.
 7. Ambient Temperature Rating: Not less than 0°F and not exceeding 104°F for drives mounted inside conditioned spaces.
 8. Ambient Temperature Rating: Not less than 0°F and not exceeding 122°F for drives mounted outside or in unconditioned spaces.
 9. Ambient Storage Temperature Rating: Not less than -4°F and not exceeding 140°F.
 10. Humidity Rating: Less than 95% (non-condensing, non-corrosive).
 11. Altitude Rating: Not less than 3,300 feet.
 12. Vibration Withstand: Comply with IEC 60068-2-6.
 13. Overload Capability: 1.1 times the base load current for 60 seconds; minimum of 1.3 times the base load current for 2 seconds.
 14. Starting Torque: Minimum 100% of rated torque from 3 to 60 Hz.
 15. Output Carrier Frequency: Selectable; 1 to 12 kHz.
 16. Stop Modes: Programmable; includes fast, free-wheel, and DC injection braking.
- H. Inverter Logic: Microprocessor based, 16 or 32 bit, isolated from all power circuits.
- I. Isolated Control Interface: Allows VFDs to follow remote-control electrical signal over a minimum 40:1 speed range.
- J. Internal Adjustability Capabilities:
1. Minimum Speed: 5 to 25% of maximum rpm.
 2. Maximum Speed: 80 to 110% of maximum rpm.
 3. Acceleration: 0.1 to 999.9 seconds.
 4. Deceleration: 0.1 to 999.9 seconds.
 5. Current Limit: 30 to minimum of 150% of maximum rating.
- K. Self-Protection and Reliability Features:
1. Input transient protection by means of surge suppressors to provide 3-phase protection against damage from supply voltage surges 10% or more above nominal line voltage.
 2. Loss of Input Signal Protection: Selectable response strategy, including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.
 3. Under- and overvoltage trips.

4. Inverter overcurrent trips.
 5. VFD and Motor Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFDs and motor thermal characteristics, and for providing VFD overtemperature and motor overload alarm and trip; settings selectable via the keypad; NRTL approved.
 6. Critical frequency rejection, with three selectable, adjustable deadbands.
 7. Instantaneous line-to-line and line-to-ground overcurrent trips.
 8. Loss-of-phase protection.
 9. Reverse-phase protection.
 10. Short-circuit protection.
 11. Motor overtemperature fault.
- L. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.
- M. Bidirectional Autospeed Search: Capable of starting VFD into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.
- N. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.
- O. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.
- P. Integral Input Disconnecting Means and OCPD: NEMA AB 1, thermal-magnetic circuit breaker with pad-lockable, door-mounted handle mechanism.
1. Disconnect Rating: Not less than 115% of NFPA 70 motor full-load current rating or VFD input current rating, whichever is larger.

2.02 CONTROLS AND INDICATION

- A. Status Lights: Door-mounted LED indicator displaying unit status.
1. Power on.
 2. Bypass enabled for units provided with a bypass.
- B. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.
1. Keypad: In addition to required programming and control keys, include keys for HAND, OFF, and AUTO modes.
 2. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: View Only; View and Operate; and View, Operate, and Service.
 - a. Control Authority: Supports at least four conditions:
 - 1) Off.
 - 2) Local Manual Control at VFD.
 - 3) Local Automatic Control at VFD.
 - 4) Automatic Control through a Remote Source.
- C. Historical Logging Information and Displays:
1. Running log of total power versus time.
 2. Total run time.

3. Fault log, maintaining last three faults with time and date stamp for each.
- D. Indicating Devices: Digital display mounted flush in VFD door and connected to display VFD parameters including, but not limited to:
1. Output frequency (Hz).
 2. Motor speed (rpm).
 3. Motor status (running, stop, fault).
 4. Motor current (amperes).
 5. Motor torque (percent).
 6. Fault or alarming status (code).
 7. PID feedback signal (percent).
 8. DC-link voltage (VDC).
 9. Setpoint frequency (Hz).
 10. Motor output voltage (VAC).
- E. Control Signal Interfaces:
1. Electric Input Signal Interface:
 - a. A minimum of two programmable analog inputs, selectable 0 to 10 VDC or 4 to 20 mA DC.
 - b. A minimum of six multi-function programmable digital inputs.
 2. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the BAS or other control systems:
 - a. 0 to 10 VDC.
 - b. 4 to 20 mA DC.
 - c. Potentiometer using up/down digital inputs.
 - d. Fixed frequencies using digital inputs.
 3. Output Signal Interface: A minimum of two programmable analog output signals (4 to 20 mA DC), which can be configured for any of the following:
 - a. Output frequency (Hz).
 - b. Output current (load).
 - c. DC-link voltage (VDC).
 - d. Motor torque (percent).
 - e. Motor speed (rpm).
 - f. Setpoint frequency (Hz).
 4. Remote Indication Interface: A minimum of three programmable dry-circuit relay outputs (120 VAC, 1 A) for remote indication of the following:
 - a. Motor running.
 - b. Setpoint speed reached.
 - c. Fault and warning indication (overtemperature or overcurrent).
 - d. PID high- or low-speed limits reached.
- F. PID Control Interface: Provides closed-loop setpoint, differential feedback control in response to dual feedback signals. Allows for closed-loop control of fans and pumps for pressure, flow, or temperature regulation.
1. Number of Loops: Two.
- G. BAS Interface: Factory-installed hardware and software to enable the BAS to monitor, control, and display VFD status and alarms and energy usage. Allows VFD to be used with an external system within a multi-drop LAN configuration; settings retained within VFD's non-volatile memory.
1. Network Communications Ports: RS-422/485.
 2. Embedded BAS Protocols for Network Communications: BACnet IP, BACnet MS/TP, Johnson Metasys N2, MODBUS RTU, MODBUS TCP, General Protocol 1 (GP1) FLN; protocols accessible via the communications ports. Provide optional, add-on protocol if required for BAS interface.

2.03 LINE CONDITIONING AND FILTERING

- A. Input Line Conditioning: Internal 5% impedance reactors. Reactors shall be dual positive and negative DC bus reactors, or AC line reactors.
- B. EMI/RFI Filtering: CE marked; certify compliance with IEC 61800-3 for Category C2.

2.04 OPTIONAL FEATURES

- A. Damper control circuit with end of travel feedback capability where indicated on the drawings or needed for proper system operation.

2.05 ENCLOSURES

- A. VFD Enclosures: NEMA 250, to comply with environmental conditions at installed location.
 - 1. Dry and Clean Indoor Locations: Type 1.
 - 2. Outdoor Locations: Type 3R.
 - 3. Kitchens or Wash-Down Areas: Type 4X, stainless steel.
 - 4. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Non-Corrosive Liquids: Type 12.
- B. Plenum Rating: UL 1995; NRTL certification label on enclosure, clearly identifying VFD as "Plenum Rated."

2.06 ACCESSORIES

- A. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.
 - 1. Current Transformers: Continuous current rating, Basic Impulse Insulating Level (BIL) rating, burden, and accuracy class suitable for connected circuitry. Comply with IEEE C57.13.
- B. Cooling Fan and Exhaust System: For NEMA 250, Type 1 or Type 12; UL 508 component recognized: Supply fan, with composite intake and exhaust grilles; 120 VAC; obtained from integral CPT.
- C. Breather and drain assemblies, to maintain interior pressure and release condensation in NEMA 250, Type 4X and Type 12 enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.
- D. Space heaters, with NC auxiliary contacts, to mitigate condensation in NEMA 250, Type 3R, Type 4X and Type 12 enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

2.07 SOURCE QUALITY CONTROL

- A. VFDs will be considered defective if they do not pass tests and inspections.
- B. Prepare test and inspection reports.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Wall-Mounting Controllers: Install VFDs on walls with tops at uniform height and with disconnect operating handles not higher than 79 inches above finished floor unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks complying with Specification Section 23 05 29, Hangers and Supports for HVAC Piping and Equipment.
- B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- C. Install fuses in control circuits if not factory installed. Comply with requirements in Specification Section 26 28 13, Overcurrent Protection.
- D. Install heaters in thermal-overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.
- E. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.
- F. Comply with NECA 1.

3.02 IDENTIFICATION

- A. Identify VFDs, components, and control wiring. Comply with requirements for identification specified in Specification Section 23 05 53, Identification for HVAC Piping and Equipment.
 - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 - 2. Label each VFD with engraved nameplate.
 - 3. Label each enclosure-mounted control and pilot device.

3.03 CONTROL WIRING INSTALLATION

- A. Install wiring between VFDs and remote devices and facility's central-control system. Comply with requirements in Specification Section 23 05 20, Electrical and Control Wiring for Mechanical Systems.
- B. Bundle, train, and support wiring in enclosures.
- C. Connect selector switches and other automatic control devices where applicable.
 - 1. Connect selector switches to bypass only those manual- and automatic control devices that have no safety functions when switches are in manual-control position.
 - 2. Connect selector switches with control circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.04 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency or manufacturer's representative to perform tests and inspections.

- B. Perform tests and inspections.
- C. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each VFD element, bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- D. Tests and Inspections:
 - 1. Inspect VFD, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
 - 2. Test insulation resistance for each VFD element, component, connecting motor supply, feeder, and control circuits.
 - 3. Test continuity of each circuit.
 - 4. Verify that voltages at VFD locations are within 10% of motor nameplate rated voltages. If outside this range for any motor, notify the Engineer before starting the motor(s).
 - 5. Test each motor for proper phase rotation.
 - 6. Perform each electrical test and visual and mechanical inspection stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 7. Correct malfunctioning units onsite, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 - 8. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- E. VFDs will be considered defective if they do not pass tests and inspections.
- F. Prepare test and inspection reports. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.
- G. Provide onsite harmonic distortion testing, if required by the Owner or Engineer.

3.05 ADJUSTING

- A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.
- B. Set field-adjustable circuit-breaker trip ranges as specified.

3.06 DEMONSTRATION

- A. Engage a factory-authorized service representative to train the Owner's maintenance personnel to adjust, operate, reprogram, and maintain VFDs. Provide minimum of 4 hours of onsite training at the time of project closeout.

END OF SECTION

Edition 0907-0721

SECTION 23 05 15

ENCLOSED MOTOR CONTROLLERS

PART 1 GENERAL

1.01 SUMMARY

- A. This section includes the following enclosed controllers rated 600 volts and less:
 - 1. Full-voltage magnetic.

1.02 DEFINITIONS

- A. BAS: Building automation system.
- B. CPT: Control power transformer.
- C. IEC: International Electrical Commission.
- D. IEEE: Institute of Electrical and Electronics Engineers.
- E. LAN: Local area network.
- F. MCCB: Molded-case circuit breaker.
- G. MCP: Motor circuit protector.
- H. N.C.: Normally closed.
- I. NECA: National Electrical Contractors Association.
- J. NEMA: National Electrical Manufacturers Association.
- K. NETA: National Electrical Testing Association.
- L. N.O.: Normally open.
- M. OCPD: Overcurrent protective device.

1.03 SUBMITTALS

- A. Product Data: For each type of enclosed controller. Include dimensions, required clearances, and wiring diagrams for power, signal, and control wiring.
- B. Operation and maintenance data.

1.04 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.

PART 2 PRODUCTS

2.01 FULL-VOLTAGE CONTROLLERS

- A. General Requirements for Full-Voltage Controllers: Comply with NEMA ICS 2, general purpose, Class A.

- B. Definite Purpose Contactors: For remote control of single-phase motors.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Square D, Type DPA, Class 8910 or comparable product by one of the following:
 - a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - b. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - c. Rockwell Automation, Inc.; Allen-Bradley brand.
 - d. Siemens Energy & Automation, Inc.
 - e. Square D; a brand of Schneider Electric.
 - 2. Configuration: Non-reversing, double-break contacts.
 - 3. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters matched to nameplate full-load current of actual protected motor; external reset pushbutton; bimetallic type.
 - 4. Surface mounting.

- C. Magnetic Controllers: Full voltage, across the line, electrically held, NEMA device.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Square D Class 8536 Type S or comparable product by one of the following:
 - a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - b. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - c. Rockwell Automation, Inc.; Allen-Bradley brand.
 - d. Siemens Energy & Automation, Inc.
 - e. Square D; a brand of Schneider Electric.
 - 2. Configuration: Non-reversing.
 - 3. Contactor Coils: Pressure-encapsulated type.
 - a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.
 - 4. Power Contacts: Totally enclosed, double break, silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.
 - 5. Control Circuits: 24 VAC; obtained from integral CPT, with primary and secondary fuses, with CPT of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.
 - 6. Bimetallic Overload Relays:
 - a. Inverse-time-current characteristic.
 - b. Class 20 tripping characteristic.
 - c. Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
 - 7. Solid-State Overload Relay:
 - a. Switch or dial selectable for motor running overload protection.
 - b. Sensors in each phase.
 - c. Class 20 or Class 10/20 selectable tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
 - 8. External overload reset pushbutton.

2.02 ENCLOSURES

- A. Enclosed Controllers: NEMA ICS 6, to comply with environmental conditions at installed location.
 - 1. Dry and Clean Indoor Locations: Type 1.
 - 2. Outdoor Locations: Type 3R.
 - 3. Kitchen Wash-Down Areas: Type 4X, stainless steel.
 - 4. Other Wet or Damp Indoor Locations: Type 4.
 - 5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Non-Corrosive Liquids: Type 12.

2.03 ACCESSORIES

- A. Pushbuttons, Pilot Lights, and Selector Switches: NEMA ICS 5; heavy-duty type; factory installed in controller enclosure cover unless otherwise indicated.
- B. Control Relays: Auxiliary and adjustable time-delay relays.
- C. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.

PART 3 EXECUTION

3.01 GENERAL

- A. Controllers: Furnish controllers for all single-phase and polyphase motors provided as part of the Division 23 work. Controllers shall be installed by the Division 26 Contractor. Controllers are not required for the following:
 - 1. Motors controlled by a variable frequency drive.
 - 2. Motors that are provided with controllers as part of packaged equipment.
 - 3. Motors controlled through a motor control center. Motor control centers are specified in Division 26.
- B. Accessories: Furnish controllers with the required accessories, auxiliary contacts, holding coils, etc., as required to achieve the sequence of controls, interlocking, etc., indicated on the drawings and as required for a fully functioning system.
 - 1. All definite purpose contactors and magnetic controllers shall be furnished with a hand-off-auto (HOA) switch.
 - 2. All single-phase controllers shall be provided with undervoltage and overvoltage relays.
 - 3. All polyphase controllers shall be provided with phase-failure, phase-reversal, and undervoltage and overvoltage relays.

3.02 APPLICATION

- A. Automatic and/or Manual Operation: Where a motor is to be controlled manually or automatically by the BAS, or other control scheme.
 - 1. Fractional Horsepower Motors: Provide with definite purpose contactors or magnetic controllers.
 - 2. Integral Horsepower Motors: Provide with magnetic controllers.
 - 3. Multi-Speed Motors: Multi-speed magnetic controller selected to match motor type.

3.03 INSTALLATION

- A. Installation shall be by the Division 26 Contractor.
- B. Installation of power wiring shall be by the Division 26 Contractor.
- C. Install control wiring.
- D. Install fuses in control circuits if not factory installed. Comply with requirements in Division 26.
- E. Install heaters in thermal overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.
- F. Comply with NECA 1.

3.04 IDENTIFICATION

- A. Identification of controllers, line-voltage components, and power wiring shall be done by the Division 26 Contractor.
- B. Identify low-voltage components and control wiring.

3.05 CONTROL WIRING INSTALLATION

- A. Install wiring between enclosed controllers and remote devices and facility's BAS. Comply with requirements in Division 23.
- B. Bundle, train, and support wiring in enclosures.
- C. Connect selector switches and other automatic-control selection devices where applicable.
 - 1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switch is in manual-control position.
 - 2. Connect selector switches with enclosed-controller circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.06 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each enclosed controller, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each control circuit.
- C. Tests and Inspections:
 - 1. Inspect controllers, control wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
 - 2. Test continuity of each control circuit.
 - 3. Test each motor for proper phase rotation.
 - 4. Perform each electrical test and visual and mechanical inspection stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 5. Correct malfunctioning units onsite, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

6. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Enclosed controllers will be considered defective if they do not pass tests and inspections.
 - E. Prepare test and inspection reports. Reports shall be on the Contractor's letterhead and shall include, at a minimum, the following information:
 1. Testing technician's name and signature.
 2. Data and time testing was performed.
 3. Ambient temperature and weather conditions.
 4. Manufacturer, model number, and other pertinent data of the test equipment.
 5. Statement of "As Left" condition.
 6. Pass/Fail statement relative to NETA Chapter 10 recommendations.
 7. Deficiencies detected.
 8. Remedial action taken.
 9. Observations after remedial action.
 10. Recommendations, if any.
 - F. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.07 ADJUSTING

- A. Set field-adjustable switches and overload-relay pickup and trip ranges.
- B. Adjust the settings of adjustable motor overloads to match the motor full-load amperes.

3.08 DEMONSTRATION

- A. Train the Owner's maintenance personnel to adjust, operate, and maintain enclosed controllers.

END OF SECTION

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SECTION 23 05 17

SLEEVES & SLEEVE SEALS FOR HVAC PIPING

PART 1 GENERAL

1.01 SUMMARY

- A. This section includes:
 - 1. Sleeves.
 - 2. Sleeve-seal systems.
 - 3. Grout.

1.02 SUBMITTALS

- A. Product Data: For each type of product indicated.

PART 2 PRODUCTS

2.01 SLEEVES

- A. Cast-Iron Wall Pipes: Cast or fabricated of cast- or ductile-iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
- B. Galvanized-Steel Wall Pipes: ASTM A53/A53M, Schedule 40, with plain ends and welded steel collar; zinc coated.
- C. Galvanized-Steel-Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.
- D. Galvanized-Steel-Sheet Sleeves: Minimum thickness 0.0239-inch; round tube closed with welded longitudinal joint.

2.02 SLEEVE-SEAL SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Advance Products & Systems, Inc.
 - 2. CALPICO, Inc.
 - 3. Link-Seal by GPT, an EnPro Industries Company.
 - 4. The Metraflex Company.
 - 5. Proco Products, Inc.
- B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
 - 1. Sealing Elements: EPDM-rubber or NBR interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 2. Pressure Plates: Stainless steel or reinforced nylon polymer.
 - 3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.03 GROUT

- A. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Non-shrink; recommended for interior and exterior applications.
- C. Design Mix: 5,000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

PART 3 EXECUTION

3.01 SLEEVE INSTALLATION

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
 - 1. Sleeves are not required for core-drilled holes through exterior walls or slab-on-grade floors.
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and interior of sleeve.
 - 1. For core-drilled holes, size hole large enough to provide 1-inch annular space between piping and concrete wall or slab-on-grade floor.
- C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
 - 2. Using grout, seal the space outside of sleeves in slabs and walls.
- D. Install sleeves in core-drilled holes in concrete floors in mechanical equipment areas or other wet areas.
 - 1. Extend sleeves 2 inches above finished floor level.
 - 2. Using grout, seal the space outside of sleeves.
- E. Install sleeves for pipes passing through interior partitions.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - 2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
 - 3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Division 07 specifications.
- F. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Division 07 specifications.

3.02 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior, above and below grade, concrete walls and slabs-on-grade at service piping entries into building.

- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve or hole. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.03 SLEEVE AND SLEEVE-SEAL SCHEDULE

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
1. Exterior Concrete Walls Above Grade:
 - a. Piping Smaller than NPS 4: Cast-iron wall sleeves, galvanized-steel wall sleeves, or galvanized-steel-pipe sleeves.
 - b. Piping NPS 4 and Larger: Cast-iron wall sleeves or galvanized-steel-pipe sleeves.
 2. Exterior Concrete Walls Below Grade:
 - a. Piping Smaller than NPS 4: Cast-iron wall sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 - b. Piping NPS 4 and Larger: Cast-iron wall sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 3. Concrete Foundation or Stem Walls Below Grade:
 - a. Piping Smaller than NPS 4: Cast-iron wall sleeves.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve.
 - b. Piping NPS 4 and Larger: Cast-iron wall sleeves.
 4. Concrete Slabs-on-Grade: Cast-iron wall sleeves with sleeve-seal system.
 - a. Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 5. Concrete Slabs Above Grade: Galvanized-steel-pipe sleeves.
 6. Interior Partitions:
 - a. Piping Smaller than NPS 6: Galvanized-steel-pipe sleeves.
 - b. Piping NPS 6 and Larger: Galvanized-steel-sheet sleeves.

END OF SECTION

Edition 0308-0715

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SECTION 23 05 18

ESCUTCHEONS FOR HVAC PIPING

PART 1 GENERAL

1.01 SUMMARY

- A. This section includes:
 - 1. Escutcheons.
 - 2. Floor plates.

1.02 SUBMITTALS

- A. Product Data: For each type of product indicated.

PART 2 PRODUCTS

2.01 ESCUTCHEONS

- A. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and set screw fastener.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.
- C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.
- D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw and polished chrome-plated finish.

2.02 FLOOR PLATES

- A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.
- B. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
- B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
 - 1. Escutcheons for New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Insulated Piping: One-piece, stamped-steel type.
 - c. Bare Piping: One-piece, cast-brass type.
 - 2. Escutcheons for existing piping shall be split-casting, cast-brass type.
- C. Install floor plates for piping penetrations of equipment-room floors.

- D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
 - 1. New Piping: One-piece, floor-plate type,
 - 2. Existing Piping: Split-casting, floor-plate type.

3.02 FIELD QUALITY CONTROL

- A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION

Edition 0308-1109

SECTION 23 05 19

METERS & GAGES FOR HVAC PIPING

PART 1 GENERAL

1.01 SUMMARY

- A. This section includes:
 - 1. Thermometers.
 - 2. Thermowells.
 - 3. Dial-type pressure gages.
 - 4. Gage attachments.

1.02 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Wiring Diagrams: For power, signal, and control wiring.
- C. Product certificates.
- D. Operation and maintenance data.

PART 2 PRODUCTS

2.01 THERMOMETERS

- A. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. H.O. Trerice Co.
 - b. Miljoco Corporation.
 - c. Palmer Wahl Instrumentation Group.
 - d. Weiss Instruments, Inc.
 - e. Winters Instruments – U.S.
 - 2. Standard: ASME B40.200.
 - 3. Case: Cast aluminum, 9 inch nominal size unless otherwise indicated.
 - 4. Case Form: Adjustable angle unless otherwise indicated.
 - 5. Tube: Glass with magnifying lens and blue or red organic liquid.
 - 6. Tube Background: Non-reflective aluminum with permanently etched scale markings graduated in degrees F.
 - 7. Window: Glass.
 - 8. Stem: Aluminum and of length to suit installation.
 - a. Design for Air Duct Installation: With ventilated shroud.
 - b. Design for Thermowell Installation: Bare stem.
 - 9. Connector: 1-1/4 inches, with ASME B1.1 screw threads.
 - 10. Accuracy: $\pm 1\%$ of scale range or one scale division, to a maximum of 1-1/2% of scale range.

- B. Solar-Powered Digital Thermometers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. H.O. Trerice Co.
 - b. Miljoco Corporation.
 - c. Winters Instruments.
 2. Case: High impact ABS plastic.
 3. Connector: Adjustable type, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device.
 4. Stem: Metal for thermowell installation and of length to suit installation, or sampling tube with flange for air duct application.
 5. Accuracy: Maximum of 1 degree or 1% of reading.
 6. Range: -50°F to +300°F.
 7. Display: LCD with 1/2-inch-tall black characters on a gray background, updated at 10-second intervals.
 8. Illuminance: Front-mounted or bi-directional solar collectors. Maximum required ambient lighting: 35 Lux.

2.02 THERMOWELLS

- A. Standard: ASME B40.200.
- B. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
- C. Material for Use with Copper Tubing: Brass.
- D. Material for Use with Steel Piping: Stainless Steel.
- E. Type: Stepped shank unless straight or tapered shank is indicated.
- F. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
- G. Internal Threads: 1-1/4 inch, with ASME B1.1 screw threads.
- H. Bore: Diameter required to match thermometer bulb or stem.
- I. Insertion Length: Length required to match thermometer bulb or stem.
- J. Lagging Extension: Include on thermowells for insulated piping and tubing.
- K. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

2.03 PRESSURE GAGES

- A. Metal-Case, Dial-Type Pressure Gages:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. H.O. Trerice Co.
 - b. Marsh Bellofram.
 - c. Miljoco Corporation.
 - d. Palmer Wahl Instrumentation Group.
 - e. Weiss Instruments, Inc.
 - f. Weksler.
 2. Standard: ASME B40.100.

3. Case: Cast aluminum or drawn steel; 4-1/2-inch nominal diameter.
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
5. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Non-reflective aluminum with permanently etched scale markings graduated in psi and kPa.
8. Pointer: Dark-colored metal.
9. Window: Glass.
10. Ring: Metal.
11. Accuracy: Grade A, $\pm 1\%$ of middle half of scale range.

2.04 GAGE ATTACHMENTS

- A. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and surge-dampening device. Include extension for use on insulated piping.
- B. Valves: Bronze or stainless-steel ball, with NPS 1/4 or NPS 1/2 ASME B1.20.1 pipe threads.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install thermowells with socket extending one-third of pipe diameter and in vertical position in piping tees.
- B. Install thermowells of sizes required to match thermometer or temperature sensor connectors. Include bushings if required to match sizes.
- C. Install thermowells as directed by the Building Automation System Contractor.
- D. Install thermowells with extension on insulated piping.
- E. Fill thermowells with heat-transfer medium.
- F. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
- G. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.
- H. Install valve and snubber in piping for each pressure gage for fluids (except steam).
- I. Install thermometers where indicated on the drawings and in the following locations:
 1. Inlet and outlet of each hydronic coil in air-handling units.
- J. Install pressure gages where indicated on the drawings and in the following locations:
 1. Discharge of each pressure-reducing valve.
 2. Each hydronic pump. Provide one gage per pump with 1/2-inch piping and ball valves to allow measurement at strainer inlet, pump inlet and pump discharge.

3.02 CONNECTIONS

- A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

3.03 ADJUSTING

- A. Adjust faces of meters and gages to proper angle for best visibility.

3.04 THERMOMETER SCALE-RANGE SCHEDULE

- A. Scale Range for Energy Recovery Water Piping: 0 to 250°F.

3.05 PRESSURE-GAGE SCALE-RANGE SCHEDULE

- A. Scale Range for Energy Recovery Water Piping: 0 to 100 psi.

END OF SECTION

Edition 0607-1015

SECTION 23 05 20

ELECTRICAL & CONTROL WIRING FOR MECHANICAL SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

- A. This section is to be used for all low- and line-voltage wiring for mechanical controls. All line-voltage work shall be performed by a licensed contractor qualified to perform the work and shall comply with the requirements contained in this section or in Division 26.
- B. This section does not apply to plenum rated cables used for electrically activated remote damper operators.
- C. This section includes the following:
 - 1. Metal conduits, tubing, and fittings.
 - 2. Metal wireways and auxiliary gutters.
 - 3. Surface raceways.
 - 4. Boxes, enclosures, and cabinets.
 - 5. Low-voltage control cabling.
 - 6. Conductors and cables rated 600 volts and less.
 - 7. Connectors, splices, and terminations rated 600 volts and less.
 - 8. Identification of power and control cables.

1.02 DEFINITIONS

- A. Low-Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 volts or for remote-control and signaling power-limited circuits.

1.03 SUBMITTALS

- A. Product Data: For each type of product indicated, include manufacturer's technical data, materials of construction, and listings.
- B. Field quality-control test reports.
- C. Maintenance data.

1.04 QUALITY ASSURANCE

- A. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: 25 or less.
 - 2. Smoke-Developed Index: 50 or less.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to the Authorities Having Jurisdiction (AHJ), and marked for intended use.
- C. Comply with NFPA 70.

- D. Comply with ANSI A13.1 for identification devices.

PART 2 PRODUCTS

2.01 METAL CONDUITS, TUBING, AND FITTINGS

- A. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. GRC: Comply with ANSI C80.1 and UL 6.
- C. IMC: Comply with ANSI C80.6 and UL 1242.
- D. EMT: Comply with ANSI C80.3 and UL 797.
 - 1. Color: Factory-applied color per schedule below.
 - a. HVAC Control Wiring: White.
 - b. Power – Normal: Natural.
 - c. Power – Standby: Orange.
- E. FMC: Comply with UL 1; zinc-coated steel or aluminum.
- F. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.
- G. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
 - 1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 1203 and NFPA 70.
 - 2. Fittings for EMT:
 - a. Material: Steel.
 - b. Type: Set screw or compression.
 - 3. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
- H. Joint Compound for IMC or GRC: Approved, as defined in NFPA 70, by the AHJ for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.02 METAL WIREWAYS AND AUXILIARY GUTTERS

- A. Description: Sheet metal, complying with UL 870 and NEMA 250; Type 1, Type 3R, Type 4 or Type 12, as required by location; and sized according to NFPA 70.
 - 1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

2.03 SURFACE RACEWAYS

- A. Listing and Labeling: Surface raceways shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

- B. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5. Where installed in finished spaces, match color of adjacent surfaces.

2.04 BOXES, ENCLOSURES, AND CABINETS

- A. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.
- B. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- C. Box extensions used to accommodate new building finishes shall be of the same material as the recessed box.
- D. Device Box Dimensions: 4" square x 2-1/8" deep or 4" x 2-1/8" x 2-1/8" deep.
- E. Gangable boxes are prohibited.
- F. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250; Type 1, Type 3R, Type 4 or Type 12, as required by location; with continuous-hinge cover with flush latch unless otherwise indicated.
 - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 - 2. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.
- G. Cabinets:
 - 1. NEMA 250; Type 1, Type 3R or Type 12, as required by location; galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
 - 2. Hinged door in front cover with flush latch and concealed hinge.
 - 3. Key latch to match panelboards.
 - 4. Metal barriers to separate wiring of different systems and voltage.
 - 5. Accessory feet where required for freestanding equipment.

2.05 LOW-VOLTAGE CONTROL CABLE

- A. Paired Cable: NFPA 70, Type CMG.
 - 1. One pair, twisted, #16 or #18 AWG, stranded (19 x 29) tinned-copper conductors.
 - 2. PVC insulation.
 - 3. Unshielded.
 - 4. PVC jacket.
 - 5. Flame Resistance: Comply with UL 1581.

2.06 CONDUCTORS AND CABLES

- A. Copper Conductors: Comply with NEMA WC 70.
- B. Conductor Insulation: Comply with the following:
 - 1. NEMA WC 70 for Types THHN-THWN and XHHW.
 - 2. UL 83 for Types TW and TF.

2.07 CONNECTORS AND SPLICES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. 3M; Electrical Products Division.

2. AFC Cable Systems, Inc.
3. Hubbell Power Systems, Inc.
4. O-Z/Gedney; EGS Electrical Group LLC.
5. Tyco Electronics Corp.

- B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

2.08 POWER AND CONTROL CABLE IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each cable size.
- B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
- C. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of cable it identifies and to stay in place by gripping action.
- D. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches long, with diameter sized to suit diameter of cable it identifies and to stay in place by gripping action.

2.09 CONDUCTOR IDENTIFICATION MATERIALS

- A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.
- B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
- C. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

PART 3 EXECUTION

3.01 RACEWAY APPLICATION

- A. Outdoors: Apply raceway products as specified below unless otherwise indicated:
 1. Exposed Conduit: GRC or IMC.
 2. Concealed Conduit, Aboveground: GRC, IMC, or EMT.
 3. Connection to Vibrating Equipment (Including Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
 4. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.
- B. Indoors: Apply raceway products as specified below unless otherwise indicated.
 1. Exposed, Not Subject to Physical Damage: EMT.
 2. Exposed, Not Subject to Severe Physical Damage: EMT.
 3. Exposed and Subject to Severe Physical Damage: GRC or IMC. Raceway locations include the following but not limited to:
 - a. Loading dock.

- b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
 - c. Gymnasiums.
 - 4. Concealed in Interior Walls and Partitions: EMT.
 - 5. Concealed Above or In Ceilings: EMT.
 - 6. Connection to Vibrating Equipment (Including Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
 - 7. Damp or Wet Locations: GRC or IMC.
 - 8. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.
- C. Minimum Raceway Size: Trade size 3/4 inch.
- D. Raceway Fittings: Compatible with raceways and suitable for use and location.
 - 1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
 - 2. EMT: Use set screw or compression, steel fittings. Comply with NEMA FB 2.10.
 - 3. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.
- E. Do not install aluminum conduit, boxes, or fittings in contact with concrete or earth.
- F. Install surface raceways only in retrofit applications where indicated.

3.02 RACEWAY INSTALLATION

- A. Install all cabling, conductors, and wiring in raceways except where noted otherwise on the drawings or in other sections.
- B. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on the drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
- C. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- D. Comply with requirements in Specification Section 23 05 29, Hangers and Supports for HVAC Piping and Equipment, for hangers and supports.
- E. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- F. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.
- G. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- H. Support conduit within 12 inches of enclosures to which attached.

- I. Raceways Embedded in Slabs:
 - 1. Run conduit larger than 1 inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-foot intervals.
 - 2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
 - 3. Arrange raceways to keep a minimum of 1 inch of concrete cover in all directions.
 - 4. Do not embed threadless fittings in concrete unless specifically approved by the Architect for each specific location.
- J. Stub-Ups to Above Recessed Ceilings:
 - 1. Use EMT, IMC, or GRC for raceways.
 - 2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- K. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
- L. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than #4 AWG.
- M. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb. tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.
- N. Surface Raceways:
 - 1. Install surface raceway with a minimum 2-inch radius control at bend points.
 - 2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.
- O. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces.
- P. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:
 - 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 - 2. Where conduits pass from humidity controlled spaces to non-humidity controlled spaces.
 - 3. Where an underground service raceway enters a building or structure.
 - 4. Where otherwise required by NFPA 70.
- Q. Expansion-Joint Fittings:
 - 1. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
 - 2. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

- R. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 48 inches of flexible conduit for equipment subject to vibration, noise transmission, or movement; and for motors.
 - 1. Use FMC in indoor, dry locations.
 - 2. Use LFMC in all other locations.
- S. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
- T. Locate boxes so that cover or plate will not span different building finishes.
- U. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.
- V. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

3.03 CONDUCTOR MATERIAL APPLICATIONS

- A. Control Circuit Sizing: Minimum sizes are listed below:
 - 1. Class 1 remote-control and signal circuits, #14 AWG.
 - 2. Class 2 low-energy, remote-control, and signal circuits, #16 AWG.
 - 3. Class 3 low-energy, remote-control, alarm, and signal circuits, #12 AWG.
- B. Branch Circuits: Copper. Solid for #10 AWG and smaller; stranded for #8 AWG and larger.
- C. Branch Circuit Sizing: Size conductors for circuits with less than a 20 ampere connected load, maximum of 16 amperes actual load, as follows:
 - 1. For 120-volt circuits up to 65 feet in length from panel to center of load: Not smaller than No. 12.
 - 2. For 120-volt circuits up to 110 feet in length from panel to center of load: Not smaller than No. 10.
 - 3. For 120-volt circuits up to 165 feet in length from panel to center of load: Not smaller than No. 8.
 - 4. For 120-volt circuits up to 255 feet in length from panel to center of load: Not smaller than No. 6.
 - 5. For 208-volt circuits up to 110 feet in length from panel to center of load: Not smaller than No. 12.
 - 6. For 208-volt circuits up to 185 feet in length from panel to center of load: Not smaller than No. 10.
 - 7. For 208-volt circuits up to 280 feet in length from panel to center of load: Not smaller than No. 8.
 - 8. For 208-volt circuits up to 440 feet in length from panel to center of load: Not smaller than No. 6.
 - 9. For 277-volt circuits up to 150 feet in length from panel to center of load: Not smaller than No. 12.
 - 10. For 277-volt circuits up to 250 feet in length from panel to center of load: Not smaller than No. 10.
 - 11. For 277-volt circuits up to 380 feet in length from panel to center of load: Not smaller than No. 8.
 - 12. For 277-volt circuits up to 590 feet in length from panel to center of load: Not smaller than No. 6.

3.04 CONDUCTOR INSULATION APPLICATIONS AND WIRING METHODS

- A. Comply with NECA 1.
- B. Exposed Branch Circuits, including in Crawlspace: Type THHN-THWN or XHHW, single conductors in raceway.
- C. Branch Circuits Concealed in Walls, and Partitions: Type THHN-THWN or XHHW, single conductors in raceway.
- D. Branch Circuits Concealed Above or in Ceilings: Type THHN-THWN or XHHW, single conductors in raceway.
- E. Branch Circuits Concealed Above Lay-In Ceilings: Type THHN-THWN or XHHW, single conductors in raceway.
- F. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN or XHHW, single conductors in raceway.
- G. Class 1 and 2 Control Circuits: Type THHN-THWN or XHHW, in raceway unless noted otherwise.
 - 1. Final raceway connections for low-voltage control wiring to equipment, actuators and similar devices may be omitted where the devices are located above lay-in ceilings. Length of exposed wire is to be less than 24 inches.
- H. Class 3 Control Circuits: Type TW or TF in raceway unless noted otherwise.
 - 1. Final raceway connections for low-voltage control wiring to equipment, actuators and similar devices may be omitted where the devices are located above lay-in ceilings. Length of exposed wire is to be less than 24 inches.

3.05 INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal raceways in finished walls, ceilings, and floors, unless otherwise indicated.
- B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage cables or raceway.
- D. Install raceways parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- E. Support cables according to Specification Section 23 05 29, Hangers and Supports for HVAC Piping and Equipment.
- F. Identify and color-code conductors and cables.
- G. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

- H. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

3.06 IDENTIFICATION INSTALLATION

- A. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- B. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by the manufacturer of the identification device.
- C. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.

3.07 IDENTIFICATION SCHEDULE

- A. Power-Circuit Conductor Identification, 600 Volts or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.
 - 1. Color-Coding for Phase and Voltage Level Identification, 600 Volts or Less: Use colors listed below for ungrounded branch-circuit conductors.
 - a. Color shall be factory applied.
 - b. Colors for 208/120-Volt Circuits:
 - 1) Phase A: Black.
 - 2) Phase B: Red.
 - 3) Phase C: Blue.
 - 4) Neutral: White.
 - c. Colors for 480/277-Volt Circuits:
 - 1) Phase A: Brown.
 - 2) Phase B: Orange.
 - 3) Phase C: Yellow.
 - 4) Neutral: Gray.
- B. Control Systems Conductor Identification: Identify field-installed control, and signal connections.
 - 1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
 - 2. Use system of marker tape designations that is uniform and consistent with the system used by the manufacturer for factory-installed connections.
 - 3. Coordinate identification with the Project Drawings, manufacturer's wiring diagrams, and the Operation & Maintenance Manual.
- C. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.
 - 1. Install underground-line warning tape for both direct-buried cables and cables in raceway.

3.08 REMOVAL OF CONDUCTORS AND CABLES

- A. Remove abandoned conductors and cables.

3.09 GROUNDING

- A. For low-voltage wiring and cabling, comply with requirements in Division 26.

3.10 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Specification Section 23 05 17, Sleeves and Sleeve Seals for HVAC Piping.

3.11 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Comply with requirements in Division 07 specifications.

3.12 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage and deterioration.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by the manufacturer.
 - 2. Repair damage to paint finishes with matching touchup coating recommended by the manufacturer.

3.13 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
- B. Tests and Inspections: Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
- C. Test Reports: Prepare a written report to record the following:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.
- D. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION

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SECTION 23 05 23

GENERAL DUTY VALVES FOR HVAC HYDRONIC PIPING

PART 1 GENERAL

1.01 SUMMARY

- A. This section includes:
 - 1. Ball valves.
 - 2. Iron butterfly valves.
 - 3. Bronze lift check valves.
 - 4. Iron lift check valves.
 - 5. Iron swing check valves.
- B. Related Sections:
 - 1. Division 23 HVAC piping sections for specialty valves applicable to those sections only.

1.02 SUBMITTALS

- A. Product Data: For each type of valve indicated.
- B. Warranty information.
- C. Operation and maintenance data.

1.03 QUALITY ASSURANCE

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance: ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS FOR VALVES

- A. Refer to HVAC Valve Schedule articles for applications of valves.
- B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- C. Valve Sizes: The same as upstream piping unless otherwise indicated.
- D. Valve Actuator Types:
 - 1. Gear Actuator: For quarter-turn valves NPS 8 and larger.
 - 2. Handlever: For quarter-turn valves NPS 6 and smaller.
 - 3. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the Valve Installation article.

- E. Valves in Insulated Piping: With 2-inch stem extensions and the following features:
 - 1. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
 - 2. Butterfly Valves: With extended neck.
- F. Valve-End Connections:
 - 1. Flanged: With flanges according to ASME B16.1 for iron valves.
 - 2. Solder Joint: With sockets according to ASME B16.18.
 - 3. Threaded: With threads according to ASME B1.20.1.
- G. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Conbraco Industries; Apollo Valves.
 - 2. FNW Grinnell.
 - 3. Hammond Valve.
 - 4. Kitz Corporation of America.
 - 5. Milwaukee Valve Company.
 - 6. Nibco Inc.
 - 7. Pratt Industrial.
 - 8. Watts.

2.02 BALL VALVES

- A. Two-Piece, Full-Port Ball Valves:
 - 1. Standard: MSS SP-110.
 - 2. CWP Rating: 600 psi.
 - 3. Body Design: Two piece.
 - 4. Body Material:
 - a. Valves 2 Inches and Smaller: Forged or cast bronze.
 - b. Valves 2-1/2 Inches and Larger: Forged or cast bronze or brass.
 - 5. Ends: Threaded.
 - 6. Seats: PTFE or TFE.
 - 7. Stem: Stainless steel, blowout proof with adjustable packing nut.
 - 8. Ball: Stainless steel.
 - 9. Port: Full.

2.03 BUTTERFLY VALVES

- A. Iron, Lug Body Butterfly Valves:
 - 1. Standard: MSS SP-67, Type I.
 - 2. CWP Rating: 150 psig.
 - 3. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - 4. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron, epoxy coated, with actuator flange.
 - 5. Seat and Seal: EPDM.
 - 6. Stem: One- or two-piece stainless steel.
 - 7. Disc: Aluminum bronze, coated ductile iron, or stainless steel.

2.04 CHECK VALVES

- A. Bronze Lift Check Valves:
 - 1. Standard: MSS SP-80.
 - 2. CWP Rating: 250 psig.

3. Type: Inline, spring assisted, center-guided.
 4. Body Material: ASTM B584, bronze.
 5. Body End Material: ASTM B584, bronze.
 6. Ends: Threaded.
 7. Disc: BUNA.
 8. Disc Holder: Stainless steel or bronze.
 9. Trim: Stainless steel or bronze.
- B. Bronze Swing Check Valves:
1. Standard: MSS SP-80, Type 4.
 2. CWP Rating: 300 psig.
 3. Body Design: Horizontal flow.
 4. Body Material: ASTM B62, bronze.
 5. Ends: Threaded.
 6. Disc: PTFE OR TFE.
- C. Iron Lift Check Valves:
1. Standard: MSS SP-125.
 2. NPS 2-1/2 to NPS 10 CWP Rating: 200 psig.
 3. NPS 12 to NPS 24 CWP Rating: 150 psig.
 4. Type: Inline, spring assisted, center-guided.
 5. Body Design: Globe style.
 6. Body Material: ASTM A126, cast iron.
 7. Ends: Flanged.
 8. Trim: Stainless steel.
 9. Seat Ring: Stainless steel or bronze.
 10. Disc: Stainless steel or bronze.
 11. Spring: Stainless steel.
- D. Iron Swing Check Valves:
1. Standard: MSS SP-71, Type I.
 2. NPS 2-1/2 to NPS 12 CWP Rating: 200 psig.
 3. NPS 14 to NPS 24 CWP Rating: 150 psig.
 4. Body Design: Clear or full waterway.
 5. Body Material: ASTM A126, gray iron with bolted bonnet.
 6. Ends: Flanged.
 7. Trim: Bronze.
 8. Gasket: Asbestos-free.
 9. Seat Rings: Bronze.
 10. Disc: Bronze, coated ductile iron, or stainless steel.
 11. Closure Control: Factory-installed exterior lever and weight.

2.05 CHAINWHEELS

- A. Description: Valve actuation assembly with sprocket rim, brackets, and chain.
1. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
 2. Attachment: For connection to valve stems.
 3. Sprocket Rim with Chain Guides: Ductile iron, of type and size required for valve.
 4. Chain: Hot-dip, galvanized steel, of size required to fit sprocket rim.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.

3.02 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem and handle movement.
- E. Install check valves with minimum five straight pipe diameters upstream of valve.
- F. Install gear actuator with hand wheel axle in horizontal position to prevent accidental engagement or disengagement.
- G. Install chainwheels on operators for ball, globe and butterfly valves NPS 4 and larger and more than 96 inches above floor. Extend chains to 60 inches above finished floor.
- H. Install chainwheels operators for all valves located more than 3 feet above a lay-in ceiling. Extend chains to 6 inches above ceiling.
- I. Install chainwheels operators for all valves located more than 2 feet above a hard ceiling access opening. Extend chains to 6 inches above ceiling.
- J. Install swing check valves for proper direction of flow and in horizontal position with hinge pin level.

3.03 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.04 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valve applications are not otherwise indicated and except as specified in piping system sections, use the following:
 - 1. Shutoff Service: Ball or butterfly valves.
 - 2. Throttling Service: Ball or butterfly valves.
 - 3. Pump-Discharge Check Valves:
 - a. NPS 2 and Smaller: Bronze lift check valves.
 - b. NPS 2-1/2 and Larger: Iron lift check valves.
- B. If valves with specified CWP ratings are not available, the same types of valves with higher CWP ratings may be substituted.
- C. Select valves with the following end connections:
 - 1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
 - 2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
 - 3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
 - 4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
 - 5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
 - 6. For Steel Piping, NPS 5 and Larger: Flanged ends.

3.05 CHILLED-WATER, ENERGY RECOVERY WATER VALVE SCHEDULE

- A. Pipe NPS 2 and Smaller:
 - 1. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.
 - 2. Ball valves.
 - 3. Bronze swing or lift check valves.
- B. Pipe NPS 2-1/2 and Larger:
 - 1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
 - 2. Iron butterfly valves, NPS 2-1/2 to NPS 24.
 - 3. Iron swing or lift check valves.

END OF SECTION

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SECTION 23 05 29

HANGERS & SUPPORTS FOR HVAC PIPING & EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

- A. This section includes:
 - 1. Metal pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3. Thermal-hanger shield inserts.
 - 4. Fastener systems.
 - 5. Equipment supports.
 - 6. Non-penetrating rooftop bases.

1.02 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
 - 1. Design supports for multiple pipes capable of supporting combined weight of supported systems, system contents, and test water with no load transmitted to connected equipment.
 - 2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.03 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Show fabrication and installation details and include calculations for the following; include product data for components:
 - 1. Trapeze pipe hangers.
 - 2. Equipment supports.
- C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by a qualified professional engineer responsible for their preparation.
- D. Welding certificates.

1.04 QUALITY ASSURANCE

- A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, Structural Welding Code - Steel.
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

- C. Surface-Burning Characteristics: For tapes, as determined by testing identical products according to ASTM E84, by a testing agency acceptable to the Authorities Having Jurisdiction. Factory-label tapes with appropriate markings of the applicable testing agency.
 - 1. Tape Installed in Return Plenums: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Tape Installed Elsewhere: No testing requirement.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with requirements, manufacturers shall be one of the following unless noted otherwise:
 - 1. Anvil International.
 - 2. B-Line Systems.
 - 3. Elgen.
 - 4. Kin-Line.
 - 5. Michigan Hanger Co.
 - 6. National Pipe Hanger Corp.
 - 7. PHD Manufacturing.
 - 8. PHS Industries.
 - 9. Pipe Technology and Products.
 - 10. Unistrut.

2.02 METAL PIPE HANGERS AND SUPPORTS

- A. Carbon-Steel Pipe Hangers and Supports:
 - 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
 - 2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
 - 3. Non-Metallic Coatings: Plastic coating, jacket, or liner.
 - 4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
 - 5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel or stainless steel.
- B. Stainless-Steel Pipe Hangers and Supports:
 - 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
 - 2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
 - 3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.
- C. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- D. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- E. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

2.03 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-58, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, pipe clamps, and U-bolts.

2.04 THERMAL-HANGER SHIELD INSERTS

- A. Insulation-Insert Material for Hot or Cold Piping: ASTM C552, Type II cellular glass with 100-psig or ASTM C591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.
- B. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- C. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- D. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.
- E. Shield: Shields shall be a minimum of 18 gauge galvanized steel, 12 inches long for piping 6 inches and smaller. Shields shall be a minimum of 16 gauge galvanized steel, 18 inches long for pipe over 6 inches.

2.05 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.06 NON-PENETRATING ROOFTOP BASES

- A. Subject to compliance with requirements, manufacturers shall be one of the following:
 - 1. Dymotek.
 - 2. Miro Industries, Inc.
 - 3. PHP Systems Design.
- B. Description: Stainless-steel or polycarbonate bases designed for direct placement on roofing membrane.
 - 1. General:
 - a. All edges and corners in contact with the roof surface shall be rounded to prevent damage to the roof membrane.
 - b. Drainage ports shall be provided to prevent ponding of water within the base.
 - c. The bottom of the base shall be solid and flat, free of voids and deformities to prevent concentrated loading of the roofing membrane.
 - d. Polycarbonate bases shall be UV stabilized with carbon black.
 - 2. Supports: Pipe, conduit, duct, and equipment supports mounted to roof bases shall be constructed as outlined above. Integral supports for small diameter piping and conduit may be integral with polycarbonate bases.
 - 3. Protective Pads: 1/8-inch-thick, flexible PVC with carbon black additive for UV stabilization, protective pad for placement beneath roof bases to protect roofing membrane.

2.07 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A36/A36M, carbon-steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C1107, factory-mixed and -packaged, dry, hydraulic-cement, non-shrink and non-metallic grout; suitable for interior and exterior applications.
 - 1. Properties: Non-staining, non-corrosive, and non-gaseous.
 - 2. Design Mix: 5,000-psi, 28-day compressive strength.
- C. Tape for Plenum Use:
 - 1. Polypropylene backing with acrylic adhesive, Hart & Cooley Part No. 011371.
 - 2. Polyethylene-coated cloth backing with rubber adhesive, Uline Black Nashua 398 Duct Tape, Model No. S-17236BL.

PART 3 EXECUTION

3.01 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-58 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
 - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
 - 2. Field fabricate from ASTM A36/A36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Hanger Sizing: Size hangers on insulated piping to fit outside of covering.
- D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- E. Fastener System Installation: Install fasteners in strict accordance with manufacturer's written instructions.
- F. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- G. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- H. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- I. Install lateral bracing with pipe hangers and supports to prevent swaying.
- J. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before

concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

- K. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- L. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- M. Insulated Piping: Thermal-hanger shield inserts shall be used. Install with insulation the same thickness as piping insulation. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
- N. Conduit Support Installation:
 - 1. Comply with NECA 1 and NECA 101 for installation requirements, except as specified in this article.
 - 2. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.
 - 3. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lbs.

3.02 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead, or to support equipment above floor or roof.
- B. Grouting: Place non-shrink grout under supports for equipment and make bearing surface smooth.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.03 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.04 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.05 PAINTING

- A. Refer to General Provisions for rust inhibiting primer.
- B. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use the same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- C. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 specifications.
- D. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780.

3.06 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in sections specifying piping systems and equipment.
- B. Comply with MSS SP-58 for pipe-hanger selections and applications that are not specified in piping system sections.
- C. Use carbon-steel pipe hangers and supports and metal trapeze pipe hangers and attachments for general service applications.
- D. Use hangers and supports with galvanized metallic coatings for piping and equipment that is exposed to weather and that will not have field-applied finish.
- E. Use stainless-steel pipe hangers and stainless-steel attachments for corrosive atmospheres.
- F. Wrap copper piping with not less than two layers of 10-mil-thick black plastic tape extending a minimum of 1 inch on each side of clamp for electrolytic protection where hangers or supports are in direct contact with copper piping.
- G. Use padded hangers for piping that is subject to scratching.
- H. Use thermal-hanger shield inserts for insulated piping and tubing.
- I. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system sections, install the following types:
 - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated, stationary pipes NPS 1/2 to NPS 30.
 - 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1,050°F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.

3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
 4. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 1-1/2 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
 5. Single-Pipe Rolls (MSS Type 43): For suspension of pipes NPS 1 to NPS 30, with one rod if longitudinal movement caused by expansion and contraction might occur.
 6. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
 7. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
- J. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.
- K. Conduit Support Applications:
1. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical conduit.
 2. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as scheduled in NECA 1, where its Table 1 lists maximum spacings less than stated in NFPA 70. Minimum rod size shall be 1/4 inch in diameter.
 3. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel-slotted or other support system, sized so capacity can be increased by at least 25% in future without exceeding specified design load limits.
 - a. Secure raceways and cables to these supports with two-bolt conduit clamps or single-bolt conduit clamps.
- L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system sections, install the following types:
1. Steel Turnbuckles (MSS Type 13).
 2. Steel Clevises (MSS Type 14): For 120 to 450°F piping installations.
- M. Building Attachments: Unless otherwise indicated and except as specified in piping system sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Top-Beam C-Clamps (MSS-Type 19): For use under roof installations with bar-joint construction, to attach to top flange of structural shape. Include retaining clip.
 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes. Include retaining clip.

7. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lbs.
 - b. Medium (MSS Type 32): 1,500 lbs.
 - c. Heavy (MSS Type 33): 3,000 lbs.
 8. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 9. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
- N. Roof Bases: Unless otherwise indicated install roof bases for roof-mounted piping, conduit, ductwork, and equipment as follows:
1. Select roof base size based on expected load to prevent crushing of the roofing membrane and underlying insulation.
 2. Space roof bases as required to properly support conduit, pipes, or ducts, or more frequently to distribute the weight of the supported systems to prevent damage to the roofing membrane, underlying insulation, or roofing system.
 3. Provide protective pads between each roof base and the roofing membrane. Size pads to extend a minimum of 2 inches beyond each roof base.
- O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system sections, install the following types:
1. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
 2. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
- P. Comply with MSS SP-58 for trapeze pipe-hanger selections and applications that are not specified in piping system sections.

END OF SECTION

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SECTION 23 05 48.13

VIBRATION CONTROLS FOR HVAC PIPING & EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

- A. This section includes the following:
 - 1. Isolation pads.
 - 2. Freestanding spring isolators.
 - 3. Spring hangers with vertical-limit stops.
 - 4. Thrust restraints.
 - 5. Floating concrete bases.

1.02 DEFINITIONS

- A. Sound Critical: Assembly spaces such as classrooms, auditoriums, etc.; normally occupied rooms such as offices, call centers, etc.; vibration critical areas such as data rooms, technical manufacturing areas, etc.; or other areas as indicated.
- B. Non-Sound Critical: Not normally occupied areas such as storage rooms, electrical rooms, mechanical yards, commercial kitchens, scullery areas, etc.

1.03 SUBMITTALS

- A. Product Data: For each product indicated.
 - 1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
 - 2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
- B. Welding certificates.
- C. Field quality-control test reports.

1.04 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, Structural Welding Code - Steel.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Wind-Restraint Performance: As listed on the drawings.

2.02 VIBRATION ISOLATORS

- A. Manufacturers: The following products are based on Mason Industries. Subject to compliance with requirements, provide comparable products by one of the following:
 - 1. Amber/Booth Company, Inc.

2. Kinetics Noise Control.
 3. Mason Industries.
 4. Vibration Mountings & Controls, Inc.
- B. Neoprene Pad: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a non-slip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.
1. Resilient Material: Oil- and water-resistant neoprene.
- C. Style D - Restrained Spring Isolators: Freestanding, steel, open-spring isolators with limit-stop restraint.
1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 1/4-inch-thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
 2. Restraint: Limit-stop as required for equipment and the Authorities Having Jurisdiction.
 3. Outside Spring Diameter: Not less than 80% of the compressed height of the spring at rated load.
 4. Minimum Additional Travel: 50% of the required deflection at rated load.
 5. Lateral Stiffness: More than 80% of rated vertical stiffness.
 6. Overload Capacity: Support 200% of rated load, fully compressed, without deformation or failure.
- D. Style G - Spring Hangers with Vertical-Limit Stop: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.
1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
 2. Outside Spring Diameter: Not less than 80% of the compressed height of the spring at rated load.
 3. Minimum Additional Travel: 50% of the required deflection at rated load.
 4. Lateral Stiffness: More than 80% of rated vertical stiffness.
 5. Overload Capacity: Support 200% of rated load, fully compressed, without deformation or failure.
 6. Elastomeric Elements: Molded, oil-resistant rubber or neoprene.
 - a. Minimum 1-1/4-inch-thick element at top of hanger with steel-washer-reinforced rod support and bushing projecting through top of frame.
 - b. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
 7. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
 8. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.
- E. Style H - Spring Hangers with Vertical-Limit Stop: Coil-spring compression hanger with a vertical-limit stop.
1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
 2. Outside Spring Diameter: Not less than 80% of the compressed height of the spring at rated load.
 3. Minimum Additional Travel: 50% of the required deflection at rated load.
 4. Lateral Stiffness: More than 80% of rated vertical stiffness.

5. Overload Capacity: Support 200% of rated load, fully compressed, without deformation or failure.
 6. Elastomeric Elements: Molded, oil-resistant rubber or neoprene, steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
 7. Adjustable Vertical Stop: Steel washer with neoprene washer “up-stop” on lower threaded rod.
 8. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.
- F. Style I - Thrust Restraint: Open-spring thrust restraint.
1. Outside Spring Diameter: Not less than 80% of the compressed height of the spring at rated load.
 2. Minimum Additional Travel: 50% of the required deflection at rated load.
 3. Lateral Stiffness: More than 80% of rated vertical stiffness.
 4. Overload Capacity: Support 200% of rated load, fully compressed, without deformation or failure.
 5. Attachments: Factory-drilled steel angles with backing plates for attachment to both duct and equipment or structure.
 6. Adjustable Precompression and Stop Nut: Adjustable nut to set spring precompression and limit travel when fan is off.
- G. Style L - Floating Concrete Base: Rectangular, welded or bolted, structural or formed, steel pouring form for field provided concrete. The depth of the base shall be a minimum of 1/12th the longest dimension of the base but no less than 6 inches. The maximum base depth is not required to be more than 12 inches. Bases shall include 1/2-inch reinforcing bars running in both directions welded in place at 6-inch centers located 1-1/2 inches above the bottom of the base. Forms shall be furnished with steel templates to secure the anchor bolts and anchor bolt sleeves during pouring activities. Bases shall be provided with height saving brackets to maintain a 1-inch clearance below the base. Bases for pumps shall be sized to support the suction and discharge elbows.

2.03 FACTORY FINISHES

- A. Finish: Manufacturer's standard paint applied to factory-assembled equipment before shipping.
1. Powder coating on springs and housings.
 2. All hardware shall be zinc electroplated.
 3. Baked enamel or powder coat for metal components on isolators for interior use.
 4. Color-code or otherwise mark vibration isolation control devices to indicate capacity range.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Engage a factory-authorized representative to inspect the intended equipment locations for deficiencies and to instruct installers in correct equipment installation procedure and sequence.
- B. Examine areas and equipment to receive vibration isolation devices for compliance with requirements for installation tolerances and other conditions affecting performance.
- C. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 APPLICATIONS

- A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application.
- B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits.
- C. Select vibration isolation elements and deflections in accordance with the following table:

Equipment	Location	Vibration Isolation Element (Minimum Deflection)
Chiller	Slab Not On-Grade	Neoprene Pad
Pump	Slab Not On-Grade	Style B & L (1.5 inches ≤ 60 HP)
Utility Set Fans	Slab Not On-Grade	Style B or L (3.5 inches)
Piping	Where connected to equipment with spring isolators.	Style G on first four hangers (match equipment deflection)
Air Moving Equipment	External Static Pressure >2 inches	Style I
Duct	Where connected to equipment with Style I thrust restraints.	Style H on first four hangers (match equipment deflection)

3.03 VIBRATION-CONTROL INSTALLATION

- A. Install bushing assemblies for mounting bolts for vibration isolated wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
- B. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
- C. Drilled-In Anchors:
1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the Structural Engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
 2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
 3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
 4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
 5. Set anchors to manufacturer's recommended torque, using a torque wrench.

- 6. Install zinc-coated steel anchors for interior and stainless steel anchors for exterior applications.
- D. Short-Circuiting: Avoid short-circuiting to the building any vibration-isolated piece of equipment, pipe, duct or other component. Short-circuits with or via rigid conduits, drain lines, rigid braces, rigid sleeves, framing, etc., shall all be avoided. The Contractor shall oversee trades to prevent the short-circuiting of any vibration isolation system and shall bring any unresolved conflicts to the Architect's attention.
- E. Incidentals: Supply and install any incidental equipment or parts needed to meet the requirements stated, even if not specified or shown on the drawings.

3.04 ADJUSTING

- A. Adjust isolators after piping system is at operating weight and temperature.
- B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.
- C. Adjust active height of spring isolators.
- D. Adjust restraints to permit free movement of equipment within normal mode of operation.

3.05 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Engage a factory-authorized representative to inspect the completed installation prior to the closing in of any unfinished work and again at the completion of the project. Complete any corrective work identified during the inspection.
- C. Tests and Inspections:
 - 1. Measure isolator restraint clearance.
 - 2. Measure isolator deflection.
 - 3. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION

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SECTION 23 05 53

IDENTIFICATION FOR HVAC PIPING & EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

- A. This section includes:
 - 1. Equipment labels.
 - 2. Warning signs and labels.
 - 3. Pipe labels.
 - 4. Hazardous exhaust duct labels.
 - 5. Diffuser, register, grille, and temperature sensor labels.
 - 6. T-bar labels.
 - 7. Environmental duct labels.

1.02 SUBMITTAL

- A. Product Data: For each type of product indicated.

PART 2 PRODUCTS

2.01 EQUIPMENT LABELS

- A. Plastic Labels for Equipment:
 - 1. Material and Thickness: Multi-layer, multi-color plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
 - 2. Letter Color: Black.
 - 3. Background Color: White.
 - 4. Maximum Temperature: Able to withstand temperatures up to 160°F.
 - 5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2" x 3/4".
 - 6. Minimum Letter Size: 1/2 inch. Include secondary lettering 3/8 inch.
 - 7. Fasteners: Stainless-steel rivets or self-tapping screws.
 - 8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Label Content: Include equipment's drawing designation or unique equipment number, and area(s) served by equipment. Coordinate with the Owner.

2.02 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multi-layer, multi-color plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
- B. Letter Color: White.
- C. Background Color: Red.
- D. Maximum Temperature: Able to withstand temperatures up to 160°F.

- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2" x 3/4".
- F. Minimum Letter Size: 1/2 inch. Include secondary lettering 3/8 inch.
- G. Fasteners: Stainless-steel rivets or self-tapping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Label Content: As indicated on the drawings or required by the local authority.

2.03 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
 - 1. Complying with latest edition of ANSI/ASME A13.1 unless specifically noted otherwise or directed by the Owner.
- B. Pretensioned Pipe Labels: Precoiled, semi-rigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Strap-On Pipe Labels: Semi-rigid plastic formed to fit circumference of pipe and to attach to pipe with stainless-steel worm-drive clamps.
- D. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent adhesive backing.
- E. Pipe Label Contents: Include identification of piping service using the same designations or abbreviations as used on the drawings, pipe size, and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
 - 2. Lettering Size: At least 1-1/2 inches high.

2.04 PAINTED PIPE AND DUCT LABELS

- A. Paint: Alkyd paint selected for use without a primer based on base material.
- B. Color: Match background color indicated in Label Color Schedules below.
- C. Application: Use stencils for paint application.
- D. Lettering Size: At least 3 inches high.
- E. Flow Arrows: To show flow direction.

2.05 HAZARDOUS EXHAUST DUCT LABELS

- A. Material and Thickness: Multi-layer, multi-color, plastic labels for mechanical engraving, 1/8 inch thick.
- B. Letter Color: Black.
- C. Background Color: White.
- D. Maximum Temperature: Able to withstand temperatures up to 160°F.

- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2" x 3/4".
- F. Minimum Letter Size: 1-1/2 inches.
- G. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- H. Duct Label Contents: Include identification of duct service using the same designations or abbreviations as used on the drawings, duct size, and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions, or as separate unit on each duct label to indicate flow direction.

2.06 DIFFUSER, REGISTER, GRILLE, AND TEMPERATURE SENSOR LABELS

- A. Material: Flexible, self-adhesive, vinyl film tape with printed markings.
- B. Letter Color: Black or color contrasting with underlying material.
- C. Background Color: Clear.
- D. Minimum Tape Size: 3/4 inch.
- E. Minimum Letter Size: 1/2 inch.
- F. Label Contents: Equipment identifier serving device.

2.07 T-BAR LABELS

- A. Description: Self-adhesive, 3/4-inch-diameter, color-coded labels.

2.08 ENVIRONMENTAL DUCT LABELS

- A. Material and Thickness: Multi-layer, multi-color, plastic labels for mechanical engraving, 1/8 inch thick.
- B. Letter Color: White.
- C. Background Color: Green.
- D. Maximum Temperature: Able to withstand temperatures up to 160°F.
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2" x 3/4".
- F. Minimum Letter Size: 1-1/2 inches.
- G. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- H. Duct Label Contents: Include identification of duct service, air handling unit or fan designation, area served, and an arrow indicating flow direction.

PART 3 EXECUTION

3.01 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.02 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.03 PIPE LABEL INSTALLATION

- A. Comply with requirements in latest edition of ANSI/ASME 13.1 unless noted otherwise.
- B. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Near each valve and control device.
 - 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 - 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.
 - 6. Spaced at maximum intervals of 20 feet along each run. Reduce intervals to 10 feet in areas of congested piping and equipment. Reduce spacing to 5 feet when required by code.
 - 7. Spaced at maximum 10 feet on piping above removable acoustical ceilings. Reduce spacing to 5 feet when required by code.
- C. Use painted pipe labels outside where piping is exposed to weather.
 - 1. Apply one or two coats using the same stencil as required for thorough coverage.
- D. Pipe Label Color Schedule:
 - 1. Chilled-Water Piping:
 - a. Background Color: Green.
 - b. Letter Color: White.
 - 2. Condensate Drain Piping:
 - a. Background Color: Green.
 - b. Letter Color: White.
 - 3. Energy Recovery Water Piping:
 - a. Background Color: Green.
 - b. Letter Color: White.
 - 4. Make-Up (Non-Potable) Water Piping:
 - a. Background Color: Green.
 - b. Letter Color: White.

3.04 HAZARDOUS EXHAUST DUCT LABEL INSTALLATION

- A. Install plastic-laminated or self-adhesive duct labels with permanent adhesive on air ducts in the following color codes:
 - 1. ASME A13.1 Colors and Designs: For hazardous material exhaust.
- B. Locate labels near points where ducts enter into concealed spaces and at maximum intervals of 20 feet in each space where ducts are exposed or concealed by removable ceiling system.
- C. Use painted duct labels outside where ductwork is exposed to weather.
 - 1. Apply one or two coats using the same stencil as required for thorough coverage.

3.05 DIFFUSER, REGISTER, GRILLE, AND TEMPERATURE SENSOR LABELS

- A. Install label on all diffusers, grilles, and registers with equipment identifier serving device.
- B. Install label on each temperature sensor or thermostat indicating unit controlled.

3.06 T-BAR LABEL INSTALLATION

- A. Install labels to locate, equipment, valves, or dampers above T-bar ceilings. Mark label with arrow to indicate corner of panel closest to item.
- B. Label Color Schedule:
 - 1. HVAC Equipment: Yellow.
 - 2. Combination Fire/Smoke Dampers: Red.
 - 3. HVAC Valves: Blue.

3.07 ENVIRONMENTAL DUCT LABEL INSTALLATION

- A. Install plastic-laminated or self-adhesive duct labels with permanent adhesive on supply, return, and exhaust air ducts.
- B. Locate labels near points where ducts enter or exit into concealed spaces and at maximum intervals of 20 feet in each space where ducts are exposed or concealed by removable ceiling.
- C. Use painted duct labels outside where ductwork is exposed to weather.
 - 1. Apply one or two coats using the same stencil as required for thorough coverage.

3.08 ADJUSTING AND CLEANING

- A. Relocate mechanical identification materials and devices that have become visually blocked by other work.
- B. Clean faces of mechanical identification devices.

END OF SECTION

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SECTION 23 05 93

TESTING, ADJUSTING & BALANCING FOR HVAC

PART 1 GENERAL

1.01 SUMMARY

- A. This section includes:
 - 1. Balancing Air Systems.
 - 2. Balancing Hydronic Systems.
 - 3. Balancing HVAC Equipment.
 - 4. Testing and Certifying the Proper Operation of Fire and Smoke Control Devices.

1.02 APPROVED CONTRACTORS

- A. Engage the services of one of the following:
 - 1. Able Balance, LLC.
 - 2. ABM Building Services, LLC., Phoenix, Arizona Balance Division.
 - 3. Arizona Air Balance Co.
 - 4. Phoenix Test and Balance, LLC.
 - 5. Precision Air.
 - 6. Southwest Testing and Balancing, LLC.
 - 7. Systems Commissioning & Testing, Inc.
 - 8. TAB Technology, Inc.
 - 9. Technical Air Balance.

1.03 DEFINITIONS

- A. AABC: Associated Air Balance Council.
- B. NEBB: National Environmental Balancing Bureau.
- C. TAB: Testing, adjusting, and balancing.
- D. TAB Specialist: An entity engaged to perform TAB work.

1.04 SUBMITTALS

- A. Contractor Qualifications: Include AABC or NEBB certificates for proposed personnel, test instrument certifications.
- B. Certified TAB reports.
- C. Sealed special inspection reports.

1.05 QUALITY ASSURANCE

- A. Supervising technicians and firm shall be AABC or NEBB certified.
- B. Certify TAB field data reports and perform the following:
 - 1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.

2. Certify that the TAB team complied with the TAB plan and the procedures specified and referenced in this Specification.
- C. TAB Report Forms: Use standard TAB Contractor's forms.
- D. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, Instrumentation.
- E. Perform special inspections as required herein and by the AHJ.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine the Contract Documents and approved submittals for the HVAC systems and equipment to become familiar with project requirements and to discover conditions in system designs that may preclude proper TAB of systems and equipment or inefficient operation. Report findings and recommendations directly to the Engineer within 30 days of document review.
- B. Examine equipment performance data including fan and pump curves. Relate performance data to project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
- C. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, filters are clean and in place, and equipment with functioning controls is ready for operation.
- D. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.
- E. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- F. Examine system pumps to ensure absence of entrained air in the suction piping.
- G. Examine operating safety interlocks and controls on HVAC equipment.
- H. Report deficiencies discovered before and during performance of TAB procedures directly to the Engineer and Mechanical Contractor. Observe and record system reactions to changes in conditions. Record default setpoints if different from indicated values.
- I. The General or Mechanical Contractor shall not in any way prohibit the TAB Contractor from communicating directly and freely with the Engineer. The TAB Contractor is required to copy the Engineer on all communications to the Contractor.

3.02 PREPARATION

- A. Prepare a TAB plan that includes strategies and step-by-step procedures.

- B. Complete system-readiness checks and prepare reports. Verify the following:
 - 1. Permanent electrical-power wiring is complete.
 - 2. Hydronic systems are filled, clean, and free of air.
 - 3. Automatic temperature-control systems are operational.
 - 4. Equipment and duct access doors are securely closed.
 - 5. Balance, smoke, and fire dampers are open.
 - 6. Isolating and balancing valves are open and control valves are operational.
 - 7. Hydronic systems are at operating temperature.
 - 8. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
 - 9. Windows and doors can be closed so indicated conditions for system operations can be met.

3.03 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's National Standards for Total System Balance or NEBB's Procedural Standards for Testing Adjusting and Balancing of Environmental Systems, and in this section.
 - 1. Comply with requirements in ASHRAE 62.1, Section 7.2.2, Air Balancing.
- B. Cut insulation and ducts for installation of test probes to the minimum extent necessary for TAB procedures.
 - 1. After testing and balancing, patch probe holes in ducts airtight.
 - 2. Coordinate with the Mechanical Contractor to restore insulation, coverings, vapor barrier, and finish according to Division 23 sections.
- C. Mark equipment and balancing devices, including damper-control positions, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

3.04 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Cross-check the summation of required outlet volumes with required fan volumes. Correct variations that exceed $\pm 10\%$.
- B. Determine the best locations in main and branch ducts for accurate duct airflow measurements.
- C. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.
- D. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- E. Verify that motor starters are equipped with properly sized thermal protection.
- F. Check dampers for proper position to achieve desired airflow path.
- G. Check for airflow blockages.
- H. Check condensate drains for proper connections.
- I. Check for proper sealing of air-handling-unit components.

- J. Verify that joints and seams in air duct systems are sealed as specified in Division 23 sections.

3.05 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by the fan manufacturer.
 - 1. Measure Total Airflow: Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.
 - 2. Measure fan static pressures as follows to determine actual static pressure:
 - a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
 - b. Measure static pressure directly at the fan outlet or through the flexible connection.
 - c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.
 - d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
 - 3. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment. Exception: Individual component measurement is not required for unitary equipment 5 tons and less in capacity. Provide external static pressure measurement across unit only.
 - a. Report the cleanliness status of filters and the time static pressures are measured.
 - 4. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.
 - 5. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
 - 6. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.
 - 7. Instruct the Mechanical Contractor to replace fan and motor sheaves and belts as required to achieve design airflow or pressurization.
- B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.
 - 1. Measure airflow of submain and branch ducts.
 - a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
 - 2. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.
 - 3. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.
 - 4. Instruct the Mechanical Contractor to install manual volume dampers where required to achieve proper air balance.

- C. Measure air outlets and inlets without making adjustments.
 - 1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.
- D. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.
 - 1. Adjust each outlet in the same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
 - 2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.06 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

- A. Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at minimum setpoint airflow with the remainder at maximum airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced-airflow terminal units from the terminal units closest to the air handling unit.
- B. Pressure-Independent, Variable-Air-Volume Systems: Adjust the variable-air-volume systems as follows:
 - 1. Set outdoor-air dampers at minimum-minimum, and set return- and relief-air dampers at a position that simulates full-cooling load.
 - 2. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
 - 3. Measure total system airflow. Adjust to within indicated airflow.
 - 4. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use terminal-unit manufacturer's written instructions to make this adjustment. When total terminal unit airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.
 - 5. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow the same as described for constant-volume air systems.
 - a. If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.
 - 6. Measure static pressure at the most critical terminal unit and set the supply duct static-pressure control setpoint in the building control system to ensure that adequate static pressure is maintained at the most critical unit. Set and record maximum speed of supply fan VFD to not exceed this speed.
 - 7. With supply fan operating at scheduled airflow, adjust the return fan speed to scheduled airflow. On ducted return systems, balance the return-air ducts and inlets as described for constant-volume air systems. Set and record maximum speed of return fan VFD to not exceed this speed.
 - 8. Confirm that the outdoor-air damper minimum-minimum and maximum-minimum positions are properly set and maintained throughout the operating range of the supply fan.
 - 9. Measure and record the following airflows and airflow measuring station readings with supply fan operating at 100% and 50% speeds: Supply air, return air, outdoor air.
 - 10. Calibrate misreading airflow measuring stations.
 - 11. Record final supply and return fan-performance data.

3.07 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

- A. Prepare test reports with pertinent design data, and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against the approved pump flow rate. Correct variations that exceed $\pm 5\%$.
- B. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:
 - 1. Open all manual valves for maximum flow.
 - 2. Check pressure in expansion tank.
 - 3. Check makeup water-station pressure gage for adequate pressure for highest vent.
 - 4. Check flow-control valves for specified sequence of operation, and set at indicated flow. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.
 - 5. Set differential-pressure control valves as directed by the valve manufacturer to maintain the required downstream differential pressure.
 - 6. Set system controls so automatic valves are wide open to heat exchangers.
 - 7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
 - 8. Check air vents for a forceful liquid flow exiting from vents when manually operated.

3.08 PROCEDURES FOR CONSTANT-FLOW HYDRONIC SYSTEMS

- A. Measure waterflow at pumps. Use the following procedures except for positive-displacement pumps:
 - 1. Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
 - a. Impeller sizes must be adjusted to achieve pump performance, if the flow exceeds 130% of the design flow. Impeller is to be trimmed by the pump manufacturer at no additional cost to the Owner.
 - 2. Check system resistance. With all valves open and pump at full speed, read pressure differential across the pump and mark pump manufacturer's head-capacity curve.
 - a. Pumps with VFD: Adjust VFD speed until indicated waterflow is achieved.
 - 1) Set maximum VFD output for indicated pump flow.
 - 2) Set minimum VFD output at 18 Hz.
 - 3) Place label on VFD stating, "Do not adjust maximum or minimum VFD speed settings. These were set by the TAB Contractor for proper pump flow on (mm/dd/yyyy)."
 - 4) Do not use pump discharge valve to balance pumps with VFD.
 - b. Pump without VFD: Adjust pump discharge valve until indicated waterflow is achieved.
 - c. Monitor motor performance during procedures and do not operate motors in overload conditions.
 - 3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
 - 4. Report flow rates that are not within $\pm 10\%$ of design.
- B. Measure flow at all automatic flow control valves to verify that valves are functioning as designed.

- C. Measure flow at all pressure-independent characterized control valves, with valves in fully open position, to verify that valves are functioning as designed.
- D. Set calibrated balancing valves, if installed, at calculated presetsings.
- E. Measure flow at all stations and adjust, where necessary, to obtain first balance.
 - 1. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.
- F. Measure flow at main balancing station and set main balancing device to achieve flow that is 5% greater than indicated flow.
- G. Adjust balancing stations to within specified tolerances of indicated flow rate as follows:
 - 1. Determine the balancing station with the highest percentage over indicated flow.
 - 2. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.
 - 3. Record settings and mark balancing devices.
- H. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and system pressures and temperatures including outdoor-air temperature.
- I. Measure and record the differential-pressure-control-valve settings at the conclusion of balancing.
- J. Check settings and operation of each safety valve. Record settings.

3.09 PROCEDURES FOR MOTORS

- A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
 - 1. Manufacturer's name, model number, and serial number.
 - 2. Motor horsepower rating.
 - 3. Motor rpm.
 - 4. Efficiency rating.
 - 5. Nameplate and measured voltage, each phase.
 - 6. Nameplate and measured amperage, each phase.
 - 7. Starter thermal-protection-element rating.
- B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Set minimum motor speed to 20%. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

3.10 PROCEDURES FOR CHILLERS

- A. Balance waterflow through each evaporator to within specified tolerances of indicated flow with all pumps operating. Measure and record the following data with each chiller operating at design conditions:
 - 1. Evaporator-water entering and leaving temperatures, pressure drop, and waterflow.
 - 2. Evaporator and condenser refrigerant temperatures and pressures, using instruments furnished by the chiller manufacturer.
 - 3. Power factor if factory-installed instrumentation is furnished for measuring kilowatts.

4. Kilowatt input if factory-installed instrumentation is furnished for measuring kilowatts.
5. Capacity: Calculate in tons of cooling.
6. For air-cooled chillers, verify condenser-fan rotation and record fan and motor data including number of fans and entering- and leaving-air temperatures.

3.11 PROCEDURES FOR CONDENSING UNITS

- A. Verify proper rotation of fans.
- B. Measure entering- and leaving-air temperatures.
- C. Record compressor data.

3.12 PROCEDURES FOR HEAT-TRANSFER COILS

- A. Measure, adjust, and record the following data for each water coil:
 1. Entering- and leaving-water temperature.
 2. Waterflow rate.
 3. Water pressure drop.
 4. Dry-bulb temperature of entering and leaving air.
 5. Wet-bulb temperature of entering and leaving air for cooling coils.
 6. Airflow.
 7. Air pressure drop.
- B. Measure, adjust, and record the following data for each electric heating coil:
 1. Nameplate data.
 2. Airflow.
 3. Entering- and leaving-air temperature at full load.
 4. Voltage and amperage input of each phase at full load and at each incremental stage.
 5. Calculated kilowatt at full load.
 6. Fuse or circuit-breaker rating for overload protection.
- C. Measure, adjust, and record the following data for each refrigerant coil:
 1. Dry-bulb temperature of entering and leaving air.
 2. Wet-bulb temperature of entering and leaving air.
 3. Airflow.
 4. Air pressure drop.

3.13 PROCEDURES FOR TESTING FIRE AND SMOKE CONTROL DEVICES

- A. Record manufacturer and model number for each fire damper, smoke detector, smoke damper, combination fire/smoke damper, and damper actuator.
- B. Confirm access door has been installed at each damper location and is properly labeled.
- C. Fire Dampers:
 1. Disconnect the fusible link and confirm that damper closes smoothly and completely.
 2. Reset the damper and replace the fusible link.
- D. Duct-Mounted Smoke Detectors:
 1. Verify the proper operation of the smoke detector using a test gas, "canned smoke," acceptable to the AHJ or Engineer. (Magnets are not acceptable.)

2. Verify activation of the smoke detector closes the appropriate smoke or combination fire/smoke damper(s) and/or de-energizes the appropriate air-moving device(s).
 3. Verify activation of the smoke detector is shown by the fire alarm system where monitoring of the detector is required.
- E. Smoke and Combination Fire/Smoke Dampers: Verify dampers controlled by a Total Coverage Smoke Detection System operate correctly on a signal from the system.
- F. Air-Moving Device Shutdown: Verify air-moving device(s) that are to be de-energized by a Total Coverage Smoke Detection System de-energize on a signal from the system.
- G. After all smoke control devices have been successfully tested, the TAB firm shall engage the services of a professional mechanical engineer, registered in the State of Arizona, to submit a signed and sealed report attesting to the proper operation of the smoke control devices and air-moving device shutdowns.

3.14 PROCEDURES FOR VERIFICATION OF HVAC SYSTEM INTERLOCKS

- A. Test and verify that interlocks between make-up air and exhaust air systems function correctly and do not allow the exhaust system to operate without the make-up air system in operation.
1. Verify that all control components are installed in accordance with project requirements.
 2. Test the interlocks between the equipment to confirm that fans operate according to the sequence of controls on the drawings.

3.15 PROCEDURES FOR FUME HOOD TESTING

- A. The TAB Specialist shall test and adjust fume hoods to assure adequate, undisturbed airflow through the hood as follows:
1. Test and adjust VAV controllers to obtain design exhaust airflows and make-up airflows, to maintain design hood pressures and face velocities and design room pressurization.
 2. Position the sash so that the fume hood opening is 18 inches. Puff smoke around the opening of the hood using a ventilation smoke tube or similar device. Smoke should enter the hood. If smoke comes out of the hood locate source of air disturbance and correct.
 3. Divide the fume hood opening into nine equal areas. Measure and record the velocity of the air at the center of each of the nine areas. Adjust the airflow through the hood to provide a minimum average face velocity of 100 fpm but no more than 120 fpm.
 4. Position the sash at a 6-inch open position. Divide the fume hood opening into three equal areas. Measure and record the velocity of the air at the center of each of the three squares. Adjust the airflow through the hood to provide a minimum average face velocity of 100 fpm but no more than 120 fpm.

3.16 PROCEDURES FOR TESTING BUILDING/ZONE PRESSURIZATION

- A. Test and adjust building/zone pressurization by adjusting airflows to meet the required flow direction and pressure differential indicated on the drawings.
1. For positive pressure areas, set the supply air to design flow and gradually reduce the exhaust air rate to obtain the required flow or pressure difference.
 2. For negative pressure areas, set the supply air to design flow and gradually increase the exhaust air rate to obtain the required flow or pressure difference.

3.17 TOLERANCES

- A. Set HVAC system's airflow and waterflow rates within the following tolerances:
 - 1. Supply, Return, and Exhaust Fans and Equipment with Fans: $\pm 10\%$.
 - 2. Air Outlets and Inlets: $\pm 10\%$.
 - 3. Waterflow Rate: $\pm 5\%$.

3.18 REPORTING

- A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in the Examination article, prepare a report on the adequacy of design for system balancing devices. Recommend changes and additions to system balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

3.19 OUTDOOR AIR SUMMARY REPORT

- A. Prepare a summary report for review by the AHJ that lists each supply-air system on the project. The report shall indicate the system or equipment designation, the scheduled outdoor-airflow rate and the balanced outdoor-airflow rate.

3.20 SPECIAL INSPECTIONS

- A. Prepare special inspection reports, signed and sealed by a professional engineer, as required by the AHJ or as required above.

3.21 FINAL REPORT

- A. General: Prepare certified reports in both paper and PDF format; tabulate and divide the report into separate sections for tested systems and balanced systems. Submit three copies of paper reports and one copy of report in PDF format.
 - 1. Assemble paper reports in 3-ring binders. Separate and order sections within each binder. Provide labeled tabs at each section with a table of contents at the front of the binder. The table of contents shall indicate the tab number and the information contained at that tab.
 - 2. Assemble PDF report in one PDF file. Separate and order sections within the file to match the paper copy. Provide bookmarks at the first page of each section and label each bookmark with the information contained in that section. Submit on digital media acceptable to the Engineer.
- B. Final Report Contents: In addition to certified field-report data, include the following:
 - 1. Pump curves.
 - 2. Fan curves.
 - 3. Other information relative to equipment performance; do not include shop drawings and product data.
- C. General Report Data: In addition to form titles and entries, include the following data:
 - 1. Title page.
 - 2. Name and address of the TAB Contractor.
 - 3. Project name.
 - 4. Project location.
 - 5. Architect's name and address.
 - 6. Engineer's name and address.
 - 7. Contractor's name and address.

8. Report date.
9. Signature of TAB supervisor who certifies the report.
10. Certification sheet signed and sealed by the certified Testing & Balancing Engineer.
11. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
12. Summary of contents including the following:
 - a. Indicated versus final performance.
 - b. Notable characteristics of systems.
 - c. Description of system operation sequence if it varies from the Contract Documents.
13. Nomenclature sheets for each item of equipment.
14. Data for terminal units, including manufacturer's name, type, size, and fittings.
15. Notes to explain why certain final data in the body of reports vary from indicated values.
16. Test conditions for fans and pump performance forms including the following:
 - a. Settings for outdoor-, return-, and exhaust-air dampers.
 - b. Conditions of filters.
 - c. Cooling coil, wet- and dry-bulb conditions.
 - d. Face and bypass damper settings at coils.
 - e. Fan drive settings including settings and percentage of maximum pitch diameter.
 - f. Variable frequency drive settings including maximum and minimum setpoints.
 - g. Inlet vane settings for variable-air-volume systems.
 - h. Settings for supply-air, static-pressure controller.
 - i. Other system operating conditions that affect performance.
17. Include a list of instruments used for procedures, along with proof of calibration.
18. Submit a preliminary, electronic copy of the final report to the Engineer for review.
19. Make any corrections noted from the Engineer's review upon receipt of comments and resubmit as required.
20. Submit the final, corrected report in electronic format to the Engineer and in both paper and electronic format to the Architect.

3.22 ADDITIONAL TESTS

- A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.
- B. TAB Report Verification: The TAB Specialist may be required to recheck, in the presence of the Owner's representative, specific or random selections of data recorded in the certified report. Points and areas for recheck shall be selected by the Owner's representative. Measurements and test procedures shall be the same as approved for the initial work for the certified report. Selections for verification, specific plus random, will not exceed 10% of the total number of measurements tabulated in the report. If the values measured during the verification process exceed $\pm 10\%$ of the values recorded in the report, the TAB Specialist may be required to re-perform the TAB work outlined above.

END OF SECTION

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SECTION 23 07 13

DUCT INSULATION

PART 1 GENERAL

1.01 SUMMARY

- A. This section includes duct exterior insulation systems.
- B. Related Sections:
 - 1. Refer to Specification Section 23 31 13, Metal Ducts, for duct liner.

1.02 SUBMITTALS

- A. Product Data: For each type of product indicated, include manufacturer's technical data with proposed thickness and R-value indicated, and application.

1.03 QUALITY ASSURANCE

- A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E84, by a testing agency acceptable to the Authorities Having Jurisdiction (AHJ). Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

PART 2 PRODUCTS

2.01 INSULATION MATERIALS

- A. Comply with requirements in the Duct Insulation Schedule article for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C795.
- E. All materials shall conform to NFPA 90A and NFPA 90B, ASHRAE 90.1 and the International Energy Construction Code (IECC).
- F. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- G. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C553, Type II and ASTM C1290, Type III with factory-applied FSK

jacket composed of aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type II.

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Bonded Logic Ultra-Touch.
 - b. CertainTeed Corp.; SoftTouch Duct Wrap.
 - c. Johns Manville; Microlite.
 - d. Knauf Insulation; Atmosphere Duct Wrap.
 - e. Manson Insulation Products Ltd.; Alley Wrap.
 - f. Owens Corning; SOFTR All-Service Duct Wrap.
- H. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C612, Type IA or Type IB with factory-applied ASJ or FSK jacket.
 1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
 2. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type II.
 3. Products: Subject to compliance with requirements, provide one of the following:
 - a. Bonded Logic Ultra-Touch.
 - b. CertainTeed Corp.; Commercial Board.
 - c. Johns Manville; 800 Series Spin-Glas.
 - d. Knauf Insulation; Earthwool Insulation Board.
 - e. Owens Corning; Fiberglas 700 Series.

2.02 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
- B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
 1. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
 1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- D. PVC Jacket Adhesive: Compatible with PVC jacket.
 1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.03 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
 1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below and above ambient services.
 1. Water-Vapor Permeance: ASTM E96/E96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
 2. Service Temperature Range: -20 to +180°F.
 3. Solids Content: ASTM D1644, 58% by volume and 70% by weight.
 4. Color: White.

2.04 SEALANTS

- A. FSK and Metal Jacket Flashing Sealants:
 - 1. Materials shall be compatible with insulation materials, jackets, and substrates.
 - 2. Fire- and water-resistant, flexible, elastomeric sealant.
 - 3. Service Temperature Range: -40 to +250°F.
 - 4. Color: Aluminum.
 - 5. For indoor applications, use sealants that have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. ASJ Flashing Sealants, and Vinyl and PVC Jacket Flashing Sealants:
 - 1. Materials shall be compatible with insulation materials, jackets, and substrates.
 - 2. Fire- and water-resistant, flexible, elastomeric sealant.
 - 3. Service Temperature Range: -40 to +250°F.
 - 4. Color: White.

2.05 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C921, Type I, unless otherwise indicated.
- B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
 - 1. Adhesive: As recommended by the jacket material manufacturer.
 - 2. Color: White.
- C. Aluminum Jacket: Comply with ASTM B209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
 - 1. Sheet and roll stock ready for shop or field sizing or factory cut and rolled to size.
 - 2. Finish and thickness are indicated in field-applied jacket schedules.
 - 3. Moisture Barrier: 3-mil-thick, heat-bonded polyethylene and kraft paper or 2.5-mil-thick polysurlyn.
- D. Self-Adhesive Outdoor Jacket: 60-mil-thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a cross-laminated polyethylene film covered with stucco-embossed aluminum-foil facing.

2.06 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.
 - 1. Width: 3 inches.
 - 2. Thickness: 11.5 mils.
 - 3. Adhesion: 90 ounces force/inch in width.
 - 4. Elongation: 2%.
 - 5. Tensile Strength: 40 lbf/inch in width.
 - 6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C1136.
 - 1. Width: 3 inches.
 - 2. Thickness: 6.5 mils.
 - 3. Adhesion: 90 ounces force/inch in width.
 - 4. Elongation: 2%.

5. Tensile Strength: 40 lbf/inch in width.
 6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
- C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
1. Width: 2 inches.
 2. Thickness: 6 mils.
 3. Adhesion: 64 ounces force/inch in width.
 4. Elongation: 500%.
 5. Tensile Strength: 18 lbf/inch in width.
- D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
1. Width: 2 inches.
 2. Thickness: 3.7 mils.
 3. Adhesion: 100 ounces force/inch in width.
 4. Elongation: 5%.
 5. Tensile Strength: 34 lbf/inch in width.

2.07 SECUREMENTS

- A. Aluminum Bands: ASTM B209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide, with wing seal or closed seal.
- B. Stainless-Steel Bands: 0.015 inch thick, 1/2 inch wide, with wing seal or closed seal.
- C. Insulation Pins and Hangers:
1. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030" thick x 2" square.
 - b. Spindle: Copper- or zinc-coated, low carbon-steel, or stainless-steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
 - c. Adhesive: Recommended by the hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
 2. Metal, Capacitor-Discharge-Weld Pin, Insulation Hangers: Copper-coated, low carbon-steel, or stainless-steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated. May be provided with base.
 3. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, galvanized or stainless-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
 - a. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
 4. Metal, Cupped-Head, Capacitor-Discharge-Weld Pins:
 - a. Head: Galvanized, carbon-steel or stainless-steel sheet, minimum of 0.016 inch thick with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
 - b. Spindle: Copper- or zinc-coated, low carbon-steel, or stainless-steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
- D. Staples: Outward-clinching insulation staples, nominal 3/4 inch wide, stainless steel or Monel.

- E. Wire: 0.062-inch, soft-annealed stainless steel.

2.08 CORNER ANGLES

- A. PVC Corner Angles: 30 mils thick, minimum 1" x 1" PVC according to ASTM D1784, Class 16354-C. White or color-coded to match adjacent surface.
- B. Aluminum Corner Angles: 0.040 inch thick, minimum 1" x 1" aluminum according to ASTM B209, Alloy 3003, 3005, 3105, or 5005; Temper H-14.

PART 3 EXECUTION

3.01 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.02 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.
- B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Keep insulation materials dry during application and finishing.
- G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by the insulation material manufacturer.
- H. Install insulation with least number of joints practical.
- I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by the insulation material manufacturer.
- J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

- K. Install insulation with factory-applied jackets as follows:
1. Draw jacket tight and smooth.
 2. Cover circumferential joints with 3-inch-wide strips, of the same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
 - a. For below ambient services, apply vapor-barrier mastic over staples.
 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.
- L. Cut insulation in a manner to avoid compressing insulation more than 75% of its nominal thickness.
- M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- N. Repair damaged insulation facings by applying the same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.03 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends below roof surface. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends inside building. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
 4. Seal jacket to wall flashing with flashing sealant.
- C. Insulation Installation at Interior Wall and Partition Penetrations (that are Not Fire Rated): Install insulation continuously through walls and partitions.
- D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.
1. Comply with requirements in Division 07 specifications for firestopping and fire-resistive joint sealers.

- E. Insulation Installation at Floor Penetrations:
1. Duct: For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.
 2. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 specifications.

3.04 INSTALLATION OF MINERAL-FIBER INSULATION

- A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100% coverage of duct and plenum surfaces.
 2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
 3. Install either adhesively attached or capacitor-discharge-weld pins and speed washers, or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
 - b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not overcompress insulation during installation.
 - e. Impale insulation over pins and attach speed washers.
 - f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
 4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
 - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
 - b. Install vapor stops for ductwork and plenums operating below 50°F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness, but not less than 3 inches.
 5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
 6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
 7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of the same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

- B. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100% coverage of duct and plenum surfaces.
 2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
 3. Install either adhesively attached or capacitor-discharge-weld pins and speed washers, or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
 - b. On duct sides with dimensions larger than 18 inches, space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not overcompress insulation during installation.
 - e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
 4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
 - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
 - b. Install vapor stops for ductwork and plenums operating below 50°F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness, but not less than 3 inches.
 5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
 6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of the same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.05 FIELD-APPLIED JACKET INSTALLATION

- A. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.
1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- B. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by the insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

1. Cross-break or slope the top of all metal jackets mounted outside the building to promote drainage and to prevent ponding of water on top of the ductwork.

3.06 DUCT INSULATION SCHEDULE

- A. Duct, Plenums and Accessories Not Requiring Insulation:
 1. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1. Refer to Specification Section 23 31 13, Metal Ducts, for duct lining requirements.
 2. Factory-insulated flexible ducts.
 3. Factory-insulated plenums and casings.
 4. Flexible connectors.
 5. Vibration-control devices.
 6. Factory-insulated access panels and doors.
- B. Duct and Plenum Insulation: Insulate ducts and plenums in accordance with the Duct and Plenum Insulation Schedule Table.

DUCT & PLENUM INSULATION SCHEDULE TABLE					
Duct/Plenum System	Duct Type	Duct Location*	Insulation Type	Minimum Insulation Density (PCF)	Minimum Insulation R-Value (Thickness)
Supply	Round/Rectangular	Interior, Concealed	Mineral-Fiber Blanket	0.75	R-6 (2 inches)
Supply (downstream of HEPA filters)	Rectangular	Interior, Concealed	Duct Lining* and Mineral-Fiber Blanket	0.75	R-6 (2 inches)
Exhaust (upstream of energy recovery coils)	Round/Rectangular	Exterior, Exposed	Mineral-Fiber Board	1.5	R-8 (2 inches)
* Refer to Specification Section 23 31 13, Metal Ducts, for liner requirements. ** Interior means within the insulated building envelope. Exterior means outside the building envelope.					

3.07 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is the Contractor's option.
- C. Ducts and Plenums, Concealed: None.
- D. Externally Insulated Ducts and Plenums, Exposed:
 1. Aluminum, Stucco Embossed: 0.020 inch thick, where ductwork is less than 96 inches above finished floor.
 2. PVC: 20 mils.

3.08 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is the Contractor's option.

- C. Ducts and Plenums, Concealed: None.
- D. Ducts and Plenums, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches:
 - 1. Aluminum, Stucco Embossed: 0.020 inch thick.
- E. Ducts and Plenums, Exposed, Larger than 48 Inches in Diameter or with Flat Surfaces Larger than 72 Inches:
 - 1. Aluminum, Stucco Embossed with 1-1/4-Inch-Deep Corrugations: 0.040 inch thick.

END OF SECTION

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SECTION 23 07 19

HVAC PIPING INSULATION

PART 1 GENERAL

1.01 SUMMARY

- A. This section includes insulating the following HVAC piping systems:
 - 1. Chilled-water and energy recovery water piping.
 - 2. Condensate drain piping.
 - 3. Make-up water piping.

1.02 SUBMITTALS

- A. Product Data: For each type of product indicated, include manufacturer's technical data with proposed thickness and R-value indicated, and application.

1.03 QUALITY ASSURANCE

- A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E84, by a testing and inspecting agency acceptable to the Authorities Having Jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

PART 2 PRODUCTS

2.01 INSULATION MATERIALS

- A. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- B. All insulating materials shall conform to NFPA 90A and NFPA 90B, ASHRAE 90.1 and the International Energy Construction Code (IECC).
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C534, Type I for tubular materials.
 - 1. Manufacturers: Subject to compliance with requirements, provide product by one of the following manufacturers:
 - a. Armacell LLC.

b. K-Flex USA

G. Mineral-Fiber Insulation:

1. Manufacturers: Subject to compliance with requirements, provide product by one of the following manufacturers:
 - a. CertainTeed Corp.
 - b. Johns Manville.
 - c. Knauf Insulation.
 - d. Manson Insulation Products Ltd.
 - e. Owens Corning.
2. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C1290, Type I.
3. Mineral-Fiber, Pre-Formed Pipe Insulation:
 - a. Type I, 850°F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C547, Type I, Grade A, with factory-applied ASJ or with factory-applied ASJ-SSL. Omit jacket on all but outermost layer where multiple insulation layers are required. Jacket shall comply with the following:
 - 1) ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
 - 2) ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.

H. Removable Insulation Wrap:

1. Manufacturers: Subject to compliance with requirements, provide product by the following: No Sweat.
2. Removable Insulation Wrap:
 - a. Insert: Mineral or glass fibers bonded with a thermosetting resin with a minimum K-factor of 0.26 suitable for use up to 450°F. Maximum flame spread index of 25 and maximum smoke developed index of 50 per ASTM E84. Insert thickness to match thickness of adjacent insulation.
 - b. Outer Jacket: Tychem wrap consisting of Tyvek fabric made of spunbonded polyolefin with a polyethylene coating to limit vapor permeability. Jacket shall be provided with elastic banding at the ends and a reclosable hook and loop closure system at the seam. Maximum flame spread index of 25 and maximum smoke developed index of 50 per ASTM E84.

2.02 INSULATING CEMENTS

- A. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C449.

2.03 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
1. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.
- C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

- D. ASJ Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
- E. PVC Jacket Adhesive: Compatible with PVC jacket.

2.04 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
 - 1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.
 - 1. Water-Vapor Permeance: ASTM E96/E96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
 - 2. Service Temperature Range: -20 to +180°F.
 - 3. Solids Content: ASTM D1644, 58% by volume and 70% by weight.
 - 4. Color: White.
- C. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.
 - 1. Water-Vapor Permeance: ASTM F1249, 1.8 perms at 0.0625-inch dry film thickness.
 - 2. Service Temperature Range: -20 to +180°F.
 - 3. Solids Content: 60% by volume and 66% by weight.
 - 4. Color: White.

2.05 SEALANTS

- A. Joint Sealants:
 - 1. For indoor applications, use sealants that have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Materials shall be compatible with insulation materials, jackets, and substrates.
 - 3. Permanently flexible, elastomeric sealant.
 - 4. Service Temperature Range: -100 to +300°F.
 - 5. Color: White or gray.
- B. Metal Jacket Flashing Sealants:
 - 1. Materials shall be compatible with insulation materials, jackets, and substrates.
 - 2. Fire- and water-resistant, flexible, elastomeric sealant.
 - 3. Service Temperature Range: -40 to +250°F.
 - 4. Color: Aluminum.
- C. ASJ Flashing Sealants and PVC Jacket Flashing Sealants:
 - 1. Materials shall be compatible with insulation materials, jackets, and substrates.
 - 2. Fire- and water-resistant, flexible, elastomeric sealant.
 - 3. Service Temperature Range: -40 to +250°F.
 - 4. Color: To match jacket.

2.06 FIELD-APPLIED FABRIC-REINFORCING MESH

- A. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in., in a Leno weave, for pipe.

2.07 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C921, Type I, unless otherwise indicated.
- B. Aluminum Jacket: Comply with ASTM B209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
 - 1. Sheet and roll stock ready for shop or field sizing, or factory cut and rolled to size.
 - 2. Finish and thickness are indicated in field-applied jacket schedules.
 - 3. Moisture Barrier for Indoor and Outdoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.
 - 4. Factory-Fabricated Fitting Covers:
 - a. The same material, finish, and thickness as jacket.
 - b. Pre-formed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
 - c. Tee covers.
 - d. Flange and union covers.
 - e. End caps.
 - f. Beveled collars.
 - g. Valve covers.
 - h. Field fabricate fitting covers only if factory-fabricated fitting covers are not available.
- C. Self-Adhesive Outdoor Jacket: 60-mil-thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a cross-laminated polyethylene film covered with stucco-embossed aluminum-foil facing.

2.08 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.
 - 1. Width: 3 inches.
 - 2. Thickness: 11.5 mils.
 - 3. Adhesion: 90 ounces force/inch in width.
 - 4. Elongation: 2%.
 - 5. Tensile Strength: 40 lbf/inch in width.
 - 6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
 - 1. Width: 2 inches.
 - 2. Thickness: 3.7 mils.
 - 3. Adhesion: 100 ounces force/inch in width.
 - 4. Elongation: 5%.
 - 5. Tensile Strength: 34 lbf/inch in width.

2.09 SECUREMENTS

- A. Aluminum Bands: ASTM B209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing seal or closed seal.
- B. Staples: Outward-clinching insulation staples, nominal 3/4 inch wide, stainless steel or Monel.
- C. Wire: 0.062-inch, soft-annealed stainless steel.

PART 3 EXECUTION

3.01 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.02 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by the insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Install insulation continuously through hangers and around anchor attachments.
- K. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by the insulation material manufacturer.
- L. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- M. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
- N. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

- O. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth.
 - 2. Cover circumferential joints with 3-inch-wide strips, of the same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 - 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
 - a. For below-ambient services, apply vapor-barrier mastic over staples.
 - 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
 - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
- P. Cut insulation in a manner to avoid compressing insulation more than 75% of its nominal thickness.
- Q. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- R. Repair damaged insulation facings by applying the same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- S. For above-ambient services, do not install insulation to the following:
 - 1. Items where insulation is prohibited by the manufacturer.
 - 2. Testing agency labels and stamps.
 - 3. Nameplates and data plates.
 - 4. Manholes.
 - 5. Handholes.
 - 6. Cleanouts.

3.03 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends below roof surface. Seal joint with joint sealant.
 - 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
 - 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
- C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends inside building. Seal joint with joint sealant.

3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
 4. Seal jacket to wall flashing with flashing sealant.
- D. Insulation Installation at Interior Wall and Partition Penetrations (that are Not Fire Rated): Install insulation continuously through walls and partitions.
- E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
1. Comply with requirements in Division 07 specifications for firestopping and fire-resistive joint sealers.
- F. Insulation Installation at Floor Penetrations:
1. Pipe: Install insulation continuously through floor penetrations.
 2. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 specifications for firestopping and fire-resistive joint sealers.
- G. Installation of Pipe Hangers and Rollers:
1. Install thermal-hanger shield inserts complying with Specification Section 23 05 29, Hangers and Supports for HVAC Piping and Equipment, at all hangers and rollers.

3.04 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
 2. Insulate pipe elbows using pre-formed fitting insulation or mitered fittings made from the same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
 3. Insulate tee fittings with pre-formed fitting insulation or sectional pipe insulation of the same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 4. Insulate valves using pre-formed fitting insulation or sectional pipe insulation of the same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
 5. Insulate strainers using pre-formed fitting insulation or sectional pipe insulation of the same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.

6. Insulate flanges and unions using a section of oversized pre-formed pipe insulation. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
 7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
 8. For services not specified to receive a field-applied jacket except for flexible elastomeric, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
 9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.
 10. Contractor's Option for Valves, Strainers and Coil Connection Kits: Removable insulation wrap system.
 - a. Below Ambient Systems or Where a Vapor Barrier is Specified:
 - 1) Provide PVC tape around ends of wrap system to seal wrap to adjacent pipe insulation.
 - 2) Provide PVC tape closure along seam. Center tape to overlap seam.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers at locations indicated and where required for maintenance. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of the same thickness as that on adjoining pipe. Install the same insulation jacket as adjoining pipe insulation.
 2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union at least 2 times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
 3. Construct removable valve insulation covers in the same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
 4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
 5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.05 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- B. Insulation Installation on Pipe Flanges:
 1. Install pipe insulation to outer diameter of pipe flange.

2. Make width of insulation section the same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of the same thickness as pipe insulation.
 4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- C. Insulation Installation on Pipe Fittings and Elbows:
1. Install mitered sections of pipe insulation.
 2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- D. Insulation Installation on Valves and Pipe Specialties:
1. Install pre-formed valve covers manufactured of the same material as pipe insulation when available.
 2. When pre-formed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 3. Install insulation to flanges as specified for flange insulation application.
 4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- E. Insulation Installation on Flexible Bellow Connectors and Flexible Hoses:
1. Install full and mitered sections of pipe insulation as required.
 2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.06 INSTALLATION OF MINERAL-FIBER PRE-FORMED PIPE INSULATION

- A. Insulation Installation on Straight Pipes and Tubes:
1. Secure each layer of pre-formed pipe insulation without jacket to pipe with wire or bands and tighten bands without deforming insulation materials.
 2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
 3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches o.c.
 4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by the insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.
- B. Insulation Installation on Pipe Flanges:
1. Install pre-formed pipe insulation to outer diameter of pipe flange.
 2. Make width of insulation section the same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
 4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

- C. Insulation Installation on Pipe Fittings and Elbows:
 - 1. Install pre-formed sections of the same material as straight segments of pipe insulation when available.
 - 2. When pre-formed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.
- D. Insulation Installation on Valves and Pipe Specialties:
 - 1. Install pre-formed sections of the same material as straight segments of pipe insulation when available.
 - 2. When pre-formed sections are not available, install mitered sections of pipe insulation to valve body.
 - 3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 - 4. Install insulation to flanges as specified for flange insulation application.

3.07 FIELD-APPLIED JACKET INSTALLATION

- A. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal seams and end joints with weatherproof sealant recommended by the insulation manufacturer or if no sealant is recommended with silicone caulk. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.08 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable pre-formed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is the Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on pre-insulated underground piping.

3.09 INDOOR PIPING INSULATION SCHEDULE

- A. Make-Up Water Piping: Insulation shall be the following:
 - 1. Mineral-Fiber, Pre-Formed Pipe, Type I:
 - a. 1 inch thick for piping 1-1/2 inches and smaller; 1-1/2 inches thick for piping larger than 1-1/2 inches.

3.10 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

- A. Chilled Water and Energy Recovery Water:
 - 1. Insulation shall have a maximum K-factor of 0.27 at a mean rating temperature of 75°F and be one of the following:
 - a. Flexible Elastomeric: 1 inch thick for piping less than 1-1/2 inches; Do not use on piping 1-1/2 inches and larger.
 - b. Mineral-Fiber Pre-Formed, Type I: 1 inch thick for pipe less than 1-1/2 inches; 1-1/2 inches thick for piping 1-1/2 inches and larger.
- B. Air Conditioning Condensate Drain Piping: Flexible elastomeric, 3/4 inch thick.
- C. Make-Up Water Piping: Flexible elastomeric, 3/4 inch thick.

3.11 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is the Contractor's option or as directed on the drawings.
- C. Piping, Concealed: None.

3.12 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is the Contractor's option.
- C. Piping, Concealed: None.
- D. Piping, Exposed:
 - 1. Aluminum, Corrugated or Stucco Embossed: 0.020 inch thick.

END OF SECTION

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SECTION 23 08 00
COMMISSIONING OF HVAC

PART 1 GENERAL

1.01 SUMMARY

- A. This section includes commissioning process requirements for HVAC systems, assemblies, and equipment.

1.02 DEFINITIONS

- A. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.
- B. CxA: Commissioning Authority.
- C. HVAC: Heating, Ventilating, Air Conditioning.
- D. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean “as-built” systems, subsystems, equipment, and components.

1.03 INFORMATIONAL SUBMITTALS

- A. Certificates of readiness.
- B. Certificates of completion of installation, pre-start, and startup activities.

1.04 CONTRACTOR'S RESPONSIBILITIES

- A. Perform commissioning tests at the direction of the CxA.
- B. Attend construction phase controls coordination meeting.
- C. Attend testing, adjusting, and balancing review and coordination meeting.
- D. Participate in HVAC systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CxA.
- E. Provide information requested by the CxA for final commissioning documentation.
- F. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.

1.05 CXA'S RESPONSIBILITIES

- A. Provide project-specific construction checklists and commissioning process test procedures for actual HVAC systems, assemblies, equipment, and components to be furnished and installed as part of the Construction Contract.
- B. Direct commissioning testing.

- C. Verify testing, adjusting, and balancing of work are complete.
- D. Provide test data, inspection reports, and certificates in systems manual.

1.06 COMMISSIONING DOCUMENTATION

- A. Provide the following information to the CxA for inclusion in the commissioning plan:
 - 1. Plan for delivery and review of submittals, systems manuals, and other documents and reports.
 - 2. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.
 - 3. Process and schedule for completing construction checklists and manufacturer's pre-start and startup checklists for HVAC systems, assemblies, equipment, and components to be verified and tested.
 - 4. Certificate of readiness, signed by the Contractor, certifying that HVAC systems, assemblies, equipment, components, and associated controls are ready for testing.
 - 5. Certificate of completion certifying that installation, pre-start checks, and startup procedures have been completed.
 - 6. Certificate of readiness certifying that HVAC systems, subsystems, equipment, and associated controls are ready for testing.
 - 7. Test and inspection reports and certificates.
 - 8. Corrective action documents.
 - 9. Verification of Testing, Adjusting, and Balancing Reports.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 TESTING PREPARATION

- A. Certify that HVAC systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.
- B. Certify that HVAC instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pre-test setpoints have been recorded.
- C. Certify that testing, adjusting, and balancing procedures have been completed and that Testing, Adjusting, and Balancing Reports have been submitted, discrepancies corrected, and corrective work approved.
- D. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
- E. Observe and verify the position of each device and interlock identified on checklists.
- F. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.
- G. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

3.02 TESTING AND BALANCING VERIFICATION

- A. Prior to performance of testing and balancing work, provide copies of reports, sample forms, checklists, and certificates to the CxA.
- B. Notify the CxA at least 10 days in advance of testing and balancing work, and provide access for the CxA to witness testing and balancing work.
- C. Provide technicians, instrumentation, and tools to verify testing and balancing of HVAC systems at the direction of the CxA.
 - 1. The CxA will notify the Testing & Balancing (TAB) Contractor 10 days in advance of the date of field verification. Notice will not include data points to be verified.
 - 2. The TAB Contractor shall use the same instruments (by model and serial number) that were used when original data was collected.
 - 3. Failure of an item includes, other than sound, a deviation of more than 10%. Failure of more than 10% of selected items shall result in rejection of final Testing, Adjusting, and Balancing Report. For sound pressure readings, a deviation of 3 dB shall result in rejection of final testing. Variations in background noise must be considered.
 - 4. Remedy the deficiency and notify the CxA so verification of failed portions can be performed.

3.03 GENERAL TESTING REQUIREMENTS

- A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.
- B. Scope of HVAC testing shall include entire HVAC installation, from central equipment for heat generation and refrigeration through distribution systems to each conditioned space. Testing shall include measuring capacities and effectiveness of operational and control functions.
- C. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.
- D. The CxA, along with the HVAC Contractor, TAB Contractor, and Building Automation System (BAS) Contractor, shall prepare detailed testing plans, procedures, and checklists for HVAC systems, subsystems, and equipment.
- E. Tests will be performed using design conditions whenever possible.
- F. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.
- G. The CxA may direct that setpoints be altered when simulating conditions is not practical.
- H. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering setpoints are not practical.

- I. If tests cannot be completed because of a deficiency outside the scope of the HVAC system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.
- J. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.04 HVAC SYSTEMS, SUBSYSTEMS, AND EQUIPMENT TESTING PROCEDURES

- A. Building Automation System Testing: Field testing plans and testing requirements are specified in Specification Section 23 09 00, Building Automation System for HVAC, and sequences of control shown on the drawings. Assist the CxA with preparation of testing plans.
- B. Pipe system cleaning, flushing, hydrostatic tests, and chemical treatment requirements are specified in HVAC piping sections. The HVAC Contractor shall prepare a pipe system cleaning, flushing, and hydrostatic testing plan. Provide cleaning, flushing, testing, and treating plan and final reports to the CxA. Plan shall include the following:
 - 1. Sequence of testing and testing procedures for each section of pipe to be tested, identified by pipe zone or sector identification marker. Markers shall be keyed to drawings for each pipe sector, showing the physical location of each designated pipe test section. Drawings keyed to pipe zones or sectors shall be formatted to allow each section of piping to be physically located and identified when referred to in pipe system cleaning, flushing, hydrostatic testing, and chemical treatment plan.
 - 2. Description of equipment for flushing operations.
 - 3. Minimum flushing water velocity.
 - 4. Tracking checklist for managing and ensuring that all pipe sections have been cleaned, flushed, hydrostatically tested, and chemically treated.
- C. Energy Supply System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of energy recovery systems and equipment at the direction of the CxA. The CxA shall determine the sequence of testing and testing procedures for each equipment item and pipe section to be tested.
- D. HVAC Distribution System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of air, steam, and hydronic distribution systems; special exhaust; and other distribution systems, including HVAC terminal equipment and unitary equipment.
- E. Vibration and Sound Tests: Provide technicians, instrumentation, tools, and equipment to test performance of vibration isolation and seismic controls.

END OF SECTION

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SECTION 23 09 00

BUILDING AUTOMATION SYSTEM FOR HVAC

PART 1 GENERAL

1.01 SUMMARY

- A. This section includes control equipment for HVAC systems and components.
- B. The Building Automation System (BAS) Contractor is responsible for the complete installation of this system as necessary to provide the sequence of operations, and monitor and control the equipment and points as shown on the drawings. The complete installation includes all required 120-volt wiring, all low-voltage wiring, and communication wiring. Refer to Specification Section 23 05 20, Electrical and Control Wiring for Mechanical Systems, for requirements.

1.02 SUBMITTALS

- A. Product Data: For the complete BAS indicated and intended for this project. Include the following as a minimum:
 - 1. Sequence of operations intended for each system component on this project.
 - 2. Copy of each graphic screen intended for this project.
 - 3. Operator workstation and all associated components.
 - 4. All control hardware including controllers, panels, sensors, thermostats, valves, dampers, etc., intended for this project. Include the following:
 - a. Manufacturer and model number.
 - b. Equipment dimensions.
 - c. Required clearances.
 - d. Electrical Data:
 - 1) Amperage.
 - 2) Voltage/Phase/Hz.
 - 3) Electrical service point(s) of connection.
 - e. Materials of construction.
 - f. Accessories and options.
 - 5. Point chart for each system component intended for this project.
 - 6. Power, signal, and control wiring diagrams.
 - 7. Damper schedule.
 - 8. Valve schedule.
- B. Software and firmware operational documentation.
- C. Field quality-control test reports.
- D. Warranty information.
- E. Operation and maintenance data: Include the following:
 - 1. Table of contents.
 - 2. As-Builts of the system showing all points and terminations in both AutoCAD and hardcopy format.
 - 3. Manufacturer's product data for each item installed.
 - 4. System operator's manuals.
 - 5. Electronic backup copy of site-specific programming, databases, and sequences.
 - 6. Network diagrams.

7. Wiring termination schedules.

1.03 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to the Authorities Having Jurisdiction (AHJ), and marked for intended use.

1.04 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which the manufacturer agrees to repair or replace components of the BAS that fail in materials or workmanship within specified warranty period.
 1. Extended warranties include, but are not limited to, the following:
 - a. Reprogramming of sequences and updating graphics.
 - b. Parts and labor.
 2. Warranty Period: 2 years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 1. Manufacturers: Subject to compliance with requirements, provide products by the facility's existing provider.

2.02 CONTROL SYSTEM

- A. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, accessories, and software connected to distributed controllers operating in multi-user, multi-tasking environment and programmed to control mechanical systems. An operator workstation permits interface with the network via dynamic color graphics with each mechanical system, building floor plan, and control device depicted by point-and-click graphics.

2.03 SOFTWARE

- A. The software operating the BAS shall provide the following features:
 1. Downloading and Uploading:
 - a. Provide the capability to generate BAS software-based sequences, database items and associated operational definition information and user-required revisions to any Operator Workstation (OWS) and the means to download the same to the associated application node.
 - b. Application software tool used for the generation of custom logic sequences shall be resident in both the application node and the OWS.
 2. Graphics:
 - a. Provide graphics to allow for monitoring and control of each piece of equipment on the project.
 - b. Graphics shall include clickable site plans, floor plans, etc., showing the actual location of each piece of equipment.
 - c. Floor plans shall use color-coding to indicate areas or items in alarm or not meeting the desired temperature setpoint.

- d. Dynamic graphics shall be provided for each piece of equipment showing real-time operating data and allowing modification of adjustable parameters.
- 3. Schedules:
 - a. The system shall provide multiple schedule input forms for automatic time-of-day scheduling and override scheduling of BAS operations. At a minimum, the following spreadsheet types shall be accommodated:
 - 1) Weekly schedules.
 - 2) Temporary override schedules.
 - 3) Special "Only Active If Today Is a Holiday" schedules.
 - 4) Monthly schedules.
 - b. Schedules shall be provided for each system or sub-system in the BAS. Each schedule shall include all commandable points residing within the system. Each point may have a unique schedule of operation relative to the system use schedule, allowing for sequential starting and control of equipment within the system. Scheduling and rescheduling of points shall be accomplished easily via the system schedule spreadsheets.
 - c. Monthly calendars for a 12-month period shall be provided that allow for simplified scheduling of holidays and special days in advance. Holidays and special days shall be user-selected with the pointing device or keyboard, and shall automatically reschedule equipment operation as previously defined on the weekly schedules.
- 4. Alarms:
 - a. Alarms shall be routed directly from primary application nodes to PCs and servers. It shall be possible for specific alarms from specific points to be routed to specific PCs and servers. The alarm management portion of the OWS software shall, at the minimum, provide the following functions:
 - 1) Log date and time of alarm occurrence.
 - 2) Generate a "pop-up" window, with audible alarm, informing a user that an alarm has been received.
 - 3) Allow a user, with the appropriate security level, to acknowledge, temporarily silence, or discard an alarm.
 - 4) Provide an audit trail on hard drive for alarms by recording user acknowledgment, deletion, or disabling of an alarm. The audit trail shall include the name of the user, the alarm, the action taken on the alarm, and a time/date stamp.
 - 5) Provide the ability to direct alarms to an e-mail address or alpha-numeric pager. This must be provided in addition to the pop-up window described above. Systems which use e-mail and pagers as the exclusive means of annunciating alarms are not acceptable.
 - 6) Any attribute of any object in the system may be designated to report an alarm.
 - b. The BAS shall annunciate diagnostic alarms indicating system failures and non-normal operating conditions.
 - c. The BAS shall annunciate application alarms at minimum.
- 5. Reports:
 - a. Reports shall be generated and directed to one or more of the following: User interface displays, printers, or archive at the user's option. As a minimum, the system shall provide the following reports:
 - 1) All points in the DDC System.
 - 2) All points in each DDC System application.
 - 3) All points in a specific application node.
 - 4) All points in a user-defined group of points.
 - 5) All points currently in alarm in a DDC System application.
 - 6) All points locked out in a DDC System application.

- 7) All DDC System schedules.
 - 8) All user defined and adjustable variables, schedules, interlocks and the like.
 - 9) DDC System diagnostic and system status reports.
6. Historical Trending and Data Collection:
- a. Trend and store point history data for all BAS points and values as selected by the user.
 - b. The trend data shall be stored in a manner that allows custom queries and reports using industry-standard software tools.
 - c. At a minimum, provide the capability to perform statistical functions on the historical database:
 - 1) Average.
 - 2) Arithmetic mean.
 - 3) Maximum/minimum values.
 - 4) Range - difference between minimum and maximum values.
 - 5) Standard deviation.
 - 6) Sum of all values.
 - 7) Variance.
7. Application Routines:
- a. Event Messaging: Provide for the automatic execution of user-defined messages on the occurrence of each predefined BAS real-time event including equipment/point status change, approaching limit or alarm, time of day and the like. Direct messages to any number of operator PCs, e-mail destinations, and pagers.
 - b. Indoor Air Quality: Provide monitoring of outside air, return air and supply air CO₂ concentration, calculate and maintain fresh air requirements. Adjust outdoor air intake to ensure return air CO₂ high level limit is not exceeded.
 - c. Optimum Start/Stop: Provide software to start equipment on a sliding schedule based upon indoor and outdoor conditions, to determine the minimum time of HVAC system operation needed to satisfy the space environmental requirements. The program shall also determine the earliest possible time to stop the mechanical systems. The optimum start/stop program shall operate in conjunction with, and be coordinated with, the scheduled start/stop and night setback programs.
 - d. Auto Alarm Lockout: Provide for scheduled and automatic lockout of alarm annunciation from equipment during non-normal operating conditions including shutdown, emergency power operation, fire alarm and the like.
 - e. Energy Monitoring: Provide software to monitor and totalize consumption as measured by pulse meters.
 - f. Event Initiated Programs and Custom Logic: Provide software to define custom logic sequences that will reside in the nodes. The definition software will also reside in the node and be accessible via the standard user interface via a browser.
 - g. System Restart: Upon restoration of the AC power to an HVAC Node, automatically restart all equipment and restore all loads to the state as required by the BAS. Provide appropriate time delays to prevent demand surges or overload trips.
 - h. Heavy Equipment Delays: The system shall provide protection against excessive demand situations during startup periods by automatically introducing time delays between successive start commands to heavy electrical loads.
 - i. Runtime Totalization: Automatically sample, calculate and store runtime hours for binary input and output points as listed in the point schedule of this specification.

- j. Analog/Pulse Totalization: Sample, calculate and store consumption totals on a daily, weekly, or monthly basis for user-selected analog and binary pulse input-type points.

2.04 DDC EQUIPMENT

- A. Network Control Units: Modular, comprising processor board with programmable, non-volatile, random-access memory; local operator access and display panel; integral interface equipment; and backup power source.
 - 1. Units monitor or control each I/O point; process information; execute commands from other control units, devices, and operator stations; and download from or upload to operator workstation.
 - 2. Standalone mode control functions operate regardless of connection to operator station. Functions include the following:
 - a. Global communications.
 - b. Discrete/digital, analog, and pulse I/O.
 - c. Monitoring, controlling, or addressing data points.
 - d. Software applications, scheduling, and alarm processing.
 - e. Testing and developing control algorithms without disrupting field hardware and controlled environment.
- B. Local Control Units: Modular, comprising processor board with electronically programmable, non-volatile, read-only memory; and backup power source.
 - 1. Units monitor or control each I/O point, process information, and download from or upload to operator workstation or diagnostic terminal unit.
 - 2. Standalone mode control functions operate regardless of connection to network control unit. Functions include the following:
 - a. Discrete/digital, analog, and pulse I/O.
 - b. Monitoring, controlling, or addressing data points.
 - 3. Local operator interface provides for download from or upload to operator workstation.
- C. I/O Interface: Hardwired inputs and outputs may tie into system through controllers. Protect points so that shorting will cause no damage to controllers.
 - 1. Binary Inputs: Allow monitoring of On-Off signals without external power.
 - 2. Pulse Accumulation Inputs: Accept up to 10 pulses per second.
 - 3. Analog Inputs: Allow monitoring of low-voltage (0 to 10 VDC), current (4 to 20 mA), or resistance signals.
 - 4. Binary Outputs: Provide On-Off or pulsed low-voltage signal, selectable for normally-open or normally-closed operation with three-position (On-Off-Auto) override switches and status lights.
 - 5. Analog Outputs: Provide modulating signal, either low-voltage (0 to 10 VDC) or current (4 to 20 mA) with status lights, two-position (Auto-Manual) switch, and manually adjustable potentiometer.
 - 6. Tri-State Outputs: Provide two coordinated binary outputs for control of three-point, floating-type electronic actuators.
 - 7. Universal I/Os: Provide software selectable binary or analog outputs.
- D. Power Supplies: Transformers with Class 2 current-limiting type or overcurrent protection; limit connected loads to 80% of rated capacity. DC power supply shall match output current and voltage requirements and be full-wave rectifier type with the following:
 - 1. Output ripple of 5.0 mV maximum peak to peak.
 - 2. Combined 1% line and load regulation with 100-mic.sec. response time for 50% load changes.
 - 3. Built-in overvoltage and overcurrent protection and be able to withstand 150% overload for at least 3 seconds without failure.

- E. Uninterruptible Power Supply (UPS):
 - 1. Where indicated for supporting operator PCs, servers, and other equipment as indicated, provide a UPS.
 - 2. UPS shall be sized for 50% spare capacity. The UPS shall be complete with batteries, external bypass and line conditioning.
- F. Power Fail/Auto Restart:
 - 1. Provide for the automatic orderly and predefined shutdown of parts or all of the BAS following total loss of power to parts or all of the BAS.
 - 2. Provide for the automatic orderly and predefined startup of parts or all of the BAS following total loss of power to those parts or all of the BAS. Archive and annunciate time and details of restoration.
 - 3. Provide for the orderly and predefined scheduling of controlled return to normal, automatically time scheduled, operation of controlled equipment as a result of the auto restart processes.
 - 4. Maintain the BAS real-time clock operation during periods of power outage for a minimum of 72 hours.

2.05 UNITARY CONTROLLERS

- A. Unitized, capable of standalone operation with sufficient memory to support its operating system, database, and programming requirements, and with sufficient I/O capacity for the application.
 - 1. Configuration: Diagnostic LEDs for power, communication, and processor; wiring termination to terminal strip or card connected with ribbon cable; and non-volatile memory for program storage and bios.
 - 2. Operating System: Manage I/O communication to allow distributed controllers to share real and virtual object information and allow central monitoring and alarms. Perform scheduling with real-time clock. Perform automatic system diagnostics; monitor system and report failures.
 - 3. Enclosure: Dustproof rated for operation at 32 to 120°F.

2.06 ANALOG CONTROLLERS

- A. Step Controllers: 6-stage or 10-stage type, with heavy-duty switching rated to handle loads and operated by electric motor.
- B. Electric, Outdoor-Reset Controllers: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range, adjustable setpoint, scale range - 10 to +70°F, and single- or double-pole contacts.
- C. Electronic Controllers: Wheatstone-bridge-amplifier type, in steel enclosure with provision for remote-resistance readjustment. Identify adjustments on controllers, including proportional band and authority.
 - 1. Single controllers can be integral with control motor if provided with accessible control readjustment potentiometer.
- D. Fan-Speed Controllers: Solid-state model providing field-adjustable proportional control of motor speed from maximum to minimum of 55% and On-Off action below minimum fan speed. Controller shall briefly apply full voltage, when motor is started, to rapidly bring motor up to minimum speed. Equip with filtered circuit to eliminate radio interference.

2.07 ELECTRONIC SENSORS

- A. Description: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.
- B. Thermistor Temperature Sensors and Transmitters:
 - 1. Accuracy: $\pm 0.5^{\circ}\text{F}$ at calibration point.
 - 2. Wire: Twisted, shielded-pair cable.
 - 3. Insertion Elements in Ducts: Single point, 18 inches long maximum or shorter as required to be centered within the duct; use where not affected by temperature stratification or where ducts are smaller than 9 sq.ft.
 - 4. Averaging Elements in Ducts: 36 inches long minimum, flexible; use where prone to temperature stratification or where ducts are larger than 9 sq.ft.
 - 5. Insertion Elements for Liquids: Brass or stainless-steel socket with minimum insertion length of 2-1/2 inches.
 - 6. Room Sensor: Wall box or surface mounting with the following features where indicated:
 - a. Override button.
 - b. LCD display for room temperature and setpoint.
 - c. Setpoint adjustment device to provide ± 3 degree (adjustable) range.
 - d. Color: White unless noted otherwise.
 - 7. Room Security Sensors: Wall box mounting, stainless-steel cover plate with insulated back and security screws.
 - 8. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight or on the north side of building.
- C. Humidity Sensors: Bulk polymer sensor element.
 - 1. Accuracy: 5% full range with linear output.
 - 2. Room Sensor Range: 20 to 80% relative humidity.
 - 3. Room Sensor: Wall box or surface mounting with the following features where indicated:
 - a. LCD display for room humidity and setpoint.
 - b. Color: White unless noted otherwise.
 - 4. Room Security Sensors: Wall box mounting, stainless-steel cover plate with insulated back and security screws.
 - 5. Duct Sensor: 20 to 80% relative humidity range with element guard and mounting plate.
 - 6. Outside-Air Sensor: 20 to 80% relative humidity range with mounting enclosure, suitable for operation at outdoor temperatures of 32 to 120°F.
 - 7. Duct and Sensors: With element guard and mounting plate, range of 0 to 100% relative humidity.
- D. Pressure Transmitters/Transducers:
 - 1. Static-Pressure Transmitter: Non-directional sensor with suitable range for expected input, and temperature compensated.
 - a. Accuracy: 2% of full scale with repeatability of 0.5%.
 - b. Output: 4 to 20 mA.
 - c. Building Static-Pressure Range: 0 to 0.25-inch wg.
 - d. Duct Static-Pressure Range: 0 to 5-inch wg.
 - 2. Water Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig operating pressure; linear output 4 to 20 mA.
 - 3. Water Differential-Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig operating pressure and tested to 300 psig; linear output 4 to 20 mA.
 - 4. Differential-Pressure Switch (Air or Water): Snap acting, with pilot-duty rating and with suitable scale range and differential.

- 5. Pressure Transmitters: Direct acting for gas or liquid service; range suitable for system; linear output 4 to 20 mA.
- E. Room Sensor: Wall box or surface mounting with the following features:
 - 1. Color: White unless noted otherwise.
 - 2. Room sensor accessories include the following:
 - a. Insulating Bases: For sensors located on exterior walls.
 - b. Guards: Locking; heavy-duty, transparent plastic; mounted on separate base, or metal wire, tamperproof, or locking, solid metal, ventilated as indicated on the drawings.
 - c. Adjusting Key: As required for calibration and cover screws.
- F. Occupancy Sensor: Passive infrared, with time delay, daylight sensor lockout, sensitivity control, and 180-degree field of view with vertical sensing adjustment; for flush mounting.

2.08 STATUS SENSORS

- A. Status Inputs for Fans: Differential-pressure switch with pilot-duty rating and with adjustable range of 0 to 5-inch wg.
- B. Status Inputs for Pumps: Differential-pressure switch with pilot-duty rating and with adjustable pressure-differential range of 8 to 60 psig, piped across pump.
- C. Status Inputs for Electric Motors: Comply with ISA 50.00.01, current-sensing fixed- or split-core transformers with self-powered transmitter, adjustable and suitable for 175% of rated motor current.
- D. Voltage Transmitter (100 to 600 VAC): Comply with ISA 50.00.01, single-loop, self-powered transmitter, adjustable, with suitable range and 1% full-scale accuracy.
- E. Power Monitor: Three-phase type with disconnect/shorting switch assembly, listed voltage and current transformers, with pulse kilowatt hour output and 4 to 20 mA kW output, with maximum 2% error at 1.0 power factor and 2.5% error at 0.5 power factor.
- F. Current Switches: Self-powered, solid-state with adjustable trip current, selected to match current and system output requirements.
- G. Electronic Valve/Damper Position Indicator: Visual scale indicating percent of travel and 2 to 10 VDC, feedback signal.
- H. Water-Flow Switches: Bellows-actuated mercury or snap-acting type with pilot-duty rating with appropriate range and differential adjustment, in NEMA 250, Type 1 enclosure.

2.09 GAS DETECTION EQUIPMENT

- A. Carbon Monoxide Detectors: Single or multi-channel, dual-level detectors using solid-state plug-in sensors with a 3-year minimum life; suitable over a temperature range of 32 to 104°F; with two factory-calibrated alarm levels at 50 and 100 ppm.
- B. Carbon Dioxide Sensor and Transmitter: Single detectors using solid-state infrared sensors; suitable over a temperature range of 23 to 130°F and calibrated for 0 to 2%, with continuous or averaged reading, 4 to 20 mA output; for wall mounting.

2.10 HUMIDISTATS

- A. Duct-Mounting Humidistats: Electric insertion, two-position type with adjustable, 2% throttling range, 20 to 80% operating range, and single- or double-pole contacts.

2.11 ACTUATORS

- A. Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.
 - 1. Manufacturer: Belimo Automation AG.
 - 2. Comply with requirements in Specification Section 23 05 13, Common Motor Requirements for HVAC Equipment.
 - 3. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
 - 4. Non-Spring-Return Motors for Valves Larger than NPS 2-1/2: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
 - 5. Spring-Return Motors for Valves Larger than NPS 2-1/2: Size for running and breakaway torque of 150 in. x lbf.
 - 6. Non-Spring-Return Motors for Dampers Larger than 25 Sq.Ft.: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
 - 7. Spring-Return Motors for Dampers Larger than 25 Sq.Ft.: Size for running and breakaway torque of 150 in. x lbf.
- B. Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
 - 1. Manufacturer: Belimo Automation AG.
 - 2. Valves: Size for torque required for valve close off at maximum pump differential pressure.
 - 3. Dampers: Size for running torque calculated as follows:
 - a. Parallel-Blade Damper with Edge Seals: 7 inch-lbs./sq.ft. of damper.
 - b. Opposed-Blade Damper with Edge Seals: 5 inch-lbs./sq.ft. of damper.
 - c. Parallel-Blade Damper without Edge Seals: 4 inch-lbs./sq.ft. of damper.
 - d. Opposed-Blade Damper without Edge Seals: 3 inch-lbs./sq.ft. of damper.
 - e. Dampers with 2 to 3-Inch wg of Pressure Drop or Face Velocities of 1,000 to 2,500 fpm: Increase running torque by 1.5.
 - f. Dampers with 3 to 4-Inch wg of Pressure Drop or Face Velocities of 2,500 to 3,000 fpm: Increase running torque by 2.0.
 - 4. Coupling: V-bolt and V-shaped, toothed cradle.
 - 5. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
 - 6. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on non-spring-return actuators.
 - 7. Power Requirements (Two-Position Spring Return): 24 or 120 VAC.
 - 8. Power Requirements (Modulating): Maximum 10 VA at 24 VAC or 8 W at 24 VDC.
 - 9. Proportional Signal: 2 to 10 VDC or 4 to 20 mA, and 2 to 10 VDC position feedback signal.
 - 10. Temperature Rating: -22 to +122°F.
 - 11. Temperature Rating (Smoke Dampers): -22 to +250°F.
 - 12. Run Time: 12 seconds open, 5 seconds closed.

2.12 CONTROL CABLE

- A. Electronic and fiber-optic cables for control wiring are specified in Specification Section 23 05 20, Electrical and Control Wiring for Mechanical Systems.

PART 3 EXECUTION

3.01 ROOM SENSOR APPLICATION SCHEDULE

- A. Furnish the room sensor listed below unless indicated otherwise. Install where indicated on the drawings.
 - 1. Room Security Sensor: Public areas such as corridors, restrooms, etc., where the occupants are transient in nature and not permitted to adjust the room temperature.
 - 2. Room Sensor: Storage rooms, commercial kitchens, back-of-house areas, gymnasiums, shop areas, warehouses, etc., where occupants are transient or not permitted to adjust room setpoints. Provide wire guards where sensors may be exposed to mechanical damage due to activities within the area and as indicated.
 - 3. Room Sensor with Display, Override Button, Setpoint Adjustment: Private offices, open office areas, meeting rooms, conference rooms, reception areas provided with a reception desk, etc., where occupants are permitted to override the occupied/unoccupied mode, and adjust the room setpoints.

3.02 FURNISH

- A. Furnish motorized isolation valves and motorized control valves to the Mechanical Contractor for installation into the piping systems and coordinate mounting locations.
- B. Furnish thermowells and instrument wells to the Mechanical Contractor for installation in the piping systems and coordinate mounting locations.
- C. Furnish flow meter installation requirements and coordinate mounting locations and methods with the Mechanical Contractor.

3.03 COORDINATION

- A. Coordinate control damper styles, sizes, and mounting locations with Mechanical Contractor.

3.04 INSTALLATION

- A. Verify location of thermostats, humidistats, and other exposed control sensors with drawings and room details before installation. Install devices at an elevation per ADA Requirements.
 - 1. Install averaging elements in ducts and plenums in crossing or zigzag pattern.
- B. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.
- C. Install labels and nameplates to identify control components according to Specification Section 23 05 53, Identification for HVAC Piping and Equipment.
- D. Install electronic and fiber-optic cables according to Specification Section 23 05 20, Electrical and Control Wiring for Mechanical Systems.

3.05 ELECTRICAL WIRING AND CONNECTION INSTALLATION

- A. Install raceways, boxes, cabinets building wire, cable, signal, and communication cable according to Specification Section 23 05 20, Electrical and Control Wiring for Mechanical Systems.

1. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
 2. Install exposed cable in raceway.
 3. Install concealed cable in raceway.
 4. Bundle and harness multi-conductor instrument cable in place of single cables where several cables follow a common path.
 5. Within control cabinets, fasten flexible conductors, bridging cabinets, and doors along hinge side; protect against abrasion. Tie and support conductors.
 6. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
 7. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.
- B. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.
- C. Connect Hand-Off-Auto selector switches to override automatic interlock controls when switch is in Hand position.

3.06 PROGRAMMING

- A. Common Routines: Use the same programming routine for common pieces of equipment within the same building and on the same campus.
- B. Floor Plans: Prepare floor plans based on the most up-to-date architectural floor plans. Room names and numbers shall match those used in the field which may differ from those contained in the drawings.
- C. Equipment Locations: Adjust equipment locations to match actual field conditions. This includes VAV box locations, temperature sensor and thermostat locations, etc.
- D. Zoning: Adjust HVAC unit zoning to match actual field conditions.

3.07 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
 2. Test and adjust controls and safeties.
 3. Test calibration of controllers by disconnecting input sensors and stimulating operation with compatible signal generator.
 4. Test each point through its full operating range to verify that safety and operating control setpoints are as required.
 5. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
 6. Test each system for compliance with sequence of operation.
 7. Test software and hardware interlocks.
- B. DDC Verification:
1. Verify that instruments are installed before calibration, testing, and loop or leak checks.
 2. Check instruments for proper location and accessibility.
 3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.

4. Check instrument tubing for proper fittings, slope, material, and support.
 5. Check pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.
 6. Check temperature instruments and material and length of sensing elements.
 7. Check control valves. Verify that they are in correct direction.
 8. Check air-operated dampers. Verify that pressure gages are provided and that proper blade alignment, either parallel or opposed, has been provided.
 9. Check DDC System as follows:
 - a. Verify that DDC controller power supply is from emergency power supply, if applicable.
 - b. Verify that wires at control panels are tagged with their service designation and approved tagging system.
 - c. Verify that spare I/O capacity has been provided.
- C. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

3.08 COMMISSIONING

- A. Commission all functions of the BAS.
- B. Acceptance Check Sheet:
1. Prepare a check sheet that includes all points for all functions of the BAS.
 2. Submit the check sheet to the Engineer for approval 1 month prior to testing.
 3. Complete the check sheet for all items and functions of the BAS and initial each entry with time/date as record of having fully calibrated and tested the BAS. Submit to the Engineer.
 4. The Engineer will use the check sheet as the basis for acceptance testing with the BAS Contractor.
- C. Provide all necessary specialist labor, materials, and tools to demonstrate to the Engineer that the BAS has been commissioned and is operating in compliance with the Contract. Prepare a list of noted deficiencies signed by both the Engineer and the BAS Contractor.
- D. Promptly rectify all listed deficiencies and submit to the Engineer that this has been done.

3.09 TRAINING

- A. The BAS Contractor shall provide the following training services:
1. One 8-hour day of onsite orientation by a system technician who is fully knowledgeable of the specific installation details of the project. This orientation shall, at a minimum, consist of a review of the project As-Built Drawings, the DDC System software layout and naming conventions, and a walkthrough of the facility to identify panel and device locations.
 2. Factory training for one Owner's representative in a factory training lab. This training shall be performed by a factory-certified professional trainer and, at a minimum, shall consist of:
 - a. Two 8-hour days training covering basic system operation.
 - b. One 8-hour day training covering system reporting and alarm management.
 - c. One 8-hour day training of scheduling and point trending.

END OF SECTION

SECTION 23 09 00.10

LABORATORY AIR VALVE CONTROLS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Laboratory Airflow Control System.

1.02 RELATED REQUIREMENTS

- A. Specification Section 01 30 00 – Administrative Requirements.
- B. Specification Section 01 40 00 – Quality Requirements.
- C. Specification Section 01 60 00 – Product Requirements.
- D. Specification Section 01 74 19 – Construction/Demolition Waste Management and Disposal.
- E. Specification Section 01 78 00 – Closeout Submittals.
- F. Specification Section 01 79 00 – Demonstration and Training.

1.03 REFERENCE STANDARDS

- A. All referenced standards in this section pertain to the most recent publication thereof, including all addenda and errata.
- B. AHRI 410 – Standard for Forced-Circulation Air-Cooling and Air-Heating Coils.
- C. ASHRAE Standard 130 – Methods of Testing for Rating Ducted Air Terminal Units.
- D. ISO 9001 – Quality Management Systems – Requirements.
- E. ISO/IEC 17025 – General Requirements for the Competence of Testing and Calibration Laboratories.
- F. NEC – National Electric Code.
- G. NIST – National Institute of Standards and Technology.
- H. UL 916 – Standard for Energy Management Equipment.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Pre-Installation Meeting: The Contractor shall conduct a pre-installation meeting prior to the start of the work of this section and requires attendance by all affected installers.

1.05 SUBMITTALS

- A. See Specification Section 01 30 00 – Administrative Requirements, for submittal procedures.
- B. Product data shall be provided with data indicating configuration, general assembly, and materials used in fabrication, including catalog performance ratings that indicate air flow, static pressure, NC designation, electrical characteristics, and connection requirements.
- C. Shop drawings shall indicate configuration, general assembly, and materials used in fabrication, and electrical characteristics and connection requirements.
- D. Certificates shall be issued to certify that the air coil capacities, pressure drops, and selection procedures meet or exceed specified requirements or coils are tested and rated in accordance with AHRI 410.
- E. Manufacturer's installation instructions shall indicate support and hanging details, installation instructions, recommendations, and service clearances required.
- F. Project record documents shall record actual locations of units and controls components and locations of access doors.
- G. Operation and maintenance data shall include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts lists. Include directions for resetting constant-volume regulators.
- H. Manufacturer's warranty shall be submitted and ensure forms have been completed in Owner's name and registered with manufacturer.
- I. Maintenance materials shall be furnished for the Owner's use in maintenance of the project.
 - 1. See Specification Section 01 60 00 – Product Requirements, for additional provisions.

1.06 WARRANTY

- A. See Specification Section 01 78 00 – Closeout Submittals, for additional warranty requirements.
- B. Provide 60-month manufacturer's warranty from date of shipment for air terminal units, integral sound attenuators, integral heating coils, and integral controls.

PART 2 PRODUCTS

2.01 MANUFACTURER

- A. Basis of Design: Antec Controls by Price.
 - 1. Laboratory Air Control System.
- B. Acceptable Manufacturers:
 - 1. The plans and specifications for the Laboratory Airflow Control System (LACS) are based on systems and equipment manufactured by Antec Controls by Price.

2. The laboratory airflow control system provider shall be an entity that designs, develops, manufactures and sells products and services to control the environment and airflow of critical spaces using a Quality Management System registered to ISO 9001.
3. In strict accordance with this specification, alternative laboratory airflow control systems and equipment shall only be considered for approval provided that the equipment is equal in every respect to the operational characteristics, capacities and intent of control sequences specified herein. Approval to bid does not relieve the laboratory airflow control system supplier from complying with the minimum requirements or intent of this specification.
4. The manufacturer shall possess a certification of accreditation by the National Voluntary Laboratory Accreditation Program (NVLAP) for calibration laboratories, in accordance with ISO/IEC 17025.
5. Manufacturers submitting as alternate suppliers shall be in compliance with the Proposed Alternate Equipment described below.
6. Other acceptable manufacturers can be submitted provided they meet the specifications.
7. The Engineer and Owner shall be the sole judges of quality and equivalence of equipment, materials, methods and life cycle cost.
8. Only those systems specifically named in this specification or by addendum shall be considered for approval. Other systems submitted after the bid opening shall be returned without review.

C. Proposed Alternate Equipment:

1. Equipment:
 - a. The laboratory airflow control system supplier shall provide a detailed proposal describing all elements of the laboratory control system. A schematic laboratory layout shall be provided, showing relations of these elements and a description of how they interact.
 - b. Technical specification data sheets shall be provided for all proposed system components and devices.
 - c. All proposed airflow control devices shall include discharge, exhaust and radiated sound power level performance obtained from testing in accordance with ASHRAE 130.
2. Performance Verification:
 - a. The laboratory airflow control system supplier shall demonstrate a typical laboratory space that includes multiple fume hoods, a general exhaust and a supply airflow control device for the purpose of verifying the laboratory airflow control system's ability to meet the performance requirements indicated in this specification.
 - b. All travel and lodging costs to witness the performance verification shall be the responsibility of the laboratory airflow control system supplier.

D. Compliance Schedule:

1. Any alternate laboratory airflow control system supplier shall provide a separate compliance schedule, which shall include the section, paragraph and subparagraph of these specifications, and a direct statement to indicate compliance or noncompliance with the requirements. For all areas of noncompliance, the supplier shall describe what specific and alternative approach has been taken and document the impact this will have on the sizing of the air delivery systems, the required cooling and heating capacities, energy costs and maintenance of the building.
2. The alternate laboratory airflow control system supplier shall furnish a letter of compliance to the Engineer, signed by a corporate officer of the laboratory system

manufacturer, certifying the compliance and noncompliance items as stated above 10 days prior to the bid.

2.02 LABORATORY AIR CONTROL SYSTEM

- A. General: The Laboratory Airflow Control System (LACS) shall be pressure independent and be furnished and installed to control the laboratory environment.
- B. Performance Requirements:
 - 1. The exhaust flow rate of a laboratory fume hood shall be controlled precisely to maintain a constant average face velocity into the fume hood.
 - 2. The laboratory control system shall vary the amount of make-up/supply air into the room to operate the laboratories at the lowest possible airflow rates necessary to maintain temperature control, achieve minimum ventilation rates, and maintain laboratory pressurization in relation to adjacent spaces.
 - 3. The LACS system shall be direct digital control (DDC) type.
 - 4. Each laboratory shall have a dedicated LACS system. The LACS system shall be independent and standalone from the building automation system.
 - 5. The LACS shall be capable of operating as a standalone system, and as a system integrated with the Building Management System (BMS) directly through BACnet without the use of field servers or gateway devices.
 - 6. The system shall not use or rely on information from controllers in other laboratory areas or from outside laboratory space to control functions within its laboratory.
 - 7. The calibration laboratory shall measure volumetric flow rate with the following calibration accuracy, in accordance with the scope of accreditation to ISO/IEC 17025:
 - a. 30 standard cubic feet per minute to 100 standard cubic feet per minute shall have 4.0% expanded uncertainty.
 - b. 100 standard cubic feet per minute to 250 standard cubic feet per minute shall have 2.5% expanded uncertainty.
 - c. 250 standard cubic feet per minute to 4,200 standard cubic feet per minute shall have 1.4% expanded uncertainty.
- C. Airflow Control Device – General:
 - 1. Airflow Control Devices – Venturi Valve:
 - a. The airflow control device shall be a mechanically pressure independent venturi valve equal to the Antec model VV venturi valve.
 - b. The venturi valve shall be a medium pressure device capable of operating at static pressures of 0.6 to 3 inches water gauge.
 - c. The airflow control device shall be pressure independent over its specified differential static pressure operating range. An integral pressure independent assembly shall respond and maintain specific airflow within 1 second of a change in duct static pressure irrespective of the magnitude of pressure and/or flow change or quantity of airflow controllers on a manifold system.
 - d. The airflow control device shall maintain accuracy within $\pm 5\%$ of signal over the entire airflow range.
 - e. No minimum entrance or exit duct diameters shall be required to ensure accuracy and/or pressure independence.
 - 2. Construction: The airflow control device shall be constructed as:
 - a. Non-Corrosive: The airflow control device for non-corrosive airstreams, such as supply and general exhaust, shall be 14-gauge aluminum (valve body) and 16-gauge aluminum (valve cone) construction. The center shaft shall be PTFE Teflon coated 316 stainless steel. The center shaft support brackets shall be 316 stainless steel. The pivot arm and internal mounting

- link shall be 316 stainless steel. The pressure independent springs shall be spring-grade stainless steel. All shaft bearing surfaces shall be Teflon.
- 1) Sound attenuating devices used in conjunction with general exhaust or supply airflow control devices shall be constructed using 24 gauge galvanized steel or other suitable material used in standard duct construction.
 - 2) Absorptive Material (select one):
 - a) No sound absorptive materials of any kind shall be used.
 - b) Silencers shall be absorptive type with polymer-lined acoustic media.
 - b. Coating Option – Phenolic Class P2: The airflow control device for highly corrosive airstreams shall have no exposed aluminum or stainless steel components. Shaft support brackets, pivot arm, and internal mounting link shall have a baked-on, corrosion-resistant phenolic coating or PFA Teflon. The internal nuts, bolts, and rivets shall be phenolic coated stainless steel or PFA Teflon.
3. Actuation: For electrically actuated VAV operation for fume hood laboratories (includes all supply, general exhaust, and fume hood valves in the space), a high speed UL 916 listed electronic actuator shall be factory mounted to the valve. Loss of main power shall cause the valve to position itself in an appropriate failsafe state:
- a. Supply/Make-Up Air Valves:
 - 1) Fail to last airflow position.
 - b. General Exhaust Air Valves:
 - 1) Fail to last airflow position.
 - c. Fume Hood Air Valves:
 - 1) Fail to last airflow position.
 - d. This position shall be maintained constantly without external influence, regardless of external conditions on the valve (within product specifications).
 - e. Constant volume valves for biosafety cabinets, snorkel exhaust, canopy exhaust, etc., shall maintain a constant volume pressure independent, manually adjustable, volume airflow setpoint. It shall be factory calibrated and set for desired airflow rate. It shall also be capable of field adjustment for future changes of desired airflow rate. Valve shall not be equipped with any pneumatic or electronic control actuator requirements. Valve airflow and pressure feedback is not required for constant volume valves.
4. Electric Heating Coil:
- a. The electric heating coil shall be ETL listed to UL 1995 and CSA 22.2, and provided by the Venturi Valve manufacturer.
 - b. The electric coil casing shall be constructed from a minimum 20 gauge, 0.038 inch galvanized steel.
 - c. The heating elements shall be open wire nickel chrome construction, supported by ceramic insulators.
 - d. The integral control panel shall be a NEMA 250, Type 1 enclosure with hinged access door for access to all controls and safety devices.
 - e. The electric coils shall be provided with a primary automatic reset thermal cutout, a secondary manual reset thermal cutout, and a differential pressure airflow switch for proof of airflow.
 - f. The electric coil shall be provided with a silicon controlled rectifier (SCR) controller with Analog Control 0-10 VDC.
 - g. The electric coil housing shall be lined with 3/4 inch fiber-free insulation.
 - h. The electric coil shall be provided with a non-fused door interlocking disconnect switch.
 - i. The electric coil shall be provided with main-line fusing.

- D. Fume Hood Control Device – General:
1. The fume hood control device shall be a 4.3 inch thin-film-transistor (TFT), dimmable, full color touchscreen display.
 2. The fume hood control device shall be capable of displaying face velocity, face velocity setpoint, alarm status, alarm reason, valve airflow, valve differential pressure, mode of operation, sash position (when the sash position control method is used) and face velocity control method.
 3. The device shall utilize a password protected menu format to permit access to user settings.
 4. The device shall have two binary outputs.
 5. The device shall have four universal inputs that can be configured as:
 - a. Binary input (contact closure or active).
 - b. Analog input (0 – 10 VDC).
 - c. Resistance input – sash position (0 – 50 kOhm).
 6. The device shall communicate with all other room level controls via a high-speed network. The device shall also have native BACnet capability to allow communication with building level networks.
 7. The fume hood control device shall be capable of operating in up to four user-defined modes. Each mode shall be fully customizable. Adjustable settings include, but are not limited to:
 - a. Mode name.
 - b. Face velocity target.
 - c. Airflow setpoint.
 - d. Alarm types and setpoints.
 - e. Background color.
 8. The device shall have a physical push button to mute audible alarms in any mode.
 9. The device shall have a physical button that is configured to engage an “Emergency Mode.”
 10. The fume hood control device shall interface to the air valve that is serving the fume hood.
- E. VAV Fume Hood Face Velocity Control:
1. Each fume hood to be equipped with a fume hood controller to control fume hood average face velocity at the desired (adjustable) setpoint.
 2. Control Type:
 - a. Hybrid Control: The fume hood controller shall employ both a sash sensor to measure the height of each vertical moving fume hood sash, and a sidewall velocity sensor to measure the fume hoods face velocity. Upon movement of the fume hood sash the controller shall measure the fume hood’s total open area to determine the fume hood exhaust air flow required to maintain the average face velocity setpoint. Once the calculated air flow target has been achieved, the fume hood controller shall adjust the exhaust volume until the hood’s measured face velocity matches the average face velocity setpoint. The response of the hybrid control method on each fume hood shall be tuned for speed and stability to meet the laboratory’s performance requirement.
 - b. Hoods utilizing combination vertical fume hood sashes with overlapping horizontal sash panes shall employ the sidewall or hybrid control method.
 3. The fume hood speed of response shall be measured in accordance with ANSI Z9.5.
 - a. Response time of less than 3 seconds after the completion of sash movement is considered acceptable for most operations.
 - b. The speed of response shall be defined as the time between the completion of sash movement and the achievement of 90% of the target airflow or face velocity.

- c. The rate of sash movement shall be from 1.0 to 1.5 feet per second.
 4. Where mechanically pressure independent venturi air valves are used with sash position control, a response time of less than 1 second after completion of sash movement is considered acceptable.
 5. The fume hood controller shall maintain a minimum hood exhaust air flow (adjustable) based on fume hood manufacturer requirements. The minimum airflow shall be maintained whenever the fume hood exhaust air flow required for maintaining average face velocity is lower than the minimum hood requirements.
- F. Room Ventilation, Pressurization, Supply and General Exhaust Control:
1. The LACS shall use volumetric offset control to maintain room pressurization. The system shall maintain proper room pressurization polarity (negative or positive) regardless of any change in room/system conditions, such as the raising and lowering of any or all fume hood sashes or rapid changes in duct static pressure. Systems achieving room pressurization control using differential pressure measurement are unacceptable.
 2. The LACS shall continuously gather the airflow values from up to 24 total devices including fume hood controllers in the laboratory, as well as any miscellaneous process exhaust airflows.
 3. The laboratory control system shall vary the amount of make-up/supply air into the room to operate the laboratories at the lowest possible airflow rates necessary to maintain temperature control, achieve minimum ventilation rates, and maintain laboratory pressurization in relation to adjacent spaces.
 4. The LACS shall continuously calculate the difference between the total exhaust airflow and the total supply airflow in the laboratory. The general exhaust valve shall modulate to maintain the room volumetric offset setpoint.
 5. As fume hoods or miscellaneous exhaust airflows are increased beyond the ability of the general exhaust valve to maintain the room offset, the LACS shall increase the make-up/supply air volume into the space above the minimum required for ventilation rate and temperature control.
- G. Room Temperature Control:
1. The LACS shall maintain the room temperature at set point by varying the supply airflow (if applicable) and supply air temperature. Supply air temperature shall be varied by modulating a reheat coil.
 2. Upon a call for heating, the make-up/supply air volume shall target the minimum airflow allowed by the room air change rate and current fume hood/miscellaneous exhaust rate. The reheat valve shall modulate to maintain the room setpoint while ensuring that the supply air temperature stays within specified limits.
 3. Upon a call for cooling, the make-up/supply air volume shall increase toward the maximum cooling airflow target to bring the room air temperature down to the room temperature setpoint. The reheat valve shall close.
 4. While the room setpoint temperature is satisfied the make-up/supply air volume shall target the minimum airflow allowed by the room air change rate and current fume hood/miscellaneous exhaust rate. The reheat valve shall modulate to maintain the room setpoint.
 5. The temperature control algorithm shall be tunable to ensure thermal comfort is maintained.
- H. Occupancy Control:
1. The LACS shall have the ability to change the minimum ventilation and temperature control set points, based on the occupied state, in order to reduce energy consumption when the space is not occupied.
 2. The occupancy state may be set by either the BMS as a scheduled event or through the use of a local occupancy sensor.

- a. Any BMS command shall be given priority over a local occupancy sensor.
 3. While in unoccupied mode and the room temperature is between the unoccupied heating and cooling room temperature setpoints, the make-up/supply air volume shall be reduced to the minimum unoccupied target. The reheat valve shall be closed.
 4. If the room temperature increases above the unoccupied cooling setpoint or decreases below the unoccupied heating setpoint, the make-up/supply air volume shall increase to the occupied heating/cooling targets and the reheat valve modulated as required. Once the room temperature is brought back to within the unoccupied heating/cooling setpoints, the supply air volume is once again reduced to the minimum unoccupied target and the reheat valve closed.
- I. Start-Up, Integration Into Building Management System:
1. The entire LACS shall be configured from a single access point. Each fume hood controller shall be available as an access point. Where fume hood controllers are not present a remotely mounted access point shall be installed. Systems that rely on users to start up each room control device and fume hood control device from separate access points are not permitted.
 2. The LACS shall be native BACnet for integration into the building management system.
 3. No protocol conversion gateway devices are acceptable for interfacing with a BACnet building-level network.
 4. The LACS shall employ a room-level network to ensure that loss of BMS communication does not affect the room airflow control or result in a loss of room pressure.
 5. A native BACnet MS/TP connection is to be provided for each space.
- J. Certification:
1. Each airflow control device shall be factory calibrated to the job specific airflows as detailed on the plans and specifications using NIST traceable air stations and instrumentation having a combined accuracy of no more than $\pm 1\%$ of signal over the entire range of measurement.
 2. Each airflow control device shall be marked with device-specific factory calibration data. At a minimum, it should include the tag number, serial number, model number, characterization information (for electronic devices), and quality control inspection numbers. All information shall be stored by the manufacturer for use with as-built documentation.
- K. Room Pressure Monitoring:
1. The LACS shall be provided with a room pressure sensor.
 2. The room pressure shall be monitored at all times with reference to the adjacent space.
 3. The room pressure reading shall be available to the BMS system.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that conditions are suitable for installation.
- B. Verify that field measurements are as shown on the drawings.

3.02 INSTALLATION

- A. All temperature control wiring required for a complete and operating system, as herein specified, shall be furnished and installed by the Temperature Control Contractor unless specifically shown on the electrical drawings.
- B. The term “wiring” shall be construed to include the use of conduit, wire, miscellaneous materials and labor, as required for installation and connection of the electrical control devices furnished as part of the control system or furnished by equipment suppliers.
- C. This wiring shall include all electrical connections required as specified in the sequence of operation. All devices and wiring required for interlocking HVAC equipment as specified in the sequence of operation shall be furnished by the Temperature Control Contractor.
- D. All line and low voltage wiring materials and installation covered by this section shall be in accordance with the latest revision of the National Electric Code and applicable local codes and shall carry the UL label where applicable.
- E. The Automatic Temperature Controls (ATC) Contractor shall install the sash sensors, sidewall sensors, presence and motion sensor, and fume hood monitor on the fume hood under initial supervision of the laboratory airflow control system supplier. Reel-type sash sensors and their stainless steel cables shall be hidden from view.
- F. The ATC Contractor shall install all routers and repeaters in an accessible location in or around the designated laboratory room.
- G. The ATC Contractor shall install appropriately sized and fused 24 VAC transformers suitable for NEC Class II wiring.
- H. All cables shall be furnished and installed by the ATC Contractor. The ATC Contractor shall terminate and connect all cables as required. The ATC Contractor shall utilize cables specifically recommended by the laboratory airflow controls supplier.
- I. The Mechanical Contractor shall install all airflow control devices in the ductwork.
- J. The Mechanical Contractor shall provide and install all reheat coils and transitions that are not integral to the venturi air valves.
- K. The Mechanical Contractor shall provide and install insulation as required.
- L. Each pressurization zone shall have either a dedicated, single-phase primary circuit or a secondary circuit disconnect.

3.03 SYSTEM START-UP AND TRAINING

- A. System start-up shall be provided by a factory trained and authorized representative of the LACS manufacturer. Start-up shall include calibrating the fume hood control device and any combination sash position/sidewall sensing equipment, as required. Start-up shall also provide electronic verification of airflow (fume hood exhaust, supply, make-up, general exhaust or return), system programming and integration to BMS (when applicable).
- B. The Balancing Contractor shall be responsible for final verification and reporting of all airflows. The factory trained and authorized representative of the LACS manufacturer shall be on hand to assist the Balancing Contractor in adjusting any airflow or velocity readings as required.

- C. The LACS supplier shall furnish a minimum of 4 hours of Owner training by factory trained and certified personnel. The training shall provide an overview of the job specific airflow control components, verification of initial fume hood monitor calibration, general procedures for verifying airflows of air valves and general troubleshooting procedures.
- D. Operation and maintenance manuals, including as-built wiring diagrams and component lists, shall be provided for each trainee.

3.04 FIELD QUALITY CONTROL

- A. See Specification Section 01 40 00 – Quality Requirements, for additional quality requirements.

3.05 CLEANING

- A. See Specification Section 01 74 19 – Construction Waste Management and Disposal, for additional cleaning requirements.

3.06 CLOSEOUT ACTIVITIES

- A. See Specification Section 01 78 00 – Closeout Submittals, for closeout submittals.
- B. See Specification Section 01 79 00 – Demonstration and Training, for additional closeout requirements.

END OF SECTION

SECTION 23 21 13

HYDRONIC PIPING

PART 1 GENERAL

1.01 SUMMARY

- A. This section includes pipe and fitting materials, joining methods, special-duty valves, and specialties for the following:
 - 1. Energy recovery water piping.
 - 2. Chilled-water piping.
 - 3. Makeup-water piping.
 - 4. Blowdown-drain piping.
 - 5. Air-vent piping.
 - 6. Safety-valve-inlet and -outlet piping.

1.02 PERFORMANCE REQUIREMENTS

- A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature:
 - 1. Energy Recovery Water Piping: 125 psig at 200°F.
 - 2. Chilled-Water Piping: 125 psig at 100°F.
 - 3. Makeup-Water Piping: 150 psig at 100°F.
 - 4. Blowdown-Drain Piping: 150°F.
 - 5. Air-Vent Piping: 200°F.
 - 6. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

1.03 SUBMITTALS

- A. Product Data: Include manufacturer's product literature indicating materials of construction, ratings, options and accessories for each type of the following:
 - 1. Pipe and fittings.
 - 2. Valves. Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves, automatic flow-control valves, reduced-pressure-principle backflow preventers.
 - 3. Air control devices.
 - 4. Hydronic specialties.
- B. Field quality-control test reports.
- C. Operation and maintenance data.

1.04 QUALITY ASSURANCE

- A. ASME Compliance: Comply with ASME B31.9, Building Services Piping, for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

PART 2 PRODUCTS

2.01 COPPER TUBE AND FITTINGS

- A. Drawn-Temper Copper Tubing: ASTM B88, Type L.
- B. Wrought-Copper Fittings: ASME B16.22.
- C. Wrought-Copper Unions: ASME B16.22.

2.02 STEEL PIPE AND FITTINGS

- A. Steel Pipe: Use the following types and grades. Wall thickness is indicated in Part 3 Piping Applications article. Standard weight may be substituted for Schedule 40.
 - 1. NPS 2 and Smaller: ASTM A106, Type S (seamless), Grade B, black steel, plain ends.
 - 2. NPS 2-1/2 through NPS 12: ASTM A53, Type E (electric-resistance welded), Grade B, black steel, plain ends.
 - 3. NPS 4 and Larger: ASTM A53, Type E (electric-resistance welded), Grade B, black steel, plain ends.
 - 4. Provide hot-dipped zinc coating where required.
- B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250 as indicated in Part 3 Piping Applications article. Provide hot-dipped zinc coated as required to match adjacent piping.
- C. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300 as indicated in Part 3 Piping Applications article. Provide hot-dipped zinc coated as required to match adjacent piping.
- D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in Part 3 Piping Applications article. Provide hot-dipped zinc coated as required to match adjacent piping.
- E. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 125 and 250; raised ground face, and bolt holes spot faced as indicated in Part 3 Piping Applications article. Provide hot-dipped zinc coated to as required to match adjacent piping.
- F. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, hot-dipped zinc coating as required to match adjacent piping, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
 - 1. Material Group: 1.1.
 - 2. End Connections: Butt welding.
 - 3. Facings: Raised face.
- G. Wrought-Steel Fittings: Factory-fabricated ASME B16.9 fittings with beveled ends for butt welding. Match schedule of connected pipe. Use long radius elbows except where space requires short radius elbows.

2.03 JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
 - 1. ASME B16.21, non-metallic, flat, asbestos free, 1/8-inch maximum thickness unless thickness or specific material is indicated.

- a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
- B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- C. Solder Filler Metals: ASTM B32, lead-free alloys. Include water-flushable flux according to ASTM B813.
- D. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BA9-1, silver alloy for joining copper with bronze or steel.
- E. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.

2.04 DIELECTRIC FITTINGS

- A. Dielectric Nipples: Galvanized- or electroplated-steel, or ductile iron nipple with inert and non-corrosive thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225°F.
- B. Copper Flange Adapters: Two-part assembly consisting of a powder coated steel flange complying with ANSI B16.5 with an EPDM insulator adhered to the steel flange and extending through the inside of the opening to prevent contact between the copper insert and the flange. The copper insert shall have a solder end complying with ANSI B16.22.

2.05 VALVES

- A. Check, Ball, and Butterfly Valves: Comply with requirements specified in Specification Section 23 05 23, General Duty Valves for HVAC Hydronic Piping.
- B. Automatic Temperature-Control Valves, Actuators, and Sensors: Comply with requirements specified in Specification Section 23 09 00, Building Automation System for HVAC.
- C. Bronze, Calibrated-Orifice, Balancing Valves:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Armstrong Pumps, Inc.
 - b. NIBCO.
 - c. Oventrop.
 - d. Red-White Valve Corp.
 - e. Tour & Andersson; available through Victaulic Company.
 - 2. Body: Bronze or Ametal®, multi-turn plug or globe type with calibrated orifice or venturi.
 - 3. Plug: Resin.
 - 4. Seat: PTFE or Ametal®.
 - 5. End Connections: Threaded or socket.
 - 6. Pressure Gage Connections: Integral seals for portable differential pressure meter with one port on each side of valve seat or calibrated orifice.
 - 7. Handle Style: Handwheel with memory stop to retain set position.
 - 8. CWP Rating: Minimum 125 psig.
 - 9. Maximum Operating Temperature: 250°F.

- D. Cast-Iron, Ductile-Iron or Steel, Calibrated-Orifice, Balancing Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Armstrong Pumps, Inc.
 - b. Bell & Gossett Domestic Pump; a Division of ITT Industries.
 - c. NIBCO.
 - d. Oventrop.
 - e. Tour & Andersson; available through Victaulic Company.
 2. Body: Cast-iron, ductile-iron or steel body, multi-turn plug or globe pattern with calibrated orifice or venturi.
 3. Stem Seals: EPDM O-rings.
 4. Disc: Glass and carbon-filled PTFE.
 5. Seat: PTFE or ductile iron.
 6. End Connections: Flanged or grooved.
 7. Pressure Gage Connections: Integral seals for portable differential pressure meter with one port on each side of valve seat or calibrated orifice.
 8. Handle Style: Handwheel with memory stop to retain set position.
 9. CWP Rating: Minimum 125 psig.
 10. Maximum Operating Temperature: 250°F.
- E. Diaphragm-Operated, Pressure-Reducing Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Amtrol, Inc.
 - b. Armstrong International Inc.
 - c. Bell & Gossett Domestic Pump; a Division of ITT Industries.
 - d. Conbraco Industries, Inc.
 - e. Watts Regulator Co.; a Division of Watts Water Technologies, Inc.
 2. Body: Bronze or brass.
 3. Disc: Glass and carbon-filled PTFE.
 4. Seat: Brass.
 5. Stem Seals: EPDM O-rings.
 6. Diaphragm: EPT.
 7. Low inlet-pressure check valve.
 8. Inlet Strainer: stainless steel, removable without system shutdown.
 9. Valve Seat and Stem: Non-corrosive.
 10. Valve Size, Capacity, and Operating Pressure: Selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.
- F. Diaphragm-Operated Safety Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Armstrong International, Inc.
 - b. Bell & Gossett Domestic Pump; a Division of ITT Industries.
 - c. Conbraco Industries, Inc.
 - d. Kunkle Valve; a Division of Pentair PLC.
 - e. Watts Regulator Co.; a Division of Watts Water Technologies, Inc.
 2. Body: Bronze or brass.
 3. Disc: Glass and carbon-filled PTFE.
 4. Seat: Brass.
 5. Stem Seals: EPDM O-rings.
 6. Diaphragm: EPT.
 7. Wetted, Internal Work Parts: Brass and rubber.
 8. Inlet Strainer: Stainless steel, removable without system shutdown.
 9. Valve Seat and Stem: Non-corrosive.

10. Valve Size, Capacity, and Operating Pressure: Comply with ASME Boiler and Pressure Vessel Code: Section IV, and selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.
- G. Reduced-Pressure-Principle Backflow Preventers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Conbraco Industries, Inc.
 - b. Watts; a Division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - c. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
 2. Standard: ASSE 1013.
 3. Operation: Continuous-pressure applications.
 4. Pressure Loss: 15 psig maximum, through middle third of flow range.
 5. Pressure Loss at Design Flow Rate: 12 psig.
 6. Body: Bronze for NPS 2 and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved for NPS 2-1/2 and larger.
 7. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
 8. Configuration: Designed for horizontal, straight-through flow.
 9. Accessories:
 - a. Valves NPS 2 and Smaller: Ball type with threaded ends on inlet and outlet.
 - b. Valves NPS 2-1/2 and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.
 - c. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.
 10. Strainer: Wye pattern type mounted upstream of inlet isolation valve. Bronze for NPS 2 and smaller and cast iron for NPS 2-1/2 and larger.

2.06 AIR CONTROL DEVICES

- A. Manual Air Vents:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Amtrol, Inc.
 - b. Armstrong Pumps, Inc.
 - c. Bell & Gossett Domestic Pump; a Division of ITT Industries.
 - d. Taco.
 2. Body: Brass or Bronze.
 3. Internal Parts: Non-ferrous.
 4. Operator: Screwdriver or thumbscrew.
 5. Inlet Connection: NPS 1/2.
 6. Discharge Connection: NPS 1/8.
 7. CWP Rating: 150 psig.
 8. Maximum Operating Temperature: 225°F.
- B. Automatic Air Vent:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Amtrol, Inc.
 - b. Armstrong Pumps, Inc.
 - c. Bell & Gossett Domestic Pump; a Division of ITT Industries.
 - d. Empire.
 - e. Hoffman.

- f. Spirax Sarco.
 - g. Taco.
 - 2. Body: Brass or Bronze.
 - 3. Internal Parts: Non-ferrous.
 - 4. Operation: Automatic float-principle.
 - 5. Inlet Connection: NPS 1/2.
 - 6. Discharge Connection: NPS 1/4.
 - 7. CWP Rating: 150 psig.
 - 8. Maximum Operating Temperature: 240°F.
- C. Bladder Expansion Tanks:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Amtrol, Inc.
 - b. Armstrong Pumps, Inc.
 - c. Aurora Pump; Division of Pentair Pump Group.
 - d. Bell & Gossett Domestic Pump; a Division of ITT Industries.
 - e. Taco.
 - 2. Tank: Bladder type, welded carbon steel rated for 125-psig working pressure and 240°F maximum operating temperature. Factory tested and labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
 - 3. Tank taps for system connection, drain, and air pressure fitting.
 - 4. Bladder: Replaceable, heavy-duty butyl rubber.
 - 5. Provide lifting rings and floor mounting skirt.
- D. Air Separators:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Amtrol, Inc.
 - b. Armstrong Pumps, Inc.
 - c. Aurora Pump; Division of Pentair Pump Group.
 - d. Bell & Gossett Domestic Pump; a Division of ITT Industries.
 - e. Spirax Sarco, Inc.
 - f. Spirotherm, Inc.
 - g. Taco.
 - h. Wheatley; a Division of Global Flow Products LLC.
 - 2. In-Line Air Separators:
 - a. Tank: One-piece cast iron with an integral weir constructed to decelerate system flow to maximize air separation.
 - b. Maximum Working Pressure: Up to 175 psig.
 - c. Maximum Operating Temperature: Up to 300°F.

2.07 HYDRONIC PIPING SPECIALTIES

- A. Temperature and Pressure Test Ports (Pete's Plug): Solid brass fitting with two valve cores of Nordel and a solid brass cap with retainer strap designed to allow for the insertion of a pressure gauge or thermometer into the piping system. Test port shall be suitable for use at pressures up to 500 psi and fluid temperatures up to 275°F. Select test port length to extend through piping insulation.
- B. Y-Pattern Strainers:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Armstrong Pumps, Inc.
 - b. Bell & Gossett ITT; Division of ITT Fluid Technology Corp.
 - c. Griswold Controls.

- d. Mueller Steam Specialty.
 - e. Spirax Sarco Inc.
 - 2. Body: Bronze with threaded gasketed cover and bottom drain connection, or ASTM A126, Class B, cast iron or ductile iron with bolted cover and bottom drain connection.
 - 3. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
 - 4. Strainer Screen: 60-mesh startup strainer, and perforated stainless-steel basket with 50% free area.
 - 5. CWP Rating: 125 psig.
- C. Stainless-Steel Bellow, Flexible Connectors:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Flex-Hose Co., Inc.
 - b. Flexonics.
 - c. Metraflex.
 - d. Twin City Hose.
 - 2. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
 - 3. End Connections: Threaded or flanged to match equipment connected.
 - 4. Performance: Capable of 3/4-inch misalignment.
 - 5. CWP Rating: 150 psig.
 - 6. Maximum Operating Temperature: 250°F.
- D. Flexible Pump Connectors:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Mason Industries.
 - b. Metraflex Co.
 - c. Proco Products, Inc.
 - d. Vibration Mountings & Controls, Inc.
 - 2. Body: Flexible, single- or double-sphere of EPDM liner and cover, Kevlar tire cord fractioning with steel ring embedded in raised face of rubber-flanged end. Provide ductile iron, external ring between double-spheres.
 - 3. End Connections: Split ductile-iron or steel flanges with hooked interlocks.
 - 4. Control Rods: Required where recommended by the manufacturer or indicated on the drawings.
 - 5. CWP Rating: 150 psig.
 - 6. Maximum Operating Temperature: 250°F.
- E. Flexible Hoses: Minimum 400-psig working pressure, and operating temperatures from 33 to 211°F. Tag hose kits to equipment designations.
- 1. Hose Material: Reinforced synthetic rubber.
 - 2. Exterior Cover: Braided stainless steel.
 - 3. Couplings: Solid brass or stainless steel.
 - 4. Length: 24 inches.
 - 5. Minimum Diameter: Equal to fan-coil-unit connection size.
- F. Expansion fittings are specified in Specification Section 23 05 16, Expansion Fittings and Loops for HVAC Piping.

PART 3 EXECUTION

3.01 PIPING APPLICATIONS

- A. Energy recovery water piping, aboveground, NPS 2 and smaller, shall be any of the following:
 - 1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered or brazed joints.
 - 2. Schedule 40 steel pipe; Class 125, cast-iron fittings; cast-iron flanges and flange fittings; and threaded joints.
- B. Energy recovery water piping, aboveground, NPS 2-1/2 and larger, shall be any of the following:
 - 1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered or brazed joints.
 - 2. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
- C. Chilled-water piping, aboveground, NPS 2 and smaller, shall be any of the following:
 - 1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered or brazed joints.
 - 2. Schedule 40 steel pipe; Class 125, cast-iron fittings; cast-iron flanges and flange fittings; and threaded joints.
- D. Chilled-water piping, aboveground, NPS 2-1/2 and larger, shall be any of the following:
 - 1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered or brazed joints.
 - 2. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
- E. Makeup-Water Piping Installed Aboveground: Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
- F. Blowdown-Drain Piping: The same materials and joining methods as for piping specified for the service in which blowdown drain is installed.
- G. Air-Vent Piping:
 - 1. Inlet: The same as service where installed.
 - 2. Outlet: Type K, annealed-temper copper tubing with soldered or flared joints.
- H. Safety-Valve-Inlet and -Outlet Piping for Hot-Water Piping: The same materials and joining methods as for piping specified for the service in which safety valve is installed.

3.02 VALVE APPLICATIONS

- A. Install shutoff-duty valves at each building entrance and exit, at each supply and return connection to each piece of equipment, and upstream and downstream of each strainer.
- B. Install check valves at each pump discharge and elsewhere as required to control flow direction.
- C. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install drain piping to nearest floor sink or as indicated on the drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.

- D. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.
- E. Install reduced-pressure-principle backflow preventers at the connection between the domestic cold water system and the hydronic systems.

3.03 PIPING INSTALLATIONS

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on the Coordination Drawings.
- B. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Do not install hydronic piping within electrical rooms, elevator equipment rooms, MDF or IDF rooms, or stairwells. Exception: Pipe supplying equipment serving the room. Maintain all required clearances to other equipment.
- E. Do not install piping above electrical equipment such as transformers, panels, motor control centers, etc., in other rooms.
- F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- G. Install piping to permit valve servicing.
- H. Install piping at indicated slopes.
- I. Install piping free of sags and bends.
- J. Install fittings for changes in direction.
- K. Install fittings for branch connections with three elbow loops for thermal expansion and contraction.
- L. Install piping to allow application of insulation.
- M. Select system components with pressure rating equal to or greater than system operating pressure.
- N. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- O. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains, at building entrance and exit, and elsewhere as required for system drainage.
- P. Reduce pipe sizes using eccentric reducer fitting installed with level side up.

- Q. Make branch connections to mains using flow tees where branch size is not less than one-third the diameter of the main. Weld-O-Lets and Thread-O-Lets, may be used in other applications. Hot-taps shall only be used to connect branch lines to live mains.
- R. Unless otherwise indicated, install branch connections to mains with the branch connected to the top or side of the main pipe.
- S. Install valves according to Specification Section 23 05 23, General Duty Valves for HVAC Hydronic Piping.
- T. Install thermowells furnished by the Controls Contractor where directed.
- U. Install unions in piping, NPS 2 and smaller at final connections of equipment, and elsewhere as indicated.
- V. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.
- W. Install strainers on inlet side of each control valve, pressure-reducing valve, solenoid valve, in-line pump, and elsewhere as indicated. Install NPS 3/4 nipple and ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2. Install strainers with strainer basket facing downward to facilitate cleaning and blowdown.
- X. Identify piping as specified in Specification Section 23 05 53, Identification for HVAC Piping and Equipment.
- Y. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Specification Section 23 05 17, Sleeves and Sleeve Seals for HVAC Piping. Do not install piping within concrete.
- Z. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Specification Section 23 05 17, Sleeves and Sleeve Seals for HVAC Piping. Do not install piping within concrete.
- AA. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Specification Section 23 05 18, Escutcheons for HVAC Piping.
- BB. Remove construction debris, dust, dirt, and other foreign material from piping systems as work progresses. Protect pipe openings during construction.

3.04 HANGERS AND SUPPORTS

- A. Hanger, support, and anchor devices are specified in Specification Section 23 05 29, Hangers and Supports for HVAC Piping and Equipment. Comply with the following requirements for maximum spacing of supports.
- B. Vibration isolation devices are specified in Specification Section 23 05 48.13, Vibration Controls for HVAC Piping and Equipment.
- C. Install the following pipe attachments:
 - 1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.

2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
4. Spring hangers to support vertical runs.
5. Wrap copper piping with not less than two layers of 10-mil-thick black plastic tape extending a minimum of 1 inch on each side of clamp for electrolytic protection where hangers or supports are in direct contact with copper piping.

D. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:

	Maximum Span	Minimum Rod Size
NPS 3/4	7 feet	1/4 inch
NPS 1	7 feet	1/4 inch
NPS 1-1/2	9 feet	3/8 inch
NPS 2	10 feet	3/8 inch
NPS 2-1/2	11 feet	3/8 inch
NPS 3	12 feet	3/8 inch
NPS 4	12 feet	1/2 inch
NPS 6	12 feet	1/2 inch
NPS 8	12 feet	5/8 inch
NPS 10	12 feet	3/4 inch
NPS 12	12 feet	7/8 inch
NPS 14	12 feet	1 inch
NPS 16	12 feet	1 inch
NPS 18	12 feet	1-1/4 inch
NPS 20	12 feet	1-1/4 inch
NPS 24	12 feet	1-1/4 inch

E. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:

	Maximum Span	Minimum Rod Size
NPS 3/4	5 feet	1/4 inch
NPS 1	6 feet	1/4 inch
NPS 1-1/4	6 feet	3/8 inch
NPS 1-1/2	8 feet	3/8 inch
NPS 2	8 feet	3/8 inch
NPS 2-1/2	9 feet	3/8 inch
NPS 3	10 feet	3/8 inch
NPS 4	10 feet	1/2 inch
NPS 6	10 feet	1/2 inch
NPS 8	10 feet	5/8 inch
NPS 10	10 feet	3/4 inch
NPS 12	10 feet	7/8 inch

- F. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

3.05 PIPE JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 23 sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B828 or CDA's Copper Tube Handbook, using lead-free solder alloy complying with ASTM B32.
- E. Brazed Joints: Construct joints according to AWS's Brazing Handbook, Pipe and Tube Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- G. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- H. Hot Taps:
 - 1. Hot taps shall only be made on systems that cannot be isolated or shut down and are not permitted in new construction.
 - 2. The hot tap machine shall be provided with a depth gauge to prevent cutting of opposite pipe wall.
 - 3. The hot tap machine shall be rated for the expected pressures and temperatures of the system being tapped.
 - 4. Weld-o-lets, split tees, saddles, branch-o-lets, or nozzles shall be used on all hot taps. Full encirclement pads or split tees shall be used if the hot tap diameter is greater than 50% of the run pipe diameter.
 - 5. Pipe coupons must be removed and not allowed to enter system. Return coupons to the Owner.
- I. Dielectric Connections: Use the following to connect copper or brass piping materials to ferrous piping materials:
 - 1. Piping NPS 4 Inches and Smaller: Dielectric nipples.
 - 2. Piping NPS 5 Inches and Larger: Copper flange adapters.
 - 3. Bronze body valves may be used in lieu of the dielectric connection specified above.

3.06 HYDRONIC SPECIALTIES INSTALLATION

- A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.

- B. Install automatic air vents in mechanical equipment rooms at high points of system piping, at heat transfer coils, at the air outlet on the air separator, and elsewhere as required for system air venting.
 - 1. Provide shutoff valve on inlet side of each automatic air vent.
 - 2. Provide drain piping from each automatic air vent outlet to nearest floor sink, mop sink, or floor drain.
- C. Install piping from air separator to expansion tank with a 2% upward slope toward air vent.
- D. Install in-line air separators in pump suction NPS 1-1/2 and smaller and centrifugal air separators in NPS 2 through NPS 24. Install drain valve on air separators NPS 2 and larger.
- E. Install bypass chemical feeders furnished by the HVAC Water Treatment Contractor in each hydronic system where indicated, in upright position with top of funnel not more than 48 inches above the floor. Install feeder in minimum NPS 3/4 bypass circuit around circulating pumps. Install full-size, full-port ball valves at inlet and outlet of feeder. Install NPS 3/4 pipe from chemical feeder drain, to nearest floor sink and include a full-size, full-port ball valve.
- F. Install expansion tanks where indicated on the drawings.
 - 1. Charge tank to initial fill pressure.
 - 2. Support tank from floor or structure above with sufficient strength to carry weight of tank, piping connections, fittings, plus tank full of water. Do not overload building components and structural members.

3.07 TERMINAL EQUIPMENT CONNECTIONS

- A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.
- B. Install flexible connectors at the inlet and outlet of all moving equipment, except pumps or as indicated otherwise. Match size of adjacent pipe.
- C. Install flexible pump connectors at the inlet and outlet of all pumps, except in-line pumps. Match size of adjacent pipe.
- D. Install flexible hoses at the inlet and outlet of all process chillers with connection sizes 1-1/2 inch NPS and smaller. Match size of equipment connection.
 - 1. Maximum Hose Bend: Do not exceed 180 degrees.
 - 2. Maximum Pipe Offset: Not to exceed 3 inches.
 - 3. Comply with manufacturer's written limitations and instructions.
- E. Install control valves in accessible locations close to connected equipment.
- F. Install ports for pressure gages and thermometers at coil inlet and outlet connections according to Specification Section 23 05 19, Meters and Gages for HVAC Piping.

3.08 CLEANING AND CHEMICAL TREATMENT

- A. Cleaning and passivation is required for all new piping whether installed as part of a new system or the extension of an existing system. This Contractor is responsible to provide pumps, valves, temporary piping, and all other items, except chemicals, required to properly clean the new piping prior to the piping being put into service or connected to an existing system.

- B. Flush water fill lines separately to drain, to prevent rust and debris in the water main from entering the hydronic system(s).
- C. During the cleaning process, maintain a minimum liquid velocity of 3 feet per second through piping systems. All manual, motorized, or thermostatically operated valves are to be open during this process. All equipment such as boilers, chillers, etc., shall be off. All dead end runs shall be looped together with piping not less than one-third the size of the run. Remove or isolate the end-run piping loop at the completion of the chemical treatment process. When connecting new piping to an existing system the new piping shall be looped together with piping not less than one-half the size of the new mains to allow for cleaning before linking the two systems. Remove or isolate the piping loop at the completion of the chemical treatment process.
- D. Fill system with fresh water, clean and passivate interior of piping systems using chemicals supplied by the HVAC Water Treatment Contractor. Circulate chemicals for a minimum of 24 hours or longer as directed to remove oils, dirt, and other compounds detrimental to the proper operation of the system.
- E. Flush piping system with clean water to remove cleaning chemicals and debris. Remove and clean strainer screens, flush mud and debris from drop legs and other low points.
- F. Immediately after cleaning and flushing, refill system with fresh water and chemicals supplied by the HVAC Water Treatment Contractor to inhibit corrosion. Circulate for a minimum of 2 hours.
- G. Do not repeatedly fill and drain system without proper chemical treatment.

3.09 FIELD QUALITY CONTROL

- A. Prepare hydronic piping according to ASME B31.9 and as follows:
 - 1. Leave joints, including welds, uninsulated and exposed for examination during test.
 - 2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
 - 3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
 - 4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
 - 5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.
- B. Perform the following tests on hydronic piping:
 - 1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
 - 2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
 - 3. Isolate expansion tanks and determine that hydronic system is full of water.
 - 4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's design pressure indicated on the drawings. If the design pressure is not indicated, use the minimum working pressure indicated above. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of

vertical runs does not exceed 90% of specified minimum yield strength or 1.7 times "SE" value in Appendix A in ASME B31.9, Building Services Piping.

5. After hydrostatic test pressure has been applied for at least 30 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
 6. Prepare written report of testing.
- C. Perform the following before operating the system:
1. Open manual valves fully.
 2. Inspect pumps for proper rotation.
 3. Set makeup pressure-reducing valves for required system pressure.
 4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
 5. Set temperature controls so all coils are calling for full flow.
 6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
 7. Verify lubrication of motors and bearings.

END OF SECTION

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SECTION 23 21 15
HVAC DRAIN PIPING

PART 1 GENERAL

1.01 SUMMARY

- A. This section includes pipe and fitting materials, and joining methods for HVAC drain piping including coil condensate drains.

1.02 PERFORMANCE REQUIREMENTS

- A. Drain piping components and installation shall be capable of withstanding 5 psig at 150°F.

1.03 SUBMITTALS

- A. Product Data: Include manufacturer's product literature indicating materials of construction, ratings, options, and accessories for each type of the following:
 - 1. Pipe and fittings.
- B. Field quality-control test reports.

1.04 QUALITY ASSURANCE

- A. ASME Compliance: Comply with ASME B31.9, Building Services Piping, for materials, products, and installation.

PART 2 PRODUCTS

2.01 COPPER TUBE AND FITTINGS

- A. Drawn-Temper Copper Tubing: ASTM B88, Type L.
- B. DWV Copper Tubing: ASTM B306, Type DWV.
- C. Wrought-Copper Fittings: ASME B16.22.
- D. Wrought-Copper Unions: ASME B16.22.

2.02 JOINING MATERIALS

- A. Solder Filler Metals: ASTM B32, lead-free alloys. Include water-flushable flux according to ASTM B813.
- B. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.

2.03 DIELECTRIC FITTINGS

- A. Description: Combination fitting of copper-alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

- B. Insulating Material: Suitable for system fluid, pressure, and temperature.
- C. Dielectric Unions: Factory-fabricated union assembly, for 250-psig minimum working pressure at 180°F.
- D. Dielectric Couplings: Galvanized-steel coupling with inert and non-corrosive thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225°F.

PART 3 EXECUTION

3.01 PIPING APPLICATIONS

- A. Drain Piping: Type DWV or Type L (B), drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

3.02 PIPING INSTALLATIONS

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated piping locations and arrangements if such were used to size pipe. Install piping as indicated unless deviations to layout are approved on the Coordination Drawings.
- B. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise. Avoid routing piping on floor across walkways. Provide steel ramps over piping where floor mounted piping crosses walkways.
- D. Do not install drain piping within electrical rooms, elevator equipment rooms, MDF or IDF rooms, or stairwells. Exception: Pipe serving equipment serving the room. Maintain all required clearances to other equipment.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping at a uniform grade of 1.0% downward towards drain outlet unless otherwise indicated.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Install cleanouts fabricated with a tee fitting with a threaded plug at each change of direction to facilitate cleaning of pipe. Cleanout shall allow for cleaning in direction of flow.
- J. Install piping to allow application of insulation.
- K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- L. Reduce pipe sizes using concentric reducer fitting or eccentric reducer fitting installed with level side up.

- M. Make branch connections to mains using flow tees.
- N. Unless otherwise indicated, install branch connections to mains with the branch connected to the top or side of the main pipe.
- O. Terminate piping with downturned elbows above an approved indirect receptor or other approved location as indicated on drawings.
- P. Provide an air gap between the pipe termination and receptor or other approved location that is not less than 2 times the effective diameter or the pipe.
- Q. Install unions in piping, NPS 2 and smaller at final connections of equipment, and elsewhere as indicated.
- R. Identify piping as specified in Specification Section 23 05 53, Identification for HVAC Piping and Equipment.
- S. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Specification Section 23 05 17, Sleeves and Sleeve Seals for HVAC Piping.
- T. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Specification Section 23 05 17, Sleeves and Sleeve Seals for HVAC Piping.
- U. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Specification Section 23 05 18, Escutcheons for HVAC Piping.

3.03 HANGERS AND SUPPORTS

- A. Hanger, support, and anchor devices are specified in Specification Section 23 05 29, Hangers and Supports for HVAC Piping and Equipment. Comply with the following requirements for maximum spacing of supports.
- B. Vibration isolation devices are specified in Specification Section 23 05 48.13, Vibration Controls for HVAC Piping and Equipment.
- C. Install the following pipe attachments:
 - 1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
 - 2. Wrap copper piping with not less than two layers of 10-mil-thick black plastic tape extending a minimum of 1 inch on each side of clamp for electrolytic protection where hangers or supports are in direct contact with copper piping.
- D. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:

	Maximum Span	Minimum Rod Size
NPS 3/4	5 feet	1/4 inch
NPS 1	6 feet	1/4 inch
NPS 1-1/4	6 feet	3/8 inch
NPS 1-1/2	8 feet	3/8 inch

	Maximum Span	Minimum Rod Size
NPS 2	8 feet	3/8 inch
NPS 2-1/2	9 feet	3/8 inch
NPS 3	10 feet	3/8 inch
NPS 4	10 feet	1/2 inch

- E. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

3.04 PIPE JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 23 sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B828 or CDA's Copper Tube Handbook, using lead-free solder alloy complying with ASTM B32.
- E. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

3.05 TERMINAL EQUIPMENT CONNECTIONS

- A. Install vented traps at cooling coil condensate pan connections. Size trap and connected piping the same as or larger than equipment connections.
- B. Size trap to provide seal against fan static pressure.

3.06 FIELD QUALITY CONTROL

- A. Prepare drain piping according to ASME B31.9 and as follows:
1. Leave joints uninsulated and exposed for examination during test.
 2. Flush drain piping systems with clean water.
 3. Isolate equipment from piping.
- B. Perform the following tests on drain piping:
1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
 2. Subject piping system to hydrostatic test pressure that is equal to 10 feet of water column or maximum that can be obtained based on installed conditions.
 3. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening,

repairing, or replacing components, and repeat hydrostatic test until there are no leaks.

4. Prepare written report of testing.

END OF SECTION

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SECTION 23 21 23

HYDRONIC PUMPS

PART 1 GENERAL

1.01 SUMMARY

- A. This section includes the following:
 - 1. Separately coupled, base-mounted, end-suction centrifugal pumps.

1.02 SUBMITTALS

- A. Product Data: Provide manufacturer's product data for each unit indicated on the drawings. Data to be specific to the equipment proposed for the project with all options and accessories indicated. Include the following as a minimum:
 - 1. Manufacturer and model number.
 - 2. Rated capacity based on scheduled conditions.
 - 3. Certified performance curves with operating point indicated.
 - 4. Equipment dimensions.
 - 5. Required clearances.
 - 6. Electrical Data:
 - a. Motor horsepower.
 - b. Motor Voltage/Phase/Hz.
 - 7. Materials of construction.
 - 8. Accessories and options.
- B. Warranty information.
- C. Operation and maintenance data.

1.03 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to the Authorities Having Jurisdiction, and marked for intended use.
- B. UL Compliance: Comply with UL 778 for motor-operated water pumps.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with requirements, provide products by one of the manufacturers specified.
 - 1. Armstrong Pumps Inc.
 - 2. Aurora Pump; Division of Pentair Pump Group.
 - 3. Bell & Gossett; Division of ITT Industries.
 - 4. PACO Pumps.
 - 5. Patterson Pump Company; A Gorman-Rupp Company.
 - 6. Taco, Inc.
 - 7. Weinman; Division of Crane Pumps & Systems.

2.02 SEPARATELY COUPLED, BASE-MOUNTED, END-SUCTION CENTRIFUGAL PUMPS

- A. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, end-suction pump as defined in HI Standards 1.1-1.2 and 1.3; designed for base mounting, with pump and motor shafts horizontal. Rate pump for 175-psig minimum working pressure and a continuous water temperature of 250°F.
- B. Pump Construction:
 - 1. Casing: Radially split, cast iron, threaded gage tapings at inlet and outlet, drain plug at bottom and air vent at top of volute, and threaded companion-flange or flanged connections. Provide integral mount on volute to support the casing, and attached piping to allow removal and replacement of impeller without disconnecting piping or requiring the realignment of pump and motor shaft.
 - 2. Impeller: ASTM B584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. Trim impeller to match specified performance.
 - 3. Pump Shaft: Stainless steel.
 - 4. Mechanical Seal:
 - a. Closed Loop Systems: Internally flushed carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N or EPT bellows and gasket.
 - b. Open Loop Systems: Externally flushed carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N or EPT bellows and gasket.
 - 5. Pump Bearings: Grease-lubricated ball bearings contained in cast-iron housing with grease fittings.
- C. Shaft Coupling: Molded EPDM two-piece element with hubs. Element shall be replaceable without disassembly and removal of pump shaft or motor. Provide Woods Dura-Flex coupling or approved equal.
- D. Coupling Guard: Dual rated; ANSI B15.1, Section 8; OSHA 1910.219 approved; steel; removable; attached to mounting frame.
- E. Mounting Frame: Welded-steel frame and cross members, factory fabricated from ASTM A36/A36M channels and angles. Fabricate to mount pump casing, coupling guard, and motor.
- F. Motor: Single speed, with grease-lubricated ball bearings, unless otherwise indicated; secured to mounting frame, with adjustable alignment. Select motor to be non-overloading throughout the entire pump curve at the scheduled operating conditions. Comply with requirements in Specification Section 23 05 13, Common Motor Requirements for HVAC Equipment.

2.03 PUMP SPECIALTY FITTINGS

- A. Suction Diffuser: Angle pattern, 175-psig pressure rating, cast or ductile-iron body and end cap, pump-inlet fitting; with stainless-steel or bronze startup, and bronze or stainless-steel permanent strainers; bronze or stainless-steel straightening vanes; drain plug; and factory-fabricated support.
- B. Triple-Duty Valve: Angle or straight pattern, 175-psig pressure rating, cast or ductile-iron body, pump-discharge fitting; with drain plug and bronze-fitted shutoff, balancing, and check valve features. Brass gage ports with integral check valve, and orifice for flow measurement.

2.04 ACCESSORIES

- A. Shaft Grounding Ring: Solid or split aluminum ring with carbon-fiber, electrically conductive brushes designed to transmit stray electrical current from the motor shaft to the motor casing. Attach ring to motor with conductive epoxy or bolted brackets.

PART 3 EXECUTION

3.01 PUMP INSTALLATION

- A. Comply with HI Standard 1.4.
- B. Install pumps with access for periodic maintenance including removal of motors, impellers, couplings, and accessories.
- C. Support pumps as recommended by the manufacturer.
- D. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.
- E. Base-Mounted Pumps:
 - 1. Install on cast-in-place concrete equipment bases. Comply with requirements in Division 03 specifications.
 - a. Coordinate sizes and locations of concrete bases with actual equipment provided.
 - b. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of concrete base.
 - c. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - d. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - e. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - f. Construct concrete bases 4 inches high and extend base not less than 2 inches in all directions beyond the maximum dimensions of base-mounted pumps unless otherwise indicated or required.
 - g. Minimum Compressive Strength: 4,000 psi at 28 days.
 - h. Mount pumps on isolation bases where required by Specification Section 23 05 48.13, Vibration Controls for HVAC Piping and Equipment. Install isolation bases on concrete bases.
 - 2. Disconnect couplings on separately coupled pumps before setting. Do not reconnect couplings until alignment procedure is complete.
 - 3. Support pump baseplate on rectangular metal blocks and shims, or on metal wedges with small taper, at points near anchor bolts to provide a gap of 3/4 to 1-1/2 inches between pump base and concrete base for grouting.
 - 4. Adjust metal supports or wedges until pump and driver shafts are level. Check coupling faces and suction and discharge flanges of pump to verify that they are level and plumb.

3.02 ALIGNMENT

- A. Engage a factory-authorized service representative to perform alignment services.

- B. Comply with requirements in the HI Standards for alignment of pump and motor shaft of separately coupled pumps. Add shims to the motor feet and bolt motor to base frame. Do not use grout between motor feet and base frame.
- C. Comply with pump and coupling manufacturer's written instructions.
- D. After alignment is correct, tighten anchor bolts evenly but not too firmly. Completely fill baseplate with non-shrink, non-metallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

3.03 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to machine to allow service and maintenance.
- C. Connect piping to pumps. Install valves that are the same size as piping connected to pumps.
- D. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.
- E. Install check valve and shutoff valve on discharge side of pumps powered by variable frequency drives or as indicated on the drawings.
- F. Install triple-duty valve on discharge side of pumps not powered by variable frequency drives or as indicated on the drawings.
- G. Install Y-type strainer or suction diffuser with strainer screen, and shutoff valve on suction side of pumps as indicated on the drawings. Provide suction diffuser with strainer screen where pump does not have a minimum of five pipe diameters of straight piping leading into the pump inlet.
- H. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.
- I. Install a single pressure gage with tubing and isolation valves to strainer inlet, pump suction and pump discharge at integral pressure-gage tapping.
- J. Ground equipment according to Division 26.
- K. Connect wiring according to Division 26.

3.04 ADJUSTMENTS

- A. During testing and balancing, at no additional cost to the Owner, coordinate with pump supplier to trim impeller as directed by the Test and Balance Contractor if pump flow exceeds 130% of scheduled flow.

END OF SECTION

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SECTION 23 25 00

HVAC WATER TREATMENT

PART 1 GENERAL

1.01 SUMMARY

- A. This section includes the following HVAC water-treatment systems:
 - 1. Closed-loop chemical feed systems.
 - 2. HVAC water-treatment chemicals.

1.02 PERFORMANCE REQUIREMENTS

- A. Water quality for HVAC systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of HVAC equipment without creating a hazard to operating personnel or the environment.
- B. Base HVAC water treatment on quality of water available at project site, HVAC system equipment material characteristics and functional performance characteristics, and requirements and guidelines of the Authorities Having Jurisdiction (AHJ).
- C. Closed-loop hydronic systems shall have the following water qualities:
 - 1. pH: Maintain a value within 8.3 to 9.5.
 - 2. "P" Alkalinity: Maintain a value within 100 to 500 ppm.
 - 3. Boron: Maintain a value within 100 to 200 ppm.
 - 4. Chemical Oxygen Demand for Non-Glycol Systems: Maintain a maximum value of 100 ppm.
 - 5. Soluble Copper: Maintain a maximum value of 0.20 ppm.
 - 6. TDS: Maintain a maximum value of 1,500 ppm.
 - 7. Ammonia: Maintain a maximum value of 20 ppm.
 - 8. Free Caustic Alkalinity: Maintain a maximum value of 20 ppm.
 - 9. Microbiological Limits:
 - a. Total Aerobic Plate Count: Maintain a maximum value of 1,000 organisms/ml.
 - b. Total Anaerobic Plate Count: Maintain a maximum value of 100 organisms/ml.
 - c. Nitrate Reducers: Maintain a maximum value of 100 organisms/ml.
 - d. Sulfate Reducers: Maintain a maximum value of 0 organisms/ml.
 - e. Iron Bacteria: Maintain a maximum value of 0 organisms/ml.
- D. Passivation for Galvanized Steel: For the first 60 days of operation.
 - 1. pH: Maintain a value within 7 to 8.
 - 2. Calcium Carbonate Hardness: Maintain a value within 100 to 300 ppm.
 - 3. Calcium Carbonate Alkalinity: Maintain a value within 100 to 300 ppm.

1.03 SUBMITTALS

- A. Product Data: For each type of product or chemical indicated. Include pretreatment and chemical treatment equipment showing tanks, maintenance space required, electrical requirements, and piping connections to HVAC systems.
 - 1. Wiring Diagrams: Power and control wiring.
- B. Material Safety Data Sheets for all chemicals.

- C. Field quality-control test reports.
- D. Other Informational Submittals:
 - 1. Water-Treatment Program: Written sequence of operation on an annual basis for the application equipment required to achieve water quality defined in the Performance Requirements article above.
 - 2. Water Analysis: Illustrate water quality available at project site.
 - 3. Loop Cleaning Confirmation Report: Verify proper cleaning of the hydronic loops and confirm this observation in a letter to the Engineer.

1.04 QUALITY ASSURANCE

- A. HVAC Water-Treatment Service Provider Qualifications: An experienced HVAC water-treatment service provider capable of analyzing water qualities, installing water-treatment equipment, and applying water treatment as specified in this section.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to the AHJ, and marked for intended use.

1.05 WARRANTY

- A. Special Guarantee: Provide a guarantee that the treated systems will remain scale- and algae-free for a period of 2 years when the provided chemicals are used as directed. If scaling or fouling occurs when the provided chemicals are used as directed, the Water Treatment Firm shall clean the system(s) at no cost to the Owner.
- B. Provide all parts, chemicals, and labor required to maintain the chemical treatment systems in good working order during the warranty period.

PART 2 PRODUCTS

2.01 PROVIDERS

- A. Approved Providers: Engage the services of the facility's current water treatment provider.

2.02 CLOSED-LOOP CHEMICAL TREATMENT

- A. Bypass Feeders: Steel welded tube body with semi-elliptical top and bottom heads, with corrosion-resistant interior and exterior epoxy coating, minimum 3-1/2-inch fill opening in the top, NPS 3/4 bottom side inlet and top side outlet, and NPS 3/4 bottom drain outlet. Quarter turn or threaded fill cap with gasket seal and diaphragm to lock the top on the feeder when exposed to system pressure in the vessel. Provide with three welded steel legs with mounting feet.
 - 1. Capacity: 5 gallons.
 - 2. Minimum Working Pressure: 125 psig at 200°F.
- B. Chemicals: Water-treatment system manufacturer shall recommend chemicals that are compatible with piping system components and connected equipment, and that can attain water quality specified in Part 1, Performance Requirements article.

1. Cleaner: Alkaline-based cleaner designed for the removal of oil, corrosion and other contaminants from closed-loop piping systems and equipment, and to form passivating film to protect against corrosion. The cleaner shall contain the following as a minimum:
 - a. Polyphosphonate: Mild Steel Corrosion Inhibitor.
 - b. Tolyltriazole (TT): Yellow Metal Corrosion Inhibitor.
 - c. Polymer: Dispersant & Oil Emulsifier.
2. Corrosion Inhibitor: Designed to prevent corrosion in closed-loop piping and containing the following:
 - a. Nitrite: Mild Steel Corrosion Inhibitor.
 - b. Molybdate: Mild Steel Corrosion Inhibitor.
 - c. Tolyltriazole (TT): Yellow Metal Corrosion Inhibitor.
 - d. Polymer Control: General Dispersant & Deposition.
 - e. Inert Chemical Tracer: Testing, Monitoring & Online Control.
3. Closed-Loop Biocide: Provide a non-oxidizing biocide for quarterly treatment of each closed-loop system. This biocide shall be Glutaraldehyde.

PART 3 EXECUTION

3.01 WATER ANALYSIS

- A. Perform an analysis of supply water to determine quality of water available at project site.

3.02 INSTALLATION

- A. Furnish to and coordinate with the Mechanical Contractor all items specified herein that are installed in piping systems.

3.03 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.
- C. Make piping connections between HVAC water-treatment equipment and dissimilar-metal piping with dielectric fittings.
- D. Unless otherwise indicated, connect piping with unions and shutoff valves to allow equipment to be disconnected without draining piping.
- E. Install shutoff valves on HVAC water-treatment equipment inlet and outlet.
- F. Confirm applicable electrical requirements in Division 26 sections for connecting electrical equipment.
- G. Ground equipment according to Division 26.
- H. Connect wiring according to Division 26.

3.04 CLEANING

- A. Provide cleaner to the Mechanical Contractor as required to maintain the manufacturer's recommended concentration for cleaning of the hydronic systems.

- B. Supervise cleaning of the hydronic systems to ensure the following:
1. The cleaning solution is circulated a minimum of 24 hours or longer as required to thoroughly clean the interior of the piping systems.
 2. The system is drain and flushed until all cleaning chemicals and suspended materials have been removed from the system.

3.05 CHEMICAL ADDITION

- A. Closed-Loop Systems:
1. Immediately after system testing, cleaning and flushing, add the required amount of corrosion inhibitor to reach the manufacturer's recommended concentration or the following:

Corrosion Inhibitor	Concentration
Chilled Loop Molybdate	62 – 125 ppm as MoO ₄
Chilled Loop Nitrite	250 – 500 ppm as NO ₂
Energy Recovery Loop Molybdate	125 – 187 ppm as MoO ₄
Energy Recovery Loop Nitrite	500 – 750 ppm as NO ₂

2. Install the corrosion coupons in the coupon rack after the initial chemical addition.

3.06 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
1. Inspect field-assembled components and equipment installation, including piping and electrical connections.
 2. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational before introducing chemicals for water-treatment system.
 3. Place HVAC water-treatment system into operation and calibrate controls during the preliminary phase of HVAC system startup procedures.
 4. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.
 5. Test for leaks and defects. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 6. Leave uncovered and unconcealed new, altered, extended, and replaced water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.
 7. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow test pressure to stand for 4 hours. Leaks and loss in test pressure constitute defects.
 8. Repair leaks and defects with new materials and retest piping until no leaks exist.
- C. At 1-week intervals during the warranty period, perform separate water analyses on hydronic systems to show that automatic chemical feed systems are maintaining water quality within performance requirements specified in this section. Submit written reports of water analysis advising the Owner of changes necessary to adhere to Part 1, Performance Requirements article.

- D. Comply with ASTM D3370 and with the following standards:
 - 1. Silica: ASTM D859.
 - 2. Acidity and Alkalinity: ASTM D1067.
 - 3. Iron: ASTM D1068.
 - 4. Water Hardness: ASTM D1126.

3.07 DEMONSTRATION

- A. Engage a factory-authorized service representative to train the Owner's maintenance personnel to adjust, operate, and maintain HVAC water-treatment systems and equipment. Refer to Division 01 specifications.
- B. Review manufacturer's safety data sheets for handling of chemicals.
- C. Train the Owner's maintenance personnel in performing onsite testing of water samples.

3.08 SUPPLIES

- A. Provide all chemicals, testing supplies, log sheets, laboratory analysis, and other consumables required to maintain the proper chemical balance in the system(s) during the warranty period.

END OF SECTION

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SECTION 23 25 01

GLYCOL FEED SYSTEM

PART 1 GENERAL

1.01 SUMMARY

- A. This section includes a complete, assembled glycol feed system complete with tanks, pump, controls, frame, piping, etc.

1.02 SUBMITTALS

- A. Product Data: Provide manufacturer's product data for each unit indicated on the drawings. Data to be specific to the equipment proposed for the project with all options and accessories indicated. Include the following as a minimum:
 - 1. Manufacturer and model number.
 - 2. Rated capacity based on scheduled conditions.
 - 3. Equipment dimensions.
 - 4. Required clearances.
 - 5. Electrical Data:
 - a. Motor horsepower.
 - b. Voltage/Phase/Hz.
 - c. Full load ampacity, minimum circuit ampacity and maximum overcurrent protection device requirements.
 - d. Electrical service point(s) of connection.
 - e. AIC rating of the equipment.
 - 6. Materials of construction.
 - 7. Accessories and options.
 - 8. Controls.
- B. Warranty information.
- C. Operation and maintenance data.

1.03 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to the Authorities Having Jurisdiction, and marked for intended use.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with requirements, provide products by one of the manufacturers specified.
 - 1. Advantage Controls.
 - 2. J. L. Wingert Company.
 - 3. John Wood Company.
 - 4. Neptune Chemical Pump Company.

2.02 GLYCOL FEED SYSTEM

- A. Tank: Translucent, polyethylene tank with fluid scale on side, minimum 50-gallon capacity, with cover and fill port.
- B. Stand: Painted, welded steel designed to support tank, pump controls and piping. Provided with bolt pads for securing system to mounting pad.
- C. Pump: Bronze rotary gear pump with a capacity of 1.5 gallons per minute at a pressure of 100 psi. Pump shall be mounted below the tank.
- D. Pump Discharge Manifold: All steel or brass construction complete with pump isolation valve, pressure gauge, check valve, and brass relief valve. Relief valve outlet to be piped to top of tank.
- E. Pump Intake Piping: Steel or PVC pipe and fittings complete with strainer and ball valve.
- F. Control Panel: NEMA 4X sized with main power switch, pump hand-off-auto switch and indicator light, low-level indicator light, contactor for building automation system monitoring of low-level alarm. Panel to be mounted to stand.
- G. Wiring: All system wiring to be contained in conduit. No exposed wiring is permitted.
- H. Controls: Low-level switch to monitor tank fluid level and disable pump on low fluid level. Pressure switch to start/stop pump based on pressure in system piping loop.

PART 3 EXECUTION

3.01 FEED SYSTEM INSTALLATION

- A. Install system with access for periodic maintenance and filling.
- B. Install on cast-in-place concrete equipment bases. Comply with requirements in Division 03 specifications.
 - 1. Coordinate sizes and locations of concrete bases with actual equipment provided.
 - 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of concrete base.
 - 3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 5. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 6. Construct concrete bases 4 inches high and extend base not less than 2 inches in all directions beyond the maximum dimensions of base-mounted pumps unless otherwise indicated or required.
 - 7. Minimum Compressive Strength: 4,000 psi at 28 days.
- C. Set pump cutoff pressure 10 psi higher than pressure-reducing valve setpoint indicated on the drawings.
- D. Set pump cut-in pressure minimum 20 psi higher than cutoff pressure.

- E. Label tank with contained solution.
- F. Fill tank with proper solution.

3.02 CONNECTIONS

- A. Connect glycol feed system discharge piping to closed-loop pressure-reducing valve using minimum 3/4-inch piping or size as indicated on the drawings.
- B. Ground equipment according to Division 26.
- C. Connect wiring according to Division 26.
- D. Connect low-level alarm to building automation system.

3.03 FIELD QUALITY CONTROL

- A. Perform the following before operating the system:
 - 1. Open manual valves fully.
 - 2. Inspect pumps for proper rotation.
 - 3. Set for required system pressure.
 - 4. Fill tank with proper solution.

END OF SECTION

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SECTION 23 31 13

METAL DUCTS

PART 1 GENERAL

1.01 SUMMARY

- A. This section includes:
 - 1. Rectangular rigid ducts and fittings.
 - 2. Round rigid ducts and fittings.
 - 3. Sheet metal materials.
 - 4. Duct liner.
 - 5. Sealants and gaskets.
 - 6. Hangers and supports.

1.02 PERFORMANCE REQUIREMENTS

- A. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- B. Wind-Restraint Performance: As listed on the drawings.

1.03 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Provide the following for each duct application and pressure classification: Metal gauge, construction methods, reinforcement details and spacing, hangers and support details, seam and joint types. Include manufacturer, description of material, locations for use, R-value, and thickness for duct liner.
- C. Delegated-Design Submittal: For wind-restraint calculations and details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - 1. Design Calculations: Calculate static and dynamic loading due to ductwork and accessories weight, wind forces required to select wind restraints.
 - 2. Coordinate design calculations with wind load calculations required for ductwork mounted outdoors.
- D. Wind-Restraint Details:
 - 1. Design Analysis: To support selection and arrangement of wind restraints. Include calculations of combined tensile and shear loads.
 - 2. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
 - 3. Coordinate seismic-restraint details with wind-restraint details required for ductwork mounted outdoors.
 - 4. Pre-Approval and Evaluation Documentation: By an agency acceptable to Authorities Having Jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations). Commercial trade organizations are not an acceptable evaluation service.

- E. Welding certificates.

1.04 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1/D1.1M, Structural Welding Code - Steel, for hangers and supports.
 - 2. AWS D9.1M/D9.1, Sheet Metal Welding Code, for duct joint and seam welding.

PART 2 PRODUCTS

2.01 RECTANGULAR RIGID DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's HVAC Duct Construction Standards - Metal and Flexible, 3rd Edition, based on indicated static-pressure class unless otherwise indicated.
- B. Duct sizes shown on the drawings are clear, inside dimensions. Adjust sizes of sheet metal ductwork to account for duct lining.
- C. Exterior Ductwork: Cross-break or slope the top of all ductwork mounted outside the building to promote drainage and prevent water from ponding on the top of the ductwork.
- D. Transverse Joints: Fabricate according to SMACNA's HVAC Duct Construction Standards - Metal and Flexible, 3rd Edition, Figure 2-1, Transverse (Girth) Joints, or manufacturer's instructions for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's HVAC Duct Construction Standards - Metal and Flexible, 3rd Edition. Select joint types from the following:
 - 1. Flat Drive Slip, T-1, T-3.
 - 2. Standing Drive Slip, T-2.
 - 3. Hemmed "S" Slip, T-6.
 - 4. Companion, Angle-Van Stone Type, T-22, T-22 Alternate.
 - 5. Flanged, formed, T-24, T-24 Alternate, or one of the following manufactured products:
 - a. Ductmate or WDCI by Ductmate Industries, Inc.
 - b. Elgen- or J-Flange by Elgen Manufacturing.
 - c. FLG J or H by Ward Industries; a Division of Hart & Cooley, Inc.
 - d. J Flange by CL Ward & Family, Inc.
 - e. J Flange by Nexus PDQ; Division of Shilco Holdings Inc.
- E. Longitudinal Seams: Fabricate according to SMACNA's HVAC Duct Construction Standards - Metal and Flexible, 3rd Edition, Figure 2-2, Longitudinal Seams - Rectangular Ducts, for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's HVAC Duct Construction Standards - Metal and Flexible, 3rd Edition. Select seam type based on the following:
 - 1. Duct with Static Pressure 2-Inch wg and Less: Pittsburgh lock hammered flat, L-1, or button punch snap lock, L-2. Do not use button punch snap lock on aluminum duct.
 - 2. Duct with Static Pressure Greater than 2-Inch wg: Pittsburgh lock hammered flat, L-1.
- F. Elbows: Fabricate according to SMACNA's HVAC Duct Construction Standards - Metal and Flexible, 3rd Edition, Figure 4-2, Rectangular Elbows. Comply with requirements for indicated static-pressure class, sealing requirements, support intervals, and other

provisions in SMACNA's HVAC Duct Construction Standards - Metal and Flexible, 3rd Edition. Select elbows from the following types:

1. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
2. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
3. Mitered Type RE 2 with single thickness turning vanes complying with SMACNA's HVAC Duct Construction Standards - Metal and Flexible, Figure 4-3, Vanes and Vane Runners, and Figure 4-4, Vane Support in Elbows.

- G. Branches: Fabricate according to SMACNA's HVAC Duct Construction Standards - Metal and Flexible, 3rd Edition, Figure 4-5, Divided Flow Branches and Figure 4-6, Branch Connections. Comply with requirements for indicated static-pressure class, sealing requirements, support intervals, and other provisions in SMACNA's HVAC Duct Construction Standards - Metal and Flexible, 3rd Edition. Select branch connections from the following types:
1. Rectangular Main to Rectangular Branch: 45-degree entry.
 2. Rectangular Main to Round Branch: Conical or 45-degree lead in.
- H. Transitions, Offsets, and Other Duct Construction: Select types and fabricate according to SMACNA's HVAC Duct Construction Standards - Metal and Flexible, 3rd Edition, Chapter 4, Fittings and Other Construction, for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's HVAC Duct Construction Standards - Metal and Flexible, 3rd Edition.

2.02 ROUND RIGID DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's HVAC Duct Construction Standards - Metal and Flexible, Chapter 3, Round, Oval, and Flexible Duct, based on indicated static-pressure class unless otherwise indicated.
- B. Duct sizes shown on the drawings are clear, inside dimensions. Adjust sizes of sheet metal ductwork to account for duct lining.
- C. Transverse Joints: Select joint types and fabricate according to SMACNA's HVAC Duct Construction Standards - Metal and Flexible, 3rd Edition, Figure 3-1, Transverse Joints - Round Duct, for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's HVAC Duct Construction Standards - Metal and Flexible, 3rd Edition.
1. Transverse Joints in Ducts Larger than 60 Inches in Diameter: Flanged or the following manufactured products:
 - a. SpiralFlange by CL Ward & Family, Inc.
- D. Spiral Seams: Provide spiral seam ductwork using seam RL-1 and fabricate according to SMACNA's HVAC Duct Construction Standards - Metal and Flexible, Figure 3-2, Round Duct Longitudinal Seams, for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's HVAC Duct Construction Standards - Metal and Flexible, 3rd Edition.
1. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
- E. Elbows: Fabricate according to SMACNA's HVAC Duct Construction Standards - Metal and Flexible, 3rd Edition, Figure 3-4, Round Duct Elbows. Comply with requirements for indicated static-pressure class, sealing requirements, support intervals, and other provisions in SMACNA's HVAC Duct Construction Standards - Metal and Flexible, 3rd Edition.
1. Minimum Radius-to-Diameter Ratio shall be 1.5.

2. Elbow Segments: Comply with SMACNA's HVAC Duct Construction Standards - Metal and Flexible, 3rd Edition, Table 3-1, Mitered Elbows. Elbows with less than 90-degree change of direction have proportionately fewer segments.
 3. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
 4. Round Elbows, 14 Inches and Larger in Diameter: Welded.
- F. Tees and Laterals: Fabricate according to SMACNA's HVAC Duct Construction Standards - Metal and Flexible, 3rd Edition, Figure 3-5, 90 Degree Tees and Laterals, and Figure 3-6, Conical Tees. Comply with requirements for indicated static-pressure class, sealing requirements, support intervals, and other provisions in SMACNA's HVAC Duct Construction Standards - Metal and Flexible, 3rd Edition. Select tees and laterals based on the following:
1. Velocity up to 1,500 fpm: Conical tap.
 2. Velocity 1,500 fpm or Higher: 45-degree lateral.
 3. Conical saddle taps may be used in existing duct.

2.03 PRODUCT CONVEYING DUCTWORK

- A. General Fabrication Requirements: Comply with SMACNA's Round Industrial Duct Construction Standards based on indicated static-pressure class unless otherwise indicated.
- B. Duct sizes shown on the drawings are clear, inside dimensions.
- C. Transverse Joints: Joints shall be air- and liquid-tight. Joints may be welded, soldered, flanged with gaskets, or clamped with gaskets.
- D. Longitudinal Seams: Seams shall be air- and liquid-tight. Seams may be welded, soldered or sealed with sealant compatible with the chemicals used in the system. Sealant shall be integral to the seam. Field-applied sealant is not allowed.
- E. Elbows: Fabricate according to SMACNA's Round Industrial Duct Construction Standards. Comply with requirements for indicated static-pressure class, sealing requirements, support intervals, and other provisions.
1. Minimum Radius-to-Diameter Ratio shall be 1.5.
 2. Elbow Segments: Comply with SMACNA's Round Industrial Duct Construction Standards. Elbows with less than 90-degree change of direction have proportionately fewer segments.
 3. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or welded.
 4. Round Elbows, 14 Inches and Larger in Diameter: Welded.
- F. Tees and Laterals: Fabricate according to SMACNA's Round Industrial Duct Construction Standards. Comply with requirements for indicated static-pressure class, sealing requirements, support intervals, and other provisions in SMACNA's Round Industrial Duct Construction Standards. Select tees and laterals based on the following:
1. Velocity up to 1,500 fpm: Conical tap.
 2. Velocity 1,500 fpm or Higher: 45-degree lateral.
 3. Conical saddle taps may be used in existing duct.

2.04 SHEET METAL MATERIALS

- A. General Material Requirements: Comply with SMACNA's HVAC Duct Construction Standards - Metal and Flexible for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

- B. Galvanized Sheet Steel: Comply with ASTM A653/A653M.
 - 1. Galvanized Coating Designation: G90.
 - 2. Finishes for Surfaces Exposed to View: Mill phosphatized.
- C. Stainless-Steel Sheets: Comply with ASTM A480/A480M, Type 304 or 316, as indicated in the Duct Schedule article; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in the Duct Schedule article.
- D. Aluminum Sheets: Comply with ASTM B209 Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.
- E. Reinforcement Shapes and Plates: ASTM A36/A36M, steel plates, shapes, and bars; black and galvanized.
 - 1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.
- F. Tie Rods: Galvanized steel, stainless steel, or aluminum to match duct material, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.05 DUCT LINER

- A. Closed-Cell Foam Duct Liner: Closed-cell elastomeric thermal and acoustical insulation formed without the use of CFCs, HFCs or HCFCs. Comply with ASTM C534 Grade 1 Type II, NFPA 90A, or NFPA 90B.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Armacell LLC.
 - b. K-Flex USA.
 - 2. Product shall have a smooth skin on the side exposed to the airstream.
 - 3. Flame Spread and Smoke Development: Products 1 inch and less in thickness shall have a flame spread of less than 25 and a smoke development rating of less than 50 when tested in accordance with ASTM E84.
 - 4. Maximum Thermal Conductivity: Maximum 0.27 Btu x in./h x sq.ft. x degrees F at 75°F mean temperature.
 - 5. Anti-Microbial Agent: Manufacture product with an anti-microbial agent incorporated into the base material.
 - 6. Adhesive: Air-drying, low-VOC, contact adhesive suitable for liner material. When dry adhesive shall have a flame spread of less than 25 and a smoke development rating of less than 50 when tested in accordance with ASTM E84.
- B. Shop Application of Closed-Cell Foam Duct Liner: Comply with SMACNA's HVAC Duct Construction Standards - Metal and Flexible, 3rd Edition, Figure 7-11, Flexible Duct Liner Installation and the insulation manufacturer's installation instructions.
 - 1. Duct sizes shown on the drawings are clear, inside dimensions. Adjust sizes of sheet metal ductwork to account for duct lining.
 - 2. Adhere a single layer of indicated thickness of duct liner with at least 90% adhesive coverage at liner contact surface area. Do not apply adhesive 1/2 inch on either side of butt joints. Attaining indicated thickness with multiple layers of duct liner is prohibited.
 - 3. Apply adhesive to transverse edges of liner facing upstream.
 - 4. Butt transverse joints using compression fit. Overlap insulation 1/4 inch at butt joints, apply adhesive to edges and compress edges into place. Liner should not be adhered to ductwork 1/2 inch on either side of joint to allow for expansion and contraction.

5. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
6. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
7. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2,500 fpm.

2.06 SEALANT AND GASKETS

- A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
- B. Polymer Joint and Seam Sealant:
 1. Application Method: Pump applied during duct forming or assembly.
 2. Solids Content: Minimum 90%.
 3. Water resistant.
 4. Mold and mildew resistant.
 5. Non-skinning, non-drying.
 6. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
 7. Service: Indoor or outdoor.
 8. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless-steel, or aluminum sheets.
- C. Water-Based Joint and Seam Sealant:
 1. Application Method: Brush on.
 2. Solids Content: Minimum 65%.
 3. Shore A Hardness: Minimum 20.
 4. Water resistant.
 5. Mold and mildew resistant.
 6. VOC: Maximum 75 g/L (less water).
 7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
 8. Service: Indoor or outdoor.
 9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless-steel, or aluminum sheets.
- D. Flanged Joint Sealant: Comply with ASTM C920.
 1. General: Single-component, acid-curing, silicone, elastomeric.
 2. Type: S.
 3. Grade: NS.
 4. Class: 25.
 5. Use: O.
 6. For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- E. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.
- F. Round Duct Joint O-Ring Seals:
 1. Seal shall provide maximum leakage class of 3 cfm/100 sq.ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
 2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
 3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.07 HANGERS AND SUPPORTS

- A. Hanger Rods for Non-Corrosive Environments: Cadmium-plated steel rods and nuts.
- B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
- C. Strap and Rod Sizes: Comply with SMACNA's HVAC Duct Construction Standards - Metal and Flexible, 3rd Edition, Table 5-1, Rectangular Duct Hangers Minimum Size, and Table 5-2, Minimum Hanger Sizes for Round Duct.
- D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A603.
- E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A492.
- F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
- G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- H. Trapeze and Riser Supports:
 - 1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
 - 2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
 - 3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

PART 3 EXECUTION

3.01 DUCT INSTALLATION – GENERAL REQUIREMENTS

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved.
- B. Install ducts according to SMACNA's HVAC Duct Construction Standards - Metal and Flexible, 3rd Edition, unless otherwise indicated.
- C. Install round ducts in maximum practical lengths.
- D. Install ducts with fewest possible joints.
- E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
- F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
- G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

- I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.
- J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of the same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.
- K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Specification Section 23 33 00, Air Duct Accessories, for fire and smoke dampers.
- L. Protect duct interiors from moisture, construction debris, dust, and other foreign materials. Comply with the "Advanced Level" of cleanliness as defined in SMACNA's Duct Cleanliness for New Construction Guidelines.
 - 1. This includes protecting the ductwork from dirt, debris and moisture, during transportation to the jobsite, prior to installation at the jobsite, and after installation.

3.02 EXPOSED DUCTWORK INSTALLATION – ADDITIONAL REQUIREMENTS

- A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.
- B. Fabricate exposed ductwork with internal seam sealant.
- C. Construct joints with internal sealing elements.
- D. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.
- E. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.
- F. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.
- G. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.03 DUCT SEALING

- A. Seal ducts to the following seal classes according to SMACNA's HVAC Duct Construction Standards - Metal and Flexible:
 - 1. All Ductwork: Seal Class A.
 - 2. All joints, wall penetrations, and seams to be externally sealed even if internal sealant is applied during duct forming and fabrication, except for exposed ductwork.

3.04 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's HVAC Duct Construction Standards - Metal and Flexible, 3rd Edition, Chapter 5, Hangers and Supports.
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.
 2. Install powder-actuated concrete fasteners after concrete is placed and completely cured and as directed by the Structural Engineer.
- C. Hanger Spacing: Comply with SMACNA's HVAC Duct Construction Standards - Metal and Flexible, 3rd Edition, Table 5-1, Rectangular Duct Hangers Minimum Size, and Table 5-2, Minimum Hanger Sizes for Round Duct, for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
- D. Hangers Exposed to View: Threaded rod, and angle or channel supports.
- E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.
- F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.05 CONNECTIONS

- A. Make connections to equipment with flexible connectors complying with Specification Section 23 33 00, Air Duct Accessories.
- B. Comply with SMACNA's HVAC Duct Construction Standards - Metal and Flexible, 3rd Edition and requirements herein for branch, outlet and inlet, and terminal unit connections.

3.06 PAINTING

- A. Paint the inside of any ductwork including manual volume dampers that is visible through a grille, register, or diffuser with one coat of flat, black paint. Visible duct liner must have a black finish.

3.07 STARTUP

- A. Air Balance: Comply with requirements in Specification Section 23 05 93, Testing, Adjusting, and Balancing for HVAC.

3.08 DUCT SCHEDULE

- A. Fabricate rigid ducts with galvanized sheet steel except as otherwise indicated and as follows:
1. Underground Ducts: Concrete-encased, PVC-coated, galvanized sheet steel with thicker coating on duct exterior.
- B. Supply Ducts:
1. Ducts Connected to Fan Coil Units, Furnaces, Air-Conditioners, Heat Pumps, and Terminal Units:
 - a. Pressure Class: Positive 2-inch wg.
 - b. Minimum SMACNA Seal Class: Refer to Duct Sealing article.
 - c. SMACNA Leakage Class for Rectangular: 16.
 - d. SMACNA Leakage Class for Round and Flat Oval: 8.
 2. Ducts Connected to Make-Up Air-Handling Units:
 - a. Pressure Class: Positive 3-inch wg.

- b. Minimum SMACNA Seal Class: Refer to Duct Sealing article.
 - c. SMACNA Leakage Class for Rectangular: 8.
 - d. SMACNA Leakage Class for Round and Flat Oval: 4.
- C. Exhaust Ducts:
 - 1. Ducts Connected to Fans Exhausting Laboratory and Process (ASHRAE 62.1, Class 3 and 4) Air:
 - a. Type 316, stainless-steel sheet.
 - 1) Exposed to View: No. 4 finish.
 - 2) Concealed: No. 2B finish.
 - b. Pressure Class: Positive or negative 3-inch wg.
 - c. Minimum SMACNA Seal Class: Welded seams, joints, and penetrations.
 - d. SMACNA Leakage Class: 2.
- D. Outdoor-Air (Not Filtered, Heated, or Cooled) Ducts:
 - 1. Ducts Connected to Air-Handling Units:
 - a. Pressure Class: Positive or negative 2-inch wg.
 - b. Minimum SMACNA Seal Class: Refer to Duct Sealing article.
 - c. SMACNA Leakage Class for Rectangular: 16.
 - d. SMACNA Leakage Class for Round and Flat Oval: 8.
- E. Intermediate Reinforcement:
 - 1. Galvanized-Steel Ducts: Galvanized steel or carbon steel coated with zinc-chromate primer.
 - 2. PVC-Coated Ducts:
 - a. Exposed to Airstream: Match duct material.
 - b. Not Exposed to Airstream: Match duct material.
 - 3. Stainless-Steel Ducts:
 - a. Exposed to Airstream: Match duct material.
 - b. Not Exposed to Airstream: Match duct material.
 - 4. Aluminum Ducts: Aluminum.
- F. Duct Liner: Furnish ducts with duct liner for the following applications unless noted otherwise on the drawings:
 - 1. Rectangular Supply Air Ducts Downstream of HEPA Filters: Closed-cell foam, Type II, 1/2 inch thick with a minimum R-value of 2.

END OF SECTION

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SECTION 23 31 16.10

CORROSION RESISTANT DUCTWORK

PART 1 GENERAL

1.01 SUMMARY

- A. This section includes corrosive resistant, round ducts and fittings for product conveying exhaust air systems.

1.02 PERFORMANCE REQUIREMENTS

- A. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- B. Wind-Restraint Performance: As listed on the drawings.

1.03 QUALITY ASSURANCE

- A. Manufacturer shall be engaged in the regular and ongoing production of corrosive resistant ductwork and related components and accessories for a minimum of 3 years.
- B. Chlorinated polyvinyl chloride duct manufacturer shall have a current Underwriter's Laboratory Canada listing verifying material has been tested per ULC S102 requirements and has a flame spread rating of less than 5 and a smoke development rating of less than 25.
- C. Code Compliance:
 - 1. Applicable Edition of "International Mechanical Code."

1.04 SUBMITTALS

- A. Product Data: Manufacturer's literature including specifications, illustrations, engineering data, and materials of construction.
- B. Submit typical shop standards and/or SMACNA details for each class of duct specified, including particulars such as gauge sizes, welds, joint details and fitting configurations prior to start of work.

PART 2 PRODUCTS

2.01 CHLORINATED POLYVINYL CHLORIDE (CPVC) DUCTWORK AND ACCESSORIES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on the drawings or comparable product by the following:
 - 1. Harrison Machine and Plastic Corp.
- B. Materials:
 - 1. Chlorinated Polyvinyl Chloride (CPVC) ductwork and fittings shall be manufactured from a Type IV, Grade I, virgin, rigid polyvinyl chloride compound with a cell classification of 23437 per ASTM D-1784. The compound shall be Corzan CPVC material as manufactured by BFGoodrich Co.

2. Duct and fittings shall be approved for use without internal sprinklers, and ULC S102 compliant as a Class 1 air duct with a flame spread rating of 5 or less and a smoke development rating of 25 or less.
3. Duct Construction: Duct shall be seamless, extruded type.
4. Fittings:
 - a. Fittings shall be constructed in accordance with SMACNA guidelines.
 - b. Fitting seams shall be solvent cemented or hot-gas welded.
 - c. Round fittings shall be provided with sockets that comply with SMACNA guidelines.
 - d. Pressure Classification: Fittings shall be designed to be free from buckling, pulsing, warpage, sagging at negative 10-inches Water Gage, minimum.
5. Standard Elbows:
 - a. Standard elbow centerline radius shall be equal to 1-1/2 times the diameter.
 - b. Standard elbows up to 24-inch diameter shall be smooth mitered sections as specified below.
 - c. 0 degree to 44 degree elbows shall contain one mitered joint and two sections. 45 degree to 80 degree elbows shall have a minimum of two mitered joints and three sections. Elbows greater than 80 degree shall have a minimum of four mitered joints and five sections.
6. Hangers:
 - a. All ductwork shall be supported from saddle type supports. Support spacing shall not exceed 12-feet. All supports shall be structural aluminum, with Type 316 stainless steel anchors.
 - b. Each support shall be furnished with a 1/8-inch thick Teflon sheet to shield the duct from the support.

PART 3 EXECUTION

3.01 DUCT INSTALLATION – GENERAL REQUIREMENTS

- A. Install ducts according to the applicable SMACNA standards and the duct manufacturer's recommendations unless otherwise indicated.
- B. Install ducts with fewest possible joints.
- C. Install fabricated fittings for changes in directions, size, and shape and for connections.
- D. Install ducts, unless otherwise indicated, vertically and horizontally and parallel and perpendicular to building lines; avoid diagonal runs.
- E. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- F. Install ducts with a clearance of 1 inch.
- G. Conceal ducts from view in finished spaces wherever possible. Do not encase horizontal runs in solid partitions unless specifically indicated.
- H. Coordinate layout with suspended ceiling, duct shafts, structural members, lighting layouts, and similar finished work.

- I. Electrical Equipment Spaces: Route ducts to avoid passing through transformer vaults and electrical equipment spaces and enclosures.
- J. Non-Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls and are exposed to view, conceal spaces between construction openings and ducts or duct insulation with sheet metal flanges of same metal thickness as ducts. Overlap openings on four sides by at least 1-1/2 inches.
- K. Protect duct interiors from the elements and foreign materials until building is enclosed. Follow SMACNA's "Duct Cleanliness for New Construction."

3.02 CHLORINATED POLYVINYL CHLORIDE (CPVC) DUCTWORK

- A. Join duct sections and fittings using solvent cementing or thermal welding.
- B. Solvent cementing shall not be used for end to end joints.
- C. Use extra-heavy bodied CPVC cement for solvent cement joints.
- D. Follow the duct and fitting manufacturer's written directions for all joints.

3.03 HANGING AND SUPPORTING

- A. Support horizontal ducts within 24 inches of each elbow and within 48 inches of each branch intersection.
- B. Support vertical ducts at maximum intervals of 16 feet and at each floor.
- C. Install upper attachments to structures with an allowable load not exceeding one-fourth of failure (proof-test) load.
- D. Install concrete inserts before placing concrete.
- E. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
 - 1. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.

END OF SECTION

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SECTION 23 33 00

AIR DUCT ACCESSORIES

PART 1 GENERAL

1.01 SUMMARY

- A. This section includes:
 - 1. Manual volume dampers.
 - 2. Combination fire/smoke dampers.
 - 3. Flange connectors.
 - 4. Turning vanes.
 - 5. Duct-mounted access doors.
 - 6. Flexible connectors.
 - 7. Flexible ducts.

1.02 SUBMITTALS

- A. Product Data: Provide manufacturer's product data for each duct accessory intended for use on this project. Data to be specific to the items proposed for the project with all options and accessories indicated. Include the following as a minimum:
 - 1. Manufacturer and model number.
 - 2. Dimensions.
 - 3. Electrical data for damper motor operators including voltage and motor ampacity.
 - 4. Materials of construction.
 - 5. Accessories and options.
 - 6. Installation details for combination fire/smoke dampers for each application intended for this project.
- B. Test reports for combination fire/smoke dampers.
- C. Warranty information.
- D. Operation and maintenance data.

1.03 QUALITY ASSURANCE

- A. Comply with NFPA 90A, Installation of Air Conditioning and Ventilating Systems, and with NFPA 90B, Installation of Warm Air Heating and Air Conditioning Systems.
- B. Comply with AMCA 500-D testing for damper rating.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Comply with SMACNA's HVAC Duct Construction Standards - Metal and Flexible for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

- B. Galvanized Sheet Steel: Comply with ASTM A653/A653M.
 - 1. Galvanized Coating Designation: G90.
 - 2. Exposed-Surface Finish: Mill phosphatized.
- C. Stainless-Steel Sheets: Comply with ASTM A480/A480M, Type 304, and having a No. 2 finish for concealed ducts and No. 4 finish for exposed ducts.
- D. Aluminum Sheets: Comply with ASTM B209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, one-side bright finish for exposed ducts.
- E. Extruded Aluminum: Comply with ASTM B221, Alloy 6063, Temper T6.
- F. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- G. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.02 DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Air Balance Inc.
 - 2. Elgen Manufacturing.
 - 3. Greenheck Fan Corporation.
 - 4. McGill Airflow LLC.
 - 5. Metal Form.
 - 6. Nailor Industries Inc.
 - 7. National Controlled Air.
 - 8. Pottorff.
 - 9. Ruskin Company.
 - 10. Safe-Air-Dowco.
 - 11. Vent Products Company, Inc.
 - 12. Young Regulator Company.
- B. Manual Volume Dampers:
 - 1. Rectangular:
 - a. Factory fabricated for shutoff or balancing duty in branch ducts:
 - 1) Standard leakage rating, with linkage outside airstream.
 - 2) Suitable for horizontal or vertical applications.
 - 3) Frames:
 - a) Hat-shaped, galvanized-steel or aluminum channels.
 - b) Mitered and welded corners.
 - c) Flanges for attaching to walls and flangeless frames for installing in ducts.
 - 4) Blades:
 - a) Multiple with maximum blade width of 8 inches.
 - b) Opposed-blade design.
 - c) Stiffen damper blades for stability.
 - d) Galvanized steel, 0.064 inch thick, or aluminum 0.10 inch thick to match frame.
 - 5) Blade Axles: Galvanized steel or aluminum to match frame and blades.
 - 6) Bearings:
 - a) Oil-impregnated bronze or molded synthetic.

- b) Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
 - 7) Tie Bars and Brackets: Galvanized steel or aluminum to match frame and blades.
 - 8) Jackshaft:
 - a) Size: 1-inch diameter.
 - b) Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
 - c) Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.
 - 9) Damper Hardware:
 - a) Zinc-plated, die-cast core with dial and handle made of 3/32-inch-thick zinc-plated steel, and a 3/4-inch hexagon locking nut.
 - b) Include center hole to suit damper operating-rod size.
 - c) Include elevated platform for insulated duct mounting.
- b. Shop and field fabricated for balancing duty in duct runouts serving a single diffuser, grille, or register:
 - 1) Blade: Single blade volume damper constructed per SMACNA Standards.
 - 2) Handle: Stamped or cast metal configured to indicate damper position in duct. Provide extension to raise handle above duct insulation and locking device such as wing nut to secure extension device to side of damper bearing and duct, or standoff with locking quadrant to secure damper in position, similar to Ventlok 641 in uninsulated ducts, Ventlok 644 in insulated ducts, or Ventlok 555 with standoff in either.

2. Round:

- a. Factory fabricated for shutoff or balancing duty in branch ducts:
 - 1) Standard leakage rating.
 - 2) Suitable for horizontal or vertical applications.
 - 3) Frames: Galvanized-steel channel.
 - 4) Blades: Galvanized steel, minimum 16 gauge.
 - 5) Blade Axles: Plated steel extending minimum 6 inches beyond frame.
 - 6) Bearings: Nylon sleeve with stainless-steel thrust washers.
 - 7) Stops: Plated screw for both open and closed positions.
 - 8) Damper Hardware:
 - a) Zinc-plated, die-cast core with dial and handle made of 3/32-inch-thick zinc-plated steel, and a 3/4-inch hexagon locking nut.
 - b) Include center hole to suit damper operating-rod size.
 - c) Include elevated platform for insulated duct mounting.
 - d) Include locking quadrant to secure damper in position similar to Ventlok 555 or self-locking handle similar to Ventlok 641 in uninsulated ducts or Ventlok 644 in insulated ducts.
- b. Shop and field fabricated for balancing duty in duct runouts serving a single diffuser, grille or register:
 - 1) Blade: Single blade volume damper constructed per SMACNA Standards.
 - 2) Stamped or cast metal configured to indicate damper position in duct. Provide extension to raise handle above duct insulation and locking device such as wing nut to secure extension device to side

of damper bearing and duct, or standoff with locking quadrant to secure damper in position, similar to Ventlok 641 in uninsulated ducts, Ventlok 644 in insulated ducts, or Ventlok 555 with standoff in either.

2.03 COMBINATION FIRE AND SMOKE DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Greenheck Fan Corporation.
 - 2. Pottorff; a Division of PCI Industries, Inc.
 - 3. Ruskin Company.
- B. Combination Fire and Smoke Dampers:
 - 1. General Requirements: Label according to UL 555 and UL 555S by an NRTL.
 - 2. Closing rating in ducts up to 4-inch wg static pressure and maximum airflow through the open damper of 2,000 fpm.
 - 3. Smoke Detector: Integral, factory wired for single-point connection where indicated.
 - 4. Fire Rating: 1-1/2 hours or longer as required or noted on the drawings.
 - 5. Leakage: Class 1.
 - 6. Rectangular Damper Construction:
 - a. Frame: Hat-shaped, minimum 0.094-inch-thick galvanized sheet steel, with welded or interlocking, gusseted corners and mounting flange.
 - b. Blades: Horizontal, airfoil shaped, minimum 0.063-inch-thick galvanized sheet steel.
 - c. Mounting Sleeve: Factory-installed, galvanized sheet steel; length to suit wall or floor application.
 - 7. Round Damper Construction:
 - a. Frame/Sleeve: Round, minimum 0.040-inch-thick galvanized sheet steel.
 - b. Blades: Two-piece, 0.080-inch-thick galvanized sheet steel with silicone edge seal.
 - 8. Heat Response Device: Electric fuse link 165°F rated.
 - 9. Damper Motors: Two-position action, externally mounted unless indicated otherwise.
 - 10. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Specification Section 23 05 13, Common Motor Requirements for HVAC Equipment.
 - a. Motor Sizes: Provide motor large enough so driven load will not require motor to operate in service factor range above 1.0.
 - b. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 sections.
 - c. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
 - d. Spring-Return Motors: Equip with an integral spiral-spring mechanism. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf. and breakaway torque rating of 150 in. x lbf.
 - e. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at -40°F.
 - f. Electrical Connection: 115 V, single phase, 60 Hz.
 - 11. Accessories:
 - a. Auxiliary switches for signaling or position indication where dampers are installed in smoke control systems or elsewhere as indicated.

- b. Momentary test switch, and test and reset switches, damper or remote mounted as indicated.

2.04 TURNING VANES

- A. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades; set into vane runners suitable for duct mounting.
- B. General Requirements: Comply with SMACNA's HVAC Duct Construction Standards - Metal and Flexible, 3rd Edition; Figures 4-3, Vanes and Vane Runners, and 4-4, Vane Support in Elbows.
- C. Vane Construction: Single thickness with 3/4-inch trailing edge spaced at 1-1/2-inch centers.

2.05 DUCT-MOUNTED ACCESS DOORS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:
 - 1. American Warming and Ventilating.
 - 2. CL Ward & Family, Inc.
 - 3. Ductmate Industries, Inc.
 - 4. Flexmaster U.S.A., Inc.
 - 5. Greenheck.
 - 6. McGill AirFlow Corporation.
 - 7. Nailor Industries Inc.
 - 8. Ventfabrics, Inc.
 - 9. Ward Industries, Inc.; a Division of Hart & Cooley, Inc.
- B. Rectangular Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's HVAC Duct Construction Standards - Metal and Flexible, 3rd Edition; Figure 7-2, Duct Access Doors and Panels.
 - 1. Door:
 - a. Double wall, rectangular.
 - b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class. Where used in product conveying ducts, match duct material.
 - c. Hinges and Latches: 1" x 1" butt- or piano-hinge and cam latches.
 - d. Fabricate doors airtight and suitable for duct pressure class.
 - 2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets. Where used in product conveying ducts, match duct material.
 - 3. Number of Hinges and Locks:
 - a. Access Doors Less than 12 Inches Square: No hinges and two sash locks.
 - b. Access Doors up to 18 Inches Square: Two hinges and two sash locks.
 - c. Access Doors up to 24 Inches by 48 Inches: Three hinges and two compression latches.
 - d. Access Doors Larger than 24 Inches by 48 Inches: Four hinges and two compression latches with outside and inside handles.
- C. Round Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's HVAC Duct Construction Standards - Metal and Flexible, 3rd Edition; Figure 7-3, Access Panels - Round Duct.
 - 1. Door:
 - a. Double wall, rectangular or oval.

- b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class. Where used in product conveying ducts, match duct material.
 - c. Hinges and Latches: 1" x 1" butt- or piano-hinge and cam latches.
 - d. Fabricate doors airtight and suitable for duct pressure class.
- 2. Number of Hinges and Locks:
 - a. Access Doors Less than 12 Inches Square: No hinges and two sash locks.
 - b. Access Doors up to 18 Inches Square: Two hinges and two sash locks.
 - c. Access Doors up to 24 Inches by 48 Inches: Three hinges and two compression latches.

2.06 FLEXIBLE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:
 - 1. CL Ward & Family, Inc.
 - 2. Ductmate Industries, Inc.
 - 3. Duro Dyne Inc.
 - 4. Elgen.
 - 5. Ventfabrics, Inc.
 - 6. Ward Industries, Inc.; a Division of Hart & Cooley, Inc.
- B. Materials: Flame-retardant or non-combustible fabrics.
- C. Coatings and Adhesives: Comply with UL 181, Class 1.
- D. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to two strips of 2-3/4-inch-wide, 0.028-inch-thick galvanized sheet steel or 0.032-inch-thick aluminum sheets. Provide metal compatible with connected ducts.
- E. Indoor System, Flexible Connector Fabric: Glass fabric, double coated with neoprene.
 - 1. Minimum Weight: 26 oz./sq.yd.
 - 2. Tensile Strength: 480 lbf./inch in the warp and 360 lbf./inch in the filling.
 - 3. Service Temperature: -40 to +200°F.
- F. Outdoor System, Flexible Connector Fabric: Glass fabric, double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
 - 1. Minimum Weight: 24 oz./sq.yd.
 - 2. Minimum Tensile Strength: 500 lbf./inch in the warp and 440 lbf./inch in the filling.
 - 3. Service Temperature: -50 to +250°F.

2.07 FLEXIBLE DUCTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Atco Flex.
 - 2. Elgen.
 - 3. Flexmaster U.S.A., Inc.
 - 4. Genflex.
 - 5. Manville.
 - 6. Owens-Corning.
 - 7. Therma Flex.
 - 8. Wiremold.

- B. Non-Insulated, Flexible Duct: UL 181, Class 1, black polymer film or coated fiberglass cover supported by helically wound, spring-steel wire.
 - 1. Pressure Rating: 4-inch wg positive and 0.5-inch wg negative.
 - 2. Maximum Air Velocity: 4,000 fpm.
 - 3. Temperature Range: -20 to +175°F.
- C. Insulated, Flexible Duct: UL 181, Class 1, polymer film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene or aluminized vapor-barrier film.
 - 1. Pressure Rating:
 - a. Low Pressure: 4-inch wg positive and 0.5-inch wg negative.
 - 2. Maximum Air Velocity: 4,000 fpm.
 - 3. Temperature Range: -20 to +175°F.
 - 4. Insulation R-Value: Comply with the latest edition of ASHRAE/ IESNA 90.1.
- D. Flexible Duct Connectors:
 - 1. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches, to suit duct size.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Select duct accessories suitable for the pressure class of the ductwork to which it is attached.
- B. Install duct accessories according to applicable details in SMACNA's HVAC Duct Construction Standards - Metal and Flexible for metal ducts.
- C. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
- D. Install turning vanes in all rectangular duct elbows having a 45-degree or greater bend as indicated.
- E. Install volume dampers at points on supply, return, and exhaust systems where branches serving diffusers and grilles extend from larger ducts. Install dampers where accessible and as close to mains as possible. Where dampers are installed in ducts having duct liner, install dampers with hat channels of the same depth as liner, and terminate liner with nosing at hat channel.
 - 1. Install steel volume dampers in steel ducts.
 - 2. Install aluminum volume dampers in aluminum ducts.
- F. Install volume dampers in outside-air systems at the connection to the equipment served.
 - 1. Install steel volume dampers in steel ducts.
 - 2. Install aluminum volume dampers in aluminum ducts.
- G. Install volume dampers where directed by the Test and Balance Contractor as required for proper system balancing.
- H. Set dampers to fully open position before testing, adjusting, and balancing.
- I. Install fire and smoke dampers according to UL listing at all duct penetrations of rated assemblies as required to maintain the rating as designated on the drawings.

- J. Mount duct smoke detectors in strict conformance with manufacturer's recommendations. Duct smoke detectors to be furnished and wired as specified in Division 21, 26 or 28.
- K. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment. Locate on side of duct with greatest clearance. Install at the following locations:
1. On both sides of duct coils. (Minimum head and hand access.)
 2. Upstream and downstream from duct filters. (Minimum head and hand access.)
 3. At outdoor-air intakes and mixed-air plenums. (Minimum head and hand access.)
 4. At drain pans and seals. (Minimum head and hand access.)
 5. Downstream from control dampers, backdraft dampers, and other duct-mounted equipment. (Minimum head and hand access.)
 6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure-relief access doors; and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers. (Minimum two-hand access.)
 7. Elsewhere as indicated.
- L. Install access doors with swing against duct static pressure.
- M. Minimum Access Door Sizes:
1. One-Hand or Inspection Access: 8" x 5".
 2. Two-Hand Access: 12" x 6".
 3. Head and Hand Access: 18" x 10".
 4. Head and Shoulders Access: 21" x 14".
 5. Body Access: 25" x 14".
 6. Body plus Ladder Access: 25" x 17".
- N. Label access doors according to Specification Section 23 05 53, Identification for HVAC Piping and Equipment, to indicate the purpose of access door.
- O. Install flexible connectors to connect ducts to equipment. Provide minimum 26 gauge sheet metal sunshields on flexible connectors exposed to weather.
- P. Install flexible connectors in duct crossing building expansion joints. Provide sheet metal sunshields on flexible connectors exposed to weather.
- Q. For fans developing static pressures of 5-inch wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.
- R. Flexible duct may only be used in the following locations with the following limitations:
1. Connect fan-powered terminal units to supply ducts with maximum 12 inch length of high-pressure flexible duct. Do not use flexible ducts to change directions.
 2. Connect diffusers, grilles, or registers located in lay-in ceilings to ducts with maximum 60-inch lengths of low-pressure flexible duct secured in place with stainless-steel clamps.
 3. Install flexible ducts stretched and supported without kinks or sags.

3.02 FIELD QUALITY CONTROL

- A. Tests and Inspections:
1. Operate dampers to verify full range of movement.
 2. Inspect locations of access doors and verify that purpose of access door can be performed.

3. Operate fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
4. Inspect turning vanes for proper and secure installation.

END OF SECTION

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SECTION 23 34 16

CENTRIFUGAL HVAC FANS

PART 1 GENERAL

1.01 SUMMARY

- A. This section includes the following utility sets:
 - 1. Backward-inclined centrifugal fans.

1.02 SUBMITTALS

- A. Product Data: Provide manufacturer's product data for each unit indicated on the drawings. Data to be specific to the equipment proposed for the project with all options and accessories indicated. Include the following as a minimum:
 - 1. Manufacturer and model number.
 - 2. Rated capacity based on scheduled conditions and project elevation.
 - 3. Arrangement, rotation, discharge direction, motor location.
 - 4. Equipment dimensions.
 - 5. Required clearances.
 - 6. Electrical Data:
 - a. Motor horsepower.
 - b. Voltage/Phase/Hz.
 - c. Full load ampacity, minimum circuit ampacity and maximum overcurrent protection device requirements.
 - d. Electrical service point(s) of connection.
 - e. AIC rating of the equipment.
 - 7. Materials of construction.
 - 8. Accessories and options.
 - 9. Controls.
- B. Warranty information.
- C. Operation and maintenance data.

1.03 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to the Authorities Having Jurisdiction (AHJ), and marked for intended use.
- B. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.
- C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA 1 for indoor applications and NEMA 3 or 4 for outdoor applications.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on the drawings or a comparable product by one of the following:
1. Acme Engineering & Manufacturing Corp.
 2. Aerovent; a Division of Twin City Fan Companies, Ltd.
 3. Chicago Blower Corporation.
 4. Greenheck.
 5. The New York Blower Company.
 6. Penn Barry.
 7. Twin City Fan & Blower.

2.02 BACKWARD-INCLINED CENTRIFUGAL FANS

- A. Description: Factory-fabricated, -assembled, -tested, and -finished, direct-or belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, and support structure.
- B. Housings: Formed panels to make curved-scroll housings with shaped cutoff; with doors or panels to allow access to internal parts and components.
1. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
 2. Spun inlet cone with flange.
 3. Fan housing to have continuously welded seams and shall be field rotatable to any one of eight discharge positions.
 4. Outlet flange.
- C. Fan Wheel: Aluminum or steel, as scheduled, backward inclined, non-overloading, single-width-single-inlet with blades welded or riveted to back plate and wheel cone; aluminum, cast-iron, or cast-steel hub fastened to shaft; wheels to be statically and dynamically balanced.
- D. Shafts: Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.
1. Turned, ground, and polished hot-rolled steel or stainless steel with keyway. Ship with a protective coating of lubricating oil.
 2. Designed to operate at no more than 70% of first critical speed at top of fan's speed range.
- E. Prelubricated and Sealed Shaft Bearings: Self-aligning, pillow-block-type ball bearings.
1. Ball- or Roller-Bearing Rating Life: ABMA 9, L10 at 50,000 hours.
- F. Drives and Motor Pedestal: Factory mounted, with final alignment and belt adjustment made after installation.
1. Service Factor based on Fan Motor Size: 1.5.
 2. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
 3. Motor Pulleys: Adjustable pitch for use with motors through 5 HP; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
 4. Belts: Oil-resistant, non-sparking, and non-static; matched sets for multiple belt drives.

5. Belt Guards: Fabricate to comply with OSHA and SMACNA requirements of diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
 6. Motor Mount: Adjustable for belt tensioning.
- G. Accessories: Provide the following accessories as scheduled.
1. Inlet Box: Steel construction similar to fan base with supporting leg.
 2. Scroll Access Doors: Shaped to conform to scroll, with quick-opening latches and gaskets.
 3. Scroll Drain Connection: NPS 1 steel pipe coupling welded to low point of fan scroll.
 4. Companion Flanges: Rolled flanges for duct connections to fan inlet and outlet of the same material as housing.
 5. Discharge Dampers: Assembly with parallel blades constructed of two plates formed around and to shaft, channel frame, and sealed ball bearings; with blades linked outside of airstream to single control lever of the same material as housing.
 6. Inlet Screens: Grid screen of the same material as housing.
 7. Spark-Resistant Construction: Type A, B, C, or D AMCA 99 as scheduled.
 8. Shaft Cooler: Shaft attachment design to prevent heat from high temperature applications from reaching bearings and drives.
 9. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.
 10. Weather Cover: Enameled-steel sheet with ventilation slots, bolted to housing with extended lubrication lines.
- H. Motors: Comply with requirements in Specification Section 23 05 13, Common Motor Requirements for HVAC Equipment.

2.03 SOURCE QUALITY CONTROL

- A. Sound-Power Level Ratings: Comply with AMCA 301, Methods for Calculating Fan Sound Ratings from Laboratory Test Data. Factory test fans according to AMCA 300, Reverberant Room Method for Sound Testing of Fans. Label fans with the AMCA-Certified Ratings Seal.
- B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, Laboratory Methods of Testing Fans for Rating.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install centrifugal fans level and plumb.
- B. Install floor-mounting units on concrete bases.
- C. Install roof-mounting units on roof support curb.
- D. Support roof-mounting units using spring isolators having a static deflection of 2 inches. Vibration control devices are specified in Specification Section 23 05 48.13, Vibration Controls for HVAC Piping & Equipment.

1. Secure vibration controls to concrete bases using anchor bolts cast in concrete base.
- E. Support suspended units from structure using threaded steel rods and spring hangers having a static deflection of 2 inches. Vibration control devices are specified in Specification Section 23 05 48.13, Vibration Controls for HVAC Piping & Equipment.
- F. Install units with clearances for service and maintenance.
- G. Label fans according to requirements specified in Specification Section 23 05 53, Identification for HVAC Piping and Equipment.

3.02 CONNECTIONS

- A. Duct installation and connection requirements are specified in other Division 23 sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Specification Section 23 33 00, Air Duct Accessories.
- B. Install ducts adjacent to fans to allow service and maintenance.
- C. Install line-sized piping from scroll drain connection, on fans provided with drains, with trap with seal equal to 1.5 times specified static pressure, to nearest floor sink.

3.03 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 1. Verify that shipping, blocking, and bracing are removed.
 2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
 3. Verify that cleaning and adjusting are complete.
 4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
 5. Adjust belt tension.
 6. Adjust damper linkages for proper damper operation.
 7. Verify lubrication for bearings and other moving parts.
 8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
 9. Refer to Specification Section 23 05 93, Testing, Adjusting, and Balancing for HVAC, for testing, adjusting, and balancing procedures.
 10. Remove and replace malfunctioning units and retest as specified above.
- B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

END OF SECTION

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SECTION 23 34 23

HVAC POWER VENTILATORS

PART 1 GENERAL

1.01 SUMMARY

- A. This section includes:
 - 1. Centrifugal roof ventilators.

1.02 SUBMITTALS

- A. Product Data: Provide manufacturer's product data for each unit indicated on the drawings. Data to be specific to the equipment proposed for the project with all options and accessories indicated. Include the following as a minimum:
 - 1. Manufacturer and model number.
 - 2. Rated capacity based on scheduled conditions and project elevation.
 - 3. Equipment dimensions and weights.
 - 4. Required clearances.
 - 5. Electrical Data:
 - a. Motor horsepower.
 - b. Voltage/Phase/Hz.
 - c. Electrical service point(s) of connection.
 - 6. Materials of construction.
 - 7. Accessories and options.
 - 8. Controls.
- B. Warranty information.
- C. Operation and maintenance data.

1.03 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. AMCA Compliance: Fans shall have AMCA-Certified performance ratings and shall bear the AMCA-Certified Ratings Seal.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on the drawings or comparable product by one of the following:
 - 1. Acme Engineering & Manufacturing Corporation.
 - 2. CaptiveAire Systems.
 - 3. Carnes Company.
 - 4. Greenheck Fan Corporation.
 - 5. Loren Cook Company.
 - 6. PennBarry.
 - 7. Twin City Fan & Blower.

2.02 CENTRIFUGAL ROOF VENTILATORS

- A. Housing: Removable, spun-aluminum, dome top and outlet baffle square, one-piece aluminum base with venturi inlet cone.
 - 1. Upblast Units: Provide spun-aluminum discharge baffle to direct discharge air upward, with rain and snow drains and grease collector for fans serving grease hoods.
 - 2. Hinged Sub-Base: Galvanized-steel hinged arrangement with cables, permitting service and maintenance.
 - 3. Downblast Units: Provide spun-aluminum discharge baffle to direct discharge air downward.
- B. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.
- C. Belt Drives:
 - 1. Resiliently mounted to housing.
 - 2. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
 - 3. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
 - 4. Pulleys: Cast-iron, adjustable-pitch motor pulley.
 - 5. Automatic Belt Tensioner: Spring-powered idler pulley designed to maintain proper belt tension during fan operation.
 - 6. Fan and motor isolated from exhaust airstream.
 - 7. Drive sized for 150% of installed motor power.
- D. Accessories: Provide the following unless indicated otherwise:
 - 1. Variable-Speed Controller: Solid-state control to reduce speed from 100% to less than 50% for all direct-drive units.
 - 2. Disconnect Switch: Non-fusible type, with thermal-overload protection mounted in fan housing, factory wired through an internal aluminum conduit.
 - 3. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
 - 4. UL 762 Listing: For restaurant exhaust applications. Provide on all fans serving Type 1 cooking hoods or as indicated otherwise.
 - 5. Hinged Sub-Base: Galvanized-steel hinged arrangement with cables, permitting service and maintenance. Provide on all fans serving Type 1 cooking hoods or as indicated otherwise.
 - 6. Grease Trough: Trough designed to separate and retain grease that is drained from the unit. Provide on all fans serving Type 1 cooking hoods or as indicated otherwise.
 - 7. Backdraft Dampers: Provide dampers as noted on the drawings.
 - a. Non-Motorized Gravity Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops. Air leakage rate shall be less than 20 CFM/sq.ft. where damper size is greater than 24 inches in either dimension and 40 CFM/sq.ft. where damper size is less than 24 inches in either dimension.
 - b. Motorized Dampers: Parallel-blade dampers mounted in curb base with power-open, spring-close electric actuator; damper to be wired in parallel with fan motor. Air leakage rate shall be less than 4 CFM/sq.ft.
- E. Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch-thick, rigid fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.
 - 1. Configuration: Self-flashing without a cant strip, with mounting flange.
 - 2. Overall Height: Minimum 9-1/2 inches or higher as required to maintain minimum 8 inches between top of roof curb and adjacent roofing material.
 - 3. Pitch Mounting: Manufacture curb for required roof slope.

4. Vented Curb: Unlined with louvered vents in vertical sides height as required for fan discharge to be 40 inches above roof. Provide on all fans serving Type 1 cooking hoods or as indicated otherwise.

2.03 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Specification Section 23 05 13, Common Motor Requirements for HVAC Equipment.
 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
 2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 sections.

2.04 SOURCE QUALITY CONTROL

- A. Certify sound-power level ratings according to AMCA 301, Methods for Calculating Fan Sound Ratings from Laboratory Test Data. Factory test fans according to AMCA 300, Reverberant Room Method for Sound Testing of Fans. Label fans with the AMCA-Certified Ratings Seal.
- B. Certify fan performance ratings, including flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests according to AMCA 210, Laboratory Methods of Testing Fans for Aerodynamic Performance Rating. Label fans with the AMCA-Certified Ratings Seal.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Secure roof-mounted fans to roof curbs with cadmium-plated hardware. Refer to Division 07 specifications for installation of roof curbs.
- B. Install accessories according to the manufacturer's written instructions.
- C. Install units with clearances for service and maintenance.
- D. Label units according to requirements specified in Specification Section 23 05 53, Identification for HVAC Piping and Equipment.

3.02 CONNECTIONS

- A. Duct installation and connection requirements are specified in other Division 23 sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Specification Section 23 33 00, Air Duct Accessories.
- B. Install ducts adjacent to power ventilators to allow service and maintenance.

3.03 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 1. Verify that shipping, blocking, and bracing are removed.

2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
 3. Verify that cleaning and adjusting are complete.
 4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
 5. Adjust belt tension.
 6. Adjust damper linkages for proper damper operation.
 7. Verify lubrication for bearings and other moving parts.
 8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
 9. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
 10. Shut unit down and reconnect automatic temperature-control operators.
 11. Remove and replace malfunctioning units and retest as specified above.
- B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Prepare test and inspection reports.

3.04 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Adjust belt tension.
- C. Comply with requirements in Specification Section 23 05 93, Testing, Adjusting, and Balancing for HVAC, for testing, adjusting, and balancing procedures.
- D. Replace fan and motor pulleys as required to achieve design airflow.
- E. Lubricate bearings.

END OF SECTION

Edition 0608-0417

SECTION 23 37 13

DIFFUSERS, REGISTERS & GRILLES

PART 1 GENERAL

1.01 SUBMITTALS

- A. Product Data: For each type of product indicated, include the following:
 - 1. Data Sheet: Indicate drawing designation, manufacturer, model number, materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, noise ratings, and accessories furnished.

PART 2 PRODUCTS

2.01 DIFFUSERS, REGISTERS & GRILLES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on the drawings or comparable product by one of the following:
 - 1. Anemostat.
 - 2. Krueger.
 - 3. Nailor Industries, Inc.
 - 4. Price Industries.
 - 5. Titus.
 - 6. Tuttle & Bailey.
- B. Materials:
 - 1. Provide diffusers, registers, and grilles constructed of the materials indicated on the drawings.
 - 2. Diffusers, registers, and grilles mounted in damp or wet locations such as shower rooms, kitchen areas, or installed in evaporative cooler systems shall be all aluminum construction.
 - 3. Diffusers, registers, and grilles are to be factory finished unless noted otherwise. Provide color as scheduled or as directed by the Architect.
- C. Source Quality Control:
 - 1. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, Method of Testing for Rating the Performance of Air Outlets and Inlets.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install diffusers, registers, and grilles level and plumb.
- B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. Where architectural features or other items conflict with installation, notify the Architect for a determination of final location.

- C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, and fire dampers.
- D. Paint all interior ductwork visible through the diffuser, register, or grille flat black.

3.02 ADJUSTING

- A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION

Edition 0306-721

SECTION 23 41 00

PARTICULATE AIR FILTRATION

PART 1 GENERAL

1.01 SUMMARY

- A. This section includes:
 - 1. Pleated panel filters.
 - 2. Self-supported pocket filters.
 - 3. HEPA rigid-cell box filters.
 - 4. Side-service housings.
 - 5. Filter gages.

1.02 SUBMITTALS

- A. Product Data: For each type of product indicated include the following:
 - 1. Manufacturer and model number.
 - 2. Rated capacity and pressure drop curves.
 - 3. Materials of construction.
- B. Operation and maintenance data.

1.03 QUALITY ASSURANCE

- A. ASHRAE Compliance:
 - 1. Comply with applicable requirements in ASHRAE 62.1, Section 4 - Outdoor Air Quality; Section 5 - Systems and Equipment; and Section 7 - Construction and Startup.
 - 2. Comply with ASHRAE 52.1 for arrestance and ASHRAE 52.2 for minimum efficiency reporting value (MERV) for methods of testing and rating air-filter units.
- B. Comply with NFPA 90A and NFPA 90B.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:
 - 1. AAF International.
 - 2. Airguard.
 - 3. Camfil Farr.
 - 4. Filtration Group.
 - 5. Flanders-Precisionaire.
 - 6. Purafil, Inc.
 - 7. Purolator.

2.02 PLEATED PANEL FILTERS

- A. Description: Factory-fabricated, self-supported, extended-surface, pleated, panel-type, disposable air filters with holding frames.

- B. Filter Unit Class: UL 900, Class 2.
- C. Media: Interlaced glass, synthetic, or cotton and synthetic fibers coated with non-flammable adhesive.
 - 1. Adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Media shall be coated with an anti-microbial agent.
 - 3. Separators shall be bonded to the media to maintain pleat configuration.
 - 4. Welded wire grid shall be on downstream side to maintain pleat.
 - 5. Media shall be bonded to frame to prevent air bypass.
 - 6. Support members on upstream and downstream sides to maintain pleat spacing.
- D. Filter-Media Frame: Cardboard frame with perforated metal retainer sealed or bonded to the media.
- E. Capacities and Characteristics:
 - 1. Thickness or Depth: 1 inch, 2 inches, or 4 inches as indicated on the drawings.
 - 2. Maximum or Rated Face Velocity: 300 fpm for 1-inch media and 500 fpm for 2-inch and 4-inch media.
 - 3. Efficiency: 90% when tested according to ASHRAE 52.1.
 - 4. Initial Resistance: 0.20-inch wg for 1-inch media and 0.26-inch wg for 2-inch and 4-inch media.
 - 5. Recommended Final Resistance: 1-inch wg.
 - 6. MERV Rating: 8 when tested according to ASHRAE 52.2.

2.03 SELF-SUPPORTED POCKET FILTERS

- A. Description: Factory-fabricated, panel-type, disposable air filters with contoured media for extended surface.
- B. Filter Unit Class: UL 900, Class 1.
- C. Media: Fibrous material constructed so individual pleats are maintained in tapered form under rated-airflow conditions by flexible internal supports.
 - 1. Media shall be coated with an anti-microbial agent.
- D. Configuration: Multi-pocket.
- E. Filter-Media Frame: Galvanized steel.
- F. Capacities and Characteristics:
 - 1. Thickness or Depth: 24 inches.
 - 2. Maximum or Rated Face Velocity: 500 fpm.
 - 3. Efficiency: 85% when tested according to ASHRAE 52.1.
 - 4. Initial Resistance: 0.40-inch wg.
 - 5. Recommended Final Resistance: 1.5 inches wg.
 - 6. MERV Rating: 13 when tested according to ASHRAE 52.2.

2.04 HEPA RIGID-CELL BOX FILTERS

- A. Description: Factory-fabricated, disposable, packaged air filters with media perpendicular to airflow and with holding frames.
- B. Filter Unit Class: UL 900, Class 1.

- C. Media: Fibrous material, constructed so individual pleats are maintained under rated-airflow conditions.
 - 1. Internal Separators: Aluminum in media folds.
 - 2. Gasket Material: Neoprene or urethane.
 - 3. Gasket Location: Downstream.
 - 4. Faceguard Material: Aluminum or stainless steel.
 - 5. Faceguard Location: Upstream and downstream.
- D. Filter-Media Frames:
 - 1. Finish of Interior Surfaces: Surfaces in contact with the airstream shall comply with requirements in the latest edition of ASHRAE 62.1.
 - 2. Materials: Stainless steel, fabricated aluminum or galvanized sheet.
 - 3. Style: Box.
- E. Capacities and Characteristics:
 - 1. Depth: 6 or 12 inches as indicated on the drawings.
 - 2. Maximum or Rated Face Velocity: 250 fpm for 6-inch depth and 500 fpm for 12-inch depth.
 - 3. Initial Resistance: 1-inch wg.
 - 4. Recommended Final Resistance: 2 inches wg.
 - 5. Performance Level: HEPA 99.97% at .3 microns.

2.05 SIDE-SERVICE HOUSINGS

- A. Description: Factory-assembled, side-service housings, constructed of galvanized steel with flanges to connect to duct or casing system.
- B. Filters: Integral channels to accommodate scheduled and specified filters.
- C. Sealing: Incorporate positive-sealing gasket material on channels to seal top and bottom of filter cartridge frames and to prevent bypass of unfiltered air.
- D. Access Doors: Continuous gaskets on perimeter and positive-locking devices. Arrange so filter cartridges can be loaded from an access door for each tier and section of the following:
 - 1. Combination prefilter and final filter.
 - 2. Upstream and downstream test section (HEPA filters only).

2.06 FILTER GAGES

- A. Diaphragm-type gage with dial and pointer in metal case, vent valves, black figures on white background, and front recalibration adjustment.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:
 - a. Airguard.
 - b. Dwyer Instruments, Inc.
 - 2. Diameter: 4-1/2 inches.
 - 3. Scale Range as required for the filter media being used.
- B. Accessories: Static-pressure tips, tubing, gage connections, and mounting bracket.
- C. Building Automation System Interface: Provide a differential pressure transmitter with a 4 to 20 mA signal output where indicated on the drawings.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Position each filter unit with clearance for normal service and maintenance. Anchor filter holding frames to substrate.
- B. Install filters in position to prevent passage of unfiltered air.
- C. Install filter gage and/or transmitter for each filter bank.
- D. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing with new, clean filters.
 - 1. Temporary filters shall be a minimum of MERV 7.
- E. Install new filters prior to system balancing.
- F. Install filter gages on filter banks with separate static-pressure taps upstream and downstream from filters. Mount filter gages on outside of filter housing or filter plenum in an accessible position. Adjust and level inclined gages.
- G. Coordinate filter installations with duct and air-handling-unit installations.

3.02 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections: Test for leakage of unfiltered air while system is operating.
- C. Prepare test and inspection reports.

3.03 CLEANING

- A. Install temporary disposable filters, minimum MERV-8, prior to start-up or operating equipment during construction.
 - 1. Replace temporary filters when pressure drop across the filter reaches the filter manufacturer's recommended dirty-filter pressure.
- B. After completing system installation and start-up, and immediately prior to testing, adjusting and balancing activities, clean filter housings, clean and reinstall washable filters, and replace disposable filters with the filters indicated.
- C. After final building cleaning or upon substantial completion, whichever is later, clean filter housings, clean and reinstall washable filters, and replace disposable filters with the filters indicated.

END OF SECTION

Edition 1206-0721

SECTION 23 74 33

PACKAGED, OUTDOOR, HEATING & COOLING MAKEUP AIR CONDITIONERS

PART 1 GENERAL

1.01 SUMMARY

- A. This section includes cooling and heating rooftop replacement-air units.

1.02 SUBMITTALS

- A. Product Data: Provide manufacturer's product data for each unit indicated on the drawings. Data to be specific to the equipment proposed for the project with all options and accessories indicated. Include the following as a minimum:
 - 1. Manufacturer and model number.
 - 2. Rated capacity based on scheduled conditions and project elevation.
 - 3. Equipment dimensions.
 - 4. Required clearances.
 - 5. Electrical Data:
 - a. Motor horsepower and electric heater ratings.
 - b. Voltage/Phase/Hz.
 - c. Full load ampacity, minimum circuit ampacity and maximum overcurrent protection device requirements.
 - d. Electrical service point(s) of connection.
 - e. AIC rating of the equipment.
 - 6. Materials of construction.
 - 7. Accessories and options.
 - 8. Controls.
- B. Startup service reports.
- C. Operation and maintenance data.
- D. Warranty information.

1.03 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to Authorities Having Jurisdiction, and marked for intended use.
- B. ASHRAE Compliance: Applicable requirements in the latest edition of ASHRAE 62.1, Section 5 - Systems and Equipment, and Section 7 - Construction and Startup.
- C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in the latest edition of ASHRAE/IESNA 90.1, Section 6 - Heating, Ventilating, and Air-Conditioning.

1.04 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace components listed below that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Compressors: Manufacturer's standard, but not less than 5 years from date of Substantial Completion.
2. Warranty Period for Heat Exchangers: Manufacturer's standard, but not less than 10 years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Trane.
 2. Valent.
 3. Innovent.

2.02 CABINET

- A. Construction: Double wall.
- B. Exterior Casing: Galvanized steel with baked-enamel paint finish and with lifting lugs and knockouts for electrical and piping connections.
- C. Interior Casing: Galvanized steel.
- D. Base Rails: Galvanized-steel rails for mounting on roof curb.
- E. Service Doors: Hinged access doors with neoprene gaskets.
- F. Internal Insulation: Fibrous-glass duct lining complying with ASTM C1071, Type II.
1. Thickness: 1 inch.
 2. Insulation Adhesive: Comply with ASTM C916, Type I.
 3. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to casing without damaging liner and without causing air leakage when applied as recommended by the manufacturer.
- G. Condensate Drain Pans: Formed sections of stainless-steel sheet designed for self-drainage. Fabricate pans and drain connection to comply with the latest edition of ASHRAE 62.1.
- H. Hail guards of galvanized steel, painted to match casing. Designed to protect condenser coil from damage.
- I. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in the latest edition of ASHRAE 62.1.

2.03 SUPPLY-AIR FAN

- A. Fan: Forward curved centrifugal; statically and dynamically balanced, galvanized or coated steel, mounted on solid-steel shaft with self-aligning, permanently lubricated ball bearings.
- B. Motor: Open drip-proof, single-speed motor.

- C. Drive: V-belt drive with matching fan pulley and adjustable motor sheaves and belt assembly with minimum 1.4 service factor.
- D. Mounting: Fan wheel, motor, and drives shall be mounted in fan casing with vibration isolators.

2.04 REFRIGERATION SYSTEM

- A. Fabricate and label refrigeration system to comply with ASHRAE 15, Safety Code for Mechanical Refrigeration.
- B. Compressors: Reciprocating or scroll compressors with integral vibration isolators, internal overcurrent and overtemperature protection, internal pressure relief.
- C. Minimum Efficiency: As defined by the latest edition of ASHRAE/IESNA 90.1, Energy Efficient Design of New Buildings except Low-Rise Residential Buildings.
- D. Refrigerant: R-407C or R-410A.
- E. Refrigeration System Specialties:
 - 1. Expansion valve with replaceable thermostatic element.
 - 2. Refrigerant dryer.
 - 3. High-pressure switch.
 - 4. Low-pressure switch.
 - 5. Thermostat for coil freeze-up protection during low ambient temperature operation or loss of air.
 - 6. Brass service valves installed in discharge and liquid lines.
 - 7. Operating charge of refrigerant.
- F. Capacity Control: Provide 0 to 100% capacity control with continuous dehumidification available.
- G. Refrigerant Coils: Evaporator, condenser, and reheat condenser (where applicable) coils shall be designed, tested, fabricated, and rated according to ARI 410 and ASHRAE 33. Coils shall be leak tested under water with air at 315 psig.
 - 1. Tubes: Copper.
 - 2. Fins: Aluminum mechanically bonded to tubes.
 - 3. Suction and Distributor: Seamless copper tube with brazed joints.
 - 4. Source Quality Control: Test to 450 psig, and to 300 psig underwater.
- H. Condenser Fan: Propeller type, directly driven by motor.
- I. Safety Controls:
 - 1. Compressor motor and outside-coil fan motor low ambient lockout.
 - 2. Overcurrent protection for compressor motor and outside-coil fan motors.

2.05 ELECTRICAL HEATING SYSTEM

- A. Electric heating coils shall comply with UL 1995.
- B. Casing Assembly: Slip-in or flanged type with galvanized-steel frame.
- C. Open Heating Elements: Resistance wire of 80% nickel and 20% chromium supported and insulated by floating ceramic bushings recessed into casing openings, fastened to supporting brackets, and mounted in galvanized-steel frame.

- D. Overtemperature Protection: Disk-type, automatically resetting, thermal-cutout, safety device; serviceable through terminal box without removing heater from coil section.
- E. Secondary Protection: Load-carrying, manually resetting or manually replaceable, thermal cutouts; factory wired in series with each heater stage.
- F. Control Panel: Unit-mounted with disconnecting means and overcurrent protection.
 - 1. Magnetic contactor.
 - 2. Solid-state, stepless pulse controller.
 - 3. Toggle switches, one per step.
 - 4. Step controller.
 - 5. Time-delay relay.
 - 6. Pilot lights, one per step.
 - 7. Airflow proving switch.

2.06 OUTDOOR-AIR INTAKE AND DAMPERS

- A. Dampers: Leakage rate, according to AMCA 500, shall not exceed 2% of air quantity at face velocity of 2,000 fpm through damper and pressure differential of 4-inch wg.
- B. Damper Operators: Electric.
- C. Outdoor-Air Intake Hoods: Galvanized steel, with bird screen complying with the latest edition of ASHRAE 62.1 and finish to match cabinet.
- D. Capacity: From 0 to 100% outside air.

2.07 FILTERS

- A. Comply with NFPA 90A.
- B. Disposable Panel Filters: 2-inch-thick, factory-fabricated, flat-panel-type disposable air filters with holding frames, MERV 8 and 13 as scheduled.

2.08 CONTROLS

- A. Factory wire connection for controls power supply.
- B. Unit Controls: Solid-state control board and components with field-adjustable control parameters.
- C. Damper Controls: When exhaust fans stop, set outdoor-air damper to close. When exhaust fans start, fully open outdoor-air damper.
- D. DDC Temperature Control: Provide BACNet compatible interface for the central HVAC control system specified in Specification Section 23 09 00, Building Automation System for HVAC. Links shall include the following:
 - 1. Start/stop interface relay, and relay to notify DDC temperature-control system alarm condition.
 - 2. Hardware interface or additional sensors for the following:
 - a. Discharge air temperature.

2.09 MOTORS

- A. Comply with requirements in Specification Section 23 05 13, Common Motor Requirements for HVAC Equipment.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Piping installation requirements are specified in other Division 23 sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to machine to allow service and maintenance.
- C. Duct Connections: Duct installation requirements are specified in Specification Section 23 31 13, Metal Ducts. Drawings indicate the general arrangement of ducts. Connect supply duct to rooftop replacement-air units with flexible duct connectors. Flexible duct connectors are specified in Specification Section 23 33 00, Air Duct Accessories.

3.02 STARTUP SERVICE

- A. Complete installation and startup checks according to manufacturer's written instructions
- B. After startup and performance testing, change filters, verify bearing lubrication, and adjust belt tension.
- C. Remove and replace components that do not pass tests and inspections and retest as specified above.
- D. Prepare written report of the results of startup services.

3.03 ADJUSTING

- A. Adjust initial temperature and humidity setpoints.
- B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

3.04 CLEANING

- A. Filters:
 - 1. Install temporary disposable filters, minimum MERV-8, prior to start-up or operating equipment during construction.
 - a. Replace temporary filters when pressure drop across the filter reaches the filter manufacturer's recommended dirty-filter pressure.
 - 2. After completing system installation and start-up, and immediately prior to testing, adjusting and balancing activities, clean filter housings and replace disposable filters with the filters indicated.
 - 3. After final building cleaning or upon substantial completion, whichever is later, clean filter housings and replace disposable filters with the filters indicated.

3.05 DEMONSTRATION

- A. Engage a factory-authorized service representative to train the Owner's maintenance personnel to adjust, operate, and maintain rooftop replacement-air units. Refer to Division 01 specifications.

END OF SECTION

Edition 0606-0721

SECTION 23 82 16.11

HYDRONIC AIR COILS

PART 1 GENERAL

1.01 SUMMARY

- A. This section includes hydronic heating and cooling air coils.

1.02 SUBMITTALS

- A. Product Data: Provide manufacturer's product data for each unit indicated on the drawings. Data to be specific to the equipment proposed for the project with all options and accessories indicated. Include the following as a minimum:
 - 1. Manufacturer and model number.
 - 2. Rated capacity based on scheduled conditions and project elevation.
 - 3. Equipment dimensions.
 - 4. Required clearances.
 - 5. Materials of construction.
 - 6. Accessories and options.
- B. Warranty information.
- C. Operation and maintenance data.

PART 2 PRODUCTS

2.01 DESCRIPTION

- A. ASHRAE Compliance: Comply with applicable requirements in ASHRAE 62.1, Section 5 - Systems and Equipment, and Section 7 - Construction and Startup.

2.02 COILS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Aerofin Corporation.
 - 2. Carrier Corporation; a UTC company.
 - 3. Coil Company, LLC.
 - 4. Colmac Coil Manufacturing, Inc.
 - 5. Dunham-Bush, Inc.
 - 6. Greenheck Fan Corporation.
 - 7. Heatcraft Refrigeration Products LLC.
 - 8. Super Radiator Coils.
 - 9. Trane.
 - 10. USA Coil & Air.
- B. Performance Ratings: Tested and rated according to AHRI 410 and ASHRAE 33.
- C. Minimum Working-Pressure/Temperature Ratings: 200 psig, 325°F.
- D. Source Quality Control: Factory tested to 300 psig.

- E. Tubes: ASTM B743 copper.
- F. Fins: Aluminum, maximum 144 per foot.
- G. Headers: Cast iron with drain and air vent tappings or seamless copper tube with brazed joints, prime coated.
- H. Frames: Galvanized-steel channel frame, for slip-in or flanged mounting as indicated on the drawings, designed to support the weight of water-filled coil.
- I. Coatings: After fabrication, coat entire coil assembly with Heresite.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install coils level and plumb.
- B. Install coils in metal ducts and casings constructed according to SMACNA's HVAC Duct Construction Standards, Metal and Flexible.
- C. Straighten bent fins on air coils.
- D. Clean coils using materials and methods recommended in writing by the manufacturers, and clean inside of casings and enclosures to remove dust and debris.

3.02 CONNECTIONS

- A. Piping installation requirements are specified in other sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to coils to allow service and maintenance.
- C. Connect water piping with unions and shutoff valves to allow coils to be disconnected without draining piping. Control valves are specified in Specification Section 23 09 00, Building Automation System for HVAC, and other piping specialties are specified in Specification Section 23 21 16, Hydronic Piping Specialties.

END OF SECTION

Edition 1211-1215

DIVISION 26

ELECTRICAL

26 05 00	Common Work Results for Electrical
26 05 00	General Provisions
26 05 01	Scope of Work
26 05 02	Temporary & Remodeling Work
26 05 19	Low-Voltage Electrical Power Conductors & Cables
26 05 20	Low-Voltage Open Wiring Systems
26 05 26	Grounding & Bonding of Electrical Equipment
26 05 33	Raceway & Boxes for Electrical Systems
26 05 44	Sleeves & Sleeve Seals for Electrical Raceways & Cabling
26 05 48	Vibration Controls & Anchors
26 05 53	Identification for Electrical Systems
26 09 00	Instrumentation & Control for Electrical Systems
26 09 23	Lighting Control Devices
26 22 00	Low-Voltage Transformers
26 22 13	Low-Voltage Distribution Transformers
26 24 00	Switchboards & Panelboards
26 24 16	Panelboards
26 27 00	Low-Voltage Distribution Equipment
26 27 26	Wiring Devices
26 28 00	Low-Voltage Circuit Protective Devices
26 28 13	Overcurrent Protection
26 28 16	Enclosed Switches & Circuit Breakers
26 43 00	Surge Protective Devices
26 43 13	Surge Protection for Low-Voltage Electrical Power Circuits
26 51 00	Interior Lighting
26 51 00	Interior Lighting Fixtures & Lamps
26 52 00	Emergency Lighting
26 52 00	Emergency Lighting

END OF INDEX



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SECTION 26 05 00

GENERAL PROVISIONS

PART 1 GENERAL

1.01 SCOPE

- A. Provisions of this section apply to all work specified in all sections under Division 26.
- B. In addition, work in Division 26 is governed by the provisions of the Bidding Requirements, Contract Forms, General Conditions, and all sections in Division 01 specifications.
- C. The drawings and specifications do not specify exact installation means and methods or Contractor safety procedures. Installation means and methods and safety procedures are, and shall remain, the responsibility of the Contractor. No instruction or statement made on the drawings, specifications, future addenda, or change orders shall be interpreted to shift this responsibility away from the Contractor.
- D. These specifications contain statements which are more definitive or more restrictive than those contained in the General Conditions. Where these statements occur, they shall take precedence over the General Conditions. Where the word "provide" or "provision" is used, it shall be definitely interpreted as "furnishing and installing complete in operating condition." Where the words "as indicated" or "as shown" are used, they shall mean "as shown on the Contract Drawings." Where items are specified in the singular, this division shall provide the quantity as shown on the drawings, plus any spares or extras mentioned on the drawings or in the specifications. All specified and supplied equipment shall be new.

1.02 DEFINITIONS

- A. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include tunnels, trenches, hollow perimeter construction, above exterior furred spaces, and exterior suspended ceilings.
- B. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings, in duct shafts, and within hollow construction.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations, under canopies, and equipment yards.
- D. Exposed, Interior Installations: Exposed to view indoors. Examples include unfinished spaces, mechanical, electrical, and communication equipment rooms, and other areas solely for maintenance and repair.
- E. Exposed: Not concealed.
- F. Finished Space: A space other than mechanical, electrical, and communication equipment rooms, crawlspaces, and utility tunnels. Not an unfinished space.
- G. Unfinished Space: A room or space that is ordinarily accessible only to building maintenance personnel. A room noted on the "Finish Schedule" with exposed and

unpainted construction for walls, floors, or ceilings, or specifically mentioned as “unfinished.”

1.03 EXAMINATION OF PREMISES

- A. Visit the site, verify all measurements and project conditions, and pay all costs necessary to perform the work.

1.04 ELECTRICAL CONTRACTOR

- A. The Electrical Contractor shall be licensed as such in the state governing the project location. This license shall remain valid for the duration of the contract and shall have been valid for a minimum of 2 years prior to the contract award date.

1.05 REGULATIONS, PERMITS, FEES, CHARGES, INSPECTIONS

- A. Regulations: Comply with all applicable codes, rules and regulations.
- B. Fees and Permits: Pay all connection, installation, use, development, etc., fees and/or charges. Obtain and pay for all required permits and licenses. Refer to Division 01 specifications.
- C. Inspections: All work must be inspected and approved by local authorities. Prior to final approval, furnish the Architect with certificates of inspections and approvals by the local authorities in accordance with Division 01 specifications.

1.06 DRAWINGS AND SPECIFICATIONS

- A. If a conflict exists on the drawings or between the drawings and specifications, promptly notify the Architect.

1.07 SUBMITTALS

- A. Submittals are for information and coordination only. The Engineer will diligently review the submittals and attempt to verify compliance with the project requirements. Such review, however, does not constitute approval or disapproval or obligation to comply with all project requirements. The submittals are not to be construed to be contract documents. Any failure by the Engineer to note a point of non-compliance shall not be construed to be acceptance or approval of the discrepancy.
- B. Product Information Sheets: Provide manufacturer's literature which includes the information required by the Product Data paragraph of the applicable specification section. Where product information sheets show multiple models or options, clearly mark the model and options to be provided.
- C. Assembly: Assemble all required submittal information for each specification section and submit in PDF format.
 - 1. Assemble PDF submittals in one PDF file for each division. Separate and order sections within each file by corresponding specification number. Provide bookmarks at the first page of each section and label each bookmark with the specification number and name to allow for easy navigation of the submittal.
 - 2. Partial submittals will be returned without review. Partial submittals and submittals that are not project specific will be returned without review.

- D. Identification and Information:
1. Name the PDF file with the project name, division number, and sequential submittal number (i.e., the first submittal shall be No. 1; the second submittal shall be No. 2).
 2. Provide a cover sheet at the front of each submittal with the following information:
 - a. Project name.
 - b. Date.
 - c. Name of Engineer.
 - d. Name of Contractor.
 - e. Name of subcontractor.
 3. Provide a cover sheet at the front of each submittal section with the following information:
 - a. Name of supplier.
 - b. Name of manufacturer.
 - c. Number and title of appropriate specification section.
 - d. Drawing number and detail references, as appropriate.
 - e. Other necessary identification.
- E. Options:
1. Identify options requiring selection by the Engineer.
 2. Identify options included with submittal item.
- F. Deviations: Identify deviations in a line-by-line comparison format to the Contract Documents and include as a cover sheet to the product submittal. Include statement(s) and documentation supporting the acceptability of the deviation.
- G. Furnished by Others: This project is to provide a complete and functional system. Where material or labor is indicated in the submittal to be provided "by others," clearly indicated who is providing those items and include information to indicate proper coordination.

1.08 MATERIAL SAFETY DATA SHEETS

- A. Provide current Material Safety Data Sheets (MSDS) for all hazardous chemicals that are proposed for use at the project site.
1. Provide one complete set to the Owner for review and approval a minimum of 1 week prior to the delivery of any hazardous chemicals to the site.
 2. Maintain a second complete set at the project location, readily accessible by both the Owner's personnel and the Contractor's personnel.

1.09 REQUEST FOR INFORMATION

- A. A document submitted by the Contractor requesting clarification of a portion of the Contract Documents, hereinafter referred to as an RFI.
- B. A properly prepared RFI shall include a detailed written statement of the clarification, apparent conflict, or information requested that indicates the specific drawings or specifications in need of clarification and the nature of the clarification requested.
1. Drawings shall be identified by drawing number and location on the drawing sheet.
 2. Specifications shall be identified by section number, page, and paragraph.
- C. Include a proposed solution, where appropriate, based on the field conditions and best knowledge of the Contractor.

1.10 AS-BUILT DRAWINGS

- A. As-Built Drawings: Maintain one set of marked-up paper copies of the Contract Drawings.
 - 1. Preparation: Mark As-Built Drawings to show the actual installation where installation varies from that shown originally. Include all equipment, and underground and overhead conduit.
 - a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
 - b. Include dimensions both horizontally and vertically to permanent points of reference, accurate within 6 inches. Include descriptors such as “below slab,” “above ceiling,” etc.
 - c. Record data daily or as soon as possible after obtaining it.
 - d. Record and check the markup before enclosing concealed installations.
 - 2. Mark the As-Built Drawings completely and accurately. Utilize personnel proficient at recording graphic information in production of the As-Built Drawings.
 - 3. Mark the As-Built Drawings with erasable, red colored pencil, or in a digital PDF format using an editor program such as Bluebeam, Adobe Acrobat Professional, or similar. Use other colors to distinguish between changes for different categories of the work at the same location.
 - 4. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.
 - 5. Update the As-Built Drawings weekly or daily as appropriate for the project size.
- B. Format: Identify and date each As-Built Drawing; include the designation “PROJECT AS-BUILT DRAWING” in a prominent location.
 - 1. Organize newly-prepared As-Built Drawings into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
 - 2. Identification, as follows:
 - a. Project name.
 - b. Date.
 - c. Designation “PROJECT AS-BUILT DRAWINGS.”
 - d. Name of Engineer.
 - e. Name of Contractor.
 - 3. Remove or obscure the Engineer’s seal and signature from As-Built drawings.

1.11 OPERATION AND MAINTENANCE MANUAL

- A. Prior to completion of the project, compile a complete equipment Operation & Maintenance Manual for all equipment supplied under Division 26.
- B. Schedule:
 - 1. Submit a preliminary copy of the manual not less than 30 days prior to Substantial Completion for review and comment.
 - 2. Submit the final version of the manual not more than 4 weeks after Substantial Completion of the project.
- C. Format: Submit manuals in the following format:
 - 1. PDF Electronic File: Assemble for each system and piece of equipment, a manual with a composite PDF file, electronically indexed. Provide a system table of contents file with hyperlinks to each of the individual equipment PDF files. Submit on digital media acceptable to the Engineer.
 - a. Name each indexed document file in the composite electronic index with the applicable item name. Include a complete electronically-linked operation and maintenance directory.
 - b. Enable inserted reviewer comments on draft submittals.

- c. Provide an updated final copy, inclusive of all review comments, to the Engineer and Owner.
- D. Provide Operation & Maintenance Manuals for all systems, subsystems, and equipment that require operation and regular maintenance, or have replaceable parts.
- E. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, product data, manufacturer's maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranty and bond information, as described below. In addition to requirements in this section, include operation and maintenance data required in individual specification sections.
- F. Source Information: List each system, subsystem, and piece of equipment included in the manual, identified by product name and arranged to match the manual's table of contents. For each product, list the name, address, and telephone number of the installer or supplier and maintenance service agent, and cross-reference the specification section number and title in the Project Manual.
- G. Product Data: Include the following information:
 - 1. System, subsystem, and equipment descriptions. Use designations for systems and equipment indicated on the Contract Documents.
 - 2. Approved submittals.
 - 3. Include the following if not shown on approved submittals:
 - a. Product name and model number. Use designations for products indicated on the Contract Documents.
 - b. Manufacturer's name.
 - c. Equipment identification with serial number of each component.
 - d. Equipment function.
 - e. Operating characteristics.
 - f. Limiting conditions.
 - g. Performance curves.
 - h. Engineering data and tests.
- H. Operating Procedures: Include the following, as applicable:
 - 1. Startup procedures.
 - 2. Equipment or system break-in procedures.
 - 3. Routine and normal operating instructions.
 - 4. Regulation and control procedures.
 - 5. Instructions on stopping.
 - 6. Normal shutdown instructions.
 - 7. Seasonal and weekend operating instructions.
 - 8. Required sequences for electric or electronic systems.
 - 9. Special operating instructions and procedures, including precautions against improper use.
 - 10. Operating logs.
- I. Wiring Diagrams: Diagram of factory-installed wiring including any options as well as any field modifications.
- J. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.
- K. Manufacturer's Maintenance Documentation: Include the following information for each component part or piece of equipment:
 - 1. Standard maintenance instructions and bulletins.

2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
 3. Identification and nomenclature of parts and components.
 4. List of items recommended to be stocked as spare parts.
- L. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:
1. Test and inspection instructions.
 2. Troubleshooting guide.
 3. Precautions against improper maintenance.
 4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
 5. Aligning, adjusting, and checking instructions.
 6. Demonstration and training video recording, if available.
- M. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.
- N. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturer's maintenance documentation and local sources of maintenance materials and related services.
- O. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.
- P. Licenses: Include copies of any licenses with requirements, including inspection and renewal dates.
- Q. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
- R. Test Reports: Include a final approved copy of the factory and field testing reports.

1.12 WORK AND MATERIALS

- A. Unless otherwise specified, all materials must be new and of the quality specified. The workmanship shall be of a quality that is acceptable to the Architect, Engineer, and Owner, and is equal to the standards of the trades. The Contractor must staff the project with sufficient skilled workmen, including a fully qualified construction superintendent, to complete the work in the time allotted. The superintendent must be qualified to supervise all of the work in his work category.
- B. Uniformity: Unless otherwise specified, provide all equipment and products of the same type or classification by the same manufacturer.

1.13 APPROVALS OF MATERIALS AND EQUIPMENT

- A. Refer to Division 01 specifications for description of material and equipment for prior approvals and substitutions.

1.14 COOPERATIVE WORK

- A. Correct without charge any work requiring alteration due to lack of proper supervision or failure to make proper provision in time. Correct without charge any damage to adjacent

work caused by the alteration. Refer to Division 01 specifications for additional requirements.

- B. Cooperative work includes:
 - 1. General supervision and responsibility for proper location, rough-in, and size of work related to Division 26 but provided under other divisions of these specifications.
 - 2. Installation of sleeves, inserts, and anchor bolts for work under sections in Division 26.
 - 3. Sealing of penetrations through fire and smoke barriers caused by work installed as part of Division 26.

1.15 EXISTING MATERIALS AND EQUIPMENT

- A. Disposition: With the exception of items that are to be re-used or retained by the Owner, all other materials indicated to be removed shall be removed and disposed of by the Contractor. Items that are indicated to be retained or returned to the Owner shall be delivered to a storage area designated by the Owner.
- B. Unused Materials: All unused raceways, conductors, boxes, equipment, and miscellaneous materials shall be removed by the Contractor except where located within walls, below or above existing construction which is not being altered and would require removal and replacement of this existing construction. All visible raceways, conductors, boxes, equipment, and miscellaneous materials shall be removed and sealed or capped within wall, below floor, unless noted otherwise.
- C. Exterior Services: The Contractor shall be responsible for maintaining electrical and control service to the existing building during the construction period. Existing services are to be retained until such a time that the new services, if any, are completely installed and ready for use. Scheduling of service interruptions is to be coordinated with the Architect and Owner.
- D. Disconnect, demolish, and remove electrical systems, equipment, and components that are indicated to be removed.
 - 1. Conduit to be Removed: Remove portion of conduit indicated to be removed and cap or plug remaining conduit with the same or compatible conduit material. Patch insulation, as required, to match adjacent areas.
 - 2. Conduit to be Abandoned In Place: Cap or plug conduit with the same or compatible conduit material.
 - 3. Equipment to be Removed: Disconnect services and remove equipment.
 - 4. Equipment to be Removed and Reinstalled: Disconnect and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
 - 5. Equipment to be Removed and Salvaged: Disconnect and remove equipment and deliver to the Owner.
- E. Continuity of Services in Existing Building: The Contractor shall permanently reroute existing electrical and control services or provide temporary connection as required to maintain service to existing receptacles, fixtures, and equipment in the building which are to remain in service.
- F. Rerouting and Relocation of Existing Electrical Equipment and Services in Existing Building:
 - 1. General: The Contractor shall reroute/relocate all existing materials which are in conflict with the building alterations and which are required to be maintained in use.

2. Existing Raceways and Conductors: Where applicable, existing material may be re-used in its original location unless otherwise indicated.
- G. Testing: All existing services affected by the new construction and which are to remain in operation shall be returned to their original condition. The existing services shall be tested as new, as described in other sections of these specifications. If, for any reason, these requirements cannot be met, the Contractor shall immediately notify the Architect.

1.16 GUARANTEE

- A. Guarantee in writing all material, equipment, installation, and workmanship for all sections under Division 26 to be free from defects of material and workmanship for 1 year from date of final acceptance as outlined in Division 01 specifications. Equipment warranties shall be a minimum of 1 year from date of Substantial Completion or as specified elsewhere. Refer to the specific product specification section for additional warranty terms. Replace without charge any material or equipment proving defective during this period. The guarantee shall include performance of the equipment under all conditions of load, installing any additional items of control and/or protective devices as required.

1.17 ELECTRICAL WIRING

- A. Provide all line voltage power wiring, line voltage interlock wiring, and line voltage control wiring for the equipment that is to be provided under Divisions 21, 22, and 23 unless wiring is specifically shown on the electrical drawings.
- B. The following schedule is intended to summarize the division of work material responsibilities between the Mechanical Contractor, Controls Contractor, and Electrical Contractor.

Item	Furn. By	Set By	Power Wiring	Control Wiring
Equipment Motors	MC	MC	EC	--
Motor Control Center	EC	EC	EC	CC
Motor Starters, Controllers, Contactors, and Overload Heaters	MC*	EC**	EC	CC
Fused and Non-Fused Disconnect Switches	EC	EC	EC	--
Manual Operating Switches, Multi- Speed Switches, Pushbutton Stations, and Pilot Lights	CC	CC	CC	CC
Control Relays and Transformers	CC	CC	CC	CC
Line Voltage Thermostats and Time Switches***	MC	MC	EC	EC
Low-Voltage Thermostats	MC	MC	--	MC
Temperature Control Panels	MC	MC	EC	CC
Smoke Detectors (Duct Mounted)	EC	MC	EC	MC or CC
Motor and Solenoid Valves, Damper Motors, PE and EP Switches	CC	MC	CC	CC
Water Treatment Equipment	MC	MC	EC	CC

Item	Furn. By	Set By	Power Wiring	Control Wiring
MC = Mechanical Contractor CC = Controls Contractor EC = Electrical Contractor *Except where such devices are located in MCCs. **Unless required by these specifications to be provided as part of a factory-furnished assembly (i.e., fan coils, air handlers, chillers, etc.). ***Motor-drive units which are controlled from line voltage automatic controls such as line voltage thermostats, float switches, or time switches which conduct full load current of the motor shall be wired for both power and control under the electrical contract.				

PART 2 PRODUCTS

2.01 CONCRETE

- A. Where used for structures to be provided under the contract such as bases, pole bases, etc., concrete work and associated reinforcing shall be as specified under that division.
- B. Refer to other sections for additional requirements for underground vaults, duct banks, etc.

2.02 FRAMING CHANNEL

- A. The framing channel shall be a cold-rolled, high-quality, carbon-steel channel with factory-applied, hot-dipped-after-fabrication galvanized finish. Utilize factory-built interconnecting components, mounting straps, connectors, etc., designed for use with the framing channel supplied. Channel nuts shall be spring type and shall utilize standard SAE threads. Provide heavy zinc paint for field touchup. B-Line "B" Series, Unistrut "P" Series, or as accepted by the Architect.

2.03 ROOFTOP SUPPORTS

- A. Where specifically allowed by Part 3, provide pyramid-style composite support base for conduit, cable tray, and equipment. Support base shall be made of a UV-stabilized composite thermoplastic material or UV-resistant rubber and include hot-dip galvanized-steel attachment components. Rubber support base must include a steel load distribution top plate or strut. Support base shall include a low abrasion interface between the base and roof membrane for roof membrane protection. The base thermoplastic or rubber shall be made of 100% recycled material.
- B. Support base shall not have sharp edges and shall be compatible with project roof surfaces including single ply, bituminous, rubberized membrane, metal, and spray foam.
- C. Manufacturer and Product: nVent/Erco Caddy "Pyramid Base" Series, Eaton "Dura-Blok" Series, or as accepted.

2.04 ANCHORS

- A. Anchors shall be expandable-lead type, as manufactured by Ackerman-Johnson, Diamond, Hilti, Pierce, or as accepted by the Architect.

- B. Adjustable concrete hanger inserts shall be as manufactured by Grinnell, or as accepted by the Architect.

PART 3 EXECUTION

3.01 SUBMITTALS

- A. Prepare submittals as directed for review by the Contractor, Owner, and Architect.
- B. Submit one copy of PDF submittals via email, project website, or other electronic media.

3.02 AS-BUILT DRAWINGS AND RECORD DOCUMENTS

- A. Recording: Post changes and modifications to the As-Built Drawings as they occur; do not wait until the end of the project.
- B. Maintenance of As-Built Drawings and Record Documents: Store Record Documents in the field office, apart from the Contract Documents used for construction. Do not use project Record Documents for construction purposes. Maintain Record Documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to project Record Documents for the Engineer's reference during normal working hours. As-Built Drawings will be reviewed by the Architect, Owner, and Engineer at each pay request review.
- C. Submit As-Built Drawings to the Architect at completion of the project.

3.03 OPERATION & MAINTENANCE MANUALS

- A. Prepare Operation & Maintenance Manuals as directed.
- B. Submit a preliminary electronic copy of the Operation & Maintenance Manual to the Engineer for review.
- C. Upon receipt of comments, make any corrections noted from the Engineer's review and resubmit as required.
- D. Submit the final, corrected Operation & Maintenance Manual in electronic format to the Architect.

3.04 VERIFICATION OF DIMENSIONS

- A. Scaled and figured dimensions are approximate only. Before proceeding with work, carefully check and verify dimensions at the site, and be responsible for properly fitting equipment and materials together and to the structure in spaces provided.

3.05 EQUIPMENT LAYOUT

- A. Drawings are diagrammatic and many offsets, bends, pull boxes, special fittings, and exact locations are not indicated. Carefully study drawings and premises in order to determine best sequence and installation methods, exact locations, feeder and branch circuit routes considering building obstructions and other project limitations.
- B. All equipment furnished with connections in the required locations shall fit the space available and include adequate space for operating and servicing.

- C. Install apparatus and equipment in a manner and in locations to avoid obstructions, preserve headroom, and keep openings and passageways clear.
- D. Do not install conduit runs or cable trays in front of or directly below any portion of the equipment access areas where access would be blocked by the installation.
- E. Do not install conduit runs or cable trays in the path of equipment removal for repairs and or maintenance.

3.06 CUTTING AND PATCHING

- A. Cut work and patch per Division 01 specifications as necessary to properly install the new work. As the work progresses, coordinate necessary openings, holes, chases, etc., in their correct location. If the required openings, holes, and chases are not in their correct locations, make the necessary corrections at no cost to the Owner. Avoid excessive cutting and do not cut structural members without the consent of the Architect. Include as a part of the work all structural framing required by penetrations through the roof and necessary steel to support electrical equipment and raceways between structural steel unless shown on the structural drawings.

3.07 CLOSING-IN OF UNFINISHED WORK

- A. Cover no work until inspected, tested, and approved. Where work is covered before inspection and test, uncover it, and when inspected, tested, and approved, restore all work to original proper condition.

3.08 ACCESSIBILITY

- A. Install all control devices or other specialties requiring reading, adjustment, inspection, repairs, removal, or replacement conveniently and accessibly throughout the finished building. Where any of these devices are shown on the Contract Drawings to be installed above any inaccessible ceiling or behind any inaccessible wall, the Electrical Contractor shall furnish access doors or panels as required.
- B. All access doors or panels in walls and ceilings required for access to control devices, control transformers, relays, power packs, and similar devices are to be furnished and installed as part of the work under this section. Provide type as specified in Division 08 specifications.
- C. Refer to the architectural drawings for type of wall and ceiling in each area and for rated construction.
- D. Coordinate work of various sections to avoid unnecessary duplication of access doors.
- E. Provide doors that pierce a fire separation with the same fire rating as the separation.

3.09 ROOF FLASHINGS

- A. Flash and counterflash all raceways penetrating roofing membrane with flashing per roofing manufacturer's recommendations. Refer to the architectural drawings for detailing of raceway penetrations through roof.

3.10 PRODUCT AND EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. All equipment, detectors, etc., shall be installed in strict conformance with the manufacturer's recommendations and all codes.
- B. Install equipment to allow maximum possible headroom unless specific mounting heights are indicated.
- C. Install equipment and raceways level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- D. Install electrical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations.
- E. Install equipment and raceways to allow right-of-way for access to removable panels and service points. This applies to equipment of all disciplines.
- F. Do not install any equipment in an application not recommended by the manufacturer.

3.11 EQUIPMENT ROUGH-IN

- A. Rough-in all equipment and fixtures as designated on the drawings and in the specifications. The drawings indicate only the approximate location of rough-ins. The exact rough-in locations must be determined from large-scale certified drawings. The Contractor shall obtain all certified rough-in information before progressing with any work for rough-in final connections.
- B. Be responsible for providing all outlets and services of proper size at the required locations.
- C. Minor changes in the Contract Drawings shall be anticipated and provided for under this division.
 - 1. Rough-in only (unless otherwise designated on the drawings) shall include providing all services as indicated and required, including all raceway, conduit, and conductors. Cap all conduit stubouts in a manner suitable for future extension.

3.12 OWNER-FURNISHED AND OTHER EQUIPMENT

- A. Rough-in only for all Owner-furnished equipment (refer to Division 01 specifications) and all equipment furnished under other sections of the specifications, except as otherwise specified and/or noted on the drawings.
- B. Obtain rough-in drawings from the Owner or other contractors, prior to roughing-in any services.
- C. Provide all services required. Cap all conduit and raceways and leave in a clean and orderly manner.

3.13 EQUIPMENT FINAL CONNECTIONS

- A. Provide all final connections for the following:
 - 1. All equipment furnished under this division.
 - 2. Electrical equipment furnished under other sections of the specifications (except as otherwise designated).
 - 3. Owner-furnished equipment as shown on the drawings.

3.14 WIRING OF EQUIPMENT FURNISHED UNDER OTHER SECTIONS

- A. All electrical wiring including power wiring and control wiring (except as specified in Divisions 21, 22, and 23), including all raceways, wiring, outlet and junction boxes, and labor for installation of the wiring and equipment, shall be included in this section of the specifications.
- B. Wiring diagrams, complete with all connection details, shall be furnished under each respective section.
- C. Provide all connections as described per Divisions 21, 22, and 23.

3.15 EQUIPMENT SUPPORTS

- A. Erection of Metal Supports and Anchorages:
 - 1. Refer to Division 05 specifications for structural steel.
 - 2. Design, cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment. Neatly fabricate and erect steel work with burrs and welding spatter ground off. Paint after fabrication with a rust-inhibitive primer.
 - 3. Field Welding: Comply with AWS D1.1.
- B. Erection of Wood Supports and Anchorages:
 - 1. Design, cut, fit, and place wood grounds, nailers, blocking, and anchorages to support and anchor electrical materials and equipment.
 - 2. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
 - 3. Attach to substrates as required to support applied loads.
- C. Where supports, foundations, suspended platforms for transformers, or other equipment are indicated or specified, perform the following:
 - 1. Locate support members to avoid equipment stresses and interference with conduit connections, service panel removal, or other maintenance operations.
 - 2. Regarding equipment of other disciplines, locate support members to avoid interference with duct, conduit, and piping connections, control connections, service panel removal, or other maintenance operations.
- D. Rooftop supports shall not be used for conduit unless specifically noted on the plans. Where used, coordinate acceptability of support to membrane interface with roof membrane manufacturer and provide accordingly.
- E. Concrete Inserts: Furnish and install all concrete inserts required for all materials and equipment specified and/or shown on the drawings for Division 26.
- F. Concrete Bases: Work under this section includes coordination of construction of all concrete foundations indicated or required for equipment specified under Division 26. Materials and workmanship shall be described in Division 03 specifications. Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at project.
 - 1. Construct concrete bases of dimensions indicated, but not less than 1 inch (25 mm) larger in both directions than supported unit footprint. Where servicing apparatus for drawout circuit breakers requires a level surface in front of the switchboard or switchgear, coordinate pad front extension so as to allow service to occur using standard apparatus. Where utility company connections and

- equipment occur, pads below underground pull section, meter, and main switch(es) shall conform to the serving utility requirements.
 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of the base.
 3. Install epoxy-coated anchor bolts for supported equipment that extends through concrete base, and anchor into structural concrete floor.
 4. Place and secure anchorage devices. Use supported equipment manufacturer's installation drawings, templates, diagrams, and instructions to locate anchors. Install anchor bolts to elevations and embedment depths required for proper attachment to supported equipment.
 5. Install anchor bolts at elevations required for proper attachment to supported equipment.
 6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
- G. Grouting:
1. Grout under lighting pole base plate after leveling, filling completely the space between base plate and foundation surface as specified in Division 03 specifications.
 2. Mix and install grout for electrical equipment base bearing surfaces and other equipment base plates, and anchors.
 3. Clean surfaces that will come into contact with grout.
 4. Provide forms as required for placement of grout.
 5. Avoid air entrapment during placement of grout.
 6. Place grout, completely filling equipment bases.
 7. Place grout on concrete bases and provide smooth bearing surface for equipment.
 8. Place grout around anchors.
 9. Cure placed grout.
 10. Finish exposed surface of grout for a neat appearance.

3.16 CLEANUP

- A. In addition to cleanup specified in Division 01 specifications, thoroughly clean all parts of the equipment. Where exposed parts are to be painted, thoroughly clean off any splattered construction materials and remove all oil and grease spots. Wipe the surface carefully and scrape out all cracks and corners.
- B. During the progress of the work, keep the premises clean and free of debris.

3.17 PAINTING

- A. Except as otherwise specified or indicated in the architectural drawings and/or specifications, paint all exposed unfinished metal with one coat of rust-inhibiting primer. Galvanized and factory-painted equipment shall be considered as having primed surface.
- B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.
- C. Finished painting is specified in Division 09 specifications.

3.18 FIRESTOPPING

- A. Coordinate with the firestopping installer for sealing of all penetrations of fire and smoke barriers and other rated assemblies created during the installation of the Division 26 work.

3.19 OBJECTIONABLE NOISE AND VIBRATION

- A. Construct and brace sheet metal housings to prevent vibration or rattling when systems are in operation. Install connections to equipment so noise and vibration will not reach the conditioned area through conduit, sheet metal work, or the building structure.

3.20 TESTING

- A. Upon completion of the electrical work, the entire installation shall be tested and demonstrated to be operating satisfactorily. Tests and documentation shall be in accordance with NETA Acceptance Testing Specifications for Electric Power Distribution Equipment and Systems.
- B. Tests, calibrations, and settings shall include the following:
 - 1. Wiring shall be tested for continuity, short circuits, and/or accidental grounds. All systems shall be entirely free from grounds, short circuits, and any or all defects.
 - 2. Motors shall be operating in proper rotation and control devices shall be functioning properly. Check all motor controllers to determine that properly sized overload devices are installed. Check all electrical equipment for proper operation.
 - 3. Insulation resistance test for all switchboard buses, bus ducts, motor and feeder conductors, including neutrals, using a megohmmeter. Apply to each conductor and maintain for 15 seconds or until reading stabilizes. Minimum value for each conductor shall be 20 megohms at 30°C. This test shall be performed by an independent testing company.
 - 4. Test, calibrate, and set all relays, circuit breaker trip devices, and ground fault protection trip units after receipt of engineered settings. Circuit breaker setups shall be performed or witnessed by a qualified representative of the circuit breaker manufacturer. This representative shall be identified by name and shall initial related test report(s).
 - 5. Additional equipment-specific testing is described in the equipment's respective section of this division.
- C. Furnish a written report of testing to the Architect. At a minimum, the report shall include:
 - 1. Testing Contractor's letterhead.
 - 2. Testing technician's name and signature.
 - 3. Date and time that test was performed.
 - 4. Ambient temperature and weather conditions.
 - 5. Test equipment manufacturer, model number, and last calibration date.
 - 6. The manufacturer, model number and, as applicable, trip unit model number and available adjustments of tested equipment.
 - 7. Statement of "As Left" conditions.
 - 8. Pass/Fail statement relative to NETA Chapter 10 recommendations.
 - 9. Recommendations if any.
- D. The Contractor shall submit the testing schedule to the Architect 2 weeks prior to initiation of testing activity.
- E. Ground fault protection (GFP) trip units shall be calibrated and tested prior to energizing any equipment served by GFP devices.
- F. The Contractor shall furnish the necessary instruments and labor required for testing, calibration, and implementation of engineered settings.

- G. Tests and adjustments shall be made prior to acceptance of the electrical installation by the Architect, and a certificate of inspection and acceptance of the electrical installation shall be provided by local inspection authorities.
- H. Any equipment or wiring provided, which through testing proves to be defective or operating improperly, shall be corrected or replaced promptly, at no additional cost to the Owner.

END OF SECTION

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SECTION 26 05 01

SCOPE OF WORK

PART 1 GENERAL

1.01 SUMMARY

- A. The work under this division includes furnishing all labor, material, and equipment necessary for the installation of and placing into operation the electrical systems as indicated on the drawings.
- B. The work shall also include the completion of such minor details of electrical work not mentioned or shown which are necessary for the successful operation of all electrical systems described on the drawings or required by these specifications.

1.02 SCOPE

- A. The work includes, but is not necessarily limited to, furnishing and installing the following:
 - 1. Complete power and lighting systems, distribution panelboards, transformers, branch circuit panelboards, safety switches, feeders, branch circuits, lighting fixtures, lamps, controls, and accessories.
 - 2. Motor and power wiring for all motors and/or equipment furnished under the Contract. Except as otherwise specified to be furnished by or under other divisions of these specifications, all wiring devices, starter wiring, conduit, feeders, control wiring, accessories, and final connections to all equipment shall be furnished under this section.
 - 3. Install controls for all equipment except as specified under the automatic temperature control system.
 - 4. All equipment and materials specified in this division.
 - 5. Empty conduit systems as indicated on the drawings.
 - 6. All other items and/or work indicated on the drawings.
 - 7. Equipment lists and maintenance manuals.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

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SECTION 26 05 02

TEMPORARY & REMODELING WORK

PART 1 GENERAL

1.01 SUMMARY

- A. Perform all temporary and remodeling work as shown on the drawings and described in the specifications, including minor items of material or equipment necessary to meet the requirements and intent of the project.
- B. All temporary and remodeling work shall be considered a part of this contract and no extra charges will be allowed.
- C. Examine architectural, structural, and mechanical drawings and specifications to determine the sequence of construction throughout the project, including existing, temporary, remodeled, and new areas.
- D. Where drawings indicate existing conditions, an attempt has been made to show electrical equipment, buildings, site details, etc., but accuracy cannot be guaranteed. Verify exact location of all conduits, outlets, etc., and all building and site details.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 INSTALLATION

- A. Branch circuits shall be re-used where practical and shall, in addition, be revised as required. Conceal all work where possible. Where exposed work is required in finished areas, use Wiremold or similar raceway system components as approved by the Architect.
- B. Existing electrical wiring intended to remain in use but which will be disturbed due to construction changes required by this Contract shall be restored to operating condition, as required and/or directed. Where required, shown, and/or directed, outlets and conduit runs shall be relocated. In some cases, it may be necessary to extend conduits and pull in new wiring or install junction boxes and splice in new wiring, or replace old wiring with new.
- C. Outlets from which lighting fixtures, switches, receptacles, and/or other electrical devices are removed and are not intended to be re-used shall be removed or, if it is not possible to remove them, a blank cover shall be placed on the outlet box. Where outlets, boxes, etc., are completely removed, the Contractor shall cut off conduits and remove wiring.
- D. Where conduits extending through floors are to be abandoned, the Contractor shall cut and cap or plug conduit so that it will not protrude above the floor.
- E. Where existing conduit is to be abandoned, the conduit shall be removed if it is exposed, in a crawl space, or in an accessible ceiling. Where it is impossible to remove the conduit, it shall be cut off and capped or plugged.

- F. The Contractor shall be held fully responsible for the proper restoration of all existing surfaces requiring patching, plastering, painting, and/or other repair due to the installation of electrical work under the terms of this specification. Close all openings, repair all surfaces, etc., as required.
 - 1. The Contractor shall employ qualified and experienced workmen for this work. All restoration work shall be subject to the approval of the Architect and/or the Owner.

END OF SECTION

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SECTION 26 05 19

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS & CABLES

PART 1 GENERAL

1.01 SUMMARY

- A. Furnish and install wire and cable for branch circuits and feeders as specified herein and as shown on the drawings.

1.02 RELATED SECTIONS

- A. Specification Section 26 05 53, Identification for Electrical Systems.

1.03 ACTION SUBMITTAL

- A. Submit product data indicating compliance with this specification for each type of conductor and cable.

PART 2 PRODUCTS

2.01 WIRE AND CABLE

- A. All wire and cable shall be new, 600-volt insulated, of types specified below for different applications. All wire and cable shall bear the UL label and shall be brought to the project in unbroken packages.
- B. Wire and cable 4 AWG size and smaller shall be Type THHN/THWN-2. Wire and cable larger than 4 AWG shall be Type XHHW-2.
- C. Wire and cable supplying Divisions 23, 24, and 25 equipment (and similar) shall be Type XHHW-2 regardless of size.
- D. Conductor Material:
 - 1. Annealed copper for all sizes. General Cable, Rome, Southwire, or as accepted.
- E. Conductor Stranding:
 - 1. Wire size 14 AWG and larger shall be stranded.
- F. Wire Pulling Lubricant:
 - 1. American Colloid "Slip X-300."
 - 2. American Polywater A, C, G, & J.
 - 3. Electro "Y-er Eas."
 - 4. Ideal "Wire Lube."
 - 5. Mac "Wirepull."
 - 6. Minerallac "Wire-Wax."
 - 7. Quelcor "Quelube."
 - 8. Richards "Gel Lube 7/5."
 - 9. Thomas/Jet Line "Slipry Loob."

- G. Metal-clad (MC) cable shall be steel corrugated interlocking type and shall include an equipment ground conductor. AFC, AmerCable, or as accepted. MC cable shall not be permitted to be used on this project unless indicated on the drawings or as noted in PART 3 of this section.

2.02 TERMINATIONS, SPLICES, AND JOINTS

- A. Terminations:
1. Locking fork, 600-volt vinyl insulated, butted seam, 3M Scotchlok terminals or as accepted.
 2. Ring tongue, 600-volt vinyl insulated, butted seam, 3M Scotchlok terminals or as accepted.
 3. Round flange solderless lug. Burndy "Quick-Lug" Type QDA, or as accepted.
 4. Solderless lug with water-resistant self-sealing gel cover. RayChem GelCap, or as accepted.
 5. Solderless compression lug type, one- or two-hole. Blackburn, Burndy, IIsco, or as accepted.
 6. Mechanical lug type listed for the application. Lug shall include an insulating cover. Burndy, IIsco, or as accepted.
 7. Flexible ferrule, copper, 600-volt, non-insulated. Dottie, NSi Industries, or as accepted.
 8. Termination of stranded wire 10 AWG or smaller on breakers and wiring devices shall include a captive plate design.
- B. Splices and Joints:
1. Pressure-type solderless insulated square spring connectors. 3M Scotchlok, Buchanan BCAP, Ideal Wing-Nut, Ideal Wire-Nut, or as accepted.
 2. Solderless mechanical in-line lug with formed insulating cover, 600-volt minimum rating. Material shall be listed for use with the specific conductor material. Blackburn, Burndy, IIsco, NSi, Panduit, or as accepted.
 3. Solderless compression type, long barrel with dimpled center stop and heat- or cold-shrink 600-volt insulation. Splice material shall match conductor material. Blackburn, Burndy, IIsco, or as accepted.
 4. Exterior Below Grade Joints in Wire (specific, case-by-case approval by the Engineer is required):
 - a. Pressure-type solderless insulated square spring connectors with self-sealing gel, UL 486D listed. Ideal Underground or as accepted.
 - b. Solderless lug, solderless compression lug with watertight self-sealing gel cover. Raychem GelCap or as accepted.
 5. Insulative Tape: Self-fusing, ethylene propylene rubber backing and highly conformable, rubber-resin adhesive. Temperature rated for continuous adhesion to 194°F (90°C). 30-mil thickness, voltage rated to 69kV. 3M Scotch 23 or as accepted.
- C. Wire Taps: Solderless mechanical or compression lug, irreversible compression "H" tap, each with formed insulating cover or heat/cold-shrink insulation, 600-volt minimum rating. Tap material shall be listed for use with the specific conductor material. Blackburn, Burndy, IIsco, Raychem Gtap, or as accepted.

2.03 APPLIED INSULATION

- A. Insulating materials shall be listed for the application. Voltage rating shall be equal to or greater than the factory-applied wire insulation. 3M, IIsco, Raychem, or as accepted.

PART 3 EXECUTION

3.01 GENERAL WIRING

- A. Drawings, in general, indicate location of items of equipment. Exact locations of motors and other devices are to be determined in the field by the Contractor. Provide an electrical feed for all equipment, not smaller than shown or NEC size where size is omitted from the drawings, together with a suitable circuit protective device. Verify panel schedules and layout, maintaining number of spare branches indicated.
- B. Complete rough-in requirements of all equipment to be wired under the Contract are not indicated. Coordinate with respective trades furnishing equipment or with the Architect, as the case may be, for complete and accurate requirements to result in a neat, workmanlike installation.
- C. Feeder conductors to distribution equipment shall be adjusted to limit voltage drop. The Contractor shall review the anticipated installed length and confirm the selected feeder results in not more than 2% voltage reduction. Base calculations on the actual load, or where the actual load is not known, 80% of the load side equipment bus rating.
- D. Conductors for branch circuit lighting, receptacle, power, and miscellaneous systems shall be as stated in this section. Wire indicated specifically to be larger than the specified minimum shall be increased for the entire length of the circuit.
- E. Conductor sizes for lighting, receptacles, and small motor branch circuits with less than a 20-amp connected load are not shown. Conductors for such circuits are sized as follows for a 3% voltage drop to single load. Submit alternate lengths with supporting calculations for review prior to installation.

BRANCH CIRCUITS		
Voltage	Length (from Branch Circuit Panel to Load)	Conductor Size (Not Smaller Than)
120 Volt	66 Feet	No. 12 (16 Amps)
120 Volt	102 Feet	No. 10 (16 Amps)
120 Volt	163 Feet	No. 8 (16 Amps)
120 Volt	256 Feet	No. 6 (16 Amps)
208 Volt	114 Feet	No. 12 (16 Amps)
208 Volt	177 Feet	No. 10 (16 Amps)
208 Volt	283 Feet	No. 8 (16 Amps)
208 Volt	443 Feet	No. 6 (16 Amps)
277 Volt	153 Feet	No. 12 (16 Amps)
277 Volt	236 Feet	No. 10 (16 Amps)
277 Volt	376 Feet	No. 8 (16 Amps)
277 Volt	590 Feet	No. 6 (16 Amps)

3.02 INSTALLATION

- A. Wire and cable shall be pulled into conduits without strain, using an approved lubricant.
- B. In no case shall wire be re-pulled if same has been pulled out of a conduit run for any purpose.

- C. No conductors shall be pulled into conduit until conduit system is complete, including junction boxes, pull boxes, etc.
- D. Feeder conductors shall be installed without splicing except where run length is in excess of 500 feet.
- E. All connections to wiring devices, circuit breakers, switches, fixtures, motors, and all joints in wires shall be made as noted below:
 - 1. Terminations at Wiring Devices:
 - a. 12 AWG Solid Wire: Formed around binding post or screw.
 - b. 14 through 10 AWG Stranded Wire: Locking fork tongue where terminals do not have a captive plate.
 - c. 8 AWG and Larger: Terminate via splice to device modular connector pigtails.
 - 2. Terminations at Circuit Breakers and Switches:
 - a. 14 through 10 AWG Stranded Wire: Locking fork tongue where terminals do not have a captive plate.
 - b. 8 AWG and Larger Wire: Where device does not include a captive plate or factory-provided lug, utilize a ring tongue.
 - c. 6 AWG and Larger Wire: Round flange solderless lug, Burndy "Quick-Lug" Type QDA or as accepted.
 - 3. Motor Connections: Solderless lug with water-resistant self-sealing gel cover.
 - 4. Joints in Wire:
 - a. 8 AWG and Smaller Wire: Pressure-type solderless square spring connectors.
 - b. 6 AWG and Larger Wire: Irreversible compression type, long barrel.
 - c. Wire Taps: Solderless compression lug, irreversible compression "H" tap. Material shall be listed for use with the specific conductor material.
 - d. Exterior Below Grade Joints in Wire (specific, case-by-case approval by the Engineer is required): Solderless lug, solderless compression lug.
 - 1) 6 AWG and Smaller Wire: Pressure-type solderless square spring connectors with self-sealing gel.
 - 2) Larger Than 6 AWG Wire: Solderless lug, solderless compression lug with watertight self-sealing gel cover.
 - 5. Other Equipment: Use mechanical lug furnished with the equipment or listed for the application.
 - 6. Solderless connectors NOT used for grounding shall be insulated. Apply wire insulation with voltage rating equal to or greater than the factory-applied wire insulation. Insulate by one of the following methods:
 - a. Pre-manufactured insulating caps.
 - b. Heat- or cold-shrink insulating sleeve. Shrink in accordance with the manufacturer's recommendations.
 - c. With Engineer Approval Only: One or more layers of ethylene propylene rubber tape, equal in thickness to the conductor insulation installed per the manufacturer's written instructions.
 - 7. Wire compression-type sleeves or lugs shall be installed with the manufacturer's recommended tool, in accordance with their published instructions.
 - 8. Termination of finely stranded conductor, such as Type W, shall be made using a flexible ferrule.
 - 9. Each conductor termination shall be tightened to the torque value recommended by the termination manufacturer. Terminations shall be marked once the final torque has been applied. Torque wrenches used for this purpose shall be calibrated and certified per NETA recommendations.
 - 10. Grounding electrode conductor splices and terminations shall be irreversible type.

3.03 COLOR CODING AND MARKING

- A. All wiring throughout shall be color-coded as follows:

	480-Volt System	208-Volt System
A Phase	Brown	Black
B Phase	Orange	Red
C Phase	Yellow	Blue
Neutral*	Grey	White
Ground	Green	Green
Iso Ground		Green with Yellow Stripe

*Where multiple neutrals are installed within the same raceway, each individual neutral shall be distinctly identified by one or more color stripes.

- B. All control wiring in a circuit shall be color-coded, each phase leg having a separate color, and with all segments of the control circuit, whether in apparatus or conduit, utilizing the same color-coding.
- C. Wiring must be color-coded throughout its entire length, except that feeders may have color-coded plastic tape at both ends and all accessible points.
- D. At all terminations of control wiring, the wiring shall have a numbered wire marker.
- E. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.04 CLAD CABLE ASSEMBLIES

- A. Metal clad (MC) cables may be used for branch circuits as follows:
1. For branch circuits within architectural millwork.
 2. Mechanical controls power routed above accessible ceilings.
- B. In medical applications, mineral insulated (MI) cables may be used for life safety or critical system circuits within architectural millwork.
1. MI cable shall be terminated with fittings designed for the application.

3.05 FIRE-RATED CABLE ASSEMBLIES

- A. Fire-rated cable assemblies shall be permitted where fire-rated cable assemblies are specifically allowed by the NEC. Coordinate use with project Fire/Life Safety Analysis Documents. Provide a copy of listing requirements to the local Authority Having Jurisdiction (AHJ) for inspection during construction. Install according to the listing requirements.

3.06 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Specification Section 26 05 43, Underground Ducts & Raceways for Electrical Systems.

3.07 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Specification Section 07 84 13, Penetration Firestopping.

END OF SECTION

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SECTION 26 05 20

LOW-VOLTAGE OPEN WIRING SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

- A. The extent of low-voltage open wiring is indicated on the drawings, schedules, and Contract Documents.
- B. Types of low-voltage open wiring specified in this section apply to the following:
 - 1. Building management systems.
 - 2. Fire alarm systems.
- C. The drawings illustrate the work specified and are intended to agree in every respect with one another and with these specifications.
- D. All discrepancies that appear shall be brought to the attention of the Engineer for correction. No omission from any drawing shall release the Contractor from furnishing equipment, materials, or services called for by the specifications or other drawings.

1.02 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in the manufacture of low-voltage open wiring components of the types as specified herein and on the drawings, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. NEC Compliance: Comply with NEC Articles 300, 640, 720, 725, 760, 770, and 800, national, state, and local codes as applicable to wiring methods, construction, and installation of low-voltage open wiring systems.
- C. NFPA Compliance: Comply with NFPA, national, state, and local codes as applicable to wiring methods, construction, and installation of low-voltage open wiring systems.
- D. UL Compliance: Comply with applicable requirements of UL 83, Thermoplastic-Insulated Wires and Cables, and UL 486A, Wire Connectors and Soldering Lugs for Use with Copper Conductors.
- E. Provide wiring/cabling and connector products which are ETL or UL listed and labeled.
- F. NEMA/ICEA Compliance: Comply with NEMA/ICEA Standard Publication Numbers WC-5 and WC-30, pertaining to electrical type wires and cables.
- G. IEEE Compliance: Comply with applicable requirements pertaining to low-voltage open wiring systems.

PART 2 PRODUCTS

2.01 GENERAL

- A. Components shall be of the latest type and design manufactured for the intended use, and shall be laid out and installed such as to afford easy maintenance and/or replacement without major disassembly of adjacent components.

- B. Any deviations from the products contained in these specifications shall be noted and shall be bid as an alternate, with deducts specified.

2.02 CABLES

- A. All cables shall be in accordance with the applicable system manufacturer's specifications.
- B. Plenum-rated cables shall be used in plenum-rated ceiling spaces.
- C. Factory "shorts," scrap, or warehouse and prior project leftovers, will not be acceptable.
- D. The outer jacket of the cable shall be printed with the manufacturer's identification and required UL markings.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Whenever possible, primary cable routing paths shall follow the logical structure of the building. All cable servicing an area shall be routed parallel and perpendicular to the building structure, following corridors and hallways. Diagonal runs are not acceptable.
- B. Where a wall must be breached, the cable shall pass through pre-established metal conduit sleeved openings.
- C. Corridor crossovers should be kept to a minimum.
- D. All non-plenum-rated cables must be routed in conduits through "return air plenum" spaces.
- E. It is the responsibility of the Contractor to verify "non-plenum" rating requirements.
- F. Cable that is run open above a suspended ceiling shall be supported by either a cable tray, channel, or hangers, as accepted. Do not lay low-voltage open wire cables in the joist or on ductwork, piping and plumbing systems, or on top of the lay-in ceiling tiles.
- G. Cable shall be routed above the bottom of all metal framing such as floor joists or trusses for the next floor or roof above.
- H. Cables shall be supported by rings and bails and shall be neatly bunched, bundled and tied together, and routed above the bottom of the joist, with supports mounted from the bar joist or truss.
- I. Cables shall not be supported from ductwork, piping, plumbing systems, ceiling tile, and lighting fixture suspension wires, or building structure.
- J. Low-voltage open wiring shall not be routed in or through data/ telecommunication or other cabling raceways, conduits, cable trays, sleeves, etc. The Contractor shall provide a dedicated raceway system for this system installation, unless noted otherwise.
- K. Cables and wiring routed above an accessible ceiling may be run as "open wiring," unless noted otherwise.
- L. Cables and wiring routed through open ceiling commercial/industrial spaces shall be routed in conduit, enclosed wireway, or cable tray, unless noted otherwise.

- M. All low-voltage wiring exposed below the bottom of the joist line shall be enclosed in conduit or other raceway system.
- N. Maximum allowable spacing between cable/wiring supports (rings, bails, etc.) shall be 60 inches.
- O. Plenum-rated cable ties and cable supports must be utilized in all plenum-rated spaces. Electrical tape is not acceptable as a cable tie, and cable ties are not acceptable as cable supports.
- P. All cables shall be free of tension at both ends, as well as over the entire length of the run.
- Q. Cable ties and supports shall not pinch, bind, crimp, or in any way cause physical or electrical characteristic damage to the cabling.
- R. The Contractor shall assure that during and upon completion of the installation, all cables are free of kinks, sharp bends, twists, gouges, cuts, or any other physical damage.
- S. For those locations where cables pass through metal studs, the Contractor shall install a bushing or grommet in all metal studs to prevent damage to the cables.
- T. Cables routed above non-accessible ceiling areas, or in open areas subject to abuse, shall be routed in conduit or other suitable raceway, subject to acceptance by the Architect.
- U. Cables shall be routed and supported away from building structure and system components, with a minimum clearance of 3 inches.

END OF SECTION

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SECTION 26 05 26

GROUNDING & BONDING OF ELECTRICAL EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

- A. Furnish and install grounding and grounding conductors as specified herein and as shown on the drawings.

1.02 ACTION SUBMITTAL

- A. Submit product data indicating compliance with this specification for each type of ground system component.
- B. Submit ground system test reports to the Architect for review.

1.03 CLOSEOUT SUBMITTAL

- A. Include final ground system test reports in the project Operation & Maintenance Manual.

PART 2 PRODUCTS

2.01 CONDUCTORS

- A. Insulated Conductors: Stranded copper with 600-volt green insulation.
- B. Bare Copper Conductors:
 - 1. Solid Conductors: ASTM B3.
 - 2. Stranded Conductors: ASTM B8.
 - 3. Tinned Conductors: ASTM B33.
 - 4. Bonding Cable: 28 kcmil, 14 strands of #17 AWG conductor, 1/4 inch (6 mm) in diameter.
 - 5. Bonding Conductor: #4 or #6 AWG, stranded conductor.
 - 6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
 - 7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
- C. Ground Busbar: Predrilled rectangular bars of annealed copper, size as noted on the plans, but not less than 1/4-inch thick by 4 inches tall by 18 inches wide. Hole pattern shall be 9/32-inch holes spaced 1-1/8 inches on center or as noted on the plans. Standoff insulators for mounting shall comply with UL 891 for use in switchboards, 600 volts, and shall be Lexan or PVC, impulse tested at 5,000 volts. Standoff insulators shall be minimum 2 inches and mounted using minimum 2-inch steel supports. Assemblies manufactured by Burndy, IlSCO, Blackburn, or as accepted.

2.02 CONNECTORS

- A. Listed and labeled by a nationally recognized testing laboratory (NRTL) acceptable to Authorities Having Jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

- B. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.
- C. Ground Busbar Connectors: Tin-plated copper, two-hole, long-barrel solderless compression.
- D. Beam Clamps: Mechanical type, terminal, ground wire access from four directions, with dual tin-plated or silicon bronze bolts.
- E. Cable End-to-End Splices: Tin-plated copper, long barrel, end-to-end compression connectors with inspection window. Provide with listed shrink on insulation.
- F. Cable Tap Splices: Tin-plated copper, heavy-duty C-tap compression connectors for splices where all conductors are #2 AWG or smaller. Tin-plated copper H-tap compression connectors with insulative cover for all other splices.
- G. Cable Tray Ground Clamp: Mechanical type, zinc-plated malleable iron.
- H. Conduit Hubs: Mechanical type, terminal with threaded hub.
- I. Ground Rod Clamps: Mechanical type, copper or copper alloy terminal with hex head bolt, listed for direct burial. Manufactured by Burndy, IlSCO, Blackburn, or as accepted.
- J. Flexible Ground Straps: Copper, flat-braided type with formed single-hole end pads.
- K. Rod and Pipe Clamps: Silicone bronze ground clamp up to 4-inch nominal pipe diameter. Field-welded bonding tabs for two-hole connectors for larger sizes.

2.03 GROUNDING ELECTRODES

- A. Ground rods shall be copper or copper-clad steel, 3/4-inch diameter by 10 feet long, listed for the purpose.
- B. Plate electrodes shall be sized as noted on the plans, but not less than 2 feet round by 1/4-inch (6.35 mm) thick steel or iron. Where copper or bronze plates are used, thickness shall not be less than 1/16 inch (1.5875 mm).
- C. Concrete-encased electrodes shall consist of bare copper conductor, in direct contact with the concrete foundation, sized as noted on the plans, but not less than #4 AWG solid copper.
- D. Ground ring shall consist of bare tinned copper stranded conductor, sized as noted on the plans, but not less than #2 AWG. Minimum length shall be 20 feet.
- E. Common Electrode System (CES) for multiple separately derived systems. The CES shall consist of a copper stranded conductor sized as noted on the plans, minimum #3/0 AWG.

PART 3 EXECUTION

3.01 APPLICATIONS

- A. All panelboard cabinets, equipment, enclosures, and conduit systems shall be grounded securely in accordance with pertinent sections of the NEC, as amended by any local codes. Conductors shall be copper. All electrically operated equipment shall be bonded to the

grounded conduit system. All non-current-carrying conductive surfaces that are likely to become energized and subject to personal contact shall be grounded by one or more of the methods detailed in the NEC. All ground connections shall have clean contact surfaces. Install all grounding conductors in conduit and make connections readily accessible for inspection.

- B. Grounding of metal raceways shall be assured by means of grounding bushings on feeder conduit terminations at the service entrance, distribution switchboards, and panelboards, and by means of a continuous, stranded, copper grounding wire extended from the ground bus in the enclosure to the conduit grounding bushings.
- C. A separate insulated grounding conductor, sized per the NEC, shall be installed in all electrical metallic tubing (EMT).
- D. Ground cable basket/tray with #6CU AWG conductor between grounding electrode system and cable tray. Utilize listed grounding connectors. Route in conduit between grounding electrode system and first connection to cable basket/tray.
- E. Rod, Pipe, and Plate Electrodes: Install per National Electrical Code (NEC) Article 250.53. Ground rods shall be installed full length, uncut. Top of ground rods shall be driven to a minimum of 2 inches below finished floor or grade.
- F. Concrete-Encased Electrodes: Install within the building foundation as described in NEC Article 250.52(A)(3).
- G. Ground Rings: Install per NEC Article 250.52(A)(4) at a minimum of 5 feet from the building and a minimum of 30 inches below finished grade or 6 inches below the frost line where deeper.
- H. Exterior direct-buried ground conductors shall be bare tinned copper at a minimum depth of 30 inches below finished grade or 6 inches below the frost line where deeper.
- I. Equipment grounding conductor size shall be increased where feeder conductors are oversized for voltage drop in accordance with NEC 250.122(B).
- J. Ground Busbars: Mount with a minimum of two standoff insulators.
- K. Labeling: Label all ground bar connections as to the element grounded or bonded with non-metallic tags and attachments.
- L. Ground conductors shall be exposed within electrical and MER/TR equipment rooms and installed in conduit elsewhere.
- M. Where grounding and bonding conductors are installed in metallic conduit, each end of the raceway shall be bonded to the grounding conductors by means of listed bond bushings. Where bushings are not available for the conduit and cable size, listed pipe clamps may be used in lieu of bushings.
- N. Use exothermic welds for all below grade connections except at test wells where mechanical connections shall be used.
- O. All interior connections shall be mechanical or compression type.
- P. All grounding conductors shall maintain a downward or horizontal direction where possible. Minimum bending radius of ground conductors shall be 8 inches.

- Q. Do not encircle ground cables completely with magnetic metal (i.e., conduit straps, junction boxes, etc.). Use one-hole straps with nylon screws, fiberglass channel framing, or similar. Where encirclement cannot be avoided, provide a #6 AWG bond to the metal encirclement.
- R. Connections of Dissimilar Metals: Coat surfaces with "NO-OX-ID-A" compound.
- S. Air Plenums or Other Spaces used for Environmental Air: Insulated ground cables shall not be exposed within. Where routing or connections are required in such spaces, provide bare copper conductors.

3.02 GROUNDING SEPARATELY DERIVED SYSTEMS

- A. Transformer:
 - 1. Extend building grounding electrode system to the transformer location. The electrode shall be connected to the transformer equipment grounding conductor and to the frame of the transformer as detailed on the plans. Install a system bonding jumper between the neutral and ground lug/terminal.
 - 2. Common electrode system (CES) shall be installed in conduit, 1-1/4 inch minimum. Conductor shall extend horizontally and vertically from the grounding electrode system to each electrical room. Provide a copper ground busbar as detailed on the plans, minimum 1/4-inch by 2-inch by length required for connections to be made. Ground busbar shall occur at each floor within each electrical room. The common grounding electrode conductor shall be continuous except where a splice is required and shall be made with a UL Listed irreversible compression-type connector or exothermic welding.
 - a. The CES shall route as a vertical riser style continuous loop from floor to floor. All bonding to the CES vertical riser shall only occur within the nearest electrical room on the same floor, at the ground bus.
 - b. A horizontal interconnect conductor shall tie each vertical riser together between electrical rooms on the same floor. All bonding to the CES vertical riser shall only occur within an electrical room.
 - c. Tap connections shall not create a splice or joint in the common grounding electrode.
 - 1) Tap connections shall be made at an accessible location by one of the following:
 - a) Connector listed for grounding and bonding.
 - b) A listed connection to a copper busbar.
 - c) Exothermic welding process.

3.03 SPLICES

- A. Where a splice is required, it shall be made with a UL Listed, irreversible compression-type connector or exothermic welding.
- B. Exothermic welds shall be cast with size-appropriate molds as recommended by the thermal weld manufacturer.

3.04 FIELD QUALITY CONTROL

- A. Perform tests and inspections of the installed grounding systems.
- B. Tests and Inspections:
 - 1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.

2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
 3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at individual ground rods. Make tests at ground rods before any conductors are connected.
 - a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
 - b. Perform tests by fall-of-potential method according to IEEE 81.
 4. Prepare dimensioned drawings locating each test well, ground rod, and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location.
 5. Report shall include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.
- C. Grounding system will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports. Reports shall include:
1. Name of equipment tested or locations in the system tested.
 2. Test type and purpose.
 3. Resultant test value(s).
 4. Statement of pass or fail.
 5. Test technician name, signature, and date for each report.
- E. Report measured ground resistances that exceed the following values:
1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.
 2. Power and Lighting Equipment or System with Capacity of 500 to 1,000 kVA: 5 ohms.
 3. Power and Lighting Equipment or System with Capacity More Than 1,000 kVA: 3 ohms.
 4. Power Distribution Units or Panelboards Serving Electronic Equipment: 1 ohm(s).
 5. Substations and Pad-Mounted Equipment: 5 ohms.
 6. Manhole Grounds: 10 ohms.
- F. Excessive Ground Resistance: If resistance to ground exceeds IEEE Standard 142 recommendations, notify the Architect/Engineer promptly and include recommendations to reduce ground resistance.

END OF SECTION

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SECTION 26 05 33

RACEWAY & BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

- A. Furnish and install conduit and fittings as shown on the drawings and as specified herein.

1.02 COORDINATION

- A. It shall be the responsibility of the Contractor to consult the other trades before installing conduit and boxes. Any conflict between the location of conduit and boxes, piping, ductwork, or structural steel supports shall be adjusted before installation. In general, large pipe mains, waste, drain, and steam lines that pitch, large air ducts, and all structural steel shall be given priority.
- B. Conduit size shall be such that the required number and sizes of wires can be easily pulled in and the Contractor shall be responsible for the selection of the conduit sizes. Conduit sizes shown on the drawings are minimum sizes in accordance with appropriate tables in the National Electrical Code (NEC). If, because of bends or elbows, a larger conduit size is required, the Contractor shall so furnish without further cost to the Owner.
- C. The Contractor shall be entirely responsible for the proper protection of this work from the other trades on the project. When conduit becomes bent, holes are punched through same, or outlets are moved after being roughed-in, the Contractor shall replace same, without additional cost to the Owner.

1.03 RELATED SECTIONS

- A. Specification Section 26 05 53, Identification for Electrical Systems.
- B. Specification Section 26 27 26, Wiring Devices.

1.04 ACTION SUBMITTAL

- A. Submit product data indicating compliance with this specification for each type of box, conduit, raceway, fitting, wall and trench duct.
- B. Exposed Conduit Routing: Where conduit must be exposed in finished areas, submit a routing diagram to the Architect for acceptance prior to installation. Submittal shall include sufficient detail to communicate the route vertically and horizontally with heights stated.

PART 2 PRODUCTS

2.01 GENERAL

- A. Conduit sizes for various numbers and sizes of wire shall be as required by NEC Chapter 9, but shall not be smaller than 3/4-inch size except as otherwise noted.
- B. Each length of conduit shall be stamped with the name or trademark of the manufacturer and shall bear the UL label for the specific product type.

- C. All concrete inserts and pipe clamps shall be galvanized. All steel bolts, nuts, washers, and screws shall be galvanized or cadmium plated. Individual hangers, trapeze hangers, and rods shall be prime-coated.
- D. Calibrated pull string/measuring tape shall be Greenlee Part No. 435, or as accepted.

2.02 CONDUIT

- A. Rigid galvanized steel (RGS), intermediate metallic conduit (IMC), and electrical metallic tubing (EMT) shall be Allied Tube & Conduit, Republic Conduit, Western Tube & Conduit Corp., Wheatland Tube Company, or as accepted.
- B. PVC-Coated RGS or IMC:
 - 1. Minimum Exterior PVC Coating: 40 mils bonded to the exterior surface.
 - 2. Minimum Interior Urethane Coating: 2 mils on both interior and steel threads.
 - 3. Listed as UL 6 and compliant with ANSI C80.1 and NEMA RN 1.
 - 4. Acceptable Manufacturers: Robroy Industries Plasti-Bond/KorKap/Perma-Cote, Thomas and Betts Ocal, or as accepted.
- C. Polyvinyl chloride (PVC) conduit shall be Cantex, Carlon, or as accepted.
- D. Liquid-tight flexible metallic conduit shall be Anaconda Sealtite Type UA, or as accepted.
- E. Conduit systems shall be color coded. Reference Specification Section 26 05 53, Identification for Electrical Systems, for additional requirements.

2.03 FITTINGS

- A. Couplings and connectors for RGS or IMC conduit shall be steel or malleable iron, threaded, and rain- and concrete-tight. Couplings and connectors that are exposed, installed in hollow construction, or above ceilings shall be threaded, uncouple, or compression type. Steel compression-type fittings shall be used for interior EMT and metallic flex. Steel weathertight compression fittings shall be used for exterior EMT. Die-cast or pressure-cast EMT and metallic flex fittings shall NOT be allowed.
- B. Liquid-tight metallic flex connectors shall be steel or malleable iron.
- C. Bushings and locknuts shall be malleable iron with sharp, clean-cut threads.
- D. Fittings shall be Appleton, Crouse-Hinds, Steel City, T&B, or as accepted.
- E. Expansion joint fittings on RGS or IMC conduit shall be Crouse-Hinds Type XJ, or as accepted. Expansion joint fittings on PVC conduit shall be Carlon Type E945, or as accepted.
- F. Entrance seals shall be O.Z. Type FSK, or as accepted.
- G. Explosion-proof and temperature seals shall be listed for 40% fill application, vertical and horizontal, and shall be Appleton Type EY, or as accepted.
- H. Couplings and connectors for PVC conduit shall be of the same manufacturer as the conduit to be coupled or connected. Fittings shall be provided in accordance with the manufacturer's recommendations.

2.04 SURFACE RACEWAY

- A. Where devices are shown within the surface raceway, they shall meet the requirements of a "Multi Outlet Assembly" as described in Specification Section 26 27 26, Wiring Devices.

2.05 BOXES

- A. All boxes must conform to the provisions of NEC Article 314. All boxes shall be of the proper size to accommodate the quantity of conductors enclosed in the box. Boxes shall not be less than 4 inches square and 1-1/2 inches deep unless otherwise noted.
- B. Generally, boxes shall be hot-dipped galvanized steel with knockouts. Where recessed, boxes shall have square cut corners. Outlet, switch, and gang size junction boxes on exterior surfaces or in damp locations shall be corrosion-resistant, cast malleable iron. Boxes shall have threaded hubs for rigid conduit and neoprene gaskets for their covers. Boxes shall be Appleton Type FS or FD, Crouse-Hinds, or as accepted. Conduit bodies shall be corrosion-resistant, cast malleable iron, and shall have threaded hubs for rigid conduit and neoprene gaskets for their covers. Bodies shall be Appleton Unilets, Crouse-Hinds, or as accepted.
- C. Deep boxes shall be used in walls covered by wainscot acoustical wall panels or paneling and in walls of glazed tile, brick, or other masonry that will not be covered with plaster. The bottom of the box shall be located on the horizontal joint. Through-the-wall type boxes shall not be used unless specifically called for. All boxes shall be non-gangable. Boxes in concrete shall be of a type to allow the placing of conduit without displacing the reinforcing bars. All lighting fixture outlet boxes shall be equipped with the proper fittings to support and attach a light fixture.
- D. All light switches, receptacles, and similar outlets shall be provided with approved boxes, suitable for their function. Back boxes shall be furnished and installed as required for the equipment and/or systems under this Contract.
- E. Pull and junction boxes shall be substantially-made code-gauge boxes with screw covers. Boxes shall be rigid under torsional and deflecting forces and shall be provided with angle-iron framing where required. Boxes shall be 4 inches square with a blank cover in unfinished areas and with a plaster ring and blank cover in finished areas, and shall be installed where required to pull cable or wire, but only in finished areas by approval of the Architect. Boxes shall be rigidly attached to the structure, independent of any conduit support. Boxes shall have their covers accessible. Covers shall be fastened to boxes with machine screws to ensure continuous contact all around. Covers for surface-mounted boxes shall line up evenly with the edges of boxes. Covers for flush-mounted oversize boxes shall extend 3/4 inch past the box all around. Covers for 4-inch square and 4-inch ganged boxes shall extend 1/4 inch past the box all around.
- F. Outlets are only approximately located on the plans and great care must be used in the actual location of outlets by consulting the various detailed drawings. Outlets shall be flush with finished wall or ceiling. Trim, cases, or other fixtures shall have their boxes installed symmetrically on such trim or fixture. Refer to the drawings for location and orientation of all outlet boxes.
- G. Furnish and install all plaster rings as may be required. Plaster rings shall be installed on all boxes where the boxes are recessed. Plaster rings shall be of a depth to reach the finished surface. Extension rings, where required, shall be installed so that the plaster ring is flush with the finished surface.

- H. Exterior gang-type boxes shall be cast type. Where any box occurs within 12 inches of the earth, provide cast iron type.
- I. Boxes with unused punched-out openings shall have the openings filled with factory-made knockout seals.
- J. Construct pull boxes and rack space for future conduits equal to 25% of present runs. Provide required barriers. Attach a plastic label to each pull box cover listing the feeder numbers enclosed within and the source of current. Identify each conduit at pull box termination with voltage and feeder number in red. Provide sufficient cable slack at terminations and in junction and pull boxes to allow for cable contraction and for future splicing. Fireproof cable in pull boxes where more than one feeder is enclosed.
- K. Boxes shall be as manufactured by Appleton, Raco, Steel City, or as accepted.

2.06 TV / MONITOR BOXES

- A. Boxes must conform to the provisions of NEC Article 314. All boxes shall be of the proper size to accommodate the quantity of conductors enclosed in the box. Boxes shall be available in multi-gang configurations but not less than a 4" high x 2-1/2" wide x 2-1/2" deep power wiring compartment unless otherwise noted.
- B. TV/Monitor boxes shall be recessed type with square cut corners. Boxes shall be corrosion-resistant hot-dipped galvanized steel with knockouts. Power and data side shall be separated by field-configurable voltage divider. Box shall include flanged regressed trim ring to permit the connection of plugs and cables to the devices contained within while remaining inside the wall surface plane. Boxes shall be Arlington Industries, Inc., FSR Inc., or as accepted.

2.07 FLOOR BOXES - POKE-THROUGH

- A. All boxes must conform to the provisions of NEC Article 314. Box construction shall be UL 514A Listed.
- B. The floor box unit shall be poke-through construction with a minimum 2-hour fire rating. Provide barriers between systems operating at different voltages.
- C. Floor box internal activation shall include mounting plates and brackets for devices indicated as required for the intended use.
- D. Floor box activation shall be provided as noted on the plans and consist of an appropriate trim flange and cover plate with openings as required for the intended use.

PART 3 EXECUTION

3.01 CONDUIT

- A. Applications:
 - 1. PVC conduit may be used for all exterior underground systems, in slab, below slab-on-grade, and in concrete or masonry walls. For medical applications, PVC conduit shall not be used to supply power to medical equipment or branch circuits in patient care areas, NO EXCEPTIONS.
 - a. All plastic conduit shall be rigid, Schedule 40, heavy wall PVC.

- b. Install bell ends at all conduit terminations in manholes and pull boxes and under equipment.
 - c. All bends over 30 degrees shall be made with wrapped IMC.
 - d. Stubups below switchboard/switchgear equipment shall be between 1 and 2 inches above the floor surface with the bell fitting installed.
 - e. All plastic conduit, except that used for telephone, shall contain a code-sized bond wire.
 - 2. IMC shall be used for all conduit larger than 2 inches, and for all underground or in-slab conduit, except where PVC is permitted or where RGS is specified. IMC conduit shall be used in explosion-proof areas.
 - 3. RGS conduit shall be used in place of IMC or where it is specified on the plans.
 - 4. PVC-coated RGS (PVC-RGS) conduit shall be used in corrosive areas where exposed to physical damage, or where specified on the plans.
 - 5. Liquid-tight flexible metallic conduit, in lengths not exceeding 3 feet, shall be used to connect motors and transformers. Installation shall be such that considerable slack is realized. The conduit shall contain a separate grounding conductor.
 - 6. Galvanized steel, flexible metallic conduit, in lengths not exceeding 6 feet, shall be used to connect fire alarm, lighting fixtures, and wiring devices or equipment mounted in movable panels such as acoustical ceiling tiles, etc. Installation shall be such that considerable slack is realized. The conduit shall contain a separate grounding conductor. Connectors shall be steel or malleable iron. Factory supplied and listed lighting fixture whips are acceptable in lieu of flexible metallic conduit.
 - 7. All other conduit shall be EMT. A separate insulated grounding conductor, sized per the NEC, shall be installed in EMT.
- B. Conduit shall be continuous from outlet to outlet, cabinet, or junction box, and shall be so arranged that wire may be pulled in with the minimum practical number of junction boxes.
 - C. All conduit shall be concealed wherever possible. All conduit runs may be exposed in mechanical equipment rooms, electrical equipment rooms, and electrical closets, and where indicated on the drawings. No conduit shall be run exposed in finished areas without specific acceptance by the Architect.
 - D. Exposed conduit shall be run in straight lines at right angles to or parallel with walls, beams, or columns. In no case shall conduit be supported or fastened to other pipes or installed to prevent the ready removal of other pipe.
 - E. Where possible, all conduit for wiring within stud or moveable partitions shall enter the partition from above.
 - F. Provide sleeves and chases where conduit passes through floors or walls as part of the work of this section. Core drilling will only be permitted where accepted by the Architect.
 - G. Conduit stubbed up/down or through floor slabs shall be wrapped RGS or wrapped IMC with a minimum of 6 inches of conduit exposed out of slab for connection of threaded or compression fitting. Where conduit bends extend out of slab, the conduit shall be placed at the maximum allowable distance from the exit surface and shall have a bend radius as allowed by code to provide as true and square a conduit exit as possible. Conduit deck flanges will be used where conditions allow and where the flange can be tightly secured flush to the face of a concrete form.
 - 1. Exception: Conduit stubbed through slabs on grade into the bottom of full height switchboard/switchgear sections, floor mounted full height UPS sections, floor mounted full height automatic transfer switches, floor mount transformers and load banks.

- H. Openings through fire-rated floors and fire walls through which conduit passes shall be sealed by fire stop material to seal off cold smoke and toxic fumes. Fire-seal material shall have an hourly fire rating equal to or higher than the fire rating of the floor or wall through which the cable or conduit passes. Material used shall conform to the Authority Having Jurisdiction (AHJ) requirements. Openings through smoke walls through which cable or conduit passes shall be sealed with non-shrink, non-combustible material approved by the AHJ to seal off cold smoke and toxic fumes.
- I. Conduit above lay-in grid-type ceilings shall be installed in such a manner that it does not interfere with the "lift-out" feature of the ceiling system.
- J. Conduit runs shall be installed to maintain the following minimum spacing wherever practical:
 - 1. Water and Waste Piping: Not less than 3 inches.
 - 2. Steam and Condensate Lines: Not less than 12 inches.
 - 3. Radiation and Reheat Lines: Not less than 6 inches.
- K. All underground conduit outside of any buildings shall be a minimum of 24 inches below finished grade, except where noted otherwise on the drawings.
- L. All underground feeder conduit (this does not include branch circuits) outside of any buildings shall be concrete encased. Concrete shall be 3/8-inch aggregate with a nominal compressive strength of 2,500 PSI. It shall have enough slump to flow to the bottom of the duct formation and not so wet as to cause the ducts to float. Each conduit shall be completely encased in concrete not less than 3 inches all around. Concrete shall not be poured until conduit has been inspected by the Architect. Separators or spacing blocks shall be made of plastic or other suitable non-metallic, non-decaying material placed on not greater than 5-foot centers. Ducts shall be anchored to prevent movement during placement of concrete.
- M. Provide corrosion protection for metallic conduit under concrete or in earth. Provide half-lap wrap of polyethylene 20-mil tape, factory PVC coating, or as accepted. Where PVC coating is provided, joints must be sealed in accordance with the coating manufacturer's published instructions.
- N. PVC-coated RGS (PVC-RGS) joints must be sealed in accordance with the coating manufacturer's published instructions. Installer shall be certified by the manufacturer and shall provide a valid, unexpired "Certified Installer" card prior to installing materials. Product manufacturer shall perform an inspection of the installed product and issue an acceptance report of the installation.
- O. Each empty conduit shall be provided with an installed nylon pull string.
- P. Each medical equipment conduit shall be provided with an installed calibrated pull string/measuring tape.
- Q. Bending: Changes in direction shall be made by bends in the conduit wherever possible, and these bends shall be made smooth and even without flattening the pipe or flaking the finish. Bends shall be of as long a radius as possible, but in no case less than shown in the NEC.
- R. Not more than four 90-degree bends will be allowed in one raceway run. Where more bends are necessary, a pull box shall be installed. All bends in 1-inch and smaller conduit shall be made with a conduit bender, and all larger conduit sizes shall have machine bends.

- S. Plastic conduit joints shall be made up in accordance with the manufacturer's recommendations for the particular conduit and coupling selected. Conduit joint couplings shall be made watertight. Plastic conduit joints shall be made up by brushing a plastic solvent cement on the inside of a plastic coupling fitting and on the outside of the conduit ends. The conduit and fitting shall then be slipped together with a quick one-quarter turn twist to set the joint tightly. Transition from plastic to steel conduit shall be with PVC female threaded adaptors.
- T. Plastic conduit shall be stored on a flat surface and protected from the direct rays of the sun.
- U. The ends of all conduit shall be securely plugged, and all boxes temporarily covered to prevent foreign material from entering the conduit. All conduit shall be thoroughly swabbed out with a dry swab to remove moisture and debris before conductors are drawn into place.

3.02 FITTINGS

- A. Bushings and Locknuts: Where conduit enters boxes, panels, cabinets, etc., it shall be rigidly clamped to the box by locknuts on the outside and inside, and a bushing on the inside of the box. All conduit shall enter the box squarely.
- B. Provide insulated bushings per the NEC on all conduit. The use of insulated bushings does not exclude the use of double locknuts to fasten conduit to the box.
- C. Provide expansion fittings for all conduit where it crosses building expansion joints, not to exceed 100 feet apart in straight runs. Fittings shall be complete with bonding jumpers and clamps and shall be suitably bonded to conduit.
- D. Provide weatherproof fittings in exterior installations or as noted on the plans.

3.03 SUPPORTS

- A. All raceways that are not buried or embedded in concrete shall be supported by straps, clamps, or hangers to provide a rigid installation.
- B. Conduit shall be supported at intervals required by the NEC, straight runs, at any bend, and at every outlet, junction box, panel, etc. This shall apply to vertical runs as well as horizontal runs. Where conduit is run individually, it shall be supported by approved conduit straps or beam clamps. Straps shall be secured by means of toggle bolts on hollow masonry; expansion shields and machine screws or standard preset inserts on concrete or solid masonry; machine screws or bolts on metal surfaces; and wood screws on wood construction. No perforated straps or wire hangers of any kind will be permitted. Where individual conduits are suspended from the ceiling, or above ceiling, they shall be supported by hanger rods and hangers. Conduit installed exposed in damp locations shall be provided with clamp backs under each conduit clamp, to prevent accumulation of moisture around the conduit. Where a number of conduits are to be run exposed and parallel, one with another, they shall be grouped and supported by trapeze hangers. Hanger rods shall be fastened to structural steel members with suitable beam clamps or to concrete inserts set through the opening provided in the concrete inserts. Beam clamps shall be suitable for structural members and conditions. Rods shall be galvanized steel, 3/8-inch diameter minimum. Each conduit shall be clamped to the trapeze hanger with conduit clamps.

3.04 GENERAL

- A. Install all boxes parallel and perpendicular to the finished floor. Adjust all flush mounting positions to compensate for wall material thickness. Where devices occur in the same horizontal viewing plane, align devices.
- B. Where outlet boxes occur on opposite sides of a common wall, do not place back-to-back or use through-the-wall boxes, to limit sound transmission between rooms.
- C. Where fire-rated walls occur, all membrane penetrations shall comply with the International Building Code (IBC) for walls/partitions, and for floor-ceilings/roof-ceilings. Outlet boxes in rated walls shall be steel. Outlet boxes on opposite sides of a rated wall shall be separated by a minimum of 24 inches horizontally.
- D. Support all boxes independently of conduit, except cast type which may be supported by rigid steel conduit only. Secure flush-mount boxes to wall and interior partition studs using stamped steel bridges as required to accurately position boxes. Secure ceiling-hung boxes to adjustable steel channel fasteners.
- E. All cabinets and boxes shall be secured by means of toggle bolts on hollow masonry; expansion shields and machine screws or standard precast inserts on concrete or solid masonry; machine screws or bolts on metal surfaces; and wood screws on wood construction. All recessed wall- and ceiling-mounted outlet boxes shall be supported by bar supports extending from the studs or channels on either side of the box. Boxes mounted on the surface of drywall or plaster shall be secured to wall or ceiling with fasteners rated for the weight to be supported, minimum 50 lbs. per fastener.
- F. Boxes with unused punched-out openings shall have the openings filled with factory-made knockout seals.
- G. Where emergency power and normal power are located in the same outlet box or a potential of 480 volts is present in a switch box, install partition barriers to separate the various systems.

3.05 TV / MONITOR BOXES

- A. Install boxes level, parallel, and perpendicular to the finished floor and walls, respectively. Adjust all finish trims tight to the respective wall finish material.
- B. Integrate adjacent low-voltage devices serving TV/monitor equipment within the common box. Adjust box size to accommodate both line-voltage and low-voltage devices. Provide appropriate activation plates and compartment barriers.
- C. Coordinate mounting height with architectural elevations and adjust to permit the installation of TV/monitor mounting brackets. Box shall remain behind the silhouette of the TV/monitor equipment.

3.06 FLOOR BOXES – POKE-THROUGH

- A. Verify that fire rating of poke-through device matches or exceeds the fire rating of the floor prior to penetration. Report any discrepancies to the Architect prior to placing poke-through device order.
- B. Install boxes level, parallel, and perpendicular to the finished floor and walls, respectively. Adjust all finish trims tight to the respective floor material.

3.07 SEPARATE CONDUIT SYSTEMS

- A. Each system shall be contained in a separate conduit system. This includes each power system, lighting system, signal system of whatever nature, telephone, emergency system, emergency subsystems, sound system, control system, fire alarm system, etc.
- B. Each item of building equipment shall have its own run of power wiring. Control wiring may be included in properly sized conduit for equipment feeders of #6 AWG and smaller, but separate conduits shall be used for larger size feeders.

3.08 ROUTING AND EXPOSURE

- A. Where conduit and boxes must be exposed, submit a sketch of the proposed route to the Architect for approval prior to installation.
- B. Where conduit is exposed to exterior ambient temperatures for more than 10% of its length or 10 feet, whichever is less, increase the conductor sizes in accordance with the application of ambient temperature factors contained in NEC Table 310.15.
- C. Conduit shall be installed at depths compliant with NEC Table 300.5.

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SECTION 26 05 44

SLEEVES & SLEEVE SEALS FOR ELECTRICAL RACEWAYS & CABLING

PART 1 GENERAL

1.01 SUMMARY

- A. Furnish and install raceway sealing systems, sleeves, and related weatherproofing as specified herein.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.

PART 2 PRODUCTS

2.01 ROUND SLEEVES

- A. Wall Sleeves, Steel: ASTM A53/A53M, Type E, Grade B, Schedule 40, zinc coated, plain ends and integral waterstop.
- B. Sheet Metal Sleeves, Galvanized Steel, Round: Galvanized-steel sheet; thickness not less than 24 gauge (0.6 mm); round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.
- C. Existing Construction - Wall Sleeves: Fabricate non-flanged pipe sleeves from standard Schedule 40 conduit cut flush at both sides of wall.

2.02 RECTANGULAR SLEEVES

- A. Sheet Metal Sleeves, Galvanized Steel, Rectangular:
 - 1. Material: Galvanized sheet steel.
 - 2. Minimum Metal Thickness:
 - a. For sleeve cross-section rectangle perimeter less than 50 inches (1,270 mm) and with no side larger than 16 inches (400 mm), thickness must be 17 gauge (1.3 mm).
 - b. For sleeve cross-section rectangle perimeter not less than 50 inches (1,270 mm) or with one or more sides larger than 16 inches (400 mm), thickness must be 10 gauge (3.5 mm).

2.03 SLEEVE SEAL SYSTEMS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable or between raceway and cable.
 - 1. Sealing Elements: EPDM or Nitrile (Buna N) rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 2. Pressure Plates: Fiber-reinforced plastic or stainless steel.
 - 3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.04 GROUT

- A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
 - 1. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
 - 2. Design Mix: 5,000-psi (34.5-MPa), 28-day compressive strength.
 - 3. Packaging: Premixed and factory packaged.

2.05 POURABLE SEALANTS

- A. Description: Single-component, neutral-curing elastomeric sealants of grade indicated below.
 - 1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.

2.06 FOAM SEALANTS

- A. Description: Multicomponent, liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam. Foam expansion must not damage cables or crack penetrated structure.

PART 3 EXECUTION

3.01 INSTALLATION OF SLEEVES FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

- A. Comply with NECA 1.
- B. Sleeves for Conduits Penetrating Above-Grade, Non-Fire-Rated, Concrete and Masonry-Unit Floors and Walls:
 - 1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
 - a. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall or floor so no voids remain. Tool exposed surfaces smooth; protect material while curing.
 - b. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07.
 - 2. Interior Penetrations of Non-Fire-Rated Floors:
 - a. Seal space outside of sleeves with pourable sealants. Pack sealing material solidly between sleeve and wall or floor so no voids remain. Tool exposed surfaces smooth; protect material while curing.
 - b. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07.
 - 3. Use round sleeves unless penetration arrangement requires rectangular sleeved opening.
 - 4. Size pipe sleeves to provide adequate annular clear space, 1/4-inch minimum, between sleeve and raceway or cable, unless sleeve seal system is to be installed or seismic criteria require different clearance.
 - 5. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
 - 6. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level. Install sleeves during erection of floors.

- C. Sleeves for Conduits Penetrating Non-Fire-Rated Wall Assemblies:
 - 1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
 - 2. Seal space outside of sleeves with approved joint compound for wall assemblies.
- D. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- E. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seal systems. Size sleeves to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- F. Underground, Exterior-Wall and Floor Penetrations:
 - 1. New Construction: Install steel pipe sleeves with integral waterstops. Size sleeves to allow for 1-inch (25-mm) annular clear space between raceway or cable and sleeve for installing sleeve seal system. Install sleeves during construction of floor or wall.
 - 2. Existing Construction with Cored Openings: Install steel pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between raceway or cable and sleeve for installing sleeve seal system. Grout sleeve into wall or floor opening.

3.02 INSTALLATION OF RECTANGULAR SLEEVES AND SLEEVE SEALS

- A. Install sleeves in existing walls without compromising structural integrity of walls. Do not cut structural elements without reinforcing the wall to maintain the designed weight bearing and wall stiffness.
- B. Install conduits and cable with no crossings within the sleeve.
- C. Fill opening around conduits and cables with expanding foam without leaving voids.
- D. Provide metal sheet covering at both wall surfaces and finish to match surrounding surfaces. Metal sheet must be same material as sleeve.

3.03 INSTALLATION OF SLEEVE SEAL SYSTEMS

- A. Install watertight sleeve seal systems in sleeves in exterior concrete walls (above and below grade) and slabs-on-grade at raceway entries into building.
- B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- C. Review the project soils report for notations regarding presence of hydrocarbons. Where present, provide Nitrile (Buna N) link and gasket material.

END OF SECTION

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SECTION 26 05 48

VIBRATION CONTROLS & ANCHORS

PART 1 GENERAL

1.01 SUMMARY

- A. This section includes the requirements for vibration controls and anchors for electrical systems, including but not limited to:
 - 1. Support wires for fixtures and devices mounted in acoustical lay-in ceilings.
 - 2. Transformer vibration isolation.
 - 3. General spring isolation.
 - 4. Equipment anchoring.
- B. Related sections include the following:
 - 1. Specification Sections under 09 51 00, Acoustical Ceilings.
 - 2. Specification Sections under 26 22 00, Low-Voltage Transformers.
 - 3. Specification Sections under 26 24 00, Switchboards & Panelboards.
 - 4. Specification Sections under 26 51 00, Interior Lighting

1.02 ACTION SUBMITTALS

- A. Submit product data indicating compliance with this specification for each type of support product to be used. Provide additional supporting information as follows:
 - 1. Transformer support details where mounting above floor slab.
 - 2. Anchoring devices for generator and transformers.
 - 3. Anchoring devices for switchboards, panelboards, and transfer switches.

1.03 REFERENCE PUBLICATIONS

- A. ACI: American Concrete Institute.
- B. ASTM: American Society for Testing and Materials.
- C. IBC: International Building Code.
- D. ICC-ES: International Code Council Evaluation Service.
- E. NEC: National Electrical Code - NFPA 70.
- F. SEI: Structural Engineering Institute.

1.04 COORDINATION

- A. Coordinate installation of inserts in concrete decks with affected trades.

PART 2 PRODUCTS

2.01 TRANSFORMER ISOLATION PADS

- A. Rubber Isolation Pads: CalDyn, Mason, or equal.

- B. Cork Reinforced Isolation Pads: CalDyn, Mason, or equal.

2.02 ANCHOR COMPONENTS

- A. Concrete Inserts: Powers, Tolco, Tomarco, or equal.
- B. Metal Framing Channel: B-Line, Unistrut , or equal.
- C. Expansion Anchors and Quick Bolts: Hilti, Powers, Remset, or equal.
- D. Beam Attachments: Mason, Tolco, or equal.
- E. Attachment Components: Mason, Tolco, or equal.

2.03 POST INSTALLATION ANCHORS

- A. Post installed anchors shall be listed in a current evaluation report, issued by an evaluation agency:
 - 1. International Code Council Evaluation Service (ICC-ES), or as accepted.
- B. The compressive strength of the material in which the anchor will be installed shall meet or exceed the compressive strength of the material in which the anchor was tested.

2.04 SUPPORT WIRES

- A. Description: "Galvanized soft annealed mild steel wires," as defined in ASTM A641 (Class 1 Coating), is the wire referred to in this section.
- B. Diameter of Wire: #10 wire is 0.135 inches in diameter and #12 wire is 0.106 inches in diameter, as shown by the U.S. Steel Wire Gauge.

PART 3 EXECUTION

3.01 GENERAL INSTALLATION

- A. Refer to specific equipment or component specification section for more installation requirements.

3.02 SUPPORT WIRES

- A. Allowable load for support wires shall be:

<u>Wire Size</u>	<u>Basic Load</u>
#10 wire	343 lbs.
#12 wire	209 lbs.

- B. Values are for tension only.
- C. Twists on wire to develop the maximum allowable load:
 - 1. Use a minimum of four twists within 1-1/2 inches. Three twists may be used to develop not more than one-half of the above values.

3.03 FIXTURES

- A. Use flexible connection for all lighting fixture and ceiling devices mounted in acoustical lay-in ceilings. Acceptable methods are as follows:
 - 1. Factory-supplied 3/8-inch by 6-foot-long whips for lay-in light fixtures (12 feet for master-slave extension whips).
 - 2. 1/2-inch flex with field-installed conductors.
 - 3. MC cable as permitted elsewhere in Division 26 of this specification.
 - 4. Do not allow cables or flex conduits to rest on ceiling tiles.
- B. Lighting fixture or ceiling device weighing up to 56 lbs. may be supported from the lay-in ceiling support system with additional requirements as follows:
 - 1. Attach two #12 AWG slack safety wires from the structure to opposite corners of lay-in fixtures. Coordinate any deviations from the contract reflected ceiling plan with wire installer.
 - 2. Install lighting-fixture-manufacturer-supplied clips or screws at the two short sides of 2' x 4' lay-in lighting fixtures, two per side.
 - 3. Install lighting-fixture-manufacturer-supplied clips at sides of 4' x 4' lay-in lighting fixtures, two per side.
 - 4. Install lighting-fixture-manufacturer-supplied bar hangers across 2-foot dimension of the lay-in grid. Attach each end to the grid as recommended for support application by the fixture manufacturer. Coordinate any deviations from the contract reflected ceiling plan with wire installer.
- C. Independently support any lighting fixture or ceiling device weighing more than 56 lbs. from the ceiling support system to the structure.

3.04 LIGHTWEIGHT MISCELLANEOUS DEVICES

- A. All lightweight miscellaneous devices, such as strobe lights, speakers, etc., shall be attached to the ceiling grid.

3.05 TRANSFORMER VIBRATION ISOLATION

- A. Transformers are to have internal vibration isolation from the metal housing to the core of the transformer.
- B. Use rubber isolation pads type CalDyn, Mason, or equal, for transformer housing isolation from the concrete structure.
- C. Use rubber isolation pads type CalDyn, Mason, or equal, for transformer housing isolation from the metal framing channel supports structure. Provide combo nut washer, B-Line NW series. Washer face to mate to isolator at transformer mount point.
- D. Use flexible metal conduit or rubber isolated gutters for final raceway connections to transformers where conduits are not brought up through the slab under the transformer. Install rubber wire guard on all edges of the gutter cut out to allow for conductor entrance in the transformer, panel, or switchgear.
- E. When stubbing up underground or through slabs for connections to transformers, cut out metal grating under transformers to allow for conduit entrances under the transformer. Install bell adapters prior to installation of conductors. Where metal conduits enter from the bottom through the metal grating, isolate the metal from the conduit and use bond bushings to protect the cable and to bond the conduit to the transformer. Add additional grating as needed to prevent rodent intrusion into the transformer. Gratings are to be

installed in a workmanlike manner and are to be painted to match the transformer factory color.

3.06 GENERATOR VIBRATION ISOLATION

- A. Refer to specification on generator installation for requirements for vibration isolation. Include spring isolators as part of the generator submittal package.
- B. Coordinate location of rebar in the generator concrete pads prior to pouring of pads to allow for proper location and depth of wedge anchor after the setting of the generator.
- C. Use flex conduit and stranded wire for all connections to the generator.
- D. Avoid connection of rigid conduit to the generator. Stub up from underground into the space below the output breaker termination location and at locations of control connections. When piping is required overhead, use metal flex for the last 18 to 36 inches as required. Avoid the use of liquid-tight flex as it is limited in deflection capabilities. Exterior flex conduit shall be liquid tight.
- E. Use bare copper not installed in conduit for the grounding electrode conductor or from any ground loop indicated on the contract drawings.
- F. Tighten the isolation springs on the generator according to the anchor manufacturer's instructions.

3.07 POST INSTALLATION ANCHORS

- A. Expansion-Type Anchors: Expansion-type anchors may be used, provided the allowable shear and tension loads are determined by test in accordance with the following:
 - 1. The allowable values listed in an ICC-ES Evaluation Service Report, with special inspection, may be used for allowable stress design, provided the report states that the anchors were tested in accordance with AC01, latest revision. Strength design values may be used, provided the anchors have been tested in accordance with AC193, latest revision. For anchors installed in the underside of a beam/slab, the allowable tension load design values should be based on the tabulated value for the anchors installed without special inspection.
- B. Epoxy-Type Anchors: Epoxy-type (adhesive) anchors include anchors that rely on organic and inorganic compounds (include epoxies, polyurethanes, methacrylates, and vinyl esters) to develop the bond to the concrete. The use of shallow epoxy-type (adhesive) anchors are those with an embedment-to-diameter ratio less than 8. Epoxy-type (adhesive) anchors shall only be installed in conditioned, interior spaces. Exception: Where epoxy-type anchors are used as shear dowels at the perimeter of an existing opening (slab or wall) to be filled with concrete, or are being used to connect new concrete elements to existing concrete elements (e.g., gunite), they may be installed in exterior locations with prior approval of the project Structural Engineer. The design shear and tension capacities of epoxy-type anchors must be determined in accordance with the following:
 - 1. The allowable loads may be based on the values listed in an ICC-ES Report that complies with the requirements of AC58 for a specific anchor in the same configuration tested.
 - 2. Where epoxy-type (adhesive) anchors are used for structural applications, such as dowels between new and existing concrete, the anchors shall be installed in a manner such that the ultimate tensile capacity is controlled by the ultimate strength of the steel element. Exception: Epoxy-type (adhesive) anchors which cannot

develop the tensile capacity of the steel element may be used to transfer shear forces only, provided that the loads on the anchor are amplified by a factor of 4.0. When epoxy-type (adhesive) anchors are used to resist tensile forces in structural applications, the minimum depth of embedment shall be greater than or equal to the development length (L_d), determined for a cast-in-place reinforcing bar of the same diameter and grade when considering a tensile splitting failure mode. Where tensile splitting need not be considered, the depth of embedment may be determined in accordance with Appendix D of ACI 318-02, as amended by Section 3.3 of AC 308.

- C. Screw Anchors: The fastener is produced from hardened steel with threads, similar in appearance to a lag bolt. Screw anchors may be used, provided the allowable shear and tension loads are determined in accordance with the following:
 - 1. The allowable values listed in the ICC-ES Report, with special inspection, may be used for allowable stress design, provided the report states that the anchors were tested in accordance with AC106, latest revision, including the seismic qualification tests of AC106, Section 4.6.
 - 2. Welding to these anchors is not permitted.
 - 3. Screw anchors may be used to attach components, such as equipment, mechanical vibration isolators, or snubbers, to structural (reinforced) concrete, or for sill bolting applications.
 - 4. The use of screw anchors is not permitted in overhead applications or for discrete hold-down forces, such as shear walls.
- D. Power-Actuated Fasteners: Power-actuated fasteners (shot pins) may be used for limited applications, provided the allowable shear and tension loads are determined in accordance with the following:
 - 1. The allowable values listed in an ICC-ES Evaluation Service Report, with special inspection, may be used for allowable stress design, provided the report states that the anchors were tested in accordance with AC70, latest revision.

3.08 ANCHORS

- A. Embedment, Spacing and Edge Distance: All anchors shall meet the minimum embedment, spacing, edge distance, and slab thickness criteria established by the relevant ICC-ES Report.
 - 1. Unless otherwise noted in the report, the edge distance should be a minimum of 10 bolt diameters from the free edge of the slab and center-to-center spacing should be a minimum of 12 bolt diameters. If the edge distance is less than 10 diameters, and the load is directed toward the free edge, the allowable shear load should be reduced.

3.09 EQUIPMENT ANCHORING

- A. Anchor equipment per switchgear manufacturer's instructions.
- B. Install anchors with the proper depth per manufacturer's instructions for the specific anchor.
- C. If edge of pad distance is not achievable, drill through the pad into the concrete floor below the pad.
- D. Move anchor location farther away from the edge of the pad as required and add clips to the anchors to secure the rail of the switchgear where there are not convenient holes to anchor through.

- E. Multi-section equipment shall be bolted together to form a single unit. Attachment shall be in conformance with the equipment manufacturer's recommendations for such equipment. No deviations will be accepted.
- F. Flush-Mounted Panelboards: Shall be anchored between wall studs, minimum four 3/8-inch-diameter bolts, two per side, with flat washers and nylock nuts.
- G. Panelboards Surface Mounted to Masonry: Shall be anchored through factory-punched mounting holes in back of the panel can. Panels up to 300 lbs., minimum four, one per corner. Panels greater than 300 lbs., minimum six, one per corner and two in the middle.
- H. Pad-Mounted Transformers: Shall be anchored through factory-punched mounting holes. Use Hilti "KB-TZ" anchors with minimum 3-1/4-inch embedment and install per ICC-ESR 1917. Allow extra anchor length to accommodate vibration isolation pad thickness.

3.10 FIELD QUALITY CONTROL

- A. Install all equipment and components per manufacturer's instructions.
- B. Visually inspect and field verify all connections and attachments for proper tightness.
- C. Coordinate inspections with the Authority Having Jurisdiction.

END OF SECTION

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SECTION 26 05 53

IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

- A. This section includes:
 - 1. Identification for raceways.
 - 2. Identification of power and control cables.
 - 3. Identification for conductors.
 - 4. Warning labels and signs.
 - 5. Instruction signs.
 - 6. Equipment identification labels.
 - 7. Miscellaneous identification products.

1.02 ACTION SUBMITTALS

- A. Product Data: For each electrical identification product indicated.

1.03 QUALITY ASSURANCE

- A. Comply with ANSI A13.1.
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
- D. Comply with ANSI Z535.4 for safety signs and labels.
- E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Comply with ASME A13.1.
- B. Comply with NFPA 70.
- C. Comply with ANSI Z535.4 for safety signs and labels.
- D. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.
- E. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
- F. Differential values in Temperature Change subparagraph below (for aluminum in particular) are suitable for most of the United States.
 - 1. Temperature Change: 120°F (67°C), ambient; 180°F (100°C), material surfaces.

2.02 COLOR AND LEGEND REQUIREMENTS

- A. Raceways Carrying Circuits at 600 Volts or Less:
 - 1. Conduit shall be identified with field-installed self-adhesive labels in system color as stated below. Labels shall be the system color with a contrasting text color of white or black to promote visibility.
 - 2. Conduits for future use shall be "No color" except where the future system is identified.

2.03 LABELS

- A. Write-On Tags: Polyester tag, 0.015 inch (0.38 mm) thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
 - 1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
 - 2. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by tag manufacturer.
- B. Adhesive Film Label with Clear Protective Overlay: Machine-printed, in black or white (as appropriate based on background color), by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm). Overlay shall provide a weatherproof and UV-resistant seal for label.
- C. Self-Adhesive Labels: Polyester or Vinyl, thermal, transfer-printed, 3-mil (0.08-mm) -thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.
 - 1. Minimum Nominal Size:
 - a. 1-1/2" x 6" (37 mm x 150 mm) for raceway and conductors.
 - b. 3-1/2" x 5" (76 mm x 127 mm) for equipment.
 - c. As required by Authorities Having Jurisdiction.

2.04 POWER AND CONTROL CABLE IDENTIFICATION MATERIALS

- A. Self-Adhesive Vinyl Labels: Preprinted flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
- B. Write-On Tags: Polyester tag, 0.015 inch (0.38 mm) thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
 - 1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
 - 2. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by tag manufacturer.
- C. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- D. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid colored acrylic sleeve 2 inches (50 mm) long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- E. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils (0.08 mm) thick by 1 to 2 inches (25 to 50 mm) wide.

- F. Marker Tapes: Vinyl or vinyl cloth, self-adhesive wraparound type, with circuit identification legend machine-printed by thermal transfer or equivalent process.

2.05 FLOOR MARKING TAPE

- A. 2-inch (50-mm) wide, 5-mil (0.125 mm) pressure-sensitive vinyl tape, with black and yellow stripes and clear vinyl overlay.

2.06 INSTRUCTIONAL SIGNS

- A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch (1.6 mm) thick for signs up to 20 sq.in. (129 sq.cm) and 1/8 inch (3.2 mm) thick for larger sizes.
 - 1. Engraved legend with black letters on white face.
 - 2. Punched or drilled for mechanical fasteners, minimum one per corner.
 - 3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.07 EQUIPMENT IDENTIFICATION LABELS

- A. Engraved, Laminated Acrylic or Melamine Label: Minimum letter height shall be 3/8 inch (10 mm). Punched or drilled for mechanical fasteners, two minimum.
- B. First line of text shall include the equipment name assigned on the floor plans. Second line of text is equipment-specific.
 - 1. Switchboards, panelboards, motor control centers, and disconnects shall include ampere rating, voltage, phase, 3- or 4-wire, and upstream source "fed from (name as appropriate)."
 - 2. Wireways shall include ampere upstream source "fed from (name as appropriate)."
 - 3. Transformers shall include kVA, voltage, phase, 3- or 4-wire, and upstream source "fed from (name as appropriate)."
 - 4. Generators and UPSs shall include kW and kVA rating, voltage, phase, 3- or 4-wire, and system type; Life Safety, Critical, Equipment, Fire Pump, System-A, NEC 700, NEC 701, NEC 702, etc.
 - 5. Transfer switches shall include ampere rating, voltage, phase, 3- or 4-wire, and on a third and fourth line of text upstream sources "Normal fed from (name as appropriate)" and "Emergency fed from (name as appropriate)."
 - 6. Lighting controls and relay panels shall include name of general area served; Classroom Bldg. B, 1st Floor, 2nd Floor West, etc.
- C. Colors:
 - 1. Normal Power: White letters on black face.

2.08 DEVICE CIRCUIT IDENTIFICATION LABELS

- A. Adhesive Film Label with Clear Protective Overlay: Machine-printed by thermal transfer or equivalent process. Minimum letter height shall be 1/4 inch (6 mm). Overlay shall provide a weatherproof and UV-resistant seal for label.
- B. Text Colors:
 - 1. Black text for normal power systems.
 - 2. Red text for emergency or essential power systems.

2.09 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: For paint materials and application requirements, comply with requirements in specification sections under 09 90 00, Painting and Coating. Select paint system applicable for surface material and location (exterior or interior).
- B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws, stainless-steel machine screws with nuts and flat and lock washers, or stainless steel rivets.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. For instance, vertically mounted boxes or equipment labels shall read horizontally.
- B. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.
- C. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other sections requiring identification applications, drawings, shop drawings, manufacturer's wiring diagrams, and Operation & Maintenance Manual. Use consistent designations throughout project.
- D. Install identifying devices before installing acoustical ceilings and similar concealment.
- E. Apply identification devices to surfaces that require finish after completing finish work.
- F. Install signs with approved legend to facilitate proper identification, operation, and maintenance of electrical systems and connected items.
- G. Signs and plastic labels shall be attached with mechanical fasteners appropriate to the location and substrate.
- H. Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.
- I. Write-on tags shall be used for temporary identification of conductor and cable only. Each tag shall be changed to a permanent solution prior to project closeout.
- J. System Identification for Raceways and Cables under 600 Volts: Identification shall completely encircle cable or conduit. Place adjacent identification of two-color markings in contact, side by side.
 - 1. Locate conduit labels at changes in direction, at penetrations of walls and floors, at 30-foot maximum intervals in straight runs.
 - 2. Raceway system junction boxes shall be painted to match system color. On junction boxes that are larger than 25 inches square, only the cover of the box need be painted.
 - 3. Locate conductor and cable circuit number labels within 9 inches of terminations and at each pull box interior.
 - 4. Secure identifications tight to surface of conductor, cable, or raceway.

- K. Painted Identification: For surface preparation and paint application, comply with requirements in specification sections under 09 90 00, Painting and Coating.
- L. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.
- M. Equipment Identification Labels: On each unit of equipment, install a unique designation label that is consistent with design plans, wiring diagrams, schedules, and the Operation & Maintenance Manual. Apply labels to switchboards, panelboards, motor control centers, lighting control panels, relay panels, transformers, disconnects, wireways, generators, transfer switches, UPSs, control cabinets, and racks.
 - 1. Labeling Instructions:
 - a. Indoor Equipment: Engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 3/8-inch (10-mm) -high letters on 1-inch (25-mm) -high label; where two lines of text are required, use labels 1-1/2 inches (38 mm) high.
 - b. Outdoor Equipment: Engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 3/8-inch (10-mm) -high letters on 1-inch (25-mm) -high label; where two lines of text are required, use labels 1-1/2 inches (38 mm) high.
 - c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
 - d. Fasten labels with appropriate mechanical fasteners that do not change the NEMA or nationally recognized testing laboratory (NRTL) rating of the enclosure.

3.02 IDENTIFICATION SCHEDULE

- A. Equipment Identification: Identify each piece of electrical equipment as described in this section.
- B. Junction boxes recessed in walls or ceilings shall be color-coded on the interior to match the raceway system color-code.
- C. Accessible Raceways and Cables Within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall match the raceway color-coding descriptions in Part 2 and shall have either dark text over light box color or light text over dark box color, as appropriate.
- D. Metal-Clad Cables, 600 Volts or Less, for Circuits More than 30 Volts, and up to 277 Volts to Ground: Install labels within 3 feet of termination.
- E. Power-Circuit Conductor Identification, 600 Volts or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.
 - 1. Color-Coding for Phase and Voltage Level Identification, 600 Volts or Less: Use colors listed below for ungrounded conductors.
 - a. Color shall be factory applied or field applied for sizes larger than #8 AWG, if Authorities Having Jurisdiction permit.
 - b. Colors for 208/120-Volt Circuits:
 - 1) Phase A: Black.
 - 2) Phase B: Red.
 - 3) Phase C: Blue.

- c. Colors for 480/277-Volt Circuits:
 - 1) Phase A: Brown.
 - 2) Phase B: Orange.
 - 3) Phase C: Yellow.
 - d. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches (150 mm) from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.
- F. Wiring Device Circuit Identification: Circuits supplying devices shall be identified on the device trim plate, panel-circuit number format.
- G. Conductors and Conduit to be Extended in the Future: Attach marker tape to conductors and conduit and list source.
- H. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
 - 1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
 - 2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
 - 3. Coordinate identification with project drawings, manufacturer's wiring diagrams, and the Operation & Maintenance Manual.
- I. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Outline NEC horizontal workspace requirements per NEC 110.26 Table for the applicable condition. Workspace width shall be the length of electrical equipment or 30 inches centered on equipment, whichever is greater.

END OF SECTION

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SECTION 26 09 23

LIGHTING CONTROL DEVICES

PART 1 GENERAL

1.01 SUMMARY

- A. Furnish and install occupancy sensors and related power packs, daylighting sensors and related power packs, intelligent relays, emergency relays, timer switches, and sensor related wall switches, as shown on the drawings and as specified herein.
- B. Contractor shall coordinate all of the work in this section with all of the trades covered in other sections of the specification to provide a complete and operable system.

1.02 REFERENCES

- A. American National Standards Institute/Institute of Electrical and Electronic Engineers (ANSI/IEEE).
- B. Underwriters Laboratories of Canada (ULC).
- C. International Electrotechnical Commission (IEC).
- D. International Organization of Standardization (ISO).
- E. National Electrical Manufacturers Association (NEMA).
 - 1. WD1 (R005) - General color requirements for wiring devices.

1.03 QUALITY ASSURANCE

- A. Firms regularly engaged in the manufacture of lighting control equipment and ancillary equipment, of types and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. All components and assemblies are to be factory pretested and burned-in prior to installation.
- C. Factory-trained technicians shall be available to functionally test each component in a programmable system after installation to verify proper operation and confirm that the panel wiring and addressing conform to the wiring documentation.
- D. System Support: Factory Applications Engineers shall be available for on-site training as well as telephone support.
- E. Comply with the NEC as applicable to electrical wiring work.
- F. Comply with applicable portions of NEMA Standards pertaining to types of electrical equipment and enclosures.
- G. All components shall be UL listed as a system under UL 916, Energy Management Equipment.

- H. All assemblies are to be in compliance with FCC Emissions Standards specified in Part 15, Subpart J, for Class A application.

1.04 SUBMITTALS

- A. Submit manufacturer's product data for the lighting control devices and components. This shall include catalog sheets, specifications, and installation instructions.
- B. Submit typical wiring diagrams for all components, including, but not limited to, input devices such as low-voltage switches, vacancy and occupancy sensors, daylighting sensors, photocells, power packs, emergency control relays, and cable/wire.

1.05 GUARANTEE

- A. Provide a 5-year manufacturer's warranty on all products to be free of manufacturer's defects. In addition to the replacement parts, this warranty shall include replacement labor.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Basis of design is Wattstopper. Product reference numbers contained herein are for standard products offered by Wattstopper. Subject to compliance with requirements, equivalent products from manufacturers listed below are acceptable.
 - 1. Greengate.
 - 2. LC & D.
 - 3. Leviton.
 - 4. Lutron.
 - 5. Philips.

2.02 GENERAL

- A. Sensor control shall utilize Zero Crossing Circuitry.
- B. Sensor shall have no leakage current to load, in Manual or in Auto/Off mode, and shall have voltage-drop protection.
- C. Sensor shall provide a field selectable option to convert sensor operation from Automatic-ON to Manual-ON.
- D. Where specified to be vandal-resistant type, sensor shall utilize a hard lens with a minimum 1.0 mm thickness. Products utilizing a soft lens will not be considered.
- E. Sensors shall have UL rated, 94V-0 plastic enclosures.
- F. Passive infrared sensors shall utilize Pulse Count Processing and Detection Signature Processing to respond only to those signals caused by human motion.
- G. Passive infrared sensors shall provide high immunity to false triggering from RFI (hand-held radios) and EMI (electrical noise on the line).
- H. Passive infrared sensors shall have a multiple segmented Fresnel lens, in a multiple-tier configuration, with grooves-in to eliminate dust and residue build-up.

- I. Where specified, passive infrared, ultrasonic, and dual technology dual relay sensors shall offer daylighting footcandle adjustment control.
- J. Dual technology sensors shall consist of passive infrared and ultrasonic/microphonic technologies for occupancy detection. Products that react to noise or ambient sound shall not be considered.
- K. Ultrasonic/microphonic sensors shall utilize Advanced Signal Processing to adjust the detection threshold dynamically to compensate for constantly changing levels of activity and air flow throughout controlled space.
- L. Ultrasonic/microphonic operating frequency shall be crystal controlled at 25 kHz within $\pm 0.005\%$ tolerance, 32 kHz within $\pm 0.002\%$ tolerance, or 40 kHz $\pm 0.002\%$ tolerance to assure reliable performance and eliminate sensor cross-talk. Sensors using multiple frequencies are not acceptable.
- M. Sensors shall be capable of operating normally with electronic ballasts, PL lamp systems, and rated motor loads.
- N. Coverage of sensors shall remain constant after sensitivity control has been set. No automatic reduction shall occur in coverage due to the cycling of air conditioner or heating fans.
- O. When specified, sensors shall utilize intelligent technology to automatically adjustable time delay and sensitivity settings.
- P. Sensors shall have readily accessible, user adjustable settings for time delay and sensitivity. Settings shall be located on the sensor (not the control unit) and shall be recessed to limit tampering.
- Q. Bypass: In the event of failure, a manual relay override shall be provided on each sensor. When override is utilized, lighting shall remain on constantly or control shall divert to a wall switch until the sensor is replaced. This control shall be recessed to prevent tampering.
- R. Sensors shall provide an LED which is responsive to presence of motion. This indicator shall be visible at all times, both in testing and normal operation.
- S. HVAC Interface: Where specified, the sensor shall have an internal isolated relay with Normally Open/Normally Closed outputs for use with HVAC Control, Data Logging, and other control options. Sensors utilizing separate components or specially modified units to achieve this function are not acceptable.
- T. HID Controller shall:
 - 1. Be compatible with all types of High Intensity Discharge (HID) lamps, including Metal Halide, Metal Halide Pulse Start, and High Pressure Sodium.
 - 2. Operate with HID lamps utilizing Constant Wattage Autotransformer (CWA) type ballasts.
 - 3. Maintain a full light level during lamp warmup for 15 minutes. Purpose: To avoid lamp damage during the HID power-up period.
 - 4. Be compatible with any 24-VDC controlling device, such as occupancy sensors, time switches, control panels, or photocells. Purpose: To maximize lighting control scenarios.
 - 5. Be capable of linking to other HID control modules to enable effective multi-zone control. Up to 100 individual devices shall be capable of being connected.

2.03 WALL SENSOR SWITCH

- A. UW-100 Series ultrasonic/microphonic technology, single relay, line-voltage sensor. Sensor shall be capable of detection of occupancy at desktop level up to 225 square feet.
 - 1. Sensor contacts shall have ratings of:
 - a. 800-W, 120-VAC ballast or tungsten.
 - b. 1/6-HP, 230 to 277-VAC motor.
 - c. 1,200-W, 277-VAC ballast.
 - 2. Sensor features shall include:
 - a. Sensitivity Adjustments: Ultrasonic/Microphonic – continuous.
 - b. Time Delays: Auto Set, Fixed (5, 10, 15, 20, 25, 30 minutes), Walk Through, and Test Mode.
- B. UW-200 Series ultrasonic/microphonic technology, dual relay, line-voltage sensor. Sensor shall be capable of detection of occupancy at desktop level up to 225 square feet.
 - 1. Sensor contacts shall have ratings of:
 - a. 800-W, 120-VAC ballast or tungsten.
 - b. 1/6-HP, 230 to 277-VAC motor.
 - c. 1,200-W, 277-VAC ballast.
 - 2. Sensor features shall include:
 - a. Sensitivity Adjustments: Ultrasonic/Microphonic – continuous.
 - b. Time Delays: Auto Set, Fixed (5, 10, 15, 20, 25, 30 minutes), Walk Through, and Test Mode.
- C. DW-100 Series dual technology, single relay, line-voltage sensor. Sensor shall be capable of detection of occupancy at desktop level up to 300 square feet, and gross motion up to 1,000 square feet.
 - 1. Sensor contacts shall have ratings of:
 - a. 800-W, 120-VAC ballast or tungsten.
 - b. 1/6-HP, 230 to 277-VAC motor.
 - c. 1,200-W, 277-VAC ballast.
 - 2. Sensor features shall include:
 - a. Sensitivity Adjustments: PIR-High/Low, Ultrasonic/Microphonic – continuous.
 - b. Time Delays: Auto Set, Fixed (5, 15, 30 minutes), Walk Through, and Test Mode.
- D. DW-200 Series dual technology, dual relay, line-voltage sensor. Sensor shall be capable of detection of occupancy at desktop level up to 300 square feet, and gross motion up to 1,000 square feet.
 - 1. Sensor contacts shall have ratings of:
 - a. 800-W, 120-VAC ballast or tungsten.
 - b. 1/6-HP, 230 to 277-VAC motor.
 - c. 1,200-W, 277-VAC ballast.
 - 2. Sensor features shall include:
 - a. A light level sensor to active second relay of dual relay switch.
 - b. Sensitivity Adjustments: PIR-High/Low, Ultrasonic/Microphonic – continuous.
 - c. Time Delays: Auto Set, Fixed (5, 15, 30 minutes), Walk Through, and Test Mode.
- E. PW-200 Series PIR, dual relay, line-voltage sensor. Sensor shall be capable of detection of occupancy at desktop level up to 300 square feet, and gross motion up to 1,000 square feet.
 - 1. Sensor contacts shall have ratings of:
 - a. 800-W, 120-VAC ballast or tungsten.

- b. 1/6-HP, 230 to 277-VAC motor.
 - c. 1,200-W, 277-VAC ballast.
- 2. Sensor features shall include:
 - a. A light level sensor to active second relay of dual relay switch.
 - b. Sensitivity Adjustments: PIR-High/Low, Ultrasonic/Microphonic – continuous.
 - c. Time Delays: Auto Set, Fixed (5, 15, 30 minutes), Walk Through, and Test Mode.

2.04 WALL SWITCH ELECTRONIC TIME SWITCHES (DIGITAL)

- A. TS-400 Series digital time switch shall be wall box type, single gang, rated 120 volts, 800 watts, and 277 volts, 1,200 watts. The switch shall include a Manual Switch On, automatic function to turn lights off after a preset elapsed time, and a user temporary time override without changing the preset off. Automatic Off function shall be adjustable from 5 minutes to 12 hours. Prior to extinguishing the lights, the switch shall provide a visual and audible warning to allow occupants to reset as needed.

2.05 CEILING MOUNT SENSORS

- A. CI-300 Series PIR sensor shall utilize low-voltage for control and include the companion single or dual level relay power pack/control unit. Sensor shall surface mount to a standard 4-inch octagon electrical back box. Provide manufacturer-recommended companion wall switch(es) for Manual Enable/Disable operation.
- B. DT-300 Series dual technology sensor shall utilize low-voltage for control and include the companion single or dual level relay power pack/control unit. Sensor shall surface mount to a standard 4-inch octagon electrical back box. Provide manufacturer recommended companion wall switch(es) for manual enable/disable operation.
- C. UT-300 Series Ultrasonic sensor shall utilize low-voltage for control and include the companion single or dual level relay power pack/control unit. Sensor shall surface mount to a standard 4-inch octagon electrical back box. Provide manufacturer-recommended companion wall switch(es) for Manual Enable/Disable operation.

2.06 CORNER MOUNT SENSORS

- A. DT-200 Series dual technology sensor shall utilize low-voltage for control and include the companion single or dual level relay power pack/control unit. The sensor shall have an adjustable corner mount housing allowing placement as depicted on plans. Provide manufacturer-recommended companion wall switch(es) for Manual Enable/Disable operation.
- B. CX-100 Series PIR sensor for corridors and aisles (warehouse of similar) only. This sensor shall utilize low-voltage for control and include the companion single or dual level relay power pack/control unit. The sensor shall have an adjustable corner mount housing allowing placement as depicted on plans. Provide manufacturer-recommended companion wall switch(es) for manual enable/disable operation.

2.07 EXTERIOR MOUNTED SENSORS

- A. EW-Series exterior sensors shall cover 35' to 52.5' radiuses, with a field of view of 180 to 270 degrees respectively.
- B. EN-100 exterior sensor shall cover up to 35 foot radius, with a field of view of 90 degrees.

- C. EN 200 exterior sensors shall cover up to 100 feet, with a long-range lens view.
- D. EWF exterior sensors shall include polycarbonate lamp holders that accept PAR 20 or 38 lamps up to 150 watts per lamp.
- E. Exterior sensors shall have UL 773A ratings. EWF exterior sensors shall additionally have UL 1571 ratings.
- F. Exterior sensors shall be manufactured with precision tooling and contain internal silicon gaskets and have an operating temperature range of -40°F to +130°F.

2.08 RELAY POWER PACK/CONTROL UNITS

- A. BZ Series relay power pack/control unit shall be able to be externally mounted through a 1/2-inch knockout on a standard electrical enclosure. The unit shall be integrated, self-contained, and consist of an internally isolated load switching control relay and a transformer to provide low-voltage power. The unit shall include single or dual relays as per the control requirements, and shall provide power to a minimum of two sensors. Housing shall be plenum rated.
- B. Relay contacts shall have ratings of:
 - 1. 20 amps – 120/230/277-VAC ballast or incandescent.
 - 2. HP – 120/230/277-VAC motor.

2.09 EMERGENCY RELAY PACK/CONTROL UNIT

- A. ELCU Series emergency relay pack/control unit shall be designed to provide emergency override control (bypass) of normal power control of emergency circuit when the power to the normal power circuit is removed, UL 924 listed. The unit shall be able to be externally mounted through a 1/2-inch knockout on a standard electrical enclosure. The unit shall be integrated, self-contained, and consist of an internally isolated load switching control relay and a transformer to provide low-voltage power. The unit shall include single or dual relays as per the control requirements, and shall provide power to a minimum of two sensors. Housing shall be plenum rated.
- B. Relay contacts shall have ratings of:
 - 1. 10 amps – 120-VAC incandescent.
 - 2. 1.0 HP – 120-VAC motor.
 - 3. 20 amps – 120/277-VAC ballast.

2.10 INTELLIGENT RELAY POWER PACK/CONTROL UNITS

- A. LC-100 Series intelligent power pack/control unit shall be a separately mounted enclosure containing four points of control: Two 0 to 10-volt dimming, two relays. Control inputs can be on/off switches, daylighting photosensor, external time controller contacts, and load shedding system contacts. The unit shall consist of internally isolated load switching control relays, each with an isolated NO/NC contact set. Unit shall include a transformer to power up to 150 mA of low-voltage devices. Pair with LS-301 photosensor for daylighting control. Housing shall be plenum rated.
- B. Relay contacts shall have ratings of:
 - 1. 20A – 120/277-VAC ballast or incandescent.
 - 2. HP – 120/250-VAC motor.

2.11 PHOTSENSORS

- A. LS-301 Series photosensor, closed loop type, shall provide full range dimming, 0.2 to 10 VDC output voltage, and control up to 50 dimming ballasts in one zone. Provide sensor with remote control for setup and user control. Sensor shall be ceiling surface mount.
- B. LS-102 Series switching photosensor, closed loop type, shall provide on-off control in conjunction with occupancy sensor and related relay power pack/control unit. Sensor shall be ceiling surface mount.
 - 1. Features:
 - a. Auto Setpoint Calculation.
 - b. Multi-Band Photosensor Range: 1 to 1,400 fc.
 - c. On Setpoint Range: 1 to 850 fc.
 - d. Status Indicator: Multi-function green LED.

2.12 CONTROL WIRING

- A. Control wiring between sensors and control units shall be Class II, #18-24 AWG, stranded UL classified, PVC insulated or Teflon jacketed cable suitable for use in plenums, where applicable. Minimum acceptable wire gauge from the circuit control hardware relays shall be #14 AWG.

PART 3 EXECUTION

3.01 PRE-INSTALLATION COORDINATION

- A. A factory-authorized manufacturer's representative shall provide the Electrical Contractor a functional overview of the lighting control system prior to installation. The Contractor shall schedule the pre-installation site visit after receipt of approved submittals to review the following:
 - 1. Confirm the location and mounting of all devices, with special attention to placement of occupancy and daylighting sensors.
 - 2. Review the specifications for low-voltage control wiring and termination requirements.
 - 3. Discuss the functionality and configuration of all products, including sequences of operation, per design requirements.
 - 4. Discuss requirements for integration with other trades and specific responsibilities regarding integration.
- B. Manufacturer's representative to provide written or computer-generated documentation for use in commissioning activities on a room-by-room basis including:
 - 1. Sensor parameters, time delays, sensitivities, daylighting setpoints.
 - 2. Sequence of operations, manual on, auto off, etc.
- C. Do not install equipment until the following conditions can be maintained in spaces to receive equipment:
 - 1. Ambient Temperature: 0 to 40°C (32 to 104°F).
 - 2. Relative Humidity: Maximum 90%, non-condensing.

3.02 INSTALLATION

- A. Provide detailed point-to-point wiring diagrams for every termination. Provide color-coded conductors to simplify Contractor termination requirements, where using building wiring. Color codes shall be noted on the diagrams.
- B. Provide wiring in accordance with the equipment manufacturer's wiring diagrams.
- C. Mount devices according to the project requirements and the equipment manufacturer's recommendations. Sensors shall be mounted in such a way as to minimize coverage in unintended areas.
- D. Switch and Relay Type: Provide single or dual relay control to match the lighting system installed in the room controlled.
- E. Sensor Type Applications:
 - 1. PIR sensors shall be provided in single occupancy offices, up to 300 square feet.
 - 2. Dual technology sensors shall be provided in single person restrooms (no stalls).
 - 3. Ultrasonic/Microphonic sensors shall be provided in other restrooms.
 - 4. PIR sensors shall be used in aisles (warehouse or similar).
 - 5. Dual technology sensors shall be provided in other spaces.
- F. Where no ceilings are utilized, conduit must be routed from a back box at the device back to a connection point at the nearest lighting fixture or control location.

3.03 DAYLIGHTING SENSORS AND CONTROLS

- A. Install and calibrate per manufacturer's recommendations. Adjust the daylighting sensor to provide even illumination between on/off sequences. The time delay shall provide adequate "dead band" to allow the passing of clouds without triggering the electric lighting off.
- B. At night with no exterior illumination except moonlight, measure and record the installed electric lighting illumination level at the floor or at the desk (at regularly occupied environments) within the daylighting zone. Set the sensor target level at the nearest increment above the measured electric lighting illumination level.

3.04 FIELD STARTUP AND COMMISSIONING

- A. Upon completion of the installation, the system shall be commissioned by the manufacturer's factory-authorized representative who will verify a complete, fully functional system. Representative shall work with the Electrical Contractor to adjust each device to operate within the manufacturer's expectations for the product.
 - 1. Calibrate all sensor time delays and sensitivity for proper coverage of occupants and for energy savings.
 - a. Adjust time delay so that controlled area remains lighted for 5 minutes after occupant leaves area.
- B. The manufacturer's representative and the Contractor shall walk the project with the Owner to demonstrate sensor functions. Contractor shall provide both the manufacturer and the Owner with 10 working days written notice of the demonstrative project walk. The Contractor shall make adjustments to sensor operations to satisfy the Owner's needs within the parameters of the sensor and the applicable energy code requirements.

- C. Upon completion of the system commissioning, the factory-authorized technician shall provide 2 hours of training to the Owner's designated personnel on the adjustment and maintenance of each type of component.

3.05 RE-COMMISSIONING

- A. Re-commission project at 30 days from occupancy, recalibrate all sensor time delays and sensitivities to meet the Owner's project requirements. Provide a detailed report to the Architect/Owner of re-commissioning activity.

END OF SECTION

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SECTION 26 22 13

LOW-VOLTAGE DISTRIBUTION TRANSFORMERS

PART 1 GENERAL

1.01 SUMMARY

- A. Furnish and install, where indicated on the drawings, dry-type transformers with the voltages and phases as shown on the drawings. Transformers shall be 60 Hz with KVA rating as shown on the drawings. Transformers noted with a K-factor rating on the drawings (K-4, 9, 13, 20) shall be listed for use to supply non-linear loads with a harmonic profile equal to or less than the stated K-factor.

1.02 ACTION SUBMITTALS

- A. Product Data: Provide manufacturer's cut sheet for each transformer specified herein. Include at a minimum:
 - 1. Physical dimensions, weight, and clearance requirements.
 - 2. Electrical ratings including impedance.
 - 3. Insulation class and temperature rise.
 - 4. Static shield material and characteristics.
 - 5. K-rating, where greater than one.
 - 6. Sound level.

1.03 REGULATORY REQUIREMENTS

- A. All transformers shall be UL listed and bear the UL label.

1.04 DELIVERY, STORAGE AND HANDLING

- A. Equipment shall be handled and stored in accordance with manufacturer's instructions. One copy of these instructions shall be included with the equipment at time of shipment.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable manufacturers are ABB, Eaton, Jefferson, Siemens, and Square D.

2.02 GENERAL

- A. Transformers shall comply with the latest NEMA and ANSI Standards. Transformers shall meet the requirements of the most current version of Federal Law 10 CFR Part 431, Energy Efficiency Program for Certain Commercial and Industrial Equipment, and shall bear the UL Energy Efficiency Verification Mark.
- B. Transformers shall be encased in a sheet steel enclosure; 10 KVA and smaller shall be non-ventilated, and above 10 KVA shall be ventilated, self-cooled. The core and coil assembly shall be completely isolated from the enclosure by means of neoprene rubber isolation pads or other acceptable vibration isolators. In addition, all transformers shall be mounted on vibration isolators. Ventilated and non-ventilated transformers installed outdoors shall conform to the requirements of NEMA 250, Type 3R.

- C. Transformers shall be designed for continuous operation at rated KVA, while in an ambient temperature not exceeding 40°C and with normal life expectancy as defined in ANSI C57.96.
- D. Transformers for non-linear loads shall be specifically designed to supply circuits with a harmonic profile equal to or less than a K-factor noted on the plans. All cores shall be constructed with low hysteresis and eddy current losses. The core flux density shall be well below the saturation point to prevent overheating and excessive sound level caused by harmonic noise distortion. Three phase transformer secondary neutral terminals shall be sized for 200% of the secondary phase current.
- E. Where K-factor transformers are indicated on the drawings, the transformers shall be specifically designed to supply circuits with a harmonic profile equal to or less than a K-factor noted on the plans.
- F. Transformer windings shall be copper or aluminum.
- G. Terminals shall be welded to the leads of the coils. Terminals shall not be spot welded or bolted to the coil leads.
- H. Ventilation of windings shall be accomplished by insulated spacers installed and arranged to brace coil layers and provide maximum ventilation. Core and coil assemblies shall be constructed to provide short circuit withstand capability as defined by ANSI and NEMA Standards.
- I. Electrostatic Shielding:
 - 1. Where shown on the drawings, provide electrostatic shield consisting of a single turn of aluminum placed between the primary and secondary winding and grounded to the housing of the transformer.
 - a. Electrostatic shield shall provide primary to secondary winding capacitance between 24 and 18 picofarads over the range of 100–20 kHz.
 - b. Electrostatic shielding shall provide the following minimum attenuation when tested per MIL-Std-220A, Method of Insertion Loss Measurement, with matched impedance no load technique:
 - 1) Common Mode Noise Attenuation: -80 dBA minimum at 0.1–1.5 kHz; -55 dBA minimum at 1.51–100 kHz.
 - 2) Normal Mode (Transverse Mode) Noise Attenuation: -35 dBA minimum at 1.5–10 kHz.

2.03 INSULATION

- A. Ventilated transformers shall have a 220°C insulation system and shall not exceed 150°C rise above a 40°C ambient under full load conditions.
- B. Non-ventilated transformers up to 75 KVA shall have a 220°C insulation system and shall not exceed 115°C rise above a 40°C ambient under full load conditions.
- C. Transformer insulation for K-factor rated units shall be a UL recognized 220°C system. Neither the primary nor the secondary temperature shall exceed 220°C at any point in the coils without exceeding 115°C temperature rise above a 40°C ambient under full load conditions. Transformers with K-factor temperature rise of 150°C shall not be acceptable.
- D. All insulation materials shall be flame-retardant and shall not support combustion as defined in ASTM Standard Test Method D635.

2.04 TAPS

- A. Transformers rated 25 KVA and below shall have two 5% taps below normal. Transformers rated 30 KVA and larger shall have six 2-1/2% taps; four below normal and two above normal.

2.05 SOUND OUTPUT

- A. Sound outputs of transformers shall not exceed the levels outlined in NEMA ST-20 using NEMA Standard Testing Procedures.

PART 3 EXECUTION

3.01 FACTORY TESTING

- A. The following standard factory tests shall be performed on the equipment provided under this section. All tests shall be in accordance with the latest version of ANSI and NEMA Standards.
 - 1. Ratio tests at the rated voltage connection and at all tap connections.
 - 2. Polarity and phase relation tests on the rated voltage connection.
 - 3. Applied potential tests.
 - 4. Induced potential test.
 - 5. No-load and excitation current at rated voltage on the rated voltage connection.

3.02 INSTALLATION

- A. Dry-type transformers shall have a minimum of 6-inch clearance between transformer ventilation openings and adjacent structure. For ratings 300 KVA and larger, provide a minimum of 6-inch clearance between transformer and adjacent structure on all sides. In no case shall the clearance be less than the manufacturer's requirements. All transformer connections shall be made with flexible metallic conduit.
- B. Install according to the manufacturer's recommendations and the Contract Drawings. Install each unit plumb, level, and rigid without distortion. The complete transformer assembly shall be installed on vibration dampening pads securely bolted to the floor, mounting assembly, stand, suspension frame, or wall bracket. A flexible grounding conductor shall be installed between the core and coil assembly and the transformer enclosure.
- C. Provide a system bonding jumper as detailed on the drawings. Where not detailed, locate at the transformer.

END OF SECTION

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SECTION 26 24 16

PANELBOARDS

PART 1 GENERAL

1.01 SUMMARY

- A. Furnish and install distribution, coordination, and branch circuit panelboards as specified herein and as indicated on the drawings.
- B. Related Requirements:
 - 1. Specification Section 26 28 13, Overcurrent Protection.
 - 2. Specification Section 26 43 13, Surge Protection for Low-Voltage Electrical Power Circuits.

1.02 REFERENCES

- A. The panelboards and all components shall be designed, manufactured, and tested in accordance with the latest applicable standards of NEMA and UL as follows:
 - 1. UL 67 – Panelboards.
 - 2. UL 50 – Cabinets and Boxes.
 - 3. NEMA PB1.
 - 4. UL 98 – Fusible Switches.

1.03 ACTION SUBMITTAL

- A. Submit product literature and data including:
 - 1. Certifications and UL listing.
 - 2. Enclosure materials and NEMA type.
 - 3. Bus rating and material including plating.
 - 4. Integrated short circuit rating.
 - 5. Main type and rating.
 - 6. Cable terminal sizes.
 - 7. Dimensional information.
 - 8. Overcurrent device layout.
 - 9. Overcurrent device data.
 - 10. Published data for selective coordination device combinations to be applied to this project.
 - 11. Seismic certification where required for the project.

1.04 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable Manufacturers for Circuit Breaker Branch Panelboards: ABB, Eaton, Siemens, and Square D.

- B. Acceptable Manufacturers for Distribution Panelboards: ABB Spectra Series, Eaton PRL3 (225A max branch) PRL4, Siemens P3 (225A max branch), P4, P5, and Square D I-line.
- C. Acceptable Manufacturers for Coordination Panelboards: Cooper/Bussmann or Siemens.

2.02 GENERAL

- A. All bus bars shall be copper, located in the rear of the panelboard cabinet. Bus bars shall extend vertically to provision each pole space scheduled and each space noted on the one-line drawing or specified herein. Provisions shall include pre-drilled bolt-on/plug-on connection points on universal centers to allow connection or insertion of standard-sized branch overcurrent devices. Overcurrent devices shall mount into suitable supporting members at the front of the cabinet that are connected with suitable lugs to the bus bars in the rear of the cabinet. Individual overcurrent devices shall be removable from the cabinet without disturbing adjacent units and without removing the main bus connectors.
- B. Enclosure shall be NEMA 250 Type 1 for indoor and Type 3R for outdoor applications.
- C. Feeder lug sizes shall accommodate the specified conductor size and quantities. Coordinate with one-line diagrams on the plans.
- D. The minimum interrupting rating of circuit breakers shall be 10,000 amps. Refer to the drawings for higher interrupting rating requirements.
- E. Locks shall be provided on all panelboards. All locks shall be keyed alike.
- F. Panelboards shall be equipped with 100% rated neutral bus bar and an equipment ground bar.
- G. Where specified on the plans, provide panelboards listed for use with non-linear loads and include a 200% rated neutral bus bar.
- H. Where specified on the plans, provide panelboards equipped with isolated ground bars in addition to the equipment ground bars. Each isolated ground bar shall include termination positions matching the number of single circuit poles in the panelboard.
- I. Each panelboard shall be identified as outlined in Specification Section 26 05 53, Identification for Electrical Systems.
- J. Each panelboard shall have a two-column circuit index directory card with a clear plastic cover mounted on the inside of the door.
- K. All panelboards shall have door-in-door trim to allow access to wireways and line/load lugs without removing front covers. Surface-mounted type may have the entire cover hinged in lieu of a second door for access to wiring.
- L. Surface trims shall be the same height and width as box. Flush trims shall overlap the box by 3/4 inch on all sides.
- M. Panels occurring in kitchen areas shall have 304 stainless steel flush trim and door.
- N. All panelboard enclosures shall have blank end-walls. The use of knockout type end-walls is prohibited.

- O. Surge Suppression: Factory installed as an integral part of indicated panelboards, complying with UL 1449 SPD Type 1 or 2 as noted on the plans.

2.03 DISTRIBUTION PANELBOARDS

- A. Designed to accept branch circuit breakers 225 amp frame size minimum and larger frame sizes as shown on the plans.
- B. Minimum integrated SCCR rating shall be 18,000 symmetrical rms.
- C. Provide physical space to accommodate future circuit breakers as noted in schedules. Minimum of one 225AF.

2.04 COORDINATION PANELBOARDS

- A. Coordination panelboards shall have a tested combination of overcurrent devices that yield selective coordination from 0.01 second. Overcurrent devices may be fuses or circuit breakers or a combination thereof.
- B. Main fuse shall be provided where indicated on the drawings, Class J.
- C. Branch circuit devices shall include a non-defeatable interlock to prevent removal of fuse under load. Branch fuses shall be finger-safe type TCF. Fuse holders shall be rated for the ampacity of the branch circuit as scheduled. Holder may accept fuses with lower ratings but shall reject fuses with larger ratings. Provide lockout/tagout provision for each branch circuit position.
- D. Panelboard shall include spare fuse storage behind the panel door that is accessible without removing the dead-front. Storage to accommodate up to six branch fuses.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install panelboards straight and true without distortion of the box. Properly support, secure and adjust enclosures, interiors and trims. Unless otherwise indicated, mount panelboards with centerline 5'-0" above floor, but with top edge of trim not to exceed 6'-6" above floor.
- B. Locate panelboards in such a way as to comply with working clearances described in NEC 110.
- C. Field-coordinate flush-mount panelboard locations with the General Contractor to assure the wall depth is adequate to achieve a flush installation.
- D. Mount recessed panelboards with back box front uniformly flush with wall finish.
- E. Create a directory to indicate installed circuit loads; incorporate the Owner's final room designations. Obtain approval before installing. Handwritten directories are not acceptable. Install directory inside panelboard door within the holder.
- F. Flush-Mounted Panelboards: Stub two 3/4-inch conduits and one 1-inch conduit into the nearest accessible ceiling space.

- G. Identify each circuit phase conductor with a number tag corresponding to the pole number the conductor is terminated on.
- H. Arrange conductors in gutters into groups and bundle and wrap with wire ties.
- I. Provide factory-made closure plates for all unused pole positions.

END OF SECTION

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SECTION 26 27 26

WIRING DEVICES

PART 1 GENERAL

1.01 SUMMARY

- A. Furnish and install all wiring devices as shown on the drawings and as herein specified.

1.02 ACTION SUBMITTALS

- A. Product Data: Provide manufacturer's product information for each item, including but not limited to voltage and ampere ratings, materials, finishes, and related accessories.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Switches, Receptacles, and Device Plates: Basis of design is Hubbell. Product reference numbers contained herein are for standard products offered by Hubbell. Subject to compliance with requirements, equivalent products from manufacturers listed below are acceptable.
1. Eaton/Arrow-Hart Wiring Devices.
 2. Legrand/Pass & Seymour.
 3. Leviton.
- B. Wall Box Dimmers: Basis of design is Lutron Electronics Co., Inc., Maestro Series. Product reference numbers contained herein are for standard products offered by Lutron. Subject to compliance with requirements, equivalent products from manufacturers listed below are acceptable.
1. Hubbell Control Solutions #RS Series.
 2. Leviton #Decora Digital Series.
 3. nLight #nPODM Series.
 4. Sensor Switch #sPODM Series.
 5. Wattstopper #Radiant Series.
- C. Miscellaneous Devices: Manufacturers are noted in the product descriptions.

2.02 SWITCHES

- A. All LINE-VOLTAGE switches shall be of the quiet mechanical type, specification grade, 20 amps, 120/277 VAC as follows:

Device	Model No.
Single Pole	1221
Two Pole	1222
Three-Way	1223
Four-Way	1224
Pilot Light	1221PL 120V 1221PL7 277V
Single Pole – weatherproof neoprene cover	HBL1750
Single Pole – weatherproof neoprene cover with pilot light	HBL1785

- B. All LOW-VOLTAGE switches shall be of the quiet mechanical type, specification grade, 3-position, 2-circuit momentary contact, center off, 15 amps, 120/277 VAC as follows:

Device	Model No.
Toggle Type – Center Position	HBL1556

- C. Switch color shall be selected by the Architect.
- D. All LINE-VOLTAGE switches shall have the ON and OFF positions indicated on the handle.
- E. If switches of higher ampere ratings are required, they shall be of similar type and quality to those shown above.
- F. Switch toggle surface shall have an antimicrobial treatment/finish applied.

2.03 WALL BOX DIMMERS

- A. Magnetic low-voltage dimmers shall be slide-to-off control. Dimmer shall be rated for use with magnetic transformers. Provide wattage rating based on load to be controlled at 125%.
- B. Electronic low-voltage dimmers shall be slide-to-off control. Dimmer shall be rated for use with electronic transformers. Provide wattage rating based on load to be controlled at 125%.
- C. 0 to 10-volt low-voltage dimmers shall be slide-to-off control. Dimmer shall be rated for use with fluorescent dimming ballasts or LED drivers. Provide wattage rating based on load to be controlled at 125%. Provide matching 3-way or 4-way switch(es) as appropriate.
- D. Coordinate all fluorescent, LED, and low-voltage dimmers with the controlled load voltage and lighting fixture component interface requirements.
- E. All requirements of “switches” apply.

2.04 RECEPTACLES

- A. All convenience receptacles and special outlets throughout shall be grounding type.
- B. Receptacles shall be specification grade, back- or side-wired, parallel slot, 2-pole, 3-wire, 20 amps as follows:

Device	Model No.
Single	5361
Duplex	5362
Controlled – 50%	BR20C1
Controlled – 100%	BR20C2
Clock Outlet	HBL5235
Isolated Power	IG5362
Weather Resistant	BR20_WR
Tamper Resistant	5362TR
Ground Fault Circuit Interrupters	GFST20

Device	Model No.
Tamper Resistant & GFCI	GFTRST20
Surge Protected Receptacle	HBL5362_SA
Surge Protected & IG Receptacle	IG5362_SA
USB Charging Duplex	USB20X2
USB Charging Only	USB4

- C. If receptacles of higher ampere ratings are required, they shall be of similar type and quality to those shown above.
- D. USB charging receptacles shall provide 5 VDC, 5.0 amps maximum output to devices. Regulated output shall be compatible with USB 1.0/2.0/3.0 device including Apple products. USB ports shall include standard and USB-C types and be rated for a minimum of 10,000 insertions and removals.
- E. Special receptacles shall be as noted on the drawings. Furnish caps for all special outlets.
- F. Modular power termination type device connectors are acceptable.

2.05 MISCELLANEOUS CONTROLS

- A. Spring-Wound Timers:
 - 1. Where noted as weatherproof (WP), provide "weatherproof while in use" cover consisting of cast aluminum material, NEMA 3R rated. Intermatic #WP1010MC or as accepted.
 - 2. All requirements of "switches" apply.
- B. Digital Timers: Digital time switch shall be wall box type, single gang, rated 120 volt, 800 watt and 277 volt, 1,200 watt. The switch shall include a Manual Switch On, Automatic function to turn lights off after a preset elapsed time, and a user temporary time override without changing the Preset Off. The Automatic Off function shall be adjustable from 5 minutes to 12 hours. Prior to extinguishing the lights, the switch shall provide a visual and audible warning to allow occupants to reset as needed. Wattstopper TS-400 Series or as accepted.
- C. Fan Controls:
 - 1. Fan controller shall provide continuous slide speed control with slide-to-off feature. Provide wattage rating based on load to be controlled at 125%. Lutron Model Nova T-star #NTFS Series.
 - 2. Additional Acceptable Manufacturers: Wattstopper Model ADFC Series or as accepted by the Architect.

2.06 DEVICE PLATES

- A. Provide wall plates for all wiring devices and outlet boxes, including special outlets, sound, signal, and telephone outlets, etc., as required. All cover plates shall be appropriate for type of device.
- B. All plates throughout shall be specification grade nylon, color to match wiring devices, EXCEPT:
 - 1. Where devices occur in mirrored surfaces, provide mirrored cover plates.
 - 2. Where devices occur in food service and kitchen areas, provide brushed stainless-steel cover plates.

- C. Where a receptacle is noted as weatherproof (WP), provide “extra duty weatherproof while in use” cover consisting of cast aluminum material with padlock hasp, NEMA 3R rated. TayMac MX3200 (duplex vertical), MX3300 (duplex horizontal), MX6200 (quad) or as accepted.
- D. Weatherproof plates for switches shall be single cover, Hubbell HBL7420.

2.07 MULTI-OUTLET ASSEMBLIES

- A. Devices within the multi-outlet assembly shall meet criteria of “Receptacles.”
- B. Assemblies shall be metallic, single-compartment, listed for grounding as a raceway, and shall accept full size wiring devices. Receptacles shall be provided at 24 inches on center unless otherwise noted on the drawings. Provide all components necessary for a complete installation.
- C. The product provided shall be Walker/Wiremold G4000 Series or as accepted by the Engineer.
- D. Coordinate finish color with the Architect prior to ordering.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Verify location and mounting height of all receptacles, wall-mounted fixtures, switches, and other equipment before roughing in. Refer to the drawings for pertinent information. Refer questionable cases to the Architect.
- B. Any receptacle mounted within 6 feet of a sink or basin shall be provided with ground fault protection for personnel.
- C. Any 125 VAC, 15-amp or 20-amp rated device located in a kitchen shall be provided with ground fault protection for personnel.
- D. Devices shall be mounted parallel and perpendicular to building lines.
- E. For a more attractive installation, all devices at the same location shall be ganged. Separate boxes shall not be acceptable.
- F. Low voltage control wiring routed above ceilings without conduit shall be tied off to lighting fixture support wires. In open ceiling areas supported from appropriate hooks or rings. Excess wire shall be neatly coiled without kinks or sharp bends.

3.02 MOUNTING HEIGHTS

- A. Switches shall be installed at heights matching the architectural elevations. In no case shall switches be mounted higher than 44 inches above finish floor (AFF) to the top of box (or gang outlet ring).
- B. Receptacles shall be installed at heights matching the architectural elevations. In no case shall receptacles be mounted lower than 15 inches to bottom of box (or gang outlet ring) above finish floor (AFF) to the bottom of the lowest plug point or where intended for ADA

access, more than 44 inches AFF to the top of box (or gang outlet ring). Receptacles noted at higher mountings shall only be for a specific purpose, not general use.

- C. Groups of switches shown at one location shall be installed under a single plate having the proper number of openings, and appropriate to the location.
- D. Multi-outlet assemblies shall be treated the same as receptacles relative to mounting heights. Other mountings may be delineated on plan drawings or elevations.
- E. Contractor shall review the Architect's elevations and details to confirm device placement prior to rough-in. Submit questionable mountings to the Architect for direction.

3.03 WEATHERPROOF DEVICES

- A. Devices shall be positioned according to the cover manufacturer's listing instructions, e.g., horizontal versus vertical mounting.

3.04 WALL BOX DIMMERS

- A. Adjust dimmer faceplate spacing to accommodate full dimmer wattage. Do not remove heat sink fins/rails.
- B. Coordinate dimmer wattage with circuit load to be controlled prior to ordering. Consider fixtures at maximum lamp wattage per NEC 210.21 and NEC 220.14(D).
- C. Install equipment in accordance with manufacturer's recommended application wiring and installation instructions.
- D. Label each dimmer, indicating which load or zone it controls.

3.05 CONTROLLED RECEPTACLES

- A. Where code required, controlled duplex receptacles shall be installed with 50% or 100% automatic occupancy control. Unless specifically indicated on the drawings, all duplex receptacles within each space required to have controlled receptacles shall be the 50% controlled type.
- B. Provide all required components to facilitate the operation of controlled receptacles to "ON" when a space is occupied. This may require occupancy sensor, power pack/relay, a wireless signal pack, and a wireless receiver receptacle for individual or multiple receptacle control if applicable.
- C. Each controlled receptacle shall have the universal receptacle control symbol indicated for 50% or 100% operation as denoted per NEC 406.3(E).

END OF SECTION

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SECTION 26 28 13

OVERCURRENT PROTECTION

PART 1 GENERAL

1.01 SUMMARY

- A. Furnish and install fuses and circuit breakers as specified herein and as indicated on the drawings.
- B. Related Requirements:
 - 1. Specification Section 26 24 16, Panelboards.
 - 2. Specification Section 26 28 16, Enclosed Switches & Circuit Breakers.

1.02 ACTION SUBMITTALS

- A. Submit with specific equipment submittal:
 - 1. Short circuit interrupting data, trip unit type, power monitoring, and other features provided for each different type of overcurrent device.
 - 2. Fuse short circuit interrupting data and melt time curve.
 - 3. Include UL series combination rating data, where applicable.
 - 4. Selective coordination documentation literature for each combination to be utilized.
 - 5. Clearly indicate each rating and/or combination being utilized.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Basis of design fuses 0 to 600V are manufactured by Bussmann. Subject to performance as compared to the basis of design fuse, the following manufacturers are acceptable:
 - 1. Littelfuse.
 - 2. Mersen.
- B. Circuit breakers shall be manufactured by the same manufacturer as the equipment within which they are installed.

2.02 MATERIALS

- A. General: Provide termination lug quantities to accommodate conductor sizes and quantities shown on the drawings. Increase circuit breaker frame sizes as required.
- B. Fuses 0 to 600V:
 - 1. Fuses 601 amperes and larger shall be UL Class L, current-limiting, time-delay, 600-volt, with interrupting rating of 200,000 amperes RMS symmetrical (Bussmann KRP-C).
 - 2. Fuses 600 amperes and smaller shall be UL Class RK1, current-limiting, time-delay, rejection-type, 600-volt or 250-volt, with interrupting rating of 200,000 amperes RMS symmetrical (Bussmann LPS-RK or LPN-RK). Ampere ratings as noted on the plans.
 - 3. Coordination panelboard fuses shall be as follows:
 - a. Branch: UL Class CF, finger safe cube type, current limiting, and status indicating (Bussmann TCF).

- b. Main: UL Class J.
 4. Fuses shall be applied considering upstream devices, in accordance with their UL series combination ratings. All applications of fuses shall be on a single fuse per phase leg basis.
 5. Furnish and deliver spare fuses to the Owner as follows:
 - a. Three spares for each type and size, in excess of 60 amperes, used for initial fusing.
 - b. 10% or a minimum of three spares for each type and size, up to and including 60 amperes, used for initial fusing.
- C. Circuit Breakers, Molded-Case (UL 489):
 1. Circuit breaker types shall be as graphically depicted on the one-line drawings and in accompanying notes. Types shall be molded-case solid-state, and molded-case thermal-magnetic.
 2. Thermal-magnetic circuit breakers shall be trip-free, quick-make, quick-break, with handles clearly indicating rating and position (ON, OFF or TRIPPED).
 3. Solid-state (SS) circuit breakers shall be equipped with a true RMS sensing, solid-state tripping system consisting of at least three current sensors, microprocessor-based trip device, and trip actuator. The trip unit shall use microprocessor-based technology to provide the basic adjustable time-current protection. The unit shall be trip-free, quick-make, quick-break, with handles clearly indicating rating and position (ON, OFF or TRIPPED).
 4. Trip Units: Trip unit functions are specified with graphical depictions and notes on the one-line drawings.
 5. Where series combinations are noted to be applied on the plans, UL series combination ratings shall be maintained with upstream overcurrent device(s).
 6. For distribution panels, lighting and appliance panels, or for individual mounting, circuit breakers shall have an interrupting rating no less than the available duty at the breaker. The following minimum duties shall apply where not otherwise specified:

<u>RMS-Symmetrical</u>		
<u>100A Frame</u>		
15A to 100A	14,000A @ 277V	10,000A @ 120/240V
<u>225A Frame</u>		
70A to 225A	22,000A @ 480V	25,000A @ 240V
<u>400A Frame</u>		
250A to 400A	30,000A @ 480V	42,000A @ 240V
 7. Circuit breakers in 120/208V branch circuit panels shall have an interrupting rating of 10,000A RMS symmetrical, unless noted otherwise.
- D. Circuit breakers shall be UL listed for application at 100% of their continuous ampere rating in their intended enclosure where specifically indicated on the plans.
- E. Ground Fault Protection:
 1. Furnish and install UL listed ground sensor relay system with ground break components for each of the protective devices indicated on the drawings. Each unit shall consist of a coordinated ground sensor with integral test winding, solid-state relay to operate the shunt trip circuit on the circuit protective device, and monitor/test panel. System shall be zero sequence type.
 2. Where the overcurrent protection device for which ground fault has been specified includes integral current transformers necessary for phase overcurrent protection, the ground fault functionality may be provided by vector summation of the load

current in the phase conductors and neutral conductor(s) ("differential current" or "residual current" method). In such instances, provide a neutral current transformer and associated wiring back to the ground fault relay.

3. The relays shall be of the standard time-delay type and have continuously adjustable current pickup settings of 100 to 1,200 amperes and continuously adjustable time-delay setting from instantaneous (0.03 second) to 1 second. The monitor panel shall indicate relay operation and provide means for testing the system with or without interruption of service, and must not permit the ground fault system to be inadvertently left in an inactive or OFF state.
4. Where noted on the one-lines, provide modified differential type (87B, 87G, etc.), arranged as described and depicted. Provide associated CTs to fully enclose the zone protected. CTs must coordinate with the 87B and 87G relay supplied.

- F. Provide arc energy-reducing maintenance switch with local status indicator for each breaker rated 1,200 amps or higher.

2.03 ACCESSORIES

- A. Provide shunt trips, bell alarms, and auxiliary contacts as shown or noted on the contract drawings.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Fuses:
 1. Install fuses in such a manner as to expose manufacturer's label indicating model number and ratings.
 2. Legibly write the design fuse type on the inside of the switch cover with an indelible ink marker.
 3. Coordinate installation location of the spare fuse cabinet with the Owner, and install prior to Project Closeout.
 4. Fuses shall be provided in accordance with the Power System Study.
- B. Circuit Breakers: Set adjustable circuit breakers in accordance with the Power System Study.
- C. Ground Fault Protection: Set trip unit in accordance with the Power System Study.

3.02 OVERCURRENT SIZE VERIFICATION

- A. Confirm maximum overcurrent protective device (MOCP) ratings with mechanical accepted shop drawings for equipment supplied PRIOR TO ORDERING. The Contractor shall adjust the supply circuit breaker and/or fuse ratings to match accepted shop drawing MOCP data per NEC 430, 440, and 695.
- B. Where equipment includes an adjustable speed drive, upstream overcurrent device and feeder size shall be adjusted to match the rated input current to the accepted drive furnished. In no case shall the overcurrent setting be less than 125% of the nameplate load. Refer to the NEC and Division 23 specifications for requirements. Confirm accepted adjustable speed drives to be supplied PRIOR TO ORDERING related overcurrent device(s) and installing underground conduit.

- C. Prior to project completion, the Contractor shall verify that MOCP ratings match nameplate data for installed equipment. Correct MOCP device sizes as required by NEC 430, 440, and 695.

3.03 TESTING

- A. Switchboard and Circuit Breaker Testing: See Specification Section 26 05 00, General Provisions, Testing article.
- B. Test functionality of arc energy-reducing maintenance switch in accordance with the manufacturer's published literature. Verify that local status indicator is functional.

END OF SECTION

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SECTION 26 28 16

ENCLOSED SWITCHES & CIRCUIT BREAKERS

PART 1 GENERAL

1.01 SUMMARY

- A. Furnish and install enclosed “safety” switches and enclosed circuit breakers as shown on the drawings and as required by the NEC.

1.02 RELATED SECTIONS

- A. Specification Section 26 05 53, Identification for Electrical Systems.
- B. Specification Section 26 28 13, Overcurrent Protection.

1.03 ACTION SUBMITTALS

- A. Submit product data indicating compliance with this specification for each type of enclosed switch and circuit breaker.

PART 2 PRODUCTS

2.01 GENERAL

- A. Basis of Design: Drawings are based on Eaton. Subject to compliance with requirements, provide the basis of design product or comparable product acceptable to the Engineer by one of the following:
 - 1. ABB/General Electric.
 - 2. Siemens.
 - 3. Square D.
- B. Switches and circuit breakers shall be mounted in a sheet metal enclosure with externally operable pad-lockable handles. Device mounting shall include an interlocking cover and suitable internal supporting members in the rear of the cabinet. Provide enclosure with an ANSI 61 finish, surface mount, except where shown recessed on the drawings. NEMA-1 for indoor applications, unless noted otherwise. All enclosures outside the building shall have a minimum of NEMA-3R ratings, unless noted otherwise.

2.02 SAFETY SWITCHES

- A. Safety switches shall be heavy-duty type, externally operated with interlocking cover, quick-make, quick-break, rated 240 Volts or 600 Volts, as applicable, with the number of poles and ampacity as noted. All switches for motors shall be horsepower rated. All switches outside the building shall have NEMA-3R enclosures. Safety switches shall be fused, except where noted to be non-fused (NF) on the drawings or otherwise specified. Fusible switches shall be capable of accepting Class R rejection fuses, but shall be set up for the fuse class indicated on the drawings.

- B. Disconnecting Means for Fractional Horsepower, 120-Volt, Single-Phase Motors:
 - 1. With Built-In Thermal Overload Protection: Single-pole, manual motor starter with pilot light unless noted otherwise. Starter ampere rating shall match branch circuit breaker.
 - 2. Without Built-In Thermal Overload Protection: Single-pole, manual motor starter with thermal overload protection and pilot light, unless noted otherwise. Starter ampere rating shall match branch circuit breaker. Overload elements shall be sized per motor manufacturer's recommendations and NEC Article 430.32. Maximum ambient temperatures shall be considered when sizing overload elements.
- C. Disconnecting means for fractional horsepower motors larger than 1/2 horsepower, for integral horsepower motors, and for equipment of similar capacity shall be provided per this section.
- D. Disconnecting means for small 120-Volt equipment 12 amps or less shall be specification grade, single-pole, 15-amp toggle switch with pilot light.

2.03 ENCLOSED CIRCUIT BREAKERS

- A. Provisions of Specification Section 26 28 13, Overcurrent Protection, shall apply.
- B. Circuit Breakers: Circuit breakers shall be molded-case, trip-free, quick-make, quick-break, thermal-magnetic type, with handles clearly indicating rating and position - ON, OFF or TRIPPED. Where series combinations are noted to be applied on the plans, UL series combination ratings shall be maintained with upstream overcurrent device(s).

2.04 DISCONNECTING MEANS FOR VFDS

- A. Where a local disconnecting means for an item of equipment is remotely located on the load side of a variable frequency drive (VFD), provide that local disconnecting means with a factory-installed electrical interlock kit. The interlock kit contact shall be wired into the VFD shutdown control to prevent damage to the VFD in the event the disconnecting means is operated while equipment is under load.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install safety switches and enclosed circuit breakers at locations indicated on the drawings, using approved fastening methods, and maintaining proper working clearances per NEC 110.26 and mounting parameters per NEC 404.
- B. Where it is not possible to install safety switches and enclosed circuit breakers on a wall, structure or item of equipment, provide rigid, freestanding supports of galvanized angle or channel. Supports shall be primed and painted.
- C. Safety Switches and Enclosed Circuit Breakers Upstream of VFDS: The shutdown interlock kit shall be field adjusted to insure the interlock contact operates before disconnecting means breaks the load contacts/switch blades.
- D. Circuit Breakers: Set adjustable circuit breakers per the engineered coordination settings.
- E. Ground Fault Protection: Set trip unit per the engineered coordination settings.

3.02 EQUIPMENT SIZE VERIFICATION

- A. Confirm the rating of the disconnecting means with mechanical shop drawings for equipment supplied PRIOR TO ORDERING. The Contractor shall adjust minimum sizes provided based on nameplate data per NEC 430 and 440.

3.03 OVERCURRENT SIZE VERIFICATION

- A. Confirm maximum overcurrent protective device (MOCP) ratings with accepted mechanical shop drawings for equipment supplied PRIOR TO ORDERING. The Contractor shall adjust the supply circuit breaker and/or fuse ratings to match accepted shop drawing MOCP data per NEC 430, 440, and 695.
- B. Where equipment includes an adjustable speed drive, upstream overcurrent device and feeder size shall be adjusted to match the rated input current to the accepted drive furnished. In no case shall the overcurrent setting be less than 125% of the nameplate load. Refer to the NEC and Division 23 specifications for requirements. Confirm accepted adjustable speed drives to be supplied PRIOR TO ORDERING related overcurrent device(s) and installing underground conduit.
- C. Prior to project completion, the Contractor shall verify that MOCP ratings match nameplate data for installed equipment. Correct MOCP device sizes as required by NEC 430, 440, and 695.

END OF SECTION

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SECTION 26 43 13

SURGE PROTECTION FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1 GENERAL

1.01 SCOPE

- A. The Contractor shall furnish and install the surge protection device (SPD) equipment having the electrical characteristics, ratings, and modifications as specified herein and as shown on the Contract Drawings. To maximize performance and reliability and to obtain the lowest possible let-through voltages, the AC surge protection shall be integrated into electrical distribution equipment such as switchgear, switchboards, panelboards, or motor control centers.

1.02 REFERENCES

- A. SPD units and all components shall be designed, manufactured, and tested in accordance with the latest applicable UL Standard (ANSI/UL 1449 3rd Edition).

1.03 SUBMITTALS FOR REVIEW/APPROVAL

- A. The following information shall be submitted to the Engineer:
 - 1. Provide verification that the SPD complies with the required ANSI/UL 1449 3rd Edition listing by Underwriters Laboratories (UL) or other Nationally Recognized Testing Laboratory (NRTL). Compliance may be in the form of a file number that can be verified on UL's website or on any other NRTL's website, as long as the website contains the following information at a minimum: Model number, SPD type, system voltage, phases, modes of protection, voltage protection rating (VPR), and nominal discharge current (In).
 - 2. For side-mount mounting applications (SPD mounted external to electrical assembly), electrical/mechanical drawings showing unit dimensions, weights, installation instruction details, and wiring configuration.
- B. Where applicable, the following additional information shall be submitted to the Engineer:
 - 1. Descriptive bulletins.
 - 2. Product sheets.

1.04 SUBMITTALS FOR CONSTRUCTION

- A. The following information shall be submitted for record purposes:
 - 1. Final As-Built Drawings and information for items listed in Specification Section 26 05 00, General Provisions, and shall incorporate all changes made during the manufacturing process.

1.05 QUALIFICATIONS

- A. The manufacturer of the assembly shall be the manufacturer of the major components within the assembly.
- B. For the equipment specified herein, the manufacturer shall be ISO 9001 or 9002 certified.

- C. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of 5 years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.
- D. The SPD shall be compliant with the Restriction of Hazardous Substances (RoHS) Directive 2002/95/EC.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Equipment shall be handled and stored in accordance with the manufacturer's instructions. One copy of the manufacturer's instructions shall be included with the equipment at the time of shipment.

1.07 OPERATION AND MAINTENANCE MANUALS

- A. Operation and Maintenance Manuals shall be provided with each SPD shipped.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. APT.
- B. Eaton Cutler-Hammer.
- C. Liebert.
- D. Square D.
- E. United Power.
- F. As approved.
- G. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features, and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety. Products in compliance with the specification and manufactured by others not named will be considered only if pre-approved by the Engineer 10 days prior to bid date.

2.02 VOLTAGE SURGE SUPPRESSION – GENERAL

- A. Electrical Requirements:
 - 1. Unit Operating Voltage: Refer to drawings for operating voltage and unit configuration.
 - 2. Maximum Continuous Operating Voltage (MCOV): The MCOV shall not be less than 125% of the nominal system operating voltage.
 - 3. The suppression system shall incorporate thermally protected metal-oxide varistors (MOVs) as the core surge suppression component for the service entrance and all other distribution levels. The system shall not utilize silicon avalanche diodes, selenium cells, air gaps, or other components that may crowbar the system voltage leading to system upset or create any environmental hazards.

4. Protection Modes: The SPD must protect all modes of the electrical system being utilized. The required protection modes are indicated by bullets in the following table:

Configuration	Protection Modes			
	L-N	L-G	L-L	N-G
Wye	•	•	•	•
Delta	N/A	•	•	N/A
Single Split Phase	•	•	•	•
High Leg Delta	•	•	•	•

5. Nominal Discharge Current (In): All SPDs applied to the distribution system shall have a 20 kA In rating regardless of their SPD type (includes Types 1 and 2) or operating voltage. SPDs having an In less than 20 kA shall be rejected.

ANSI/UL 1449 3rd Edition Voltage Protection Rating (VPR) – The maximum ANSI/UL 1449 3rd Edition VPR for the device shall not exceed the following:			
Modes	208Y/120	480Y/277	600Y/347
L-N; L-G; N-G	700	1,200	1,500
L-L	1,200	2,000	3,000

B. SPD Design:

1. Maintenance-Free Design: The SPD shall be maintenance free and shall not require any user intervention throughout its life. SPDs containing items such as replaceable modules, replaceable fuses, or replaceable batteries shall not be accepted. SPDs requiring any maintenance of any sort such as periodic tightening of connections shall not be accepted. SPDs requiring user intervention to test the unit via a diagnostic test kit or similar device shall not be accepted.
2. Balanced Suppression Platform: The surge current shall be equally distributed to all MOV components to ensure equal stressing and maximum performance. The surge suppression platform must provide equal impedance paths to each matched MOV. Designs incorporating replaceable SPD modules shall not be accepted.
3. Electrical Noise Filter: Each unit shall include a high-performance EMI/RFI noise rejection filter. Noise attenuation for electric line noise shall be up to 50 dB from 10 kHz to 100 MHz using the MIL-STD-220A insertion loss test method. Products unable able to meet this specification shall not be accepted.
4. Internal Connections: No plug-in component modules or printed circuit boards shall be used as surge current conductors. All internal components shall be soldered, hardwired with connections utilizing low-impedance conductors.
5. Monitoring Diagnostics: Each SPD shall provide the following integral monitoring options:
 - a. Protection Status Indicators: Each unit shall have a green/red solid-state indicator light that reports the status of the protection on each phase.
 - 1) For wye-configured units, the indicator lights must report the status of all protection elements and circuitry in the L-N and L-G modes. Wye-configured units shall also contain an additional green/red solid-state indicator light that reports the status of the protection elements and circuitry in the N-G mode. SPDs that indicate only the status of the L-N and L-G modes shall not be accepted.

- 2) For delta-configured units, the indicator lights must report the status of all protection elements and circuitry in the L-G and L-L modes.
- 3) The absence of a green light and the presence of a red light shall indicate that damage has occurred on the respective phase or mode. All protection status indicators must indicate the actual status of the protection on each phase or mode. If power is removed from any one phase, the indicator lights must continue to indicate the status of the protection on all other phases and protection modes. Diagnostics packages that simply indicate whether power is present on a particular phase shall not be accepted.
- b. Remote Status Monitor: The SPD must include Form C dry contacts (one NO and one NC) for remote annunciation of its status. Both the NO and NC contacts shall change state under any fault condition.
- c. Audible Alarm and Silence Button: The SPD shall contain an audible alarm that will be activated under any fault condition. There shall also be an audible alarm silence button used to silence the audible alarm after it has been activated.
- d. Surge Counter: The SPD shall be equipped with an LCD display that indicates to the user how many surges have occurred at the location. The surge counter shall trigger each time a surge event with a peak current magnitude of a minimum of 50 amps $\pm$ 20 amps occurs. A reset pushbutton shall also be standard, allowing the surge counter to be zeroed. The reset button shall contain a mechanism to prevent accidental resetting of the counter via a single, short-duration button press. In order to prevent accidental resetting, the surge counter reset button shall be depressed for a minimum of 2 seconds in order to clear the surge count total.
 - 1) The ongoing surge count shall be stored in non-volatile memory. If power to the SPD is completely interrupted, the ongoing count indicated on the surge counter's display prior to the interruption shall be stored in non-volatile memory and displayed after power is restored. The surge counter's memory shall not require a backup battery in order to achieve this functionality.
6. Overcurrent Protection: The unit shall contain thermally protected MOVs. These thermally protected MOVs shall have a thermal protection element packaged together with the MOV in order to achieve overcurrent protection of the MOV. The thermal protection element shall disconnect the MOV(s) from the system in a fail-safe manner should a condition occur that would cause them to enter a thermal runaway condition.
7. Fully Integrated Component Design: All of the SPD's components and diagnostics shall be contained within one discrete assembly. SPDs or individual SPD modules that must be ganged together in order to achieve higher surge current ratings or other functionality shall not be accepted.
8. Safety Requirements:
 - a. The SPD shall minimize potential arc flash hazards by containing no user serviceable/replaceable parts and shall be maintenance free. SPDs containing items such as replaceable modules, replaceable fuses, or replaceable batteries shall not be accepted. SPDs requiring any maintenance of any sort such as periodic tightening of connections shall not be accepted. SPDs requiring user intervention to test the unit via a diagnostic test kit or similar device shall not be accepted.

- b. SPDs designed to interface with the electrical assembly via conductors shall require no user contact with the inside of the unit. Such units shall have any required conductors be factory installed.
- c. Side-mount SPDs shall be factory sealed in order to prevent access to the inside of the unit. Side-mount SPDs shall have factory-installed phase, neutral, ground, and remote status contact conductors factory installed and shall have a pigtail of conductors protruding outside of the enclosure for field installation.

2.03 SYSTEM APPLICATION

- A. The SPD applications covered under this section include distribution and branch panel locations, motor control centers (MCC), switchgear, and switchboard assemblies. All SPDs shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category C, B, and A environments.
- B. Surge Current Capacity: The minimum surge current capacity the device is capable of withstanding shall be as shown in the following table:

Minimum Surge Current Capacity Based on ANSI/IEEE C62.41 Location Category			
Category	Application	Per Phase	Per Mode
C	Service Entrance Locations (Switchboards, Switchgear, MCC, Main Entrance)	250 kA	125 kA
B	High Exposure Roof Top Locations (Distribution Panelboards)	160 kA	80 kA
A	Branch Locations (Panelboards, MCCs)	120 kA	60 kA

- C. SPD Type: All SPDs installed on the line side of the service entrance disconnect shall be Type 1 SPDs. All SPDs installed on the load side of the service entrance disconnect shall be Type 1 or Type 2 SPDs.

2.04 LIGHTING AND DISTRIBUTION PANELBOARD REQUIREMENTS

- A. The SPD application covered under this section includes lighting and distribution panelboards. The SPD units shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category B environments.
 - 1. The SPD shall not limit the use of through-feed lugs, sub-feed lugs, and sub-feed breaker options.
 - 2. SPDs shall be installed immediately following the load side of the main breaker. SPDs installed in main lug only panelboards shall be installed immediately following the incoming main lugs.
 - 3. The panelboard shall be capable of re-energizing upon removal of the SPD.
 - 4. The SPD shall be interfaced to the panelboard via a direct bus bar connection. Alternately, an SPD connected to a 30-amp circuit breaker for disconnecting purposes may be installed using short lengths of conductors as long as the conductors originate integrally to the SPD. The SPD shall be located directly adjacent to the 30-amp circuit breaker.
 - 5. The SPD shall be included and mounted within the panelboard by the manufacturer of the panelboard.
 - 6. The SPD shall be of the same manufacturer as the panelboard.
 - 7. The complete panelboard, including the SPD, shall be UL 67 listed.

- B. Side-Mount Mounting Applications Installation (SPD Mounted External to Electrical Assembly): Lead length between the breaker and suppressor shall be kept as short as possible to ensure optimum performance. Any excess conductor length shall be trimmed in order to minimize let-through voltage. The installer shall comply with the manufacturer's recommended installation and wiring practices.
- C. Switchgear, Switchboard, and MCC Requirements:
1. The SPD application covered under this section is for switchgear, switchboard, and MCC locations. Service entrance located SPDs shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category C environments.
 2. The SPD shall be of the same manufacturer as the switchgear, switchboard, and MCC.
 3. The SPD shall be factory installed inside the switchgear, switchboard, and MCC at the assembly point by the original equipment manufacturer.
 4. Locate the SPD on the load side of the main disconnect device, as close as possible to the phase conductors and the ground/neutral bar.
 5. The SPD shall be connected through a disconnect (30-amp circuit breaker). The disconnect shall be located in immediate proximity to the SPD. Connection shall be made via bus, conductors, or other connections originating in the SPD and shall be kept as short as possible.
 6. The SPD shall be integral to switchgear, switchboard, and MCC as a factory-standardized design.
 7. All monitoring and diagnostic features shall be visible from the front of the equipment.

2.05 ENCLOSURES

- A. All enclosed equipment shall have NEMA 1 general purpose enclosures, unless otherwise noted. Provide enclosures suitable for locations as indicated on the drawings and as described below:
1. NEMA 1: Constructed of a polymer (units integrated within electrical assemblies) or steel (side-mount units only), intended for indoor use to provide a degree of protection to personal access to hazardous parts and provide a degree of protection against the ingress of solid foreign objects (falling dirt).
 2. NEMA 4: Constructed of steel intended for either indoor or outdoor use to provide a degree of protection against access to hazardous parts; to provide a degree of protection of the equipment inside the enclosure against ingress of solid foreign objects (dirt and windblown dust); to provide a degree of protection with respect to the harmful effects on the equipment due to the ingress of water (rain, sleet, snow, splashing water, and hose directed water); and that will be undamaged by the external formation of ice on the enclosure (side-mount units only).
 3. NEMA 4X: Constructed of stainless steel providing the same level of protection as the NEMA 4 enclosure with the addition of corrosion protection (side-mount units only).

PART 3 EXECUTION

3.01 FACTORY TESTING

- A. Standard factory tests shall be performed on the equipment under this section. All tests shall be in accordance with the latest version of NEMA and UL Standards.

3.02 INSTALLATION

- A. The Contractor shall install all equipment per the manufacturer's recommendations and the contract drawings.

3.03 WARRANTY

- A. The manufacturer shall provide a full 10-year warranty from the date of shipment against any SPD part failure when installed in compliance with manufacturer's written instructions and any applicable national or local code.

END OF SECTION

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SECTION 26 51 00

INTERIOR LIGHTING FIXTURES & LAMPS

PART 1 GENERAL

1.01 SUMMARY

- A. Furnish and install all interior lighting fixtures with lamp assemblies as specified and as shown on the drawings. Lighting fixtures shall be complete, including canopies, hangers, reflectors, diffusers, drivers, etc.

1.02 ACTION SUBMITTALS

- A. Provide a product-specific submittal for each lighting fixture type. Catalog cut sheets illustrating conformance with specifications will be acceptable for standard units. Drawings shall indicate materials, assembly, finish, and dimensions.
- B. Photometric data shall be furnished for all lighting fixtures listed on the Lighting Fixture Schedule, and shall include the following:
 - 1. Light engine output assembly type used in photometric tests.
 - 2. Fixture candela curve with perpendicular and parallel sections.
- C. LED (light-emitting diode) light engine and driver data matrix shall include the following:
 - 1. LED light engine assembly type, wattage, dimensions, light engine color temperature in Kelvin, and Color Rendition Index for each type of lighting fixture.
 - 2. Driver type, quantity per lighting fixture, wattage/ampereage, voltage, switching criteria, and dimensions for each type of lighting fixture. Clearly indicate driver power factor, load (ma), and compliance to the specifications.

1.03 WARRANTY

- A. LED lamps and drivers shall have a 24-month warranty. Lamps and drivers that fail during the initial 24-month warranty period will be replaced and installed at no cost to the Owner. Lamp failure is defined to be failure of more than 10% of the LEDs within the fixture for a specific distribution (up, down, etc.).

PART 2 PRODUCTS

2.01 GENERAL

- A. All catalog numbers are given for manufacturer's identification and do not relieve the Contractor from responsibility of full conformance to all applicable written description requirements governing material and fabrication, either in the general or specific sections. Where conflicts occur, the most expensive option shall be enforced. Where catalog numbers are indicated as modified, no modification will be required if the standard unit fully conforms to descriptive requirements in the specifications and matches the specified installation requirements.
- B. All lighting fixtures of the same type shall be of one manufacturer and of identical finish and appearance.
- C. All lighting fixtures and component parts shall bear the UL label.

- D. All lamp assemblies installed within the same lighting fixture type shall be of the same manufacturer.
- E. All drivers installed within the same lighting fixture type shall be of the same manufacturer.
- F. Where intrusion protection (IP) ratings are specified, provide documentation indicating compliance.
- G. Clearly indicate any deviations to dimensions of specified lighting fixture.

2.02 CONSTRUCTION

- A. All steel parts shall be phosphate treated in multi-stage power spray system for corrosion resistance and paint adhesion. Standard final finish shall be electrostatically applied, baked white enamel of not less than 87% reflectance on reflecting surfaces. Refer to the Lighting Fixture Schedule and/or the drawings for other finish types.
- B. Each recessed/flush-mounted lighting fixture shall have a continuous light-seal gasket seated in such a manner as to prevent any light leakage through any portion or around any edge of the trim frame.
- C. Lenses/diffusers shall be framed in a hinged continuous assembly. Lens/diffuser frame latches shall be loaded or cam operated. Where noted on the drawings, provide tamper-resistant latches.
- D. All lighting fixture sockets shall be securely fastened to the lighting fixture body to prevent movement during relamping.
- E. For recessed lighting fixtures, provide a through-wiring junction box set to the side, where it shall be accessible when the lighting fixture reflector assembly is removed from the lighting fixture housing. Connect the box to the lighting fixture housing with flexible conduit. Clearly indicate when a lighting fixture requires above-soffit/ceiling access.
- F. All recessed lighting fixtures shall be provided with frames appropriate for the type of soffit/ceiling involved. No lighting fixtures shall be submitted for review or ordered until the soffit/ceiling construction and mounting method have been verified by the Contractor.
- G. The finish of all lighting fixtures is subject to final approval by the Architect and Engineer. Furnish paint chips to the Architect and Engineer for selection for all non-standard finishes. Color selection shall be reviewed by the Architect prior to the review of submittals by the Engineer.
- H. All electrical requirements for lighting fixtures shall be verified with the drawings, catalog number, and Lighting Fixture Schedule prior to ordering.
- I. The Contractor shall provide dimming and switching as indicated on the plans. The driver quantities shall be determined by the required switching criteria.
- J. Fixture manufacturer will test and ensure compatibility of the system components including, but not limited to, light source (engine), luminaire, driver power supply, and control interface with added components as needed for a complete and functioning system.

2.03 DRIVERS

- A. LED drivers shall be high power factor electronic type. An audible noise rating of Class A shall be maintained. Driver and lamp combination shall match for optimum operational efficiency. Provide reverse polarity protection, open circuit protection requiring no minimum load. Provide 80% minimum efficiency. Manufactured by Advance, CREE, Osram Sylvania, Philips, or as accepted.
- B. Provide LED Dimming: Provide system capable of full range continuous dimming, 0 to 10-volt control.
- C. Drivers shall be CBM certified, bear the UL label, and have a sound rating of "A."
- D. Driver shall be modular in design, readily available as a replacement component, designed to be removable and replaceable from within a fixture. Driver shall not be integral to the light engine circuit board.
- E. Lighting fixtures located within low temperature, damp, and wet environments shall have drivers designed for proper operation.
- F. The Contractor shall be responsible for the replacement of drivers due to excessive noise or failure within the project warranty period.

2.04 LENSES/DIFFUSERS/LOUVERS/REFLECTORS

- A. Lenses/diffusers shall be furnished as indicated on the drawings.
- B. Lenses/diffusers shall be 100% virgin acrylic with a minimum thickness of 1/8 inch (0.125 inch), Pattern A19, unless noted otherwise on the drawings.
- C. No lens/diffuser shall be manufactured with polystyrene, copolymer (mixture of polystyrene and acrylic), or reclaimed or recycled acrylic plastic.
- D. All parabolic louvers and open reflectors shall be shipped with a protective plastic covering or coating. The protective covering shall not be removed until all construction is complete and final lighting fixture assembly is complete. The Contractor shall be responsible for cleaning all louver assemblies; in particular, removing all smudges, fingerprints, dust particles, etc.
- E. All reflector or louver striations deemed unacceptable by the Engineer shall be replaced prior to project closeout.
- F. Align lenses/diffusers/louvers/reflectors for all lighting fixtures in a like manner, unless noted otherwise.
- G. Clean luminaire reflector systems, lenses, and enclosures after all construction dust has been removed from the area.

2.05 SUPPORT

- A. Surface- or pendant-mounted lighting fixtures shall be supported as follows:
 - 1. From the outlet box by means of a metal strap, where its weight is less than 5 pounds.
 - 2. From its outlet box by means of a hickey or other threaded connection, where its weight is from 5 to 50 pounds.

- B. Lighting fixtures shall be supported independently of the ceiling system or additional ceiling suspension must be added to support the weight of the lighting fixtures. It is the responsibility of the Electrical Contractor to coordinate all support requirements with the ceiling system installer. Recessed lighting fixtures supported from ceiling grid tee systems shall be furnished with hold-down clips in conformance with NEC 410.36.
- C. Furnish and install supplementary blocking and support as required to support lighting fixtures from structural members. This blocking may include multiple members and shall be coordinated with the Structural Engineer prior to rough-in.
- D. Suspended lighting fixtures shall be stem mounted and shall be free to swing 20 degrees in any direction. Ceiling swivels shall be of the ball-aligner type.
- E. Chain suspension may be used only where specifically permitted on the drawings. Chain shall be heavy-duty, nickel- or cadmium-plated, suitable for weight of specific lighting fixture. Lighting fixtures installed in rows, continuous or spaced apart, shall be attached to a unistrut-type backbone. This backbone shall align all lighting fixtures true, straight, and level. Where chain suspension is not allowed, provide 1/4-inch-diameter, all-thread nickel- or cadmium-plated rod.
- F. All supports, where not concealed, shall be painted. Coordinate paint requirements with the Architect.

2.06 LAMPS

- A. LED Light Engines:
 - 1. LED light engines shall provide illumination with CRI greater than 80.
 - 2. LED light engines shall comply with ANSI chromaticity standard for classifications of color temperature. Reference Luminaire Schedule for specified LED lamp color and color temperature. LED light engines shall be UL or ETL listed and labeled.
 - 3. LED light engines shall be luminaire tested per IESNA LM-79 and LM-80 requirements.
 - a. Lamp Life for White LEDs: 100,000+ hours with lamp failure occurring when LED produces 70% of initial rated lumens.
 - b. Lamp Life for Color LEDs: 50,000+ hours with lamp failure occurring when LED produces 50% of initial rated lumens.
 - 4. LED Light Source Manufacturers: CREE, GE Lighting, Nichia, Osram Sylvania, Philips, or approved equal.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Fixtures installed in rows shall be aligned. For square trims, the flat sides shall be aligned to other fixtures in the row; or where individually mounted, aligned with the surrounding walls.
- B. Pendant fixtures shall be installed level, unless otherwise noted. Pendant fixtures occurring in rows shall be vertically and horizontally aligned.
- C. Protective films or covers shall be provided for each fixture to prevent dust and debris contamination of the fixture interior. These covers shall remain in place until substantial completion.

- D. Cleaning of reflectors shall be performed as recommended by the manufacturer. At minimum, protective gloves shall be worn to prevent body oils from contacting the reflector.

3.02 LIGHTING FIXTURE OPERATION

- A. Test for proper operation of all lighting fixtures, including control requirements for each. This may include line-voltage or low-voltage switching and/or dimming requirements.

END OF SECTION

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SECTION 26 52 00

EMERGENCY LIGHTING

PART 1 GENERAL

1.01 SUMMARY

- A. Furnish and install all interior and exterior emergency unit equipment, emergency exit signage, and emergency battery packs (EBPs) as specified and as shown on the drawings. Units shall be complete, including remote mounting, test switches, etc.

1.02 ACTION SUBMITTALS

- A. Provide a product-specific submittal for each different item. Identify use within each lighting fixture type or as a standalone unit as specified. Catalog cuts illustrating conformance with specifications will be acceptable for standard units. Drawings shall indicate materials, assembly, finish, and dimensions.
- B. Provide mounting coordination for EBP equipment installed within the specified lighting fixture prior to submitting the units for review.
- C. Illumination data shall be furnished for lighting fixtures with integral or remote-mounted EBPs, and for unit equipment per the Lighting Fixture Schedule. Data shall include the following:
 - 1. Unit Equipment and Emergency Exit Signage:
 - a. Rated voltage and wattage output at the end of the 90-minute period of operation.
 - b. Battery type and temperature limitations.
 - c. Listed lamp operational matrix marked with the specified lamp.
 - d. Specified and supplied lamp candela curve with perpendicular and parallel sections.
 - e. Overall dimensions of the complete assembly.
 - f. Table of equipment for remote lamp wire size recommendations based on length.
 - 2. Emergency Battery Packs:
 - a. Fixture cut sheet indicating the rated lumen output at the end of the 90-minute period of operation.
 - b. Battery type and temperature limitations.

1.03 WARRANTY

- A. LED lamps and drivers shall have a 24-month warranty. Lamps and drivers that fail during the initial 24-month warranty period will be replaced and installed at no cost to the Owner. LED lamp failure is defined as a failure of 10% of the LED chips on any one LED module (array or grouping on a single PC board).
- B. Emergency batteries shall have a 60-month warranty against battery failure.

PART 2 PRODUCTS

2.01 GENERAL

- A. All catalog numbers are given for manufacturer's identification and do not relieve the Contractor from responsibility of full conformance to all applicable written description requirements governing material and fabrication, either in the general or specific sections. Where conflicts occur, the most expensive option shall be enforced. Where catalog numbers are indicated as modified, no modification will be required if the standard unit fully conforms to descriptive requirements in the specifications and matches specified ceiling.
- B. Equipment shall be listed for use on emergency systems and bear the confirming UL label, UL 924.
- C. All steel parts shall be phosphate treated in multi-stage power spray system for corrosion resistance and paint adhesion. Standard final finish shall be electrostatically applied, baked enamel.
- D. Batteries shall be maintenance-free nickel-cadmium type. Battery charger shall be designed to maintain batteries at full output capacity.
- E. Fixtures located within low temperature, damp, and wet environments shall have ballasts designed for proper operation within the installed environment.
- F. The Contractor shall be responsible for the replacement of all ballasts due to excessive noise or failure for 1 year after final acceptance.

2.02 UNIT EQUIPMENT AND EMERGENCY EXIT SIGNAGE

- A. Electronics section shall include:
 - 1. Brownout protection.
 - 2. Current-limiting charger to maximize battery life and minimize energy consumption.
 - 3. Short-Circuit Protection: Current-limiting charger circuitry and fused output circuit to protect printed circuit board from shorts.
 - 4. Thermal protection to sense circuitry temperature and adjust charge current to prevent overheating and charger failure.
 - 5. Thermal compensation to adjust charger output to provide optimum charge voltage relative to ambient temperature.
 - 6. Regulated charge voltage to maintain constant-charge voltage over a wide range of line voltages and to prevent over/under charging that shortens battery life and reduces capacity.
 - 7. Filtered charger output to minimize charge voltage ripple and extend battery life.
- B. Self-diagnostic circuitry shall be provided where specified. Functionality shall include:
 - 1. Single multi-chromatic LED indicator to display charging state, test activation, and diagnostic status.
 - 2. Test switch, manual or magnetic, shall provide manual activation of 30-second diagnostic testing for on-demand visual inspection.
 - 3. Self-diagnostic testing shall occur for 5 minutes every 30 days and 30 minutes every 6 months. Diagnostic evaluation shall include lamp, AC to DC transfer, charging, and battery condition.
 - 4. Automatic test postponement for up to 8 hours by activating manual test switch.

- 5. Load-learning component shall self-calibrate to DC load at first test, enabling it to detect a lamp failure on future tests. Simple functionality shall be provided for recalibration at any time.
- C. Equipment housing shall include a test pushbutton and a charger failure-indicating lamp.
- D. Lamp heads shall be as scheduled. Where not indicated, provide halogen-type sealed beam.

2.03 EMERGENCY BATTERY PACKS (EBP)

- A. EBPs for LED lamps shall be provided for egress lighting fixtures when indicated on the Lighting Fixture Schedule or on the floor plans. EBPs shall illuminate LEDs to a lumen level indicated on the Lighting Fixture Schedule for 90 minutes per UL, NFPA, NEC, and OSHA Standards. All EBPs shall allow for normal switched operation with automatic switching to emergency (battery) operation upon loss of AC power. EBPs shall be installed by the fixture manufacturer. Batteries shall be NiCad or nickel metal hydride. The indication on the drawings for an "EBP" is not for night-light continuous illumination, unless otherwise specified. Pilot light and test switch shall be accessible from below fixture location and remote mount at wall where fixtures are cove mounted. Lumen output shall be provided as scheduled.

2.04 SUPPORT

- A. Surface-mounted fixtures shall be supported as follows:
 - 1. From the outlet box by means of a metal strap, where its weight is less than 5 pounds.
 - 2. From the outlet box by means of a hickey or other threaded connection, where its weight is from 5 to 50 pounds.
- B. Where remotely mounted, EBPs shall be supported independently of the ceiling system or additional ceiling suspension must be added to support the weight of the lighting fixtures. It is the responsibility of the Electrical Contractor to coordinate all support requirements with the ceiling system installer.
- C. Furnish and install supplementary blocking and support as required to support fixtures from structural members. This blocking may include multiple members and shall be coordinated with the Structural Engineer prior to rough-in.
- D. All supports, where not concealed, shall be painted. Coordinate paint requirements with the Architect.

PART 3 EXECUTION

3.01 GENERAL

- A. Provide continuous (unswitched) power source to unit equipment and to each EBP. Do not wire fixtures containing an EBP as a default night-light, unless specified.
- B. Remote mount test switch to accessible position in wall or ceiling for remotely mounted emergency ballasts. Location shall be accessible from no more than a 6-foot ladder. Provide label as to area served.

- C. Upon completion of the project, initiate unit equipment self-diagnostic function manual test to reset memory.

3.02 BATTERIES

- A. Where emergency egress lighting fixtures are located at the exterior or in high ambient temperature environments, provide a remote battery assembly within the building interior and/or in a temperature environment suitable for the battery unit based on the equipment manufacturer recommendations to maintain the design battery life.

3.03 LIGHTING FIXTURE OPERATION

- A. Test for proper operation of unit equipment and lighting fixtures containing emergency ballasts or emergency carryover ballasts, including control requirements for each. This may include local switching, low-voltage switching, and/or dimming requirements. Verify that emergency ballasts or emergency carryover ballasts have not been wired as default night-lights, unless specified.

END OF SECTION

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DIVISION 27

COMMUNICATIONS

27 05 00	Common Work Results for Communications
27 05 00	General Provisions
27 05 13	Communication Services
27 05 26	Grounding & Bonding for Communications Systems
27 05 28	Pathways for Communications Systems
27 05 44	Sleeves & Sleeve Seals for Communications Pathways & Cabling
27 15 00	Communications Horizontal Cabling
27 15 00	Communications Horizontal Cabling

END OF INDEX



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SECTION 27 05 00

GENERAL PROVISIONS

PART 1 GENERAL

1.01 SCOPE

- A. Provisions of this section apply to all work specified in all sections under Division 27.
- B. In addition, work in Division 27 is governed by the provisions of the Bidding Requirements, Contract Forms, General Conditions, and all sections under Division 01 specifications.
- C. Communications equipment coordination and installation.

1.02 QUALITY ASSURANCE

- A. Reference Standards:
 - 1. Design, manufacture, test, and install data distribution systems per manufacturer's requirements and in accordance with NFPA 70 (National Electric Code), state codes, local codes, requirements of authorities having jurisdiction, and particularly the following specifications.
 - a. This Technical Specification and Associated Drawings.
 - b. ANSI/TIA-568-C.0, Generic Telecommunications Cabling for Customer Premises, and its published addenda.
 - c. ANSI/TIA-568-C.1, Commercial Building Telecommunications Cabling Standard, and its published addenda.
 - d. ANSI/TIA-568-C.2, Copper Cabling Components Standard, and its published addenda.
 - e. ANSI/TIA-568-C.3, Optical Fiber Cabling Components Standard, and its published addenda.
 - f. ANSI/TIA/EIA-569-B, Commercial Building Standard for Telecommunications Pathways and Spaces, and its published addenda.
 - g. ANSI/TIA/EIA-606-A, Administration Standard for the Telecommunications Infrastructure of Commercial Buildings, and its published addenda.
 - h. ANSI/J-STD-607-A, Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications, and its published addenda.
 - i. Building Industries Consulting Services International (BICSI) Telecommunications Distribution Methods Manual (TDMM).
 - j. Manufacturer's Design and Installation Contractor Agreement.
 - k. ANSI/TIA-942, Telecommunications Infrastructure Standard for Data Centers, and its published addenda.

1.03 EXAMINATION OF PREMISES

- A. Visit the site, verify all measurements and job conditions, and pay all costs necessary to perform the work.

1.04 SUMMARY

- A. Types of data/communication cable systems specified in this section include the following:
 - 1. Fiber-optic cable systems.

2. Voice communication cable system.
 3. Data communication cable system.
 4. CATV communication cable system.
 5. Associated conduit raceway distribution and equipment rack/cabinet system.
- B. The Contractor shall furnish, install, and test conduit system, cable and conduit support system, fire-stopping, fiber-optic, voice, data and CATV cables, associated connectors, patch panels, equipment racks, grounding system, patch cords, etc., as indicated on the drawings and in these specifications.
- C. The Contractor shall include all work shown on the drawings and in the specifications. The drawings and specifications are intended to agree with each other. Any discrepancies shall be brought to the attention of the Architect/Engineer for correction. No omission from any drawing shall release the Contractor from furnishing equipment, materials, or services required by these documents.
- D. The Contractor, the cable manufacturer, the connectivity manufacturer, and the distributor shall collaborate and work in partnership with one another so as to provide the Owner with UL or ETL independently verified cabling installation that is guaranteed to perform at levels above and beyond the EIA/TIA-568B Standards, as per the minimum acceptable full channel performance specification contained herein. The partnership shall make available optional UL or ETL independent testing and verification of the completed installation.
- E. Cable infrastructure project requires a manufacturer structured cabling system. the cabling system shall be backed by 25-year system performance guarantee/warranty. The system guarantee/warranty shall be facilitated by the Contractor and be established between the Customer and the cabling system manufacturer.
- F. Any deviation, alteration, or substitution from the drawings and specifications shall be fully documented by the Contractor and submitted as a voluntary alternate to the base bid with the amount of deduct to the base bid specified. Approval of requests for substitution of products, processes, or procedures other than those specified shall be contingent upon submission of fully acceptable documentation to the Engineer.
- G. Products that are submitted for substitution must be electrically and mechanically interchangeable with the specified product. Substitutions shall only be allowed with written approval from the Engineer. Samples of proposed substitutions must be submitted prior to approval, at the discretion of the Engineer. Any substitutions without the written approval of the Engineer are done so at the risk of the Contractor. Substitutions unacceptable to the Engineer shall be rejected without explanation or appeal.
- H. The Contractor shall also be responsible for protecting any and all equipment and materials from damage during his installation process. Any equipment, material, and/or facilities damaged by the Contractor during, due to, or in the performance of his contract, shall be replaced or repaired at the expense of the Contractor, as directed by the Engineer.

1.05 QUALITY CONTROL

- A. Manufacturer Qualifications: Firms regularly engaged in the manufacture of communication cabling system equipment whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Installer Qualifications:
1. Installers shall be fully capable and experienced in communication cabling system specified and a certified installer by specified manufacturer. This Contractor and

- all subcontractors engaged in this communication cabling installation shall have experience in this business for not less than 5 years and shall have successfully completed a minimum of five projects of similar size.
2. The Contractor shall specify, in his bid, all subcontractors who shall be utilized in this project. Each subcontractor's company name, contact, and responsibilities shall be listed.
 3. The Contractor shall employ a Registered Communication Distribution Designer (RCDD) who shall be responsible to the Engineer, Architect, and Owner for all work performed by the Contractor and his subcontractors. The RCDD shall have the authority of the Contractor to make immediate decisions regarding implementation of changes to the project as directed by the Engineer or Architect.
 4. The RCDD must be a full-time employee of the company.
 5. If, in the opinion of the Engineer, Architect, or Owner, the RCDD does not possess or demonstrate adequate qualifications to support the project, the Owner reserves the right to require the Contractor to assign an RCDD who, in the Owner's opinion, possesses the skill necessary to complete the project.
- C. On-Site Project Manager (Project Foreman):
1. The Project Manager shall report directly to the RCDD, Engineer, Architect, and Owner for quality of installation and compliance with these documents.
 2. The Project Manager shall be a manufacturer-certified and BICSI-registered cabling installation technician, National Joint Apprenticeship & Training Committee (NJATC) installer technician, BICSI RCDD, or Engineer-approved equal and have a minimum of 2 years of experience.
 3. The Project Manager shall maintain all documentation in accordance with these specifications.
- D. Journeymen and apprentices performing work under this specification shall be enrolled in or have completed the BICSI, registered cabling installation technician, NJATC installer technician, or Engineer-approved equal course.

1.06 EQUIPMENT PURCHASES

- A. All materials and equipment shall be ordered in ample quantities for delivery at the proper time. If items are not on the project in time to expedite completion, the Owner may purchase said equipment and materials and deduct the cost from the Contract Sum.
- B. Provide all materials of similar class or service by one manufacturer.

1.07 DRAWINGS AND SPECIFICATIONS

- A. If a conflict exists on the drawings or between the drawings and specifications, promptly notify the Architect.

1.08 SUBMITTALS

- A. Submittals are for information and coordination only. The Engineer will diligently review the submittals and attempt to verify compliance with the project requirements. Such review, however, does not constitute approval or disapproval or obligation to comply with all project requirements. The submittals are not to be construed to be Contract Documents. Any failure by the Engineer to note a point of non-compliance shall not be construed to be acceptance or approval of the discrepancy.
- B. Product Information Sheets: Provide manufacturer's literature which includes the information required by the Product Data paragraph of the applicable specification section.

Where Product Information Sheets show multiple models or options, clearly mark the model and options to be provided.

- C. Assembly: Assemble all required submittal information for each specification section and submit in PDF format.
 - 1. Assemble PDF submittals in one PDF file for each division. Separate and order sections within each file by corresponding specification number. Provide bookmarks at the first page of each section and label each bookmark with the specification number and name to allow for easy navigation of the submittal.
 - 2. Partial submittals will be returned without review.
- D. Identification and Information:
 - 1. Name the PDF file with the project name, division number, and sequential submittal number (i.e., the first submittal shall be No. 1; the second submittal shall be No. 2).
 - 2. Provide a cover sheet at the front of each submittal with the following information:
 - a. Project name.
 - b. Date.
 - c. Name of Engineer.
 - d. Name of Contractor.
 - e. Name of subcontractor.
 - 3. Provide a cover sheet at the front of each submittal section with the following information:
 - a. Name of supplier.
 - b. Name of manufacturer.
 - c. Number and title of appropriate specification section.
 - d. Drawing number and detail references, as appropriate.
 - e. Other necessary identification.
- E. Options:
 - 1. Identify options requiring selection by the Engineer.
 - 2. Identify options included with submittal item.
- F. Deviations: Identify deviations from the Contract Documents on submittals.

1.09 MATERIAL SAFETY DATA SHEETS

- A. Provide current Material Safety Data Sheets (MSDS) for all hazardous chemicals that are proposed for use at the project site.
 - 1. Provide one complete set to the Owner for review and approval a minimum of 1 week prior to the delivery of any hazardous chemicals to the site.
 - 2. Maintain a second complete set at the project location, readily accessible by both the Owner's personnel and the Contractor's personnel.

1.10 REQUEST FOR INFORMATION

- A. Request for Information:
 - 1. A document submitted by the Contractor requesting clarification of a portion of the Contract Documents, hereinafter referred to as RFI.
 - 2. A properly prepared Request for Information shall include a detailed written statement of the clarification, apparent conflict, or information requested that indicates the specific drawings or specification in need of clarification and the nature of the clarification requested.
 - a. Drawings shall be identified by drawing number and location on the drawing sheet.

- b. Specifications shall be identified by section number, page, and paragraph. Include a proposed solution, where appropriate, based upon the field conditions and best knowledge of the Contractor.
- B. Improper or Frivolous RFIs: RFIs which are not properly prepared or that request information which is clearly shown in the Contract Documents will be returned unanswered. Processing time for multiple submissions of improper or frivolous RFIs will be billed at the Engineer's standard hourly rate to the Owner who may deduct an equal amount from the monies due the Contractor.

1.11 AS-BUILT DRAWINGS

- A. As-Built Drawings: Maintain one set of marked-up paper copies of the Contract Drawings.
 - 1. Preparation: Mark As-Built Drawings to show the actual installation where installation varies from that shown originally. Include all equipment, and underground and overhead conduit. Require individual or entity who obtained record data, whether individual or entity is installer, subcontractor, or similar entity, to provide information for preparation of corresponding marked-up As-Built Drawings.
 - a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
 - b. Include dimensions both horizontally and vertically to permanent points of reference, accurate within 6 inches. Include descriptors such as "below slab," "above ceiling," etc.
 - c. Record data daily or as soon as possible after obtaining it.
 - d. Record and check the markup before enclosing concealed installations.
 - 2. Mark the As-Built Drawings completely and accurately. Utilize personnel proficient at recording graphic information in production of As-Built Drawings.
 - 3. Mark the As-Built Drawings with erasable, red colored pencil, or in a digital PDF format using an editor program such as Bluebeam, Adobe Acrobat Professional, or similar. Use other colors to distinguish between changes for different categories of the work at the same location.
 - 4. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.
 - 5. Update the As-Built Drawings weekly or daily as appropriate for the project size.
- B. Format: Identify and date each As-Built Drawing; include the designation "PROJECT AS-BUILT DRAWING" in a prominent location.
 - 1. Organize newly-prepared As-Built Drawings into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
 - 2. Identification, as follows:
 - a. Project name.
 - b. Date.
 - c. Designation "PROJECT AS-BUILT DRAWINGS."
 - d. Name of Engineer.
 - e. Name of Contractor.
 - 3. Remove or obscure the Engineer's seal and signature from As-Built Drawings.

1.12 OPERATION AND MAINTENANCE MANUAL

- A. Prior to completion of the project, compile a complete equipment Operation and Maintenance Manual for all equipment supplied under Division 27.
- B. Schedule:
 - 1. Submit a preliminary copy of the manual not less than 30 days prior to substantial completion for review and comment.

2. Submit the final version of the manual not more than 4 weeks after substantial completion of the project.
- C. Format: Submit manuals in both of the following formats:
1. PDF electronic file. Assemble each manual into a composite electronically indexed file. Submit on digital media acceptable to Engineer.
 - a. Name each indexed document file in composite electronic index with applicable item name. Include a complete electronically-linked operation and maintenance directory.
 - b. Enable inserted reviewer comments on draft submittals.
 - c. Provide one final copy to the Engineer and two copies to the Owner.
 2. Three paper copies. Include a complete operation and maintenance directory. Enclose title pages and directories in clear plastic sleeves. Engineer will return three copies.
- D. Provide Operation and Maintenance Manuals for all systems, subsystems, and equipment that require operation and regular maintenance, or have replaceable parts.
- E. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, product data, manufacturer's maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranty and bond information, as described below. In addition to requirements in this section, include operation and maintenance data required in individual specification sections.
- F. Source Information: List each system, subsystem, and piece of equipment included in the manual, identified by product name and arranged to match the manual's table of contents. For each product, list the name, address, and telephone number of the installer or supplier and maintenance service agent, and cross-reference specification section number and title in the Project Manual.
- G. Product Data: Include the following information:
1. System, subsystem, and equipment descriptions. Use designations for systems and equipment indicated on Contract Documents.
 2. Approved submittals.
 3. Include the following if not shown on approved submittals:
 - a. Product name and model number. Use designations for products indicated on Contract Documents.
 - b. Manufacturer's name.
 - c. Equipment identification with serial number of each component.
 - d. Equipment function.
 - e. Operating characteristics.
 - f. Limiting conditions.
 - g. Performance curves.
 - h. Engineering data and tests.
- H. Operating Procedures: Include the following, as applicable:
1. Startup procedures.
 2. Equipment or system break-in procedures.
 3. Routine and normal operating instructions.
 4. Regulation and control procedures.
 5. Instructions on stopping.
 6. Normal shutdown instructions.
 7. Seasonal and weekend operating instructions.
 8. Required sequences for electric or electronic systems.

9. Special operating instructions and procedures, including precautions against improper use.
 10. Operating logs.
- I. Wiring Diagrams: Diagram of factory-installed wiring, including any options as well as any field modifications.
 - J. Systems and Equipment Controls: Describe the sequence of operation and diagram controls as installed.
 - K. Manufacturer's Maintenance Documentation: Manufacturer's maintenance documentation, including the following information for each component part or piece of equipment:
 1. Standard maintenance instructions and bulletins.
 2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
 3. Identification and nomenclature of parts and components.
 4. List of items recommended to be stocked as spare parts.
 - L. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:
 1. Test and inspection instructions.
 2. Troubleshooting guide.
 3. Precautions against improper maintenance.
 4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
 5. Aligning, adjusting, and checking instructions.
 6. Demonstration and training video recording, if available.
 - M. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.
 - N. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturer's maintenance documentation and local sources of maintenance materials and related services.
 - O. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.
 - P. Licenses: Include copies of any licenses with requirements, including inspection and renewal dates.
 - Q. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

1.13 WORK AND MATERIALS

- A. Unless otherwise specified, all materials must be new and of the quality specified. The workmanship shall be of a quality that is acceptable to the Architect, Engineer, and Owner, and is equal to the standards of the trades. Contractor must staff the project with sufficient skilled workmen, including a fully qualified construction superintendent, to complete the work in the time allotted. The superintendent must be qualified to supervise all of the work in his work category.

- B. Uniformity: Unless otherwise specified, provide all equipment and products of the same type or classification by the same manufacturer.

1.14 APPROVALS OF MATERIALS AND EQUIPMENT

- A. Refer to Division 01 specifications for description of material and equipment for prior approvals and substitutions.

1.15 COOPERATIVE WORK

- A. Correct without charge any work requiring alteration due to lack of proper supervision or failure to make proper provision in time. Correct without charge any damage to adjacent work caused by the alteration. Refer to Division 01 specifications for additional requirements.
- B. Cooperative Work Includes:
 - 1. General supervision and responsibility for proper location, rough-in, and size of work related to Division 27 but provided under other divisions of these specifications.
 - 2. Installation of sleeves, inserts, and anchor bolts for work under sections in Division 27.

1.16 CONSTRUCTION FACILITIES

- A. General: Under this division of the specifications, execute all work in a manner to provide safe and lawful ingress and egress to the Owner's establishment and such facilities shall be kept clear of materials or equipment. Refer to Division 01 specifications for additional requirements.
- B. Furnish and maintain from the beginning to the completion of all work all lawful and necessary guards, railings, fences, canopies, lights, and warning signs. Take all necessary precautions required by city and state laws to avoid injury or damage to any and all persons and property.

1.17 WARRANTY

- A. Manufacturer Warranty:
 - 1. Facilitate a 25-year system performance warranty between the manufacturer and the Owner. An extended component warranty shall be provided which warrants functionality of all cabling and connectivity components used in the system for 25 years from the date of acceptance. The performance warranty shall warrant the installed horizontal copper and both the horizontal and the backbone optical fiber portions of the cabling system. Copper and Fiber Optic drops shall be warranted to the link performance as defined in the ANSI/TIA-568-C Standards.
 - 2. Upon completion of the project, the Customer's technical representative will perform a final inspection of the installed cabling system with the Contractor's Project Foreman. The final inspection will be performed to validate that all horizontal and backbone cables were installed as defined in the drawing package, and that the installation meets the aesthetic expectations of the Customer.
 - 3. Upon receipt of the test documentation, the Customer reserves the right to perform spot testing of a representative sample of the cabling system to validate test results provided in the test document. Customer testing will use the same method employed by the Contractor, and minor variations will be allowed to account for differences in test equipment and test variability. If significant discrepancies are found, the Contractor will be notified for resolution.

4. During the 3-week period between final inspection and delivery of the test and as-built documentation, the Customer will activate the cabling system. The Customer will validate operation of the cabling system during this period.
 5. Completion of the installation, in-progress and final inspections, receipt of the test, receipt of the as-built documentation, and successful performance of the system for a 2-week period will constitute acceptance of the system.
- B. Special Warranty: Warrant the cabling system against defects in workmanship for a period of 1 year from the date of system acceptance. The warranty shall cover all labor and materials necessary to correct a failed portion of the system and to demonstrate performance within the original installation specifications after repairs are accomplished. This warranty shall be provided at no additional cost to the Owner.

1.18 CONNECTIONS TO UTILITY SYSTEMS

- A. Provide connections to serving utility companies, including, but not limited to, telephone and CATV, as indicated on the plans. Contact utility companies and obtain the final design plans. Coordinate equipment, installation, and inspections with the serving utility. The Contractor shall include contact, coordination, inspections, utility company fees, and work described on the serving utility design plans as part of the work of this contract.

1.19 CONSTRUCTION FACILITIES

- A. General: Under this section of the specifications, execute all work in a manner to provide safe and lawful ingress and egress to the Owner's establishment. Construction facilities shall be kept clear of materials or equipment as directed by the Architect.
- B. From the beginning to completion, furnish and maintain all lawful and necessary guards, railings, fences, canopies, lights, warning signs, etc. Take all necessary precautions required by city and state laws and OSHA to avoid injury or damage to any persons and property.
- C. Temporary toilet facilities are specified and furnished under another section.

PART 2 PRODUCTS

2.01 CONCRETE

- A. Where used for structures to be provided under the Contract such as bases, etc., concrete work and associated reinforcing shall be as specified under that division.
- B. Refer to other sections for additional requirements for underground vaults, cable ducts, etc.

2.02 FRAMING CHANNEL

- A. The framing channel shall be a cold-rolled, high-quality, carbon steel channel with factory-applied, hot-dipped-after-fabrication finish. Utilize factory-built interconnecting components, mounting straps, connectors, etc., designed for use with the framing channel supplied. Channel nuts shall be spring type and shall utilize standard US threads. Provide heavy zinc paint for field touchup. B-Line "B" Series, Unistrut "P" Series, or as accepted by the Architect.

2.03 ANCHORS

- A. Anchors shall be expandable lead type, as manufactured by Ackerman-Johnson, Diamond, Hilti, Pierce, or as accepted by the Architect.
- B. Adjustable concrete hanger inserts shall be as manufactured by Grinnell or as accepted by the Architect.

PART 3 EXECUTION

3.01 SUBMITTALS

- A. Prepare submittals as directed for review by the Contractor, Owner, Architect, and Engineer.
- B. Submit one copy of PDF submittals via email, project website, or other electronic media.

3.02 AS-BUILT DRAWINGS AND RECORD DOCUMENTS

- A. Recording: Post changes and modifications to the As-Built Drawings as they occur; do not wait until the end of the project.
- B. Maintenance of As-Built Drawings and Record Documents: Store Record Documents in the field office, apart from the Contract Documents used for construction. Do not use project Record Documents for construction purposes. Maintain Record Documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to project Record Documents for the Engineer's reference during normal working hours. As-Built Drawings will be reviewed by the Architect, Owner, and Engineer at each pay request review.
- C. Submit As-Built Drawings to the Architect at completion of the project.

3.03 OPERATION AND MAINTENANCE MANUALS

- A. Prepare Operation and Maintenance Manuals as directed for review by the Contractor, Owner, Architect, and Engineer.
- B. Make corrections and resubmit as required.

3.04 VERIFICATION OF DIMENSIONS

- A. Scaled and figured dimensions are approximate only. Before proceeding with work, carefully check and verify dimensions at the site, and be responsible for properly fitting equipment and materials together and to the structure in spaces provided.
- B. Drawings are diagrammatic and many offsets, bends, special fittings, and exact locations are not indicated. Carefully study drawings and premises in order to determine the best methods, exact locations, routes, and building obstructions, and install apparatus and equipment in available locations. Install apparatus and equipment in a manner and in locations to avoid obstructions, preserve headroom, and keep openings and passageways clear.

3.05 CUTTING AND PATCHING

- A. Cut work and patch per Division 01 specifications as necessary to properly install the new work. As the work progresses, coordinate necessary openings, holes, chases, etc., in their correct location. If the required openings, holes, and chases are not in their correct locations, make the necessary corrections at no cost to the Owner. Avoid excessive cutting and do not cut structural members without the consent of the Architect. Include as a part of the work all structural framing required by penetrations through the roof and necessary steel to support ducts and pipes between structural steel unless shown on the structural drawings.

3.06 CLOSING-IN OF UNFINISHED WORK

- A. Cover no work until inspected, tested, and approved. Where work is covered before inspection and test, uncover it, and when inspected, tested, and approved, restore all work to original proper condition.

3.07 EXCAVATION AND BACKFILL

- A. Perform all necessary excavation, shoring, and backfilling required for the proper laying of all raceways, ducts, and conduits inside the building and premises, and outside as may be necessary. Remove all excess excavated materials from the site or dispose of on site as directed by the General Contractor.
- B. Excavate all trenches open cut, keep trench banks as nearly vertical as practicable, and sheet and brace trenches where required for stability and safety. Excavate trenches true to line and make bottoms not less than 18 inches wide but no wider than necessary to provide ample work room. Grade trench bottoms accurately to provide uniform bearing and support for each section of pipe on undisturbed soil along its entire length. Dig "bell" holes after the trench bottom has been graded. Machine grade only to the top line of the raceways, doing the balance by hand. Do not cut any trench near or under footings without first consulting the Architect. Comply with OSHA requirements.
- C. Provide not less than 4 inches of granular material as pipe bedding prior to laying pipe in trench to continuously support pipe and maintain required slope. Granular material shall be pea gravel or sand per MAG Standards.
- D. Provide backfilling and compaction in accordance with provisions of these specifications and under the direction of the Architect to the required density.
- E. Provide not less than 4 inches of granular material, same as piping bedding, all around pipe. Make the first 2 feet of fill in 6-inch layers, each thoroughly compacted as directed, and free from rocks, large clods of earth, leaves, branches, and debris. Compact the rest of the backfill as directed, using in the backfill no rocks larger than 4 inches in diameter, and using no rock in the top 12 inches.

3.08 ACCESSIBILITY

- A. Install all control devices or other specialties requiring reading, adjustment, inspection, repairs, removal, or replacement conveniently and accessibly throughout the finished building. Where any of these devices are shown on the Contract Drawings to be installed above any inaccessible ceiling or behind any inaccessible wall, the Low-Voltage Communications Contractor shall furnish access doors or panels as required.

- B. All access doors or panels in walls and ceilings required for access to control devices, traps, valves, and similar devices are to be furnished and installed as part of the work under this section. Provide type as specified in Division 08 specifications.
- C. Refer to architectural drawings for type of wall and ceiling in each area and for rated construction.
- D. Coordinate work of various sections to locate valves, traps, and dampers with others to avoid unnecessary duplication of access doors.
- E. The Contractor, along with the Owner's representative, shall complete the Low-Voltage Communications Accessibility/Clearance Checklist at the end of this section for all communications equipment. The chart shall be submitted to the Architect for approval prior to Substantial Completion. All conflicts shall be resolved to the Architect's and Owner's satisfaction prior to submission.
- F. Provide doors that pierce a fire separation with the same fire rating as the separation.

3.09 ROOF FLASHINGS

- A. Flash and counterflash all piping, conduits, and ductwork penetrating roofing membrane with flashing per roofing manufacturer's recommendations. Refer to architectural drawings for detailing of duct and pipe penetrations through roof.

3.10 PRODUCT AND EQUIPMENT INSTALLATION – COMMON REQUIREMENTS

- A. All equipment, valves, sensors, dampers, detectors, etc., shall be installed in strict conformance with the manufacturer's recommendations and all codes.
- B. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- C. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- D. Install communications equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations.
- E. Do not install any equipment in an application not recommended by the manufacturer.

3.11 EQUIPMENT ROUGH-IN

- A. Rough-in all equipment and fixtures as designated on the drawings and in the specifications. The drawings indicate only the approximate location of rough-ins. The exact rough-in locations must be determined from large-scale certified drawings. The Contractor shall obtain all certified rough-in information before progressing with any work for rough-in final connections.
- B. Be responsible for providing all outlets and services of proper size at the required locations.
- C. Minor changes in the Contract Drawings shall be anticipated and provided for under this division.

1. Rough-in only (unless otherwise designated on the drawings) shall include providing all services as indicated and required, including all conduit and conductors. Cap all conduit stub-outs in a manner suitable for future extension.

3.12 EQUIPMENT FINAL CONNECTIONS

- A. Provide all final connections for the following:
 1. All equipment furnished under this division.
 2. Communications equipment furnished under other sections of the specifications (except as otherwise designated).
 3. Owner-furnished equipment as shown on the drawings.

3.13 OWNER-FURNISHED AND OTHER EQUIPMENT

- A. Rough-in only for all Owner-furnished equipment (refer to Division 01 specifications) and all equipment furnished under other sections of the specifications, except as otherwise specified and/or noted on the drawings.

3.14 EQUIPMENT SUPPORTS

- A. Erection of Metal Supports and Anchorages:
 1. Refer to Division 05 specifications for structural steel.
 2. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor communications materials and equipment. Neatly fabricate and erect steel work with burrs and welding spatter ground off. Paint after fabrication with a rust-inhibitive primer.
 3. Field Welding: Comply with AWS D1.1.
- B. Erection of Wood Supports and Anchorages:
 1. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support and anchor communications materials and equipment.
 2. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
 3. Attach to substrates as required to support applied loads.
- C. Concrete Inserts: Furnish and install all concrete inserts required for all materials and equipment specified and/or shown on the drawings for Division 27.
- D. Concrete Bases: Work under this section includes coordination of construction of all concrete foundations indicated or required for equipment specified under Division 27. Materials and workmanship shall be as described in Division 03 specifications. Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at project.
 1. Construct concrete bases of dimensions indicated, but not less than 1 inch (25 mm) larger in both directions than supported unit footprint. Where servicing apparatus for draw-out circuit breakers requires a level surface in front of the switchboard or switchgear, coordinate pad front extension so as to allow service to occur using standard apparatus. Where utility meters occur, pads shall conform to the serving utility requirements.
 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of the base.
 3. Install epoxy-coated anchor bolts for supported equipment that extends through concrete base, and anchor into structural concrete floor.

4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded. Install anchor bolts to elevations required for proper attachment to supported equipment.
 5. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
- E. Grouting:
1. Grout under all equipment after leveling, filling completely the space between machinery bed plate and foundation surface as specified in Division 03 specifications.
 2. Mix and install grout for communications equipment base bearing surfaces and other equipment base plates, and anchors.
 3. Clean surfaces that will come into contact with grout.
 4. Provide forms as required for placement of grout.
 5. Avoid air entrapment during placement of grout.
 6. Place grout, completely filling equipment bases.
 7. Place grout on concrete bases and provide smooth bearing surface for equipment.
 8. Place grout around anchors.
 9. Cure placed grout.
 10. Finish exposed surface of grout for a neat appearance.

3.15 CLEANUP

- A. In addition to cleanup specified in Division 01 specifications, thoroughly clean all parts of the equipment. Where exposed parts are to be painted, thoroughly clean off any splattered construction materials and remove all oil and grease spots. Wipe the surface carefully and scrape out all cracks and corners.
- B. During the progress of the work, keep the premises clean and free of debris.

3.16 PAINTING

- A. Except as otherwise specified or indicated in the architectural drawings and/or specifications, paint all exposed unfinished metal with one coat of rust-inhibiting primer. Galvanized ductwork and factory-painted equipment shall be considered as having primed surface.
- B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.
- C. Finished painting is specified in Division 09 specifications.

3.17 OBJECTIONABLE NOISE AND VIBRATION

- A. Construct and brace the metal partitions, ducts, and sheet metal housings to prevent vibration or rattling when systems are in operation. Install connections to equipment so noise and vibration will not reach the conditioned area through ducts, piping, conduit, sheet metal work, or the building structure.

3.18 TESTING

- A. Upon completion of the communication work, the entire installation shall be tested and demonstrated to be operating satisfactorily. Tests and documentation shall be in accordance with EIA/TIA Acceptance Testing Specifications for Communication Equipment and Systems.

- B. Additional equipment-specific testing is described in the equipment's respective section of this division.
- C. Furnish a written report of testing to the Architect. At a minimum, the report shall include:
 - 1. Testing Contractor's letterhead.
 - 2. Testing technician's name and signature.
 - 3. Date and time that test was performed.
 - 4. Ambient temperature and weather conditions.
 - 5. Test equipment manufacturer, model number, and last calibration date.
 - 6. The manufacturer, model number, and, as applicable, trip unit model number and available adjustments of tested equipment.
 - 7. Statement of "As Left" conditions.
 - 8. Pass/Fail statement.
 - 9. Recommendations if any.
- D. The Contractor shall submit the Testing Schedule to the Architect 2 weeks prior to initiation of testing activity.

END OF SECTION

[illegible]

SECTION 27 05 13

COMMUNICATION SERVICES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 specifications, apply to this section.

1.02 SUMMARY

- A. Section Includes:
 - 1. Communications equipment coordination and installation.
 - 2. Sleeves for pathways and cables.
 - 3. Raceway systems.
 - 4. Common communications installation requirements.
- B. Related Sections:
 - 1. Specification Section 27 05 26, Grounding & Bonding for Communications Systems.
 - 2. Specification Section 26 05 33, Raceway & Boxes for Electrical Systems.

1.03 QUALITY ASSURANCE

- A. NEC Compliance: Comply with NEC as applicable to Communication System Materials and Installation.
- B. NEMA Compliance: Comply with applicable portions of NEMA Standards pertaining to Types of Electrical Equipment Enclosures.
- C. EIA/TIA-569A Compliance: Comply with EIA/TIA-569A Standards for Telecommunication Pathways and Spaces for Commercial Buildings.

1.04 SUBMITTALS

- A. Product Data: For sleeves, seals, cable ladder, and back boxes.

1.05 COORDINATION

- A. Coordinate arrangement, mounting, and support of communications equipment.
 - 1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
 - 2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
 - 3. To allow right-of-way for piping and conduit installed at required slope.
 - 4. So connecting pathways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.
- B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

- C. Coordinate location of access panels and doors for communications item that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 specifications.
- D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 specifications.
- E. Conduit systems shall be color coded. Conduit shall be factory anodized in color as stated within Specification Section 26 05 53, Identification for Electrical Systems.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 COMMON REQUIREMENTS FOR COMMUNICATIONS INSTALLATION

- A. Comply with NECA 1.
- B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.
- C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.
- D. Equipment: Installed to facilitate service, maintenance, and repair or replacement of components of both communications equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
- E. Right-of-Way: Give to piping systems installed at a required slope.

3.02 CABLE LADDER

- A. Cable ladders shall be installed per manufacturer's instructions, utilizing product series accessories and components.
- B. Cable ladders, supports, and brackets shall be cleanly cut, deburred, and sharp edges removed.
- C. Verify installed loading requirements and install the raceway system per the manufacturer's recommendations. Provide additional load capacity to support a 2X growth factor.
- D. Install end caps, mounting spacers, couplings, hangers, brackets, dropouts, connectors, supports, and other manufacturer's accessories as required to provide a complete and functioning installation.

3.03 CONDUIT

- A. Conduit shall be sized per Table 1 below, or as noted on the drawings. Where sections of conduit runs are longer than 100 feet, or have more than 180 degrees of bends, or have a reverse bend (greater than 90 degrees), pull boxes shall be provided and installed. Bends

in conduit larger than 2 inches shall be long sweep type. Except where specifically noted, the inside radius of bends shall not be less than:

1. Six times the internal diameter of conduits 2 inches and smaller.
2. Ten times the internal diameter for conduits 2-1/2 inches and larger.

TABLE 1.											
Inside Diameter in mm	Trade Size	Cable Outside Diameter in mm (inches)									
		3.3 (0.13)	4.6 (0.18)	5.6 (0.22)	6.1 (0.24)	7.4 (0.29)	7.9 (0.31)	9.4 (0.37)	13.5 (0.53)	15.8 (0.62)	17.8 (0.70)
16	1/2	1	1	0	0	0	0	0	0	0	0
21	3/4	6	5	4	3	2	2	1	0	0	0
27	1	8	8	7	6	3	3	2	1	0	0
35	1-1/4	16	14	12	10	6	4	3	1	1	1
41	1-1/2	20	18	16	15	7	6	4	2	1	1
53	2	30	26	22	20	14	12	7	4	3	2
63	2-1/2	45	40	36	30	17	14	12	6	3	3
78	3	70	60	50	40	20	20	17	7	6	6
91	3-1/2							22	12	7	6
103	4							30	14	12	7

- B. Conduits entering telephone and data closets shall terminate as close as possible to the wall through which the conduits enter, unless otherwise noted. In-floor conduit shall terminate 4 inches above finish floor (AFF) or curb unless noted otherwise. All conduits shall be left clean, dry, and free of debris or other obstructions, with insulated grounding bushings installed.
- C. Pull boxes shall be sized and installed per BICSI Standards.
- D. Conduit, sleeves, and stubs through fire rated floors and walls shall be rigid galvanized steel conduit with insulated and/or grounding bushings per specifications. Conduit sleeve shall extend a minimum of 6 inches beyond each wall surface. Upon completion of the work, install fire stop per specifications and codes.
- E. Furnish and install pipe sleeves as shown on the drawings. The sleeves shall extend 4 inches above the floor and a minimum of 2 inches below the bottom of the ceiling slab. The inner edges of the sleeve shall be reamed, providing a smooth surface to prevent damage to cable insulation. Sleeves shall be equipped with metal caps to ensure fireproofing between floors and/or insulated bushings when occupied with cable.
- F. Feeder conduit should enter from the top or bottom, close to one side; never in the center. Distribution conduit should enter in the center.
- G. Conduit for outlets shall turn toward the main pathway and have an insulated bushing installed.

3.04 MISCELLANEOUS

- A. Raceway systems shall be bonded to the telecommunication grounding system per NEC Article 250, EIA/TIA-607 Standard, and Specification Section 27 05 26, Grounding & Bonding for Communications Systems.

- B. Provide a 1/8-inch nylon or polypropylene line in all conduits.
- C. Where cable tray is specified, or conduits are routed back to MDF or IDF Rooms or extended beyond the stub-out (greater than 3 feet from wall), install grounding bushing and bond to telecommunication grounding system.

3.05 SLEEVE INSTALLATION FOR COMMUNICATIONS PENETRATIONS

- A. Communications penetrations occur when pathways, cables, wireways, or cable trays penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.
- B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
- C. Use pipe sleeves unless penetration arrangement requires rectangular sleeve opening.
- D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- E. Cut sleeves to length for mounting flush with both surfaces of walls.
- F. Furnish and install pipe sleeves as shown on the drawings. The sleeves shall extend 4 inches above the floor and a minimum of 2 inches below the bottom of the ceiling slab. The inner edges of the sleeve shall be reamed, providing a smooth surface to prevent damage to cable insulation. Sleeves shall be equipped with metal caps to ensure fireproofing between floors and/or insulated bushings when occupied with cable.
- G. Seal space outside of sleeves with grout for penetrations of concrete and masonry.
 - 1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.
- H. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 specifications.
- I. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pathway and cable penetrations. Install sleeves and seal pathway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 specifications.
- J. Roof-Penetration Sleeves: Seal penetration of individual pathways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- K. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- L. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

3.06 SLEEVE-SEAL INSTALLATION

- A. Communications penetrations occur when pathways, cables, wireways, or cable trays penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.
- B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
- C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- E. Cut sleeves to length for mounting flush with both surfaces of walls.
- F. Furnish and install pipe sleeves as shown on the drawings. The sleeves shall extend 4 inches above the floor and a minimum of 2 inches below the bottom of the ceiling slab. The inner edges of the sleeve shall be reamed, providing a smooth surface to prevent damage to cable insulation.
- G. Sleeves shall be equipped with metal caps to ensure fireproofing between floors and/or insulated bushings when occupied with cable.
- H. Seal space outside of sleeves with grout for penetrations of concrete and masonry.
- I. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.
- J. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint.
- K. Comply with requirements in Division 07 specifications.
- L. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pathway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 specifications.
- M. Roof-Penetration Sleeves: Seal penetration of individual pathways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- N. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- O. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between pathway or cable and sleeve for installing mechanical sleeve seals.
- P. Install to seal exterior wall penetrations.
 - 1. Use type and number of sealing elements recommended by manufacturer for pathway or cable material and size. Position pathway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pathways

or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.07 FIRESTOPPING

- A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for communications installations to restore original fire-resistances rating of assembly. Firestopping materials and installation requirements are specified in Division 07 specifications.

END OF SECTION

SECTION 27 05 26

GROUNDING & BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

- A. This section outlines the requirements of the telecommunication grounding work as indicated on the drawings and in the contract documents.

1.02 RELATED DOCUMENTS

- A. Division 26 sections as applicable shall apply to work of this section.

1.03 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in the manufacture of electrical connectors, terminals, and fittings, of types and ratings required, and ancillary grounding materials, including stranded cable, copper braid and bus, ground rods, and plate electrodes, whose products have been in satisfactory use in similar service for not less than 3 years.
- B. NEC Compliance: Comply with NEC requirements as applicable to materials and installation of data/telecommunication grounding systems, associated equipment, and wiring. Provide grounding products which are UL listed and labeled.
- C. UL Compliance: Comply with applicable requirements of UL 467 and UL 869, pertaining to data/telecommunication grounding and bonding.
- D. TIA/EIA Compliance: Comply with TIA/EIA-607 Standards and the BICSI Telecommunications Distribution Methods Manual (TDMM) for the installation of data/telecommunication grounding and bonding systems.

PART 2 PRODUCTS

2.01 TELECOMMUNICATION GROUNDING SYSTEM

- A. Provide a low-impedance telecommunication grounding system with a stable ± 0 volt to ground signal reference point for communication system equipment and infrastructures.
- B. Telecommunication bonding backbone (TBB) shall be sized per NEC Table 250-66 (based on largest service entrance conductor or equivalent area for parallel conductors), minimum of a #2 AWG copper conductor.
- C. All bonding conductors shall be minimum #6 AWG, insulated (green jacket), stranded copper.
- D. In multi-story buildings requiring two or more vertical MDFs, IDF, and/or TBBs, they shall be bonded together at the top and bottom floors, with a minimum of every third floor when the building exceeds four floors.

- E. System connections shall be irreversible compression-type connectors or exothermic welding with bronze bolt, star washer, and nut connection hardware.
- F. Zinc-clad or nickel-plated steel hardware is not acceptable.
- G. Setscrew, box lug, and split-bolt connectors are not acceptable.
- H. Where required by local code interpretation, the data/telecommunication grounding system backbone cable conductor shall be a bare stranded copper conductor in lieu of an insulated conductor when installed in open cable trays and/or exposed in a return air plenum space or riser rated space. The Contractor shall verify requirements and coordinate with the Engineer.
- I. 2-hole compression lugs shall be utilized for backbone cable terminations of #2 AWG and larger. 1-hole compression lugs may be utilized for cable terminations of #6 up to #2 AWG.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Bonding and grounding conductors installed in ferrous metallic conduit shall be bonded at each end of conduit, utilizing a minimum #6 AWG copper conductor and bond bushings. Conduits less than 3 feet in length shall be bonded at one end. Bond bushing lug shall be replaced with a compression-type ground lug, bolted to bushing with bronze machine screw and star washer.
- B. Bonding and grounding conductor splices shall be kept to a minimum. All splices shall be located in the telecommunication spaces only and shall be fully accessible.
- C. Bonding conductors shall be individually routed to each piece of equipment.
- D. Conductors shall terminate onto dedicated grounding lugs, one conductor per termination.
- E. All conductors shall be maintained as short and as straight as possible.
- F. Conductors shall be free from loops and coils; no bend shall be greater than 90 degrees.
- G. The data/telecommunication grounding system shall be extended to and through data/communication raceways, such as cable trays, cable channels, ladder systems, metallic surface-mounted raceways, etc., by means of extending a #6 AWG minimum bonding conductor through the length of the raceway system and bonding to each section of raceway, lugging at 10-foot maximum intervals along the length of the raceway, and lugging to any section of raceway greater than 3 feet in length, in lieu of the installation of individual bonding jumpers between each raceway section.
- H. Where a bare copper TBB conductor or bonding conductor is routed through a cable tray system, the conductor shall be tied down and anchored to the cable tray, 36 inches maximum on center, utilizing a UL listed wire fastener as required.
- I. The data/telecommunication grounding system shall meet the requirements of NEC Articles 250 and 800. The Contractor shall bond individual electronic components and equipment to the grounding system per the equipment manufacturer's recommendations and instructions.

- J. Each telecommunication bonding conductor shall be labeled. Labels shall be located on conductors, as close as practicable to their point of termination. Label shall be non-metallic and include the following information: "WARNING – IF THIS CONNECTOR OR CABLE IS LOOSE OR MUST BE REMOVED, PLEASE CALL THE BUILDING TELECOMMUNICATION MANAGER."
- K. Items to be bonded to the data/telecommunication grounding system at the ground distribution bus bars shall include, but not be limited to, the following:
 - 1. Telephone equipment (e.g., PBXs, KSUs, ISDN equipment, etc.).
 - 2. CATV equipment.
 - 3. Equipment racks and cabinets.
 - 4. Cable ladders, trays, and channels.
 - 5. Surface-mounted metallic raceways and wireways.
 - 6. Metallic conduit systems.
 - 7. Service entrance protected terminals.
 - 8. Telecommunications and fiber-optic splice enclosures.
 - 9. Inter-building cable sheaths and messengers.
 - 10. Coupled bonding conductors.
 - 11. Paging and access control systems.

3.02 SYSTEM TESTING

- A. Upon completion of the installation of the data/telecommunication grounding system and/or servicing of the existing grounding systems, the Contractor shall perform approved standard ground resistance tests with an Engineer-approved ground resistance test unit (i.e., stakeless clamp-on ground resistance tester, 3-point fall of potential tester), using approved procedures as noted in this specification.
- B. The Contractor shall perform telecommunication grounding system testing as follows:
 - 1. Measure ground current and ground resistance readings on all TBB conductors at each telecommunications main grounding bus bar.
 - 2. Measure ground current and ground resistance readings on all bonding jumpers at each telecommunications main grounding bus bar.
 - 3. Record all readings in a Test Report.
 - 4. Where test results indicate a ground current of 1 amp or greater, the Contractor shall take appropriate action to identify and reduce the ground current to less than 1 amp. The Contractor shall notify the Engineer in writing of the excessive ground current, the source, and the action taken to reduce the current.
- C. The Contractor shall demonstrate to the Owner or Owner's representative, by testing, that the data/telecommunication ground system to earth resistance value is 10 ohms or less, utilizing a "clamp-on" or 3-point fall of potential tester.
- D. The Contractor shall be able to demonstrate to the Owner or Owner's representative, by test, that the data/telecommunication grounding system resistance from any grounded non-current-carrying conductor in the system to the electrical service entrance neutral/ground bonding conductor is less than 0.1 ohm.
- E. The Contractor shall record the test results in a Test Report, and provide a description of the testing procedures for submission to the Engineer for approval.

- F. The Contractor shall include copies of the completed and approved Test Report in the Instruction Manuals.

END OF SECTION

SECTION 27 05 28

PATHWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 specifications, apply to this section.

1.02 SUMMARY

- A. Section Includes:
 - 1. Communications equipment coordination and installation.
 - 2. Sleeves for pathways and cables.
 - 3. Raceway systems.
 - 4. Common communications installation requirements.
- B. Related Sections:
 - 1. Specification Section 27 05 26, Grounding & Bonding for Communications Systems.
 - 2. Specification Section 26 05 33, Raceway & Boxes for Electrical Systems.
 - 3. Specification Section 26 05 53, Identification for Electrical Systems.

1.03 QUALITY ASSURANCE

- A. NEC Compliance: Comply with NEC as applicable to Communication System Materials and Installation.
- B. NEMA Compliance: Comply with applicable portions of NEMA Standards pertaining to Types of Electrical Equipment Enclosures.
- C. EIA/TIA-569A Compliance: Comply with EIA/TIA-569A Standards for Telecommunication Pathways and Spaces for Commercial Buildings.

1.04 SUBMITTALS

- A. Product Data: For sleeves, seals, cable ladder, and back boxes.

1.05 COORDINATION

- A. Coordinate arrangement, mounting, and support of communications equipment.
 - 1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
 - 2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
 - 3. To allow right-of-way for piping and conduit installed at required slope.
 - 4. So connecting pathways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.
- B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

- C. Coordinate location of access panels and doors for communications item that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 specifications.
- D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 specifications.
- E. Conduit systems shall be color coded the entire length. Conduit shall be factory anodized in color as stated in Specification Section 26 05 53, Identification for Electrical Systems.
 - 1. As an option, the Contractor may use natural colored conduit with painted markings every 5 feet.
 - 2. Where conduit system is painted, all junction boxes shall be required to be painted to match system color. On junction boxes that are larger than 16 inches square, only the cover of the box need be painted.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 COMMON REQUIREMENTS FOR COMMUNICATIONS INSTALLATION

- A. Comply with NECA 1.
- B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.
- C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.
- D. Equipment: Installed to facilitate service, maintenance, and repair or replacement of components of both communications equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
- E. Right-of-Way: Give to piping systems installed at a required slope.

3.02 CABLE LADDER

- A. Cable ladders shall be installed per manufacturer's instructions, utilizing product series accessories and components.
- B. Cable ladders, supports, and brackets shall be cleanly cut, deburred, and sharp edges removed.
- C. Verify installed loading requirements and install the raceway system per the manufacturer's recommendations. Provide additional load capacity to support a 2X growth factor.
- D. Install end caps, mounting spacers, couplings, hangers, brackets, dropouts, connectors, supports, and other manufacturer's accessories as required to provide a complete and functioning installation.

3.03 CONDUIT

- A. Conduit shall be sized per Table 1 below, or as noted on the drawings. Where sections of conduit runs are longer than 100 feet, or have more than 180 degrees of bends, or have a reverse bend (greater than 90 degrees), pull boxes shall be provided and installed. Bends in conduit larger than 2 inches shall be long sweep type. Except where specifically noted, the inside radius of bends shall not be less than:
1. Six times the internal diameter of conduits 2 inches and smaller.
 2. Ten times the internal diameter for conduits 2-1/2 inches and larger.

TABLE 1.											
Inside Diameter in mm	Trade Size	Cable Outside Diameter in mm (inches)									
		3.3 (0.13)	4.6 (0.18)	5.6 (0.22)	6.1 (0.24)	7.4 (0.29)	7.9 (0.31)	9.4 (0.37)	13.5 (0.53)	15.8 (0.62)	17.8 (0.70)
16	1/2	1	1	0	0	0	0	0	0	0	0
21	3/4	6	5	4	3	2	2	1	0	0	0
27	1	8	8	7	6	3	3	2	1	0	0
35	1-1/4	16	14	12	10	6	4	3	1	1	1
41	1-1/2	20	18	16	15	7	6	4	2	1	1
53	2	30	26	22	20	14	12	7	4	3	2
63	2-1/2	45	40	36	30	17	14	12	6	3	3
78	3	70	60	50	40	20	20	17	7	6	6
91	3-1/2							22	12	7	6
103	4							30	14	12	7

- B. Conduits entering telephone and data closets shall terminate as close as possible to the wall through which the conduits enter, unless otherwise noted. In-floor conduit shall terminate 4 inches above finish floor (AFF) or curb unless noted otherwise. All conduits shall be left clean, dry, and free of debris or other obstructions, with insulated grounding bushings installed.
- C. Pull boxes shall be sized and installed per BICSI Standards.
- D. Conduit, sleeves, and stubs through fire rated floors and walls shall be rigid galvanized steel conduit with insulated and/or grounding bushings per specifications. Conduit sleeve shall extend a minimum of 6 inches beyond each wall surface. Upon completion of the work, install fire stop per specifications and codes.
- E. Furnish and install pipe sleeves as shown on the drawings. The sleeves shall extend 4 inches above the floor and a minimum of 2 inches below the bottom of the ceiling slab. The inner edges of the sleeve shall be reamed, providing a smooth surface to prevent damage to cable insulation. Sleeves shall be equipped with metal caps to ensure fireproofing between floors and/or insulated bushings when occupied with cable.
- F. Feeder conduit should enter from the top or bottom, close to one side; never in the center. Distribution conduit should enter in the center.
- G. Conduit for outlets shall turn toward the main pathway and have an insulated bushing installed.

3.04 MISCELLANEOUS

- A. Raceway systems shall be bonded to the telecommunication grounding system per NEC Article 250, EIA/TIA 607 Standard, and Specification Section 27 05 26, Grounding & Bonding for Communications Systems.
- B. Provide a 1/8-inch nylon or polypropylene line in all conduits.
- C. Where cable tray is specified, or conduits are routed back to MDF or IDF Rooms or extended beyond the stub-out (greater than 3 feet from wall), install grounding bushing and bond to telecommunication grounding system.

3.05 SLEEVE INSTALLATION FOR COMMUNICATIONS PENETRATIONS

- A. Communications penetrations occur when pathways, cables, wireways, or cable trays penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.
- B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
- C. Use pipe sleeves unless penetration arrangement requires rectangular sleeve opening.
- D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- E. Cut sleeves to length for mounting flush with both surfaces of walls.
- F. Furnish and install pipe sleeves as shown on the drawings. The sleeves shall extend 4 inches above the floor and a minimum of 2 inches below the bottom of the ceiling slab. The inner edges of the sleeve shall be reamed, providing a smooth surface to prevent damage to cable insulation. Sleeves shall be equipped with metal caps to ensure fireproofing between floors and/or insulated bushings when occupied with cable.
- G. Seal space outside of sleeves with grout for penetrations of concrete and masonry.
 - 1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.
- H. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 specifications.
- I. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pathway and cable penetrations. Install sleeves and seal pathway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 specifications.
- J. Roof-Penetration Sleeves: Seal penetration of individual pathways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- K. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

- L. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

3.06 SLEEVE-SEAL INSTALLATION

- A. Communications penetrations occur when pathways, cables, wireways, or cable trays penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.
- B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
- C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- E. Cut sleeves to length for mounting flush with both surfaces of walls.
- F. Furnish and install pipe sleeves as shown on the drawings. The sleeves shall extend 4 inches above the floor and a minimum of 2 inches below the bottom of the ceiling slab. The inner edges of the sleeve shall be reamed, providing a smooth surface to prevent damage to cable insulation.
- G. Sleeves shall be equipped with metal caps to ensure fireproofing between floors and/or insulated bushings when occupied with cable.
- H. Seal space outside of sleeves with grout for penetrations of concrete and masonry.
- I. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.
- J. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint.
- K. Comply with requirements in Division 07 specifications.
- L. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pathway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 specifications.
- M. Roof-Penetration Sleeves: Seal penetration of individual pathways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- N. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- O. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between pathway or cable and sleeve for installing mechanical sleeve seals.

- P. Install to seal exterior wall penetrations.
 - 1. Use type and number of sealing elements recommended by manufacturer for pathway or cable material and size. Position pathway of cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pathways or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.07 FIRESTOPPING

- A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for communications installations to restore original fire-resistances rating of assembly. Firestopping materials and installation requirements are specified in Division 07 specifications.

END OF SECTION

SECTION 27 05 44

SLEEVES & SLEEVE SEALS FOR COMMUNICATIONS PATHWAYS & CABLING

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Sleeves for pathway and cable penetration of non-fire-rated construction walls and floors.
 - 2. Sleeve-seal systems.
 - 3. Sleeve-seal fittings.
 - 4. Grout.
 - 5. Silicone sealants.
- B. Related Requirements:
 - 1. Division 07 specifications, for penetration firestopping installed in fire resistance rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.

PART 2 PRODUCTS

2.01 SLEEVES

- A. Wall Sleeves:
 - 1. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
 - 2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
- B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized steel sheet; 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw fastening the sleeve on the board.
- C. Sleeves for Rectangular Openings:
 - 1. Material: Galvanized steel sheet.
 - 2. Minimum Metal Thickness:
 - a. For sleeve cross-section rectangular perimeter less than 50 inches (1,270 mm) and with no side larger than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
 - b. For sleeve cross-section rectangle perimeter 50 inches (1,270 mm) or more and one or more sides larger than 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

2.02 SLEEVE-SEAL SYSTEMS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and pathway or cable.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:
 - a. Advance Products & Systems, Inc.
 - b. CALPICO, Inc.
 - c. The Metraflex Company.
 - d. Pipeline Seal and Insulator, Inc.
 - e. Proco Products, Inc.
 - 2. Sealing Elements: EPDM Nitrile or Buna N rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 3. Pressure Plates: Stainless steel.
 - 4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.03 SLEEVE-SEAL FITTINGS

- A. Description: Manufactured plastic, sleeve type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:
 - a. Presealed systems.

2.04 GROUT

- A. Description: Non-shrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
- B. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume adjusting, dry, hydraulic cement grout.
- C. Design Mix: 5,000 psi (34.5 MPa), 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

2.05 SILICONE SEALANTS

- A. Silicone Sealants: Single component, silicone based, neutral curing elastomeric sealants of grade indicated below:
 - 1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
- B. Silicone Foams: Multi-component, silicone based liquid elastomers that when mixed, expand and cure in place to produce flexible, non-shrinking foam.

PART 3 EXECUTION

3.01 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

- A. Comply with NECA 1.
- B. Comply with NEMA VE 2 for cable tray and cable penetrations.
- C. Sleeves for conduits penetrating above grade non-fire-rated concrete and masonry unit floors and walls:
 - 1. Interior penetrations of non-fire-rated walls and floors:
 - a. Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 specifications.
 - b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
 - 2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
 - 3. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pathway or cable unless sleeve seal is to be installed.
 - 4. Install sleeves for all penetrations unless core drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
 - 5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level. Install sleeves during erection of floors.
- D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:
 - 1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved openings.
 - 2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.
- E. Roof Penetration Sleeves: Seal penetration of individual pathways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- F. Aboveground, Exterior Wall Penetrations: Seal penetration using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- G. Underground, Exterior Wall and Floor Penetrations: Install cast iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between pathway or cable and sleeve for installing sleeve seal system.

3.02 SLEEVE SEAL SYSTEM INSTALLATION

- A. Install sleeve seal systems in sleeves in exterior concrete walls and slabs-on-grade at pathway entries into building.
- B. Install type and number of sealing elements recommended by manufacturer for pathway or cable material and size. Position pathway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pathway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.03 SLEEVE SEAL FITTING INSTALLATION

- A. Install sleeve seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Using grout, seal the space around outside of sleeve seal fittings.

END OF SECTION

SECTION 27 15 00

COMMUNICATIONS HORIZONTAL CABLING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 specifications, apply to this section.

1.02 SUMMARY

- A. Section Includes:
 - 1. Pathways.
 - 2. UTP cabling.
 - 3. Coaxial cable.
 - 4. Cable connecting hardware, patch panels, and cross-connects.
 - 5. Telecommunications outlet/connectors.
 - 6. Cabling system identification products.
 - 7. Cable management system.
- B. Related Sections:
 - 1. Specification Section 27 13 00, Communications Backbone Cabling, for voice and data cabling associated with system panels and devices.
 - 2. Specification Section 27 05 26, Grounding & Bonding for Communications Systems.
 - 3. Specification Section 27 05 28, Pathways for Communications Systems.
 - 4. Specification Section 27 06 10, Schedules for Structured Cabling & Enclosures.
 - 5. Specification Section 27 06 20, Schedules for Data Communications.
 - 6. Specification Section 27 11 00, Communications Equipment Room Fittings.

1.03 DEFINITIONS

- A. Basket Cable Tray: A fabricated structure consisting of wire mesh bottom and side rails.
- B. BICSI: Building Industry Consulting Service International.
- C. Channel Cable Tray: A fabricated structure consisting of a 1-piece, ventilated-bottom or solid-bottom channel.
- D. Consolidation Point: A location for interconnection between horizontal cables extending from building pathways and horizontal cables extending into furniture pathways.
- E. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.
- F. EMI: Electromagnetic interference.
- G. IDC: Insulation displacement connector.
- H. Ladder Cable Tray: A fabricated structure consisting of two longitudinal side rails connected by individual transverse members (rungs).

- I. LAN: Local area network.
- J. NECA: National Electrical Contractors Association.
- K. NRTL: Nationally Recognized Testing Laboratory.
- L. Outlet/Connectors: A connecting device in the work area on which horizontal cable or outlet cable terminates.
- M. RCDD: Registered Communications Distribution Designer.
- N. UTP: Unshielded twisted pair.
- O. Owner: City of Chandler.

1.04 HORIZONTAL CABLING DESCRIPTION

- A. Horizontal cable and its connecting hardware provide the means of transporting signals between the telecommunication outlet/connector and the horizontal cross-connect located in the communications equipment room. This cabling and its connecting hardware are called "permanent link," a term that is used in the testing protocols.
 - 1. A minimum of three communications outlets/connectors shall be installed for each work area (one voice/two data).
 - 2. Horizontal cabling shall contain no transition point or consolidation point between the horizontal cross-connect and the telecommunications outlet/connector.
 - 3. Bridge taps and splices shall not be installed in the horizontal cabling.
 - 4. Splitters shall not be installed as part of the optical fiber cabling.
- B. A work area includes the components that extend from the telecommunications outlet/connectors to the station equipment.
- C. The maximum allowable horizontal cable length is 295 feet (90 m). This maximum allowable length does not include an allowance for the length of 16 feet (4.9 m) to the workstation equipment. The maximum allowable length does not include an allowance for the length of 16 feet (4.9 m) in the horizontal cross-connect.

1.05 PERFORMANCE REQUIREMENTS

- A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA/EIA-568-B.1, when tested according to test procedures of this standard.

1.06 SUBMITTALS

- A. Product Data: For each type of product indicated.
 - 1. Refer to Specification Section 27 05 13, Communication Services.
 - 2. Include the following installation data for each type used:
 - a. Nominal OD.
 - b. Minimum bending radius.
 - c. Maximum pulling tension.
- B. Shop Drawings:
 - 1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by the Owner.
 - 2. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.

3. Cabling administration drawings and printouts.
 4. Cross-Connects and Patch Panels: Detail mounting assemblies and show elevations and physical relationship between the installed components.
- C. Testing Documentation:
1. Provide one electronic copy of test reports for horizontal UTP cables, coaxial cables, and fiber-optic cables. Test reports provided in electronic format shall include a shareware copy of the appropriate software for managing the reports in CSV format.
 2. Documentation (PDF format) shall be submitted to the Architect within 5 working days of the completion of each testing phase (e.g., subsystem, cable type, area, floor, etc.).

1.07 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
1. Installation Supervision: Installation shall be under the direct supervision of Registered Technician, who shall be present at all times when work of this section is performed at project site.
 2. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise onsite testing.
- B. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
1. Flame-Spread Index: 25 or less.
 2. Smoke-Developed Index: 450 or less.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-A.
- E. Grounding: Comply with ANSI-J-STD-607-A.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Test cables upon receipt at project site.
1. Test each pair of UTP cables for open and short circuits.
 2. Delivery and receipt of products shall be at the site described in this section.
 3. Cable shall be stored according to manufacturer's recommendations as a minimum. In addition, cable must be stored in a location protected from vandalism and weather. Air temperature at cable storage location shall be well ventilated to prevent condensation. If necessary, cable shall be stored offsite at the Contractor's expense.

1.09 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
- B. Cable shall be stored according to manufacturer's recommendations as a minimum. In addition, cable must be stored in a location protected from vandalism and weather. Air

temperature at cable storage location shall not exceed 50°F minimum, 130°F maximum. Storage location shall be well ventilated to prevent condensation. If necessary, cable shall be stored offsite at the Contractor's expense.

1.10 COORDINATION

- A. Coordinate layout and installation of telecommunications pathways and cabling with the Owner's telecommunications and LAN equipment and service suppliers.
- B. Coordinate telecommunications outlet/connector locations with location of power receptacles at each work area.
- C. Refer to Specification Section 27 05 13, Communication Services.

PART 2 PRODUCTS

2.01 UTP CABLE

- A. Manufacturers: Subject to compliance with requirements, provide products by:
 - 1. Berk-Tek; a Nexans company.
- B. Description: 100-ohm, 4-pair UTP, covered with a blue thermoplastic jacket.
 - 1. Comply with ICEA S-90-661 for mechanical properties.
 - 2. Comply with TIA/EIA-568-B.1 for performance specifications.
 - 3. Comply with TIA/EIA-568-B.2, Category-5e for renovation of existing facility and Category 6 for new construction.
 - 4. Listed and labeled by an NRTL acceptable to Authorities Having Jurisdiction (AHJ) as comply with UL 444 and NFPA 70 for the following types:
 - a. Communications, Plenum Rated: Type CMP complying with NFPA 262.
 - b. Communications, Riser Rated: Type CMR complying with UL 1666.
 - c. Communications, Limited Purpose: Type CMX.
 - d. Multi-Purpose: Type MP or MPG.
 - e. Multi-Purpose, Plenum Rated: Type MPP complying with NFPA 262.
 - f. Multi-Purpose, Riser Rated: Type MPR complying with UL 1666.

2.02 UTP CABLE HARDWARE

- A. Manufacturers: Subject to compliance with requirements, provide products by:
 - 1. Ortronics.
- B. General Requirements for Cable Connecting Hardware: Comply with TIA/EIA-568-B.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.
- C. Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.
 - 1. Number of Jacks per Field: One for each 4-pair UTP cable indicated.
- D. Jacks and Jack Assemblies: Modular, color-coded, 8-position modular receptacle units with integral IDC-type terminals.
- E. Patch Cords: Factory-made, 4-pair cables in 36-inch (900-mm) or 48-inch (1,200-mm) length as directed by the Owner; terminated with 8-position modular plug at each end.

1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure Category 6 performance. Patch cords shall have latch guards to protect against snagging.
2. Patch cords shall have color-coded boots for circuit identification.

2.03 COAXIAL CABLE

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Leviton.
 2. Or to match existing in building.
- B. Cable Characteristics: Broadband type, recommended by cable manufacturer specifically for broadband data transmission applications. Coaxial cable and accessories shall have 75-ohm nominal impedance with a return loss of 20 dB maximum from 7 to 806 MHz.
- C. RG-6/U: NFPA 70, Type CATVP.
 1. #16 AWG, solid, copper-covered steel conductor; gas-injected, foam-PE insulation.
 2. Double shielded with 100% aluminum-foil shield and 60% aluminum braid.
 3. Jacketed with copolymer jacket.
 4. Suitable for indoor installations.
- D. RG59/U (Plenum Rated): NFPA 70, Type CMP.
 1. #20 AWG, solid, copper-covered steel conductor; foam fluorinated ethylene propylene insulation.
 2. Double shielded with 100% aluminum-foil shield and 65% aluminum braid.
 3. Copolymer jacket.
- E. NFPA and UL compliance listed and labeled by an NRTL acceptable to AHJ as complying with UL 1655 and the NFPA 70 Radio and Television Equipment and Community Antenna Television and Radio Distribution articles. Type is as follows:
 1. CATV Plenum Rated: Type CATVP, complying with NFPA 262.

2.04 TELECOMMUNICATIONS OUTLET/CONNECTORS

- A. Jacks: 100-ohm, balanced, twisted-pair connector; 4-pair, 8-position modular. Comply with TIA/EIA-568-B.1.
- B. Workstation Outlets: Four port-connector assemblies mounted in single faceplate.
 1. Plastic Faceplate: High-impact plastic. Coordinate color with Specification Section 26 27 26, Wiring Devices.
 2. For use with snap-in jacks accommodating any combination of UTP, optical fiber, and coaxial work areas cords.
 - a. Flush mounting jacks, positioning the cord at a 90-degree angle.
 3. Legend:
 - a. Machine printed, in the field, using adhesive-tape label for cable.
 - b. Snap-in, clear-label covers and machine-printed paper inserts for faceplate.

2.05 IDENTIFICATION PRODUCTS

- A. Comply with TIA/EIA-606-A and UL 969 for labeling materials, including label stocks, laminating adhesives, and inks used by printers.

- B. Comply with requirements in Specification Section 26 05 53, Identification for Electrical Systems.
- C. Cable identification shall be by means of permanently applied, preprinted, wraparound wire markers (i.e., "Brady-Wrap" B-292, LAT-18, or LAT-19 self-laminating markers). These labels must withstand the requirements of UL 969 as outlined in the EIA/TIA-606 Standard.
- D. Patch panel labels shall be preprinted and enclosed in self-adhesive clear strips (Panduit, Ortronics, or as accepted by the Engineer).
- E. Data/Telecommunications Outlet Face Plates: Permanent, clear, preprinted laminated label with black lettering (Brade Label #CL-311-621 or LAT-7-722-10, or as accepted by the Engineer).

2.06 SOURCE QUALITY CONTROL

- A. Factory test UTP on reels according to TIA/EIA-568-B.1.
- B. Factory test UTP cables according to TIA/EIA-568-B.2.
- C. Factory-sweep test coaxial cables at frequencies from 5 MHz to 1 GHz. Sweep test shall test the frequency response, or attenuation over frequency, or a cable, by generating a voltage whose frequency is varied through the specified frequency range and graphing the results.
- D. Cable will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports. Provide software to read original test results on disc provided by the Owner.

PART 3 EXECUTION

3.01 WIRING METHODS

- A. Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces. Conceal raceway and cables except in unfinished spaces.
 - 1. Install plenum cable in environmental air spaces, including plenum ceilings.
 - 2. Comply with requirements for raceways and boxes specified in Specification Section 26 05 33, Raceway & Boxes for Electrical Systems.
- B. Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
- C. Wiring Within Enclosures: Bundle, lace, and train cables to terminal points with no excess and without exceeding manufacturer's limitations on bending radius. Provide and use lacing bars and distribution spools.

3.02 INSTALLATION OF CABLES

- A. Comply with NECA 1.
- B. General Requirements for Cabling:
 - 1. Comply with TIA/EIA-568-B.1.

2. Comply with BICSI Information Technology Systems Installation Methods Manual (ITSIM), Chapter 6, Cable Termination Practices.
3. Install 110-style IDC termination hardware unless otherwise indicated.
4. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
5. Cables may not be spliced. Cabling shall be installed in continuous runs from cross-connect fields to cross-connect fields, to patch panels, workstation outlets, etc. Cabling shall be free from splices, taps, splitters, baluns, and any other inline connections.
6. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
7. Unsupported spans between cable trays and conduit sleeve shall not exceed 12 inches horizontally, 24 inches vertically.
8. All cables shall be new and as specified on the drawings. Cables shall be shipped on 1,000-foot reels or boxed. Coiled cables are not acceptable. Factory shorts and/or factory seconds, salvaged, leftover, and reused cables are not acceptable. Cables of a given type shall be of a single manufacturer and part number. All unapproved or unacceptable cable shall be removed and replaced at the Contractor's expense.
9. Cables routed above a suspended ceiling in exposed space, and not installed in a conduit system, shall be supported by a cable tray, channel, or hangers.
10. Cables shall not be supported from ceiling support wires, lighting fixture support wires, ductwork, plumbing line, fire suppression systems, mechanical systems, or electrical conduits. Cable shall not come in contact with ductwork or piping, or lay on top of ceiling systems and lighting fixtures.
11. Where cables are routed through inaccessible ceilings, the Contractor shall install conduit sleeves extending 1 foot beyond the inaccessible area, sized in accordance with ANSI/TIA/EIA-569-A Guidelines, as outlined in Table 1. Install insulated conduit bushing on both ends of sleeve and ground conduit per Specification Section 27 05 26, Grounding & Bonding for Communications Systems.
12. Install conduit sleeves where cables pass through walls. Conduits shall be sized in accordance with ANSI/TIA/EIA-569-A Guidelines, as outlined in Specification Section 27 05 28, Pathways for Communications Systems, Table 1. Install insulated conduit bushing on both ends of sleeve and ground conduit per Specification Section 27 05 26, Grounding & Bonding for Communications Systems.
13. Cables supported by hangers shall utilize Caddy Cable-Cat hangers or approved equal communication cable hangers. Hangers shall be supported from the building structure. Hangers shall not utilize other systems support wires or rods.
14. A maximum of 36 cables (3 groups of 12) cables shall be supported in a single hanger with a spacing of 48 inches on center. Cables shall be loosely bundled.
15. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radius than minimums recommended by manufacturer.
16. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radius, but not less than radius specified in BICSI ITSM, Cabling Termination Practices chapter. Use lacing bars and distribution spools.
17. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
18. Cold-Weather Installation: Bring cable to room temperatures before de-reeling. Heat lamps shall not be used for heating.

19. In the communications equipment room, install a 10-foot (3-m) long service loop on each end of cable.
 20. Pulling Cable: Comply with BICSI ITSIM Chapter 4, Pulling Cable. Monitor cable pull tensions.
 21. Cables requiring additional length shall be stored in an extended loop or in a "Figure 8" configuration. Do not store additional length in bundled loops. Each individual loop shall be tagged with cable number.
 22. The Contractor shall make certain that during the installation and upon completion, all cables have been installed in good condition, free from jacket cuts, or tears, kinks, twists, knots, sharp bends, etc., or any other physical damage. During the installation, the Contractor shall not allow the cables to be exposed to foot, vehicle, or equipment traffic, or be exposed to any other form of abuse which shall cause damage to cables, altering the electrical characteristics. Cable exhibiting such damage or an attempt by the Contractor to correct, hide, or otherwise conceal such damage, shall result in cables being replaced at the Contractor's expense.
 23. Cable pulls shall not exceed 100 feet in length. Cables shall be neatly coiled in a "Figure 8" pattern at the completion of a pull in preparation of the next pull.
 24. Data/telecommunication and fiber-optic cables shall not be stored or installed in an unheated building where the temperature is less than 40°F. The structure and the cable must be brought to a minimum 50°F ambient for a minimum of 48 hours prior to installation of the cables. Failure to observe this precaution may result in damage to the cable and shall result in the cable being replaced at the Contractor's expense.
- C. UTP Cable Installation:
1. Comply with TIA/EIA-568-B.2.
 2. Do not untwist UTP cables more than 1/2 inch (12 mm) from the point of termination to maintain cable geometry.
- D. Open-Cable Installation:
1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
 2. Suspend UTP cable not in a wireway or pathway a minimum of 8 inches (200 mm) above ceilings by cable supports not more than 48 inches (1,524 mm) apart. Refer to this section for support requirements.
 3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.
- E. Group connecting hardware for cables into separate logical fields.
- F. Separation from EMI Sources:
1. Comply with BICSI Telecommunications Distribution Methods Manual (TDMM) and TIA/EIA-569-A for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
 2. Separation between open communications cables or cables in non-metallic raceways and unshielded power conductors and electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less than 2 kVA: A minimum of 5 inches (127 mm).
 - b. Electrical Equipment Rating Between 2 and 5 kVA: A minimum of 12 inches (300 mm).
 - c. Electrical Equipment Rating More than 5 kVA: A minimum of 24 inches (610 mm).

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less than 2 kVA: A minimum of 2-1/2 inches (64 mm).
 - b. Electrical Equipment Rating Between 2 and 5 kVA: A minimum of 6 inches (150 mm).
 - c. Electrical Equipment Rating More than 5 kVA: A minimum of 12 inches (300 mm).
4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
 - a. Electrical Equipment Rating Less than 2 kVA: No requirement.
 - b. Electrical Equipment Rating Between 2 and 5 kVA: A minimum of 3 inches (76 mm).
 - c. Electrical Equipment Rating More than 5 kVA: A minimum of 6 inches (150 mm).
5. Separation Between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches (1,200 mm).
6. Separation Between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches (127 mm).

3.03 FIRESTOPPING

- A. Comply with requirements in Division 07 specifications.
- B. Comply with TIA/EIA-569-A, Annex A, Firestopping.
- C. Comply with BICSI TDMM, Chapter 11 Firestopping Systems article.

3.04 IDENTIFICATION

- A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Specification Section 26 05 53, Identification for Electrical Systems.
 1. Administration Class 4.
 2. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.
- B. Using cable management system software specified in Part 2, develop Cabling Administration Drawings for system identification, testing, and management. Use unique, alphanumeric designation for each cable and label cable, jacks, connectors, and terminals to which it connects with same designation. At completion, cable and asset management software shall reflect as-built conditions.
- C. Comply with requirements in Division 09 specifications for painting backgrounds. For fire-resistant plywood, do not paint over manufacturer's label.
- D. Paint and label colors for equipment identification shall comply with TIA/EIA-606-A for Class 4 level of administration.
- E. Cable Schedule: Post in prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for project.

- F. Cabling Administration Drawings: Show building floor plans with cable administration-point labeling. Identify labeling convention and show labels for telecommunications closet, backbone pathways and cables, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors. Follow convention of TIA/EIA-606-A. Furnish electronic record of all drawings, in software and format selected by the Owner.
- G. Cable and Wire Identification:
1. Label each cable within 4 inches (100 mm) of each termination point.
 2. Exposed Backbone Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet (4.5 m).
 3. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
 - a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with name and number of particular device as shown.
 - b. Label each unit and field within distribution racks and frames.
 4. Identification Within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.
- H. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA/EIA-606-A.
1. Cables are flexible vinyl or polyester that flex as cables are bent.

3.05 FIELD QUALITY CONTROL

- A. Testing Agency: Installing Contractor to perform tests and inspections.
- B. Perform tests and inspections.
- C. Tests and Inspections:
1. Visually inspect UTP and optical fiber cable jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA/EIA-568-B.1.
 2. Visually confirm Category 5e or Category 6, marking of outlets, cover plates, outlet/connectors, and patch panels.
 3. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
 4. Test UTP backbone copper cabling for DC loop resistances, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shoring bars in connection blocks. Test cables after termination but not cross-connection.
 - a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.2. Perform tests with a tester that complies with performance requirements in Test Instruments (Normative) Annex, complying with measurement accuracy specified in Measurement Accuracy (Informative) Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
 5. UTP Performance Tests:
 - a. Test for each outlet. Perform the following test according to TIA/EIA-568-B-1 and TIA/EIA-568-B.2:
 - 1) Wire map.

- 2) Length (physical vs. electrical, and length requirements).
 - 3) Insertion loss.
 - 4) Near-end crosstalk (NEXT) loss.
 - 5) Power sum near-end crosstalk (PSNEXT) loss.
 - 6) Equal-level far-end crosstalk (ELFEXT).
 - 7) Power sum equal-level far-end crosstalk (PSELFEXT).
 - 8) Return loss.
 - 9) Propagation delay.
 - 10) Delay skew.
6. Coaxial Cable Tests: Conduct tests according to Specification Section 27 41 33, Master Antenna Television System.
- D. Document Data for Each Measurement. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.
- E. End-to-end cabling will be considered defective if it does not pass test and inspections. Minimum acceptable level above testing standard is 3 dBA. Although test equipment may "pass" a cable based on standard values, the Owner reserves the right to reject any cable test report indicating 3 dBA or less. The Contractor shall repair or replace unaccepted cable at their expense.
- F. Prepare test and inspection reports.

END OF SECTION

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DIVISION 28

ELECTRONIC SAFETY & SECURITY

28 05 00	Common Work Results for Electronic Safety & Security
28 05 00	General Provisions
28 05 01	Scope of Work
28 05 02	Temporary & Remodeling Work
28 05 05	Low-Voltage Open Wiring Systems
28 05 93	Testing of Duct Detectors & Smoke/Fire Dampers
28 46 00	Fire Detection & Alarm
28 46 00	Fire Detection & Alarm

END OF INDEX



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SECTION 28 05 00

GENERAL PROVISIONS

PART 1 GENERAL

1.01 SCOPE

- A. Provisions of this section apply to all work specified in all sections under Division 28.
- B. In addition, work in Division 28 is governed by the provisions of the Bidding Requirements, Contract Forms, General Conditions, and all sections under Division 01.
- C. Fire alarm equipment coordination and installation.

1.02 DEFINITIONS

- A. Exposed, not concealed.
- B. Finished Spaces: Spaces other than mechanical, electrical, and communication equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspace, and utility tunnels.
- C. Exposed, Interior Installations: Exposed to view indoors. Examples include unfinished spaces, mechanical, electrical, and communication equipment rooms.
- D. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations and equipment yards.
- E. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.
- F. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- G. Unfinished Space: A room or space that is ordinarily accessible only to building maintenance personnel, a room noted on the "Finish Schedule" with exposed and unpainted construction for walls, floors, or ceilings, or specifically mentioned as "unfinished."

1.03 EXAMINATION OF PREMISES

- A. Visit the site, verify all measurements and job conditions, and pay all costs necessary to perform the work.

1.04 FIRE ALARM CONTRACTOR

- A. The Fire Alarm Contractor shall be licensed and hold a current contracting license that has been valid for a minimum of 2 years in the State of Arizona as a Fire Alarm Contractor.

1.05 REGULATIONS, PERMITS, FEES, CHARGES, INSPECTIONS

- A. Regulations: Comply with all applicable codes, rules, and regulations.
- B. Fees and Permits: Pay all connection, installation, use, development, etc., fees and/or charges. Obtain and pay for all required permits and licenses. Refer to Division 01 specifications.
- C. Inspections: All work must be inspected and approved by local authorities. Prior to final approval, furnish the Architect with certificates of inspections and approvals by the local authorities in accordance with Division 01 specifications.

1.06 DRAWINGS AND SPECIFICATIONS

- A. If a conflict exists on the drawings or between the drawings and specifications, promptly notify the Architect.

1.07 SUBMITTALS

- A. Submittals are for information and coordination only. The Engineer will diligently review the submittals and attempt to verify compliance with the project requirements. Such review, however, does not constitute approval or disapproval or obligation to comply with all project requirements. The submittals are not to be construed to be contract documents. Any failure by the Engineer to note a point of non-compliance shall not be construed to be acceptance or approval of the discrepancy.
- B. Product Information Sheets: Provide manufacturer's literature, which includes the information required by the Product Data paragraph of the applicable specification section. Where Product Information Sheets show multiple models or options, clearly mark the model and options to be provided.
- C. Assembly: Assemble all required submittal information for each specification section and submit in PDF format.
 - 1. Assemble PDF submittals in one PDF file for each division. Separate and order sections within each file by corresponding specification number. Provide bookmarks at the first page of each section and label each bookmark with the specification number and name to allow for easy navigation of the submittal.
 - 2. Partial submittals will be returned without review. Floor plans with calculations may be submitted for the fire alarm system separately.
- D. Identification and Information:
 - 1. Name the PDF file with the project name, division number and sequential submittal number (i.e., the first submittal shall be No. 1; the second submittal shall be No. 2.).
 - 2. Provide a cover sheet at the front of each submittal with the following information:
 - a. Project name.
 - b. Date.
 - c. Name of Engineer.
 - d. Name of Contractor.
 - e. Name of subcontractor.
 - 3. Provide a cover sheet at the front of each submittal section with the following information:
 - a. Name of supplier.
 - b. Name of manufacturer.
 - c. Number and title of appropriate specification section.
 - d. Drawing number and detail references, as appropriate.

- e. Other necessary identification.
- E. Options:
 - 1. Identify options requiring selection by the Engineer.
 - 2. Identify options included with submittal item.
- F. Deviations: Identify deviations from the Contract Documents on submittals.

1.08 MATERIAL SAFETY DATA SHEETS

- A. Provide current Material Safety Data Sheets (MSDS) for all hazardous chemicals that are proposed for use at the project site.
 - 1. Provide one complete set to the Owner for review and approval a minimum of 1 week prior to the delivery of any hazardous chemicals to the site.
 - 2. Maintain a second complete set at the project location, readily accessible by both the Owner's personnel and the Contractor's personnel.

1.09 REQUEST FOR INFORMATION

- A. Request for Information:
 - 1. A document submitted by the Contractor requesting clarification of a portion of the Contract Documents, hereinafter referred to as RFI.
 - 2. A properly prepared RFI shall include a detailed written statement of the clarification, apparent conflict, or information requested that indicates the specific drawings or specification in need of clarification and the nature of the clarification requested.
 - a. Drawings shall be identified by drawing number and location on the drawing sheet.
 - b. Specifications shall be identified by section number, page, and paragraph.
 - 3. Include a proposed solution, where appropriate, based upon the field conditions and best knowledge of the Contractor.
- B. Improper or Frivolous RFIs: RFIs which are not properly prepared or that request information which is clearly shown in the Contract Documents will be returned unanswered. Processing time for multiple submissions of improper or frivolous RFIs will be billed at the Engineer's standard hourly rate to the Owner who may deduct an equal amount from the monies due the Contractor.

1.10 AS-BUILT DRAWINGS

- A. As-Built Drawings: Maintain one set of marked-up paper copies of the Contract Drawings.
 - 1. Preparation: Mark As-Built Drawings to show the actual installation where installation varies from that shown originally. Include all equipment, and underground and overhead conduit.
 - a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
 - b. Include dimensions both horizontally and vertically to permanent points of reference, accurate within 6 inches. Include descriptors such as "below slab," "above ceiling," etc.
 - c. Record data daily or as soon as possible after obtaining it.
 - d. Record and check the markup before enclosing concealed installations.
 - 2. Mark the As-Built Drawings completely and accurately. Utilize personnel proficient at recording graphic information in production of As-Built Drawings.
 - 3. Mark the As-Built Drawings with erasable, red colored pencil, or in a digital PDF format using an editor program such as Bluebeam, Adobe Acrobat Professional,

- or similar. Use other colors to distinguish between changes for different categories of the work at the same location.
 - 4. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.
 - 5. Update the As-Built Drawings weekly or daily as appropriate for the project size.
- B. Format: Identify and date each As-Built Drawing; include the designation "PROJECT AS-BUILT DRAWING" in a prominent location.
- 1. Organize newly-prepared As-Built Drawings into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
 - 2. Identification, as follows:
 - a. Project name.
 - b. Date.
 - c. Designation "PROJECT AS-BUILT DRAWINGS."
 - d. Name of Engineer.
 - e. Name of Contractor.
 - 3. Remove or obscure the Engineer's seal and signature from As-Built Drawings.

1.11 RECORD DRAWINGS

- A. Record Drawings: Immediately before inspection for Certificate of Substantial Completion, submit final marked-up As-Built Drawings to the Architect for review. When authorized, prepare a full set of corrected Record Drawings of the Contract Drawings, as follows:
- 1. Utilize the same digital data software program, version, and operating system as for the original Contract Drawings to incorporate changes and additional information previously marked on As-Built Drawings. Delete, redraw, and add details and notations where applicable.
 - 2. Identify and date each Record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.
 - 3. Refer instances of uncertainty to the Architect for resolution.
 - 4. Format: Provide Digital Record Drawing files in both DWG and PDF format. Organize Record Drawing information into separate electronic files that correspond to each sheet of the Contract Drawings. Name each file with the sheet identification. Include identification in each digital data file.
- B. Record Drawings Submittal:
- 1. Submit Digital Record Drawings and three sets of Record Drawing plots.
 - 2. Plot each drawing file, whether or not changes and additional information were recorded.

1.12 OPERATION AND MAINTENANCE MANUAL

- A. Prior to completion of the project, compile a complete equipment Operation and Maintenance Manual for all equipment supplied under Division 28.
- B. Schedule:
- 1. Submit a preliminary copy of the manual not less than 30 days prior to Substantial Completion for review and comment.
 - 2. Submit the final version of the manual not more than 4 weeks after Substantial Completion of the project.
- C. Format:
- 1. Submit manuals in both of the following formats:
 - a. PDF electronic file. Assemble each manual into a composite electronically-indexed file. Submit on digital media acceptable to the Engineer.

- 1) Name each indexed document file in the composite electronic index with applicable item name. Include a complete electronically-linked operation and maintenance directory.
 - 2) Enable inserted reviewer comments on draft submittals.
 - 3) Provide one final copy to the Engineer and two copies to the Owner.
 - b. Three paper copies. Include a complete operation and maintenance directory. Enclose title pages and directories in clear plastic sleeves. The Engineer will return three copies.
- D. Provide Operation & Maintenance Manuals for all systems, subsystems, and equipment that require operation and regular maintenance, or have replaceable parts.
- E. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, product data, manufacturer's maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranty and bond information, as described below. In addition to requirements in this section, include operation and maintenance data required in individual specification sections.
- F. Source Information: List each system, subsystem, and piece of equipment included in the manual, identified by product name and arranged to match the manual's table of contents. For each product, list the name, address, and telephone number of the installer or supplier and maintenance service agent, and cross-reference the specification section number and title in the Project Manual.
- G. Product Data: Include the following information:
1. System, subsystem, and equipment descriptions. Use designations for systems and equipment indicated on the Contract Documents.
 2. Approved submittals.
 3. Include the following if not shown on approved submittals:
 - a. Product name and model number. Use designations for products indicated on the Contract Documents.
 - b. Manufacturer's name.
 - c. Equipment identification with serial number of each component.
 - d. Equipment function.
 - e. Operating characteristics.
 - f. Limiting conditions.
 - g. Performance curves.
 - h. Engineering data and tests.
- H. Operating Procedures:
1. Include the following, as applicable:
 - a. Startup procedures.
 - b. Equipment or system break-in procedures.
 - c. Routine and normal operating instructions.
 - d. Regulation and control procedures.
 - e. Instructions on stopping.
 - f. Normal shutdown instructions.
 - g. Seasonal and weekend operating instructions.
 - h. Required sequences for electric or electronic systems.
 - i. Special operating instructions and procedures, including precautions against improper use.
 - j. Operating logs.

- I. Wiring Diagrams: Diagram of factory-installed wiring, including any options as well as any field modifications.
- J. Systems and Equipment Controls: Describe the sequence of operation and diagram controls as installed.
- K. Manufacturer's Maintenance Documentation: Manufacturer's maintenance documentation, including the following information for each component part or piece of equipment:
 - 1. Standard maintenance instructions and bulletins.
 - 2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
 - 3. Identification and nomenclature of parts and components.
 - 4. List of items recommended to be stocked as spare parts.
- L. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:
 - 1. Test and inspection instructions.
 - 2. Troubleshooting guide.
 - 3. Precautions against improper maintenance.
 - 4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
 - 5. Aligning, adjusting, and checking instructions.
 - 6. Demonstration and training video recording, if available.
- M. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.
- N. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturer's maintenance documentation and local sources of maintenance materials and related services.
- O. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.
- P. Licenses: Include copies of any licenses with requirements, including inspection and renewal dates.
- Q. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
- R. Test and Balance Report: Include a final, approved copy of the Test and Balance Report.

1.13 WORK AND MATERIALS

- A. Unless otherwise specified, all materials must be new and of the quality specified. The workmanship shall be of a quality that is acceptable to the Architect, Engineer, and Owner, and is equal to the standards of the trades. Contractor must staff the project with sufficient skilled workmen, including a fully qualified construction superintendent, to complete the work in the time allotted. The superintendent must be qualified to supervise all of the work in his work category.
- B. Uniformity: Unless otherwise specified, provide all equipment and products of the same type or classification by the same manufacturer.

1.14 APPROVALS OF MATERIALS AND EQUIPMENT

- A. Refer to Division 01 specifications for description of material and equipment for prior approvals and substitutions.

1.15 COOPERATIVE WORK

- A. Correct without charge any work requiring alteration due to lack of proper supervision or failure to make proper provision in time. Correct without charge any damage to adjacent work caused by the alteration. Refer to Division 01 specifications for additional requirements.
- B. Cooperative work includes:
 - 1. General supervision and responsibility for proper location, rough-in, and size of work related to Division 28 but provided under other divisions of these specifications.
 - 2. Installation of sleeves, inserts, and anchor bolts for work under sections in Division 28.

1.16 EXISTING MATERIALS AND EQUIPMENT

- A. Disposition: With the exception of items that are to be reused or retained by the Owner, all other materials indicated to be removed shall be removed and disposed of by the Contractor. Items that are indicated to be retained or returned to the Owner shall be delivered to a storage area designated by the Owner.
- B. Unused Materials: All unused raceways, conductors, boxes, equipment, and miscellaneous materials shall be removed by the Contractor except where located within walls, below or above existing construction which is not being altered and would require removal and replacement of this existing construction. All visible raceways, conductors, boxes, equipment, and miscellaneous materials shall be removed and sealed or capped within wall, below floor unless noted otherwise.
- C. Exterior Services: The Contractor shall be responsible for maintaining fire alarm service to the existing building during the construction period. Existing services are to be retained until such a time that the new services, if any, are completely installed and ready for use. Scheduling of service interruptions is to be coordinated with the Architect and Owner.
- D. Disconnect, demolish, and remove fire alarm systems, equipment, and components that are indicated to be removed.
 - 1. Conduit to be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material. Patch insulation, as required, to match adjacent areas.
 - 2. Conduit to be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
 - 3. Equipment to be Removed: Disconnect services and remove equipment.
 - 4. Equipment to be Removed and Reinstalled: Disconnect and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
 - 5. Equipment to be Removed and Salvaged: Disconnect and remove equipment and deliver to Owner.
- E. Continuity of Services in Existing Buildings: Contractor shall permanently reroute existing fire alarm services or provide temporary connection as required to maintain service to existing fixtures in buildings which are to remain in service.

- F. Rerouting and Relocation of Existing Fire Alarm Equipment and Services in Existing Buildings:
 - 1. General: Contractor shall reroute/relocate all existing materials which are in conflict with the building alterations and which are required to be maintained in use.
 - 2. Existing Raceways and Conductors: Where applicable, existing material may be reused in its original location unless otherwise indicated.
- G. Testing: All existing services affected by the new construction and which are to remain in operation shall be returned to their original condition. The existing services shall be tested as new, as described in other sections of these specifications. If for any reason these requirements cannot be met, the Contractor shall immediately notify the Architect.

1.17 CONSTRUCTION FACILITIES

- A. General: Under this division of the specifications, execute all work in a manner to provide safe and lawful ingress and egress to the Owner's establishment and such facilities shall be kept clear of materials or equipment. Refer to Division 01 specifications for additional requirements.
- B. Furnish and maintain, from the beginning to the completion of all work, all lawful and necessary guards, railings, fences, canopies, lights, and warning signs. Take all necessary precautions required by city and state laws to avoid injury or damage to any and all persons and property.

1.18 GUARANTEE

- A. Guarantee, in writing, all material, equipment, installation, and workmanship for all sections under Division 28 to be free from defects of material and workmanship for 1 year from the date of final acceptance as outlined in Division 01 specifications. Equipment warranties shall be a minimum of 1 year from the date of Substantial Completion or as specified elsewhere. Replace without charge any material or equipment proving defective during this period. The guarantee shall include performance of the equipment under all conditions of load, installing any additional items of control and/or protective devices as required, and the replacing of any refrigerant lost.

PART 2 PRODUCTS

2.01 CONCRETE

- A. Where used for structures to be provided under the contract such as bases, etc., concrete work and associated reinforcing shall be as specified under that division.
- B. Refer to other sections for additional requirements for underground vaults, cable ducts, etc.

2.02 FRAMING CHANNEL

- A. The framing channel shall be a cold-rolled, high-quality, carbon steel channel with factory-applied, hot-dipped-after-fabrication finish. Utilize factory-built inter-connecting components, mounting straps, connectors, etc., designed for use with the framing channel supplied. Channel nuts shall be spring type and shall utilize standard US threads. Provide heavy zinc paint for field touchup. B-Line "B" Series, Unistrut "P" Series, or as accepted by the Architect.

2.03 ANCHORS

- A. Anchors shall be expandable lead type as manufactured by Ackerman-Johnson, Diamond, Hilti, Pierce, or as accepted by the Architect.
- B. Adjustable concrete hanger inserts shall be as manufactured by Grinnell or as accepted by the Architect.

PART 3 EXECUTION

3.01 SUBMITTALS

- A. Prepare submittals as directed for review by the Contractor, Owner, Architect, and Engineer.
- B. Submit one copy of PDF submittals via email, project website, or other electronic media.

3.02 RECORD DOCUMENTS

- A. Recording: Post changes and modifications to the project Record Documents as they occur; do not wait until the end of the project.
- B. Maintenance of Record Documents and Samples: Store Record Documents in the field office, apart from the Contract Documents used for construction. Do not use project Record Documents for construction purposes. Maintain Record Documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to project Record Documents for the Engineer's reference during normal working hours. As-Built Drawings will be reviewed by the Architect, Owner, and Engineer at each pay request review.
- C. Submit As-Built Drawings to the Architect for approval before completion of Record Drawings.
- D. Secure the Record Drawings in adjacent to the fire alarm panel at completion of the project.

3.03 OPERATION AND MAINTENANCE MANUALS

- A. Prepare Operation & Maintenance Manuals as directed for review by the Contractor, Owner, Architect, and Engineer.
- B. Make corrections and resubmit as required.

3.04 VERIFICATION OF DIMENSIONS

- A. Scaled and figured dimensions are approximate only. Before proceeding with work, carefully check and verify dimensions at the site, and be responsible for properly fitting equipment and materials together and to the structure in spaces provided.
- B. Drawings are diagrammatic and many offsets, bends, special fittings, and exact locations are not indicated. Carefully study drawings and premises in order to determine the best methods, exact locations, routes, and building obstructions, and install apparatus and equipment in available locations. Install apparatus and equipment in a manner and in locations to avoid obstructions, preserve headroom, and keep openings and passageways clear.

3.05 CUTTING AND PATCHING

- A. Cut work and patch per Division 01 specifications as necessary to properly install the new work. As the work progresses, coordinate necessary openings, holes, chases, etc., in their correct location. If the required openings, holes, and chases are not in their correct locations, make the necessary corrections at no cost to the Owner. Avoid excessive cutting and do not cut structural members without the consent of the Architect. Include as a part of the work all structural framing required by penetrations through the roof and necessary steel to support ducts and pipes between structural steel unless shown on the structural drawings.

3.06 CLOSING-IN OF UNFINISHED WORK

- A. Cover no work until inspected, tested, and approved. Where work is covered before inspection and test, uncover it, and when inspected, tested, and approved, restore all work to original proper condition.

3.07 EXCAVATION AND BACKFILL

- A. Perform all necessary excavation, shoring, and backfilling required for the proper laying of all raceways, ducts, and conduits inside the building and premises, and outside as may be necessary. Remove all excess excavated materials from the site or dispose of onsite as directed by the General Contractor.
- B. Excavate all trenches open cut, keep trench banks as nearly vertical as practicable, and sheet and brace trenches where required for stability and safety. Excavate trenches true to line and make bottoms not less than 18 inches wide but no wider than necessary to provide ample work room. Grade trench bottoms accurately to provide uniform bearing and support for each section of pipe on undisturbed soil along its entire length. Dig "bell" holes after the trench bottom has been graded. Machine grade only to the top line of the raceways, doing the balance by hand. Do not cut any trench near or under footings without first consulting the Architect. Comply with OSHA requirements.
- C. Provide not less than 4 inches of granular material as pipe bedding prior to laying pipe in trench to continuously support pipe and maintain required slope. Granular material shall be pea gravel or sand.
- D. Provide backfilling and compaction in accordance with provisions of these specifications and under the direction of the Architect to the required density.
- E. Provide not less than 4 inches of granular material, same as piping bedding, all around pipe. Make the first 2 feet of fill in 6-inch layers, each thoroughly compacted as directed, and free from rocks, large clods of earth, leaves, branches, and debris. Compact the rest of the backfill as directed, using in the backfill no rocks larger than 4 inches in diameter, and using no rock in the top 12 inches.

3.08 ACCESSIBILITY

- A. Install all control devices or other specialties requiring reading, adjustment, inspection, repairs, removal, or replacement conveniently and accessibly throughout the finished building. Where any of these devices are shown on the Contract Drawings to be installed above any inaccessible ceiling or behind any inaccessible wall, the Fire Alarm Contractor shall furnish access doors or panels as required.

- B. All access doors or panels in walls and ceilings required for access to control devices, traps, valves, and similar devices are to be furnished and installed as part of the work under this section. Provide type as specified in Division 08 specifications.
- C. Refer to architectural drawings for type of wall and ceiling in each area and for rated construction.
- D. Coordinate work of various sections to locate valves, traps, and dampers with others to avoid unnecessary duplication of access doors.
- E. The Contractor, along with the Owner's representative, shall complete the Division 28 Accessibility/Clearance Checklist at the end of this section for all fire alarm equipment. The chart shall be submitted to the Architect for approval prior to Substantial Completion. All conflicts shall be resolved to the Architect's and Owner's satisfaction prior to submission.
- F. Provide doors that pierce a fire separation with the same fire rating as the separation.

3.09 ROOF FLASHINGS

- A. Flash and counterflash all piping, conduits, and ductwork penetrating roofing membrane with flashing per roofing manufacturer's recommendations. Refer to architectural drawings for detailing of duct and pipe penetrations through roof.

3.10 PRODUCT AND EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. All equipment, valves, sensors, dampers, detectors, etc., shall be installed in strict conformance with the manufacturer's recommendations and all codes.
- B. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- C. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- D. Install fire alarm equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations.
- E. Do not install any equipment in an application not recommended by the manufacturer.

3.11 EQUIPMENT ROUGH-IN

- A. Rough in all equipment and fixtures as designated on the drawings and in the specifications. The drawings indicate only the approximate location of rough-ins. The exact rough-in locations must be determined from large-scale certified drawings. The Contractor shall obtain all certified rough-in information before progressing with any work for rough-in final connections.
- B. Be responsible for providing all outlets and services of proper size at the required locations.
- C. Minor changes in the Contract Drawings shall be anticipated and provided for under this division.
 - 1. Rough-in only (unless otherwise designated on the drawings) shall include providing all services as indicated and required, including all conduit and conductors. Cap all conduit stub-outs in a manner suitable for future extension.

3.12 EQUIPMENT FINAL CONNECTIONS

- A. Provide all final connections for the following:
 - 1. All equipment furnished under this division.
 - 2. Fire alarm equipment furnished under other sections of the specifications (except as otherwise designated).
 - 3. Owner-furnished equipment as shown on the drawings.

3.13 OWNER-FURNISHED AND OTHER EQUIPMENT

- A. Rough-in only for all Owner-furnished equipment (refer to Division 01 specifications) and all equipment furnished under other sections of the specifications, except as otherwise specified and/or noted on the drawings.

3.14 EQUIPMENT SUPPORTS

- A. Erection of Metal Supports and Anchorages:
 - 1. Refer to Division 05 specifications for structural steel.
 - 2. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor fire alarm materials and equipment. Neatly fabricate and erect steel work with burrs and welding spatter ground off. Paint after fabrication with a rust-inhibitive primer.
 - 3. Field Welding: Comply with AWS D1.1.
- B. Erection of Wood Supports and Anchorages:
 - 1. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support and anchor fire alarm materials and equipment.
 - 2. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
 - 3. Attach to substrates as required to support applied loads.
- C. Concrete Inserts: Furnish and install all concrete inserts required for all materials and equipment specified and/or shown on the drawings for Division 28.

3.15 CLEANUP

- A. In addition to cleanup specified in Division 01 specifications, thoroughly clean all parts of the equipment. Where exposed parts are to be painted, thoroughly clean off any splattered construction materials and remove all oil and grease spots. Wipe the surface carefully and scrape out all cracks and corners.
- B. During the progress of the work, keep the premises clean and free of debris.

3.16 PAINTING

- A. Except as otherwise specified or indicated in the architectural drawings and/or specifications, paint all exposed unfinished metal with one coat of rust-inhibiting primer. Galvanized ductwork and factory-painted equipment shall be considered as having primed surface.
- B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.
- C. Finished painting is specified in Division 09 specifications.

3.17 OBJECTIONABLE NOISE AND VIBRATION

- A. Construct and brace the metal partitions, ducts, and sheet metal housings to prevent vibration or rattling when systems are in operation. Install connections to equipment so noise and vibration will not reach the conditioned area through ducts, piping, conduit, sheet metal work, or the building structure.

3.18 TESTING

- A. Upon completion of the fire alarm work, the entire installation shall be tested and demonstrated to be operating satisfactorily. Tests and documentation shall be in accordance with NFPA 72, Acceptance Testing Specifications for Fire Alarm Equipment and Systems.
- B. Additional equipment-specific testing is described in the equipment's respective section of this division.
- C. Furnish a written report of testing to the Architect. At a minimum, the report shall include:
 - 1. Testing Contractor's letterhead.
 - 2. Testing technician's name and signature.
 - 3. Date and time that test was performed.
 - 4. Ambient temperature and weather conditions.
 - 5. Test equipment manufacturer, model number, and last calibration date.
 - 6. The manufacturer, model number, and, as applicable, trip unit model number and available adjustments of tested equipment.
 - 7. Statement of "As Left" conditions.
 - 8. Pass/Fail statement.
 - 9. Recommendations if any.
- D. The Contractor shall submit the testing schedule to the Architect 2 weeks prior to initiation of testing activity.

END OF SECTION

[illegible]

SECTION 28 05 01

SCOPE OF WORK

PART 1 GENERAL

1.01 SUMMARY

- A. The work under this division includes furnishing all labor, material, and equipment necessary for the installation and placing into operation of the electrical systems as indicated on the drawings.
- B. The work shall also include the completion of such minor details of electrical work not mentioned or shown which are necessary for the successful operation of all electrical systems described on the drawings or required by these specifications.

1.02 SCOPE

- A. The work includes, but is not necessarily limited to, furnishing and installing the following:
 - 1. Complete fire alarm and all accessories, branch circuits, etc.
 - 2. All equipment and materials specified in this division.
 - 3. Empty conduit systems as indicated on the drawings.
 - 4. All other items and/or work indicated on the drawings.
 - 5. Equipment lists and maintenance manuals.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

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SECTION 28 05 02

TEMPORARY & REMODELING WORK

PART 1 GENERAL

1.01 SUMMARY

- A. Perform all temporary and remodeling work as shown on the drawings and described in the specifications, including minor items of material or equipment necessary to meet the requirements and intent of the project.
- B. All temporary and remodeling work shall be considered a part of this contract and no extra charges will be allowed.
- C. Examine architectural, structural, and mechanical drawings and specifications to determine the sequence of construction throughout the project, including existing, temporary, remodeled, and new areas.
- D. Where drawings indicate existing conditions, an attempt has been made to show electrical equipment, buildings, site details, etc., but accuracy cannot be guaranteed. Verify exact location of all conduits, outlets, etc., and all building and site details.
- E. Branch circuits shall be reused where practical and shall, in addition, be revised as required. Conceal all work where possible. Where exposed work is required in finished areas, use Wiremold raceway with #500 being the minimum size acceptable.
- F. Existing electrical wiring intended to remain in use but which will be disturbed due to construction changes required by this contract shall be restored to operating condition, as required and/or directed. Where required, shown, and/or directed, outlets and conduit runs shall be relocated. In some cases, it may be necessary to extend conduits and pull in new wiring or install junction boxes and splice in new wiring, or replace old wiring with new.
- G. Outlets from which lighting fixtures, switches, receptacles, and/or other electrical devices are removed and are not intended to be reused shall be removed or, if it is not possible to remove, a blank cover shall be placed on the outlet box. Where outlets, boxes, etc., are completely removed, the Contractor shall cut off conduits and remove wiring.
- H. Where conduits extending through floors are to be abandoned, the Contractor shall cut and cap or plug conduit so that it will not protrude above the floor.
- I. Where existing conduit is to be abandoned, the conduit shall be removed if it is exposed, in a crawl space, or in an accessible ceiling. Where it is impossible to remove the conduit, it shall be cut off and capped or plugged.
- J. The Contractor shall be held fully responsible for the proper restoration of all existing surfaces requiring patching, plastering, painting, and/or other repair due to the installation of electrical work under the terms of this specification. Close all openings, repair all surfaces, etc., as required.
- K. The Contractor shall employ qualified and experienced workmen for this work. All restoration work shall be subject to the approval of the Architect and/or the Owner.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 28 05 05

LOW-VOLTAGE OPEN WIRING SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

- A. The extent of low-voltage open wiring is indicated on the drawings, schedules, and Contract Documents.
- B. Types of low-voltage open wiring specified in this section apply to the following:
 - 1. Fire alarm systems.
- C. The drawings illustrate the work specified and are intended to agree in every respect with one another and with these specifications.
- D. All discrepancies that appear shall be brought to the attention of the Engineer for correction. No omission from any drawing shall release the Contractor from furnishing equipment, materials, or services called for by the specifications or other drawings.

1.02 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in the manufacture of low-voltage open wiring components of the types as specified herein and on the drawings, whose products have been in satisfactory use in similar service for not less than five years.
- B. NEC Compliance: Comply with NEC Articles 300, 640, 720, 725, 760, 770, and 800, national, state, and local codes as applicable to wiring methods, construction, and installation of low-voltage open wiring systems.
- C. NFPA Compliance: Comply with NFPA, national, state, and local codes as applicable to wiring methods, construction, and installation of low-voltage open wiring systems.
- D. UL Compliance: Comply with applicable requirements of UL Standard 83, Thermoplastic-Insulated Wires and Cables; and UL Standard 486A, Wire Connectors and Soldering Lugs for Use with Copper Conductors.
- E. Provide wiring/cabling and connector products which are ETL or UL Listed and labeled.
- F. NEMA/ICEA Compliance: Comply with NEMA/ICEA WC 5 and WC 30, pertaining to electrical type wires and cables.
- G. IEEE Compliance: Comply with applicable requirements pertaining to low-voltage open wiring systems.

PART 2 PRODUCTS

2.01 GENERAL

- A. Components shall be of the latest type and design manufactured for the intended use, and shall be laid out and installed such as to afford easy maintenance and/or replacement without major disassembly of adjacent components.

- B. Any deviations from the products contained in these specifications shall be noted and shall be bid as an alternate, with deducts specified.

2.02 CABLES

- A. All cables shall be in accordance with the applicable system manufacturer's specifications.
- B. Plenum-rated cables shall be used in plenum-rated ceiling spaces.
- C. Factory "shorts," scrap, or warehouse and prior project leftovers, will not be acceptable.
- D. The outer jacket of the cable shall be printed with the manufacturer's identification and required UL markings.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Whenever possible, primary cable routing paths shall follow the logical structure of the building. All cable servicing an area shall be routed parallel and perpendicular to the building structure, following corridors and hallways. Diagonal runs are not acceptable.
- B. Where a wall must be breached, the cable shall pass through pre-established metal conduit sleeved openings.
- C. Corridor crossovers should be kept to a minimum.
- D. All non-plenum-rated cables must be routed in conduits through "return air plenum" spaces.
- E. It is the responsibility of the Contractor to verify "non-plenum" rating requirements.
- F. Cable that is run open above a suspended ceiling shall be supported by either a cable tray, channel, or hangers, as accepted. Do not lay low-voltage open wire cables in the joist or on ductwork, piping and plumbing systems, or on top of the lay-in ceiling tiles.
- G. Cable shall be routed above the bottom of all metal framing such as floor joists or trusses for the next floor or roof above.
- H. Cables shall be supported by rings and bails and shall be neatly bunched, bundled, and tied together, and routed above the bottom of the joist, with supports mounted from the bar joist or truss.
- I. Cables shall not be supported from ductwork, piping, plumbing systems, ceiling tile and lighting fixture suspension wires, or building structure.
- J. Low-voltage open wiring shall not be routed in or through data/ telecommunication or other cabling raceways, conduits, cable trays, sleeves, etc. The Contractor shall provide a dedicated raceway system for this system installation, unless noted otherwise.
- K. Cables and wiring routed above an accessible ceiling may be run as "open wiring," unless noted otherwise.
- L. Cables and wiring routed through open ceiling commercial/industrial spaces shall be routed in conduit, enclosed wireway, or cable tray, unless noted otherwise.

- M. All low-voltage wiring exposed below the bottom of the joist line shall be enclosed in conduit or other raceway system.
- N. Maximum allowable spacing between cable/wiring supports (rings, bails, etc.) shall be 60 inches.
- O. Plenum-rated cable ties and cable supports must be utilized in all plenum-rated spaces. Electrical tape is not acceptable as a cable tie, and cable ties are not acceptable as cable supports.
- P. All cables shall be free of tension at both ends, as well as over the entire length of the run.
- Q. Cable ties and supports shall not pinch, bind, crimp, or in any way cause physical or electrical characteristic damage to the cabling.
- R. The Contractor shall assure that during and upon completion of the installation, all cables are free of kinks, sharp bends, twists, gouges, cuts, or any other physical damage.
- S. For those locations where cables pass through metal studs, the Contractor shall install a bushing or grommet in all metal studs to prevent damage to the cables.
- T. Cables routed above non-accessible ceiling areas, or in open areas subject to abuse, shall be routed in conduit or other suitable raceway, subject to acceptance by the Architect.
- U. Cables shall be routed and supported away from the building structure and system components, with a minimum clearance of 3 inches.

END OF SECTION

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SECTION 28 05 93

TESTING OF DUCT DETECTORS & SMOKE/FIRE DAMPERS

PART 1 GENERAL

1.01 SUMMARY

- A. Unless otherwise noted in Division 23 of the specifications, this section covers the testing requirements for duct smoke detectors and smoke/fire dampers. The fire alarm supplier shall include third-party certification of the proper operation of these components as described herein.
- B. The third-party testing company shall be an AABC or NEBB certified Technical Air Balance company. Technicians performing testing qualified as "Special Inspections" shall be recognized by the local Authority Having Jurisdiction (AHJ) for said testing.

1.02 DEFINITIONS

- A. AABC: Associated Air Balance Council.
- B. NEBB: National Environmental Balancing Bureau.
- C. TAB: Testing, adjusting, and balancing.
- D. TAB Specialist: An entity engaged to perform TAB work.

1.03 SUBMITTALS

- A. Contractor Qualifications: Include AABC or NEBB certificates for proposed personnel, and test instrument certifications.
- B. Certified TAB reports.
- C. Sealed special inspection reports.

1.04 QUALITY ASSURANCE

- A. Supervising technicians and firm shall be AABC or NEBB certified.
- B. Certify TAB field data reports and perform the following:
 - 1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
 - 2. Certify that the TAB team complied with the TAB plan and the procedures specified and referenced in this specification.
- C. TAB Report Forms: Use standard TAB Contractor's forms.
- D. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, Instrumentation.
- E. Perform special inspections as required herein and by the AHJ.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 TESTING FIRE AND SMOKE CONTROL DEVICES

- A. Perform all work as described below:
 - 1. Record manufacturer and model number for each fire damper, duct smoke detector, smoke damper, and combination fire/smoke damper.
 - 2. Duct Mounted Smoke Detectors:
 - a. Verify the proper operation of the smoke detector using a test gas, "canned smoke," acceptable to the AHJ or Engineer. Magnets are not acceptable.
 - b. Test airflow using a micromanometer and record differential pressure across the sampling tube and the exhaust tube to verify if the differential pressure is within the listed range of the device.
 - c. Verify if the activation of the smoke detector closes the appropriate smoke or combination fire/smoke damper(s) and/or de-energizes the appropriate air-moving device(s).
 - d. Verify if the activation of the smoke detector is annunciated at the fire alarm system and verify if the fire alarm audiovisual devices are activated.
 - 3. Smoke and Combination Fire/Smoke Dampers: Verify that dampers controlled by an Area Coverage Smoke Detection System operate correctly on a signal from the system.
 - 4. Air-Moving Device Shutdown: Verify that air-moving device(s) that are to be de-energized by an Area Coverage Smoke Detection System de-energize on a signal from the fire alarm system.
 - 5. After all smoke control devices have been successfully tested, the TAB firm shall engage the services of a Professional Mechanical Engineer, registered in the State of Arizona, to submit a signed and sealed report attesting to the proper operation of the smoke control devices and air-moving device shutdowns.
 - 6. Submit sealed report to the Architect and the AHJ.

END OF SECTION

SECTION 28 46 00

FIRE DETECTION AND ALARM

PART 1 GENERAL

1.01 SUMMARY

- A. The work covered by this section of the specifications includes the furnishing of all labor, equipment, materials, and performance of all operations in connection with the extensions/modifications of the existing fire alarm system as shown on the drawings and as herein specified.
- B. The vendor shall submit, as herein described, detailed shop drawings, equipment, and device data sheets to the Architect for acceptance. Once accepted, submit to the Fire Marshal's office for review and approval. Once the Fire Marshal has approved, installation may proceed. No allowance shall be made for non-conforming work installed prior to Fire Marshal approval.
- C. The Contractor may install conduit, wire, and outlet boxes, but all equipment shall be installed and connected by an experienced and accredited specialist. The Contractor shall be responsible for having the system installer:
 - 1. Make Fire Marshal submissions.
 - 2. Furnish four sets of schematic diagrams, operating and maintenance information to the Owner after installation.
 - 3. Check and inspect system to the Architect's satisfaction.
 - 4. Instruct the Owner's personnel in the operation and maintenance of the system.
 - 5. Certify that the Contractor maintains a fully equipped service organization capable of furnishing inspection and service to the system and that the Contractor is prepared to offer the Owner a service contract for system maintenance after the guarantee period.
 - 6. Guarantee the performance of the system for the warranty period, starting from the date of Substantial Completion, and make all changes necessary to meet the required performance without additional cost to the Owner.

1.02 PLANS AND SPECIFICATIONS

- A. If any departures from the drawings are deemed necessary by the Contractor, details of such departures and the reasons therefore shall be submitted to the Architect for review. No departures shall be made without prior acceptance of the Architect.
- B. The interrelation between the specifications and the drawings is as follows: The specifications determine the nature and setting of the materials; the drawings establish the quantities, dimensions, and details; and the schedules give the performance characteristics.
- C. If conflicting information is found either within the drawings or between the drawings and the specifications, the better quality of work or materials shall be estimated upon and, unless otherwise directed by the Architect in writing, shall be performed or furnished. If the specifications do not fully agree with the drawings, the drawings shall govern.
- D. Items specifically mentioned in the specifications but not shown on the drawings and/or items shown on the drawings but not specifically mentioned in the specifications shall be

installed by the Contractor under the appropriate section of work as if they were both specified and shown.

1.03 CODES AND STANDARDS

- A. The system shall comply with the applicable provisions of the current NFPA 72 Standards, local building codes, and all requirements of the local Authorities Having Jurisdiction (AHJ). The system shall be listed, labeled, or approved by Underwriters Laboratories, Inc. (UL). The system shall also meet the requirements of the State Fire Marshal's Office, State Administrative Codes, and the AHJ.
- B. NFPA Compliance: Provide fire alarm and detection systems conforming to the requirements of the current editions of the following publications:
 - 1. NFPA 72 - Installation, Maintenance, Testing, and Use of Local, Auxiliary, Remote Station, and Proprietary Protective Signaling Systems.
 - 2. NFPA 72E - Automatic Fire Detectors.
 - 3. NFPA 101 - Life Safety Code.
- C. Electrical Component Standard: Components and installation shall comply with the Americans with Disabilities Act (ADA) and NFPA 70, National Electric Code (NEC), Article 760.
- D. In any instance where these specifications call for materials for construction of a better quality or larger size than required by the codes, the provisions of these specifications shall take precedence. The codes shall govern in case of direct conflict between the codes and the drawings.

1.04 QUALITY ASSURANCE

- A. Each and every item of the fire alarm system shall be listed as a product of a single fire alarm system manufacturer under the appropriate category by UL, and shall bear the UL label. All control equipment shall be listed under UL Category UOJZ as a single control unit. Partial listing shall not be acceptable.
- B. UL Listing and Labeling: The systems and all components shall be listed by UL, for use in fire protective signaling systems under the following standards, as applicable.
 - 1. UL 38 - Manually Activated Signaling Boxes.
 - 2. UL 217 - Smoke Detectors for Single Station.
 - 3. UL 228 - Door Holders for Fire Protective Signaling Systems.
 - 4. UL 268 - Smoke Detectors for Fire Protective Signaling Systems.
 - 5. UL 268A - Smoke Detectors for Duct Applications.
 - 6. UL 346 - Waterflow Indicators for Fire Protective Signaling Systems.
 - 7. UL 464 - Audible Signaling Appliances.
 - 8. UL 521 - Heat Detectors for Fire Protective Signaling Systems.
 - 9. UL 864/UOJZ, APOU - Control Units for Fire Protective Signaling.
 - 10. UL 1481 - Power Supplies for Fire Protective Signaling Systems.
 - 11. UL 1971 - Visual Signaling Appliances.
 - 12. UL 1711 - Amplifiers for Fire Protective Signaling Systems.
- C. All control equipment shall have transient protection devices to comply with UL 864 requirements.
 - 1. Where not existing, provide transient protection at all power input circuits.
 - 2. Where fire alarm circuits leave any buildings, transient suppression devices shall be provided for each circuit.

- D. In addition to the UL Category UOJZ requirement mentioned above, the system controls shall be UL Listed for power limited applications per NEC 760. All circuits must be marked in accordance with NEC 760.10.
- E. All fire alarm equipment shall be provided by the manufacturer's factory-authorized distributor in the State of Arizona.

1.05 GENERAL

- A. Furnish and install devices indicated and connect them to the existing fire alarm system. Provide necessary programming to include added devices and functions.
- B. The existing system is to be extended as needed. Match existing installations.
- C. New devices shall match and be compatible with the existing fire alarm system devices. Each component shall display the manufacturer's name and shall be provided by the manufacturer's factory-authorized distributor in the State of Arizona.
- D. Expansion zones shall be provided as addressable loop(s) routed through Admin/Lab Building. Provide a new addressable zone card for the fire alarm control panel (FACP). Provide an additional remote annunciator for the system as shown/noted on the drawings.

1.06 ACTION SUBMITTALS

- A. Submit the following drawings and technical data for review by the Architect for acceptance:
 - 1. Fully prepared shop drawing set, including scaled floor plan layout drawings, detailed shop drawings, voltage drop and battery calculations, and wiring and connectivity diagrams.
 - 2. Equipment and device data sheets.
 - 3. A document certifying that the vendor maintains a fully equipped service organization capable of furnishing inspection and service to the system.
 - 4. A document indicating that the vendor is prepared to offer the Owner a service contract for system maintenance after the guarantee period.
- B. Submit the following drawings and technical data for review by the Fire Marshal for approval:
 - 1. Fully prepared shop drawing set, including scaled floor plan layout drawings, detailed shop drawings, voltage drop and battery calculations, and wiring and connectivity diagrams.
 - 2. Equipment and device data sheets.
 - 3. Engineer of Record drawing set showing device locations, general concept riser diagram, and design specifications.

1.07 GUARANTEE

- A. The Contractor shall warrant the programming revisions and added fire alarm system components, including wiring, to be free from inherent mechanical and electrical defects for a period of 1 year from the date of the completed and certified test or from the date of first beneficial use.

PART 2 PRODUCTS

2.01 PERIPHERAL DEVICES

- A. Manual stations shall be double action and shall be constructed of cast metal or high impact, red polycarbonate with raised white lettering and a smooth high-gloss finish. To minimize nuisance alarms, activation shall require two separate and distinct actions. Once activated, the station shall provide a visual indication of the station in alarm. Reset shall require a key, common to the control panel.
- B. Heat Detectors:
 - 1. Combination Fixed-Temperature/Rate-of-Rise Heat Detectors: Provide low-profile heat detectors rated for a maximum smooth ceiling rating of 2,500 sq.ft. (232 m2). The detectors shall be finished pure white and have a positive identification for the operation of the fixed-temperature element. The detectors shall be rated at 15°F (9°C) per minute rate-of-rise and 135°F (57°C) fixed temperature.
 - 2. Fixed-Temperature Heat Detectors: Provide low-profile heat detectors rated for a maximum smooth ceiling rating of 2,500 sq.ft. (232 m2). The detectors shall be finished pure white and have a positive identification for the operation of the fixed-temperature element. The detectors shall be rated at 135°F (57°C) fixed temperature.
- C. Duct Smoke Detectors: Duct smoke detectors shall be of the solid-state photoelectric type and UL Listed per UL S911, Standard for Smoke Detectors for Duct Applications, specifically for use in air handling systems. The detectors shall operate at air velocities from 300 feet per minute to 4,000 feet per minute. The detectors shall have an operating temperature range of 32°F to 100°F for indoor applications and 0°F to 150°F for exterior applications, 10% to 93% RH noncondensing. The detectors shall be designed to ignore invisible airborne particles or smoke densities that are below the factory-set alarm point. No radioactive materials shall be used. Detector construction shall be of the split type (housing with integral mounting base plus a twist-lock detecting head). Contacts between the base and the head shall be of the bifurcated type using spring-type, self-wiping contacts. The detectors shall be capable of local testing via a magnetic switch or remote testing station. The duct detector housing shall incorporate an airtight smoke chamber in compliance with UL S911. The housing shall be capable of mounting to rectangular or round ducts up to 12 feet wide without adapter brackets. Sampling tubes shall be installed after the housing is mounted to the duct by passing through the duct housing. Terminal connections shall be of the strip and clamp method suitable for #12 to #18 AWG wiring. Detectors shall have an alarm LED visible through a transparent front cover. Detectors shall obtain their operating power from the supervised current in the fire alarm loop. Provide power relays slave connected to the duct detector AUX relays for control of HVAC fans as required. At each duct smoke detector, provide relay contacts which open on alarm signal from associated duct smoke detector. Contact ratings shall be 24 volts AC, 5 amps. A remote alarm LED indicator/test station shall be provided for each duct smoke detector.
 - 1. Remote LED alarm indicators shall be provided where indicated, and at any location where a detector is installed in a concealed space.
- D. Smoke Detector (Photoelectric): Smoke detectors shall be the solid-state photoelectric type and shall operate on the light-scattering photodiode principle. The detectors shall be designed to ignore invisible airborne particles or smoke densities that are below the factory-set alarm point. No radioactive materials shall be used. Detectors shall have an alarm LED visible through a transparent front cover. Detectors shall obtain their operating power from the supervised current in the fire alarm loop.
- E. Smoke Detector (Beam Type): Projected-beam, single-reflection type smoke detectors listed for operating distances from 16 to 328 feet. Temperature range of -22°F to +131°F.

Detectors shall obtain their operating power from the supervised current in the fire alarm loop. Provide power relays slave connected to the duct detector AUX relays for control as required. Contact ratings shall be 24 volts AC, 5 amps. A remote test station shall be provided in an accessible location with each beam detector.

- F. Notification Appliance General Requirements:
1. All appliances which are supplied for the requirements of this specification shall be UL Listed for fire protective service and shall be capable of providing the "equivalent facilitation" which is allowed under the ADA Accessibilities Guidelines, and shall be UL 1971 Listed.
 2. All appliances shall be of the same manufacturer as the specified FACP, to ensure absolute compatibility between the appliances and the control panels, and to ensure that the application of the appliances is done in accordance with the single manufacturer's instructions.
 3. Any appliances that are submitted for use but do not meet the above requirements must show written proof of their compatibility for the purpose intended. Such proof shall be in the form of documentation from each respective manufacturer, clearly stating that the equipment as submitted is 100% compatible with each other for the purpose intended. All wall-mounted strobes shall be provided with lens markings oriented for wall mounting. It shall be possible to replace the lens of any installed strobe in order to facilitate the replacement of a broken lens, or to change the orientation of the lens markings. Removal of an installed strobe to facilitate the changing of a lens shall not be acceptable.
 4. Ceiling-mounted strobes shall have lens markings with correctly oriented lettering.
 5. Appliance finish color shall match existing like devices.
- G. Horns: Low-profile ceiling- or wall-mounted alarm horns shall be polarized and operate on 24 volts DC. Each horn assembly shall include separate wire lead for in/out wiring for each leg of the associated signal circuit. T-tapping of signal device conductors to signal circuit conductors shall not be accepted. The alarm horns shall be suitable for rear mounting behind audiovisual assemblies which shall be flush mounted in a back box and flush trim ring. The device shall have the word "FIRE" in lettering on the sides.
- H. Strobes: Low-profile ceiling- or wall-mounted strobes with "In" and "Out" screw terminals shall be provided for wiring. Strobes shall provide synchronized flash outputs. Strobe output shall be as noted on the drawings. Device shall have a field-selectable candela output of 15 cd, 15/75 cd, 30 cd, 75 cd, 95 cd, or 110 cd. The device shall meet the requirements of the ADA and have the word "FIRE" in lettering on the sides. Strobes shall mount in a North American single-gang box.
- I. Combination Horn/Visual Strobes: Audio and visual characteristics the same as individual devices.
- J. Chimes: Low-profile ceiling- or wall-mounted chimes shall provide an 84 dBA sound output at 10 feet when measured in reverberation room per UL 464. The chime shall have a selectable steady or synchronized temporal output. "In" and "Out" screw terminals shall be provided for wiring. The chime shall mount in a North American single-gang box.
- K. Chime/Strobes: Low-profile ceiling- or wall-mounted chime/strobes shall provide an audible output of 84 dBA at 10 feet when measured in reverberation room per UL 464. Strobes shall provide synchronized flash outputs. Strobe output shall be as noted on the drawings. Where it is not noted, strobe output shall be determined by its specific location and application from a family of 15 cd, 30 cd, 60 cd, 75 cd, 90 cd, and 110 cd devices. The chime shall have a selectable steady or synchronized temporal output. "In" and "Out" screw terminals shall be provided for wiring.

- L. Strobes: Low-profile ceiling- or wall-mounted strobes with “In” and “Out” screw terminals shall be provided for wiring. Strobes shall provide synchronized flash outputs. Strobe output shall be as noted on the drawings. Where it is not noted, strobe output shall be determined by its specific location and application from a family of 15 cd, 30 cd, 60 cd, 75 cd, 90 cd, and 110 cd devices. Low-profile strobes shall mount in a North American single-gang box.
- M. Remote Booster Power Supply: Notification appliance power booster with supervised 8.0-amp power supply. Unit to include sufficient battery capacity to meet the Fire Marshal's requirements, but no less than coverage for a 24-hour power outage with 5 minutes of notification appliance circuit operation at the end of the time period.
- N. Addressable Control Relays: Relays shall be motor rated for control of combination smoke/fire dampers (CSFDs), 120-volt, 5-amp contacts.
- O. Door Holders: Magnetic door holders shall be furnished under this section of the specifications. The armature assemblies shall be wired into the fire alarm system as required. Mounting of door holders shall be accomplished and coordinated by the General Contractor to ensure proper structural support. Coordinate mounting styles (semiflush, surface, flush, etc.) with the Architect prior to ordering. The door holders shall have brushed aluminum finish, operating voltage matching the existing system. The unit shall be supplied and wired by the Electrical Contractor. Provide contacts NO/NC in the FACP to operate door holder circuits upon alarm initiation.
- P. Remote Annunciator: Provide an 80-character LCD screen with silence and reset buttons and key lockout. The annunciator shall be flush mounted in a 5-gang box. The annunciator shall mimic the main FACP fire alarm panel display.

2.02 TRANSIENT PROTECTION

- A. Provide transient protection utilizing inline diode technology surge suppressors with clamping voltage of 330 volts, surge current rating of 7 kA or greater, with a response time of 10 nanoseconds or less.
- B. Manufacturer: DITEK or Engineer-accepted equal.

PART 3 EXECUTION

3.01 INSTALLATION, GENERAL

- A. Provide and install the system in accordance with the plans and specifications, all applicable codes, and the manufacturer's recommendations. All wiring shall be installed in strict compliance with all the provisions of NEC 760 A and C, Power-Limited Fire Protective Signaling Circuits, or if required may be reclassified as non-power limited and wired in accordance with NEC 760 A and B. Minimum wire size shall be #14 AWG, 7-strand for 24 volts DC and #12 AWG, solid for 120 volts AC. All wiring shall be installed in conduit with a minimum 6-foot separation between outgoing and incoming circuits.
 - 1. All junction boxes shall be painted red and labeled “FIRE ALARM.” Wiring color code shall be maintained throughout the installation.
- B. All wires shall be tagged at all junction points and shall test free from grounds or crosses between conductors.

- C. Provide reprogramming services to include activation subsequent response programming for added devices.
- D. The fire alarm panel shall be programmed to shut down air handler system(s) when the associated duct smoke detectors are activated. However, the duct smoke detector which exists to control a specific smoke damper shall not shut down the associated air handling system unless specifically required by the building life safety plan.
- E. Confirm that the existing FACP recognizes the new equipment.
- F. Update any graphic system displaying fire alarm system components to the final system configuration.
- G. The manufacturer's authorized representative shall provide onsite supervision of installation.

3.02 EQUIPMENT INSTALLATION

- A. Manual Pull Stations: Mount semi-flush in recessed back boxes at heights noted on the plans, but in no case shall the handle be located higher than 48 inches above finished floor.
- B. Notification Appliances: Install appliances in ceiling or wall positions as shown or noted on the drawings.
 - 1. Strobe appliances shall be centered where practicable within the space. Corridors and halls shall have a strobe appliance located within 15 feet of the end of the corridor/hall.
 - 2. Strobe appliances shall be applied within their area of coverage limits per NFPA 72 tables or manufacturer's product literature, whichever is smaller.
 - 3. Ceiling-Mounted Strobe Appliances: The Contractor shall verify that the candela output of the appliance is adequate for the ceiling height. Provide higher output strobes as required to maintain compliance with NFPA 72 criteria.
 - 4. Wall mount appliances at heights noted on the plans, but in no case shall the bottom of the device be lower than 80 inches above finished floor to bottom. Wall-mounted appliance locations shall be adjusted and augmented as required by additional appliances where furniture obstructs the function of the specified appliance.
- C. Smoke Detectors: Install ceiling-mounted detectors not less than 4 inches from a sidewall to the near edge. Install detectors located on the wall at least 4 inches but not more than 12 inches below the ceiling. For exposed solid joist construction, mount detectors on the bottoms of the joists. On smooth ceilings, install detectors not over 30 feet apart in any direction. Install detectors no closer than 3 feet from air registers. In all cases, detectors shall be located in accordance with NFPA 72 spacing requirements. Coordinate with the latest architectural ceiling plans for final ceiling conditions.
- D. Projected-Beam Smoke Detectors: Install at ceiling level in accordance with NFPA 72 requirements and the manufacturer's installation instructions.
- E. Smoke Duct Detector Installation: Detectors used in duct applications shall be located in accordance with NFPA 72, NFPA 90A, and manufacturer's recommendations. Where controlling a smoke damper, locate detector within 5 feet of the damper to be controlled. Mount smoke duct detectors as far as possible downstream from duct openings, bends, deflection plates, sharp bends, air diffuser, etc. Smoke duct detectors may be installed closer than 6 duct widths where it is physically impossible to locate them within the 6 to 10 equivalent duct widths, but not less than 2 equivalent duct widths away from duct

openings, bends, etc. If it is physically impossible to mount the smoke duct detector in the area greater than 2 equivalent duct widths, install additional smoke duct detectors as necessary.

- F. Locate remote indicators for duct smoke detectors flush in the ceiling and directly below the associated detector.
- G. Remote Annunciator: Arrange as indicated, with the top of the unit in conformance with ADA mounting height criteria.

3.03 WIRING INSTALLATION

- A. Wiring Method: Install wiring in metal raceway according to Specification Section 26 05 33, Raceway & Boxes for Electrical Systems. Conceal raceway except in unfinished spaces and as indicated.
- B. Wiring Within Enclosures: Install conductors parallel with or at right angles to the sides and back of the enclosure. Bundle, lace, and train the conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the wiring diagrams of the system. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.
- C. Cable Taps: Use numbered terminal strips in junction boxes, pull boxes, outlet boxes, cabinets, or equipment enclosures where any circuit tap is made.
- D. System Wiring: Wire and cable shall be a type listed for its intended use by an approval agency acceptable to the AHJ and shall be installed in accordance with the appropriate articles from the current approved edition of the NEC (NFPA 70). It is the Contractor's responsibility to obtain written instruction from the fire alarm system manufacturer regarding the appropriate wire/cable to be used for this installation. No deviation from the written instruction shall be made by the Contractor without the prior written approval of the fire alarm system manufacturer.
- E. Color Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color code for alarm initiating device circuits wiring and a different color code for supervisory circuits. Color-code notification appliance circuits differently from alarm-initiating circuits. Paint fire alarm system junction boxes and covers red.
- F. Fan Shutdown: Air handling equipment shall be connected to fire alarm system control relays. Where duct smoke detectors are installed, provide air handling equipment control via mechanical equipment's respective duct smoke detector.
- G. Smoke Dampers: Where the building smoke detection system is providing full area coverage, dampers shall be controlled from locally-mounted fire alarm system control relays. The control method shall conform to IBC 716.3.2.1.

3.04 MECHANICAL EQUIPMENT FAN SHUTDOWN CONTROL

- A. At air handling equipment with design capacity greater than 2,000 cfm, provide duct smoke detectors in the return air system (IMC), upstream of any filters, exhaust air connections, outdoor air connections, or decontamination equipment and appliances or main supply air duct (UMC), downstream of unit air connection per code.

1. Exception: Duct smoke detectors are not required in the air system where the space served by the air distribution system is protected by a complete system of area smoke detectors in accordance with building code.
- B. Multiple air handling systems share common supply or return air ducts or plenums with an aggregate design capacity greater than 2,000 cfm. The return air system (IMC) or supply air system (UMC) shall be provided with individual duct smoke detectors at each unit or full coverage area smoke detection system or return plenum-mounted area smoke detectors within the area served by the air handling system per code.
 1. Provide a control module at each piece of air handling equipment to be controlled. Upon activation of air handler smoke detection system, the fire alarm panel shall activate the control module for air handling unit shutdown.
- C. Return Air Designs with Capacity greater than 15,000 cfm and Serving more than One Story: Provide a duct smoke detector at each story, in the return air duct, upstream (air-wise) of recirculation and outdoor air connections.

3.05 SMOKE DAMPER CONTROL

- A. Smoke damper actuation shall be achieved by one of the following methods. In all methods, smoke dampers occurring within an air handling system shall close upon activation of the fan shutdown controls. Installations shall meet the requirements of UBC 713.10 or IFC 715.3.2.1, as applicable.
 1. Corridor Walls or Ceilings: Smoke dampers penetrating corridor walls shall receive power from a single 24-volt circuit, controlled by a normally closed contact which is responsive to the detection of smoke in the corridor. Provide an addressable heavy-duty control relay (120-volt, 30-amp contacts) or multiple relays as needed. Upon activation of any of the associated corridor smoke detectors, the control relay shall remove power from the damper circuit, causing dampers in the corridor walls to close. The addressable control relay may power multiple smoke dampers, up to circuit limit of 12 amps on a 120-volt, 20-amp circuit. Smoke dampers occurring within an air handling system shall close upon activation of the fan shutdown controls.
 2. Non-Corridor Walls, Floors, and Shafts: Install multiple voltage, 120-volt, 1-amp rated, addressable control relay at each smoke damper. Locate a duct smoke detector within 5 feet on either side of the damper. Upon activation of this smoke detector, the control relay shall remove power from the damper, causing it to close. Smoke dampers occurring within an air handling system shall close upon activation of the fan shutdown controls.
 3. Non-Ducted Openings: Install multiple voltage, 120-volt, 1-amp rated contacts, addressable control relay at each smoke damper. Locate a spot-type smoke detector within 5 feet horizontally on either side of the opening. Upon activation of this smoke detector, the control relay shall remove power from the damper, causing it to close. The smoke detector shall be listed for releasing service.
 4. Corridor Walls or Ceilings: Smoke dampers penetrating corridor walls shall receive power from a single 24-volt circuit, controlled by a normally closed contact which is responsive to the detection of smoke in the corridor. Provide an addressable heavy-duty control relay (120-volt, 30-amp contacts) or multiple relays as needed. Upon activation of any of the associated corridor smoke detectors, the control relay shall remove power from the damper circuit, causing dampers in the corridor walls to close. The addressable control relay may power multiple smoke dampers, up to circuit limit of 12 amps on a 120-volt, 20-amp circuit. Smoke dampers occurring within an air handling system shall close upon activation of the fan shutdown controls.
 5. Non-Corridor Walls, Floors, and Shafts: Install multiple voltage, 1 amp rated, addressable control relay at each smoke damper. Upon activation of any smoke

- detector in that smoke compartment or an adjacent smoke compartment, the control relay shall remove power from the damper, causing the damper to close.
6. Non-Ducted Openings: Install multiple voltage, 120-volt, 1-amp rated contacts, addressable control relay at each smoke damper. Locate a spot-type smoke detector within 5 feet horizontally on either side of the opening. Upon activation of this smoke detector, the control relay shall remove power from the damper, causing it to close. The smoke detector shall be listed for releasing service.

3.06 GROUNDING

- A. Ground equipment and conductor and cable shields as specified by the equipment manufacturer. Provide 5-ohm ground at main equipment location. Measure, record, and report ground resistance.

3.07 FIRE ALARM RECORD DRAWINGS CABINET

- A. Where not existing, provide a record drawings cabinet and locate it at the FACP location. Where the FACP is located in a public space, locate the cabinet in the fire riser room. Provide a permanently affixed label on the cabinet exterior stating, "FIRE ALARM RECORD DRAWINGS."

3.08 FIELD QUALITY CONTROL

- A. Manufacturer's Field Services: Provide the services of a factory-authorized service representative to supervise the field assembly and connection of components and the pretesting, testing, and adjustment of the system.
- B. Pretesting: Upon completing installation of the system, align, adjust, and balance the system and perform complete pretesting. Determine, through pretesting, the conformance of the system to the requirements of the drawings and specifications. Correct deficiencies observed in pretesting. Replace malfunctioning or damaged items with new and retest until satisfactory performance and conditions are achieved. Prepare forms for systematic recording of acceptance test results.
- C. Report of Pretesting: After pretesting is complete, provide a letter certifying that the installation is complete and fully operable, including the names and titles of the witnesses to the preliminary tests.
- D. Final Test Notice: Provide a 10-day minimum notice in writing when the system is ready for final acceptance testing.
1. The completed fire alarm system shall be fully tested in accordance with NFPA 72, Chapter 7, and local AHJ requirements. All tests shall be performed by the Contractor, in the presence of the Owner's representative and the local Fire Marshal. Upon completion of a successful test, the Contractor shall so certify in writing to the Owner and the General Contractor.
- E. Retesting: Correct deficiencies indicated by tests and completely retest work affected by such deficiencies. Verify by the system test that the total system meets the specifications and complies with applicable standards.
- F. Report of Tests and Inspections: Provide a written record of inspections, tests, and detailed test results in the form of a test log. Submit log upon the satisfactory completion of tests.

- G. Tag all equipment, stations, and other components at which tests have been satisfactorily completed.
- H. Final Test, Certificate of Completion, and Certificate of Occupancy: Test the system as required by the AHJ in order to obtain a certificate of occupancy. Demonstrate that the system meets the specifications and complies with applicable standards. This final test shall be witnessed by a representative of the AHJ and a factory-authorized service representative.
- I. The Contractor and/or the system manufacturer's representatives shall provide a typewritten "Sequence of Operation."
- J. Update fire alarm system record drawings and sequence of operation and place them in the system cabinet. Identify the following information on record documents:
 - 1. The name of the modifying vendor company and their contact information.
 - 2. Date of changes.

3.09 CLEANING AND ADJUSTING

- A. Cleaning: Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish. Clean unit internally using methods and materials recommended by the manufacturer.
- B. Occupancy Adjustments: When requested within 1 year of date of Substantial Completion, provide onsite assistance in adjusting sound levels and adjusting controls and sensitivities to suit actual occupied conditions. Provide up to three visits to the site for this purpose.

3.10 TRAINING

- A. Provide the services of a factory-authorized service representative to demonstrate the system and train the Owner's maintenance personnel as specified below.
 - 1. Train the Owner's maintenance personnel in the procedures and schedules involved in operating, troubleshooting, servicing, and preventive maintaining of the system. Provide a minimum of 4 hours of training.
 - 2. Schedule training with the Owner at least 7 days in advance.

3.11 SERVICE SUPPORT

- A. The system vendor shall employ factory-trained technicians and maintain a service organization within 75 miles of the project site. A maintenance proposal, including system monitoring, shall be presented to the Owner with the closeout package. Provide operating instructions to the Owner.

END OF SECTION

Edition: L-1807

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EXHIBIT D

ACCEPTED GMP/PRICE PROPOSAL

Caliente Construction Inc.

General Construction - Construction Management - Design/Build - Facilities Management

2/13/2023

Ivan Magana
Project Manager
City of Chandler Public Works & Utilities
ivan.magana@chandleraz.gov

Dear Mr. Magana,

We are pleased to provide you with a procurement package for PECOS SWTP Admin Building HVAC and Water Quality Lab Renovation. Attached you will find our proposal based off design documents prepared by DFDG Architecture.

SCOPE OF WORK:

Based on Drawings titled and specs titled Pecos SWTP Water Quality Lab and HVAC Renovation & Pecos SWTP Admin Building HVAC Renovation:

1. Design and Engineering work required for new mechanical equipment penetrations and deferred submittal.
2. Design and Engineering for Specified Kewaunee Casework & Equipment in Lab
3. Procurement of Mechanical Units as Specified (MAU, CRAC, AHU, Chiller, Exhaust Plume & Mini Split System)
4. Structural Steel Shop Drawings

Thank you again for the opportunity to work with the City of Chandler on this project. Feel free to contact me with any questions or concerns you may have.

GMP-1 Budget

\$1,319,649

Sincerely,



David Rockwood | Project Engineer/Jr. Estimator
Caliente Construction Inc.
485 W Vaughn St. Tempe, AZ 85283
Mobile: 978.609.5160
Office: 480.870.9223
drockwood@calienteconstruction.com



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ID RCE-28529 . NM 85371 . CO 233580 . MT 159637 . OR 218626 . WA 604-190-884

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EXHIBIT D					
CM@RISK GMP SUMMARY (PAGE 2 of 2)					
Project Name:		Pecos SWTP Admin Building HVAC and Water Quality Lab Renovation		Date:	2/13/2022
Project Location:		1475 E. Pecos Rd., Chandler, AZ 85225			
City of Chandler Project No.:		WA2106.401			
					Amount
A. Cost of Work					
A1 Cost of Work (self perform, no mark-up)					\$0
A2 Cost of Work (subcontractors, suppliers, materialmen)					\$994,595
TOTAL COST OF WORK:					\$994,595
B. General Conditions					
					\$21,590
SUBTOTAL 1 (Cost of Work) (A + B):					\$1,016,185
C. CM@Risk's Fee					
					\$69,622
SUBTOTAL 2 (A + B + C):					\$1,085,807
D. Bonds and Insurance (on Subtotal 1)					
D1 Bonds (Payment and Performance)					\$10,804
D2 Insurance					\$19,186
TOTAL BONDS & INSURANCE:					\$29,990
SUBTOTAL 3 (SUBTOTAL 2 + BONDS & INS):					\$1,115,797
E. Sales Tax					
E1 Sales Tax					\$58,852
E2 Tax Credits					\$0
TOTAL SALES TAX:					\$58,852
F. Approved Allowances					
F1 Owner's Allowance					\$100,000
F2 Owner's Allowance for Water and Wastewater					\$0
TOTAL ALLOWANCES:					\$100,000
G. Contingencies					
G1	Design				\$0
G2	Construction				\$45,000
G3	Escalation				\$0
TOTAL CONTINGENCIES:					\$45,000
TOTAL GMP PROPOSAL:					\$1,319,649
Establishment of Values:					
a. Cost of Work (A) and Allowances (F) to be submitted with GMP Proposal.					
b. General Conditions Cost (B) to be established in Baseline Cost Model.					
c. CM@Risk Fee as set forth in Section 3.7.3 of this Contract					

Project Information

BID INFORMATION

PROJECT NAME:	Pecos SWTP Admin Building HVAC and Water Quality Lab Renovation: GMP-1	PROPOSAL #	B220181
LOCATION OF PROJECT:	1475 E Pecos Road, Chandler, AZ 85225		
OWNER:	City of Chandler	LEAD ESTIMATOR	David Rockwood
CONTRACT VALUE:	\$ 1,219,649	PROPOSAL DATE	2/13/2023
DURATION (CALENDAR DAYS):	517 DAYS	DELIVERY METHOD:	Construction Manager @ Risk (CMAR)
CONSTRUCTION START DATE:	3/23/2023	CONTRACT METHOD:	Guarenteed Maximum Price (GMP)
COMPLETION DATE:	8/21/2024	CONTRACT RATES:	Internal
PERFORMANCE BOND:	Yes	PRECONSTRUCTION START DATE:	3/23/2023
BUILDER'S RISK INSURANCE:	Yes	PRECONSTRUCTION COMPLETION:	12/14/2023
TPT / MRRA	TPT	DURATION (CALENDAR DAYS):	266
Tax Juristicition / Rate (County City)	Mar Chandler		5.070%

DISCIPLINE	FIRM	CONTACT	PHONE	EMAIL
OWNER:	City of Chandler	Jason Garcia		James.Jason.Garcia@chandleraz.gov
ARCHITECT:	DFDG			

DOCUMENTS

DOCUMENTS PROVIDED:

- SOILS REPORT
- SPECS
- CIVILS
- SWPP
- LANDSCAPE
- ARCHITECTURAL
- ELECTRICAL
- STRUCTURAL'S
- HVAC
- PLUMBING

No
Yes
N/A
N/A
N/A
Yes
Yes
Yes
Yes
Yes
Yes

STRUCTURE:

WALLS:	CMU
ROOF STRUCTURE:	
ROOFING:	
SITE	
OFFSITE:	

BUILDING/ SITE SF:

SITE SIZE	872,002 SF
	20.02 ACRE
OFFSITE SIZE	N/A SF
BUILDING SF (GROSS)	4,486 SF
BUILDING FOOTPRINT	26,333 SF

ADDENDUM / RFI'S:	ASI-001

Pecos SWTP Admin Building HVAC and Water Quality Lab Renovation: GMP-1

PROJECT INFORMATION

OWNER:	City of Chandler
LOCATION	1475 E Pecos Road, Chandler, AZ 85225
PROPOSAL NO.:	B220181
PROPOSAL DATE:	2/13/2023
BUILDING AREA (SF)	4,485.85
SITE AREA (SF)	872,002.00

PHASE CODE	DESCRIPTION/TRADE	ESTIMATE VALUE	SUBCONTRACTOR	NOTES
03-3800	CFRP	7,144	Restruction	
05-5000	Metal Fabrications	21,600	R-N-R	
12-3600	Lab Equipment and Casework	85,870	Isec	
23-6000	Mechanical Procurement	879,981	Midstate	
SUBTOTAL DIRECT COST		\$ 994,595		
General Conditions		\$ 21,190		
General Requirements		\$ 400		
Design Contingency				
Construction Contingency		\$ 45,000		
Contractor's Liability Insurance		\$ 8,489		
Builders Risk Insurance		\$ 10,697		
Bonding Fees		\$ 10,804		
Escalation				
Fee (Overhead & Profit)		\$ 69,622		
Sales Tax		\$ 58,852		
SUBTOTAL INDIRECT COST		\$ 225,054		
TOTAL CONSTRUCTION COSTS		\$ 1,219,649		



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ID RCE-28529 NM 85371 CO 233580 MT 159637



Caliente Construction Inc.

General Construction - Construction Management - Design/Build - Facilities Management

BASIS OF ESTIMATE

Owner: City of Chandler
Project : Pecos SWTP Admin Building HVAC and Water Quality Lab Renovation: GMP-1
Location: 1475 E Pecos Road, Chandler, AZ 85225
Proposal No.: B220181
Proposal Date: 2/13/2023

GENERAL CONSTRUCTION

Inclusions

- 1 Pricing was based on Construction set of drawings titled "Pecos SWTP Water Quality Lab and HVAC Renovation" dated 2/11/2022 & specifications dated 3/11/2022. & drawings Titled "Pecos SWTP Admin Building HVAC Renovation" dated 9/1/2022 & Specifications dated 7/29/2022
- 2 Estimate is based on a Procurement Package of both Sets of drawings.
- 3 Approval and release of mechanical units deadline is 2-15 to hold pricing
- 4 Acknowledge ASI-001.
- 5 This bid includes a contingency of 45k for expected escalation of procurement of materials due to council approval set on 3/23/23 and contracting. Should the amount set aside not cover costs of escations and material price increases set forth in the procurement GMP, the City of Chandler shall properly reimburse Caliente for the remainder of the amount not covered.

Exclusions

- 1 Hygenist for ACM removal.
- 2 Architectural design fees or costs.
- 3 Furniture, fixtures, or equipment.
- 4 Land costs, development, financing or real estate fees.
- 5 Testing and Special inspections. Owner provided per S000.1
- 6 Professional jobsite photos.
- 7 Escalation of material costs above designated contingency



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Site Area =	872,002	SF	GC \$ / MO \$ GC Labor Fee / Month \$	1,242	Sub/Supplier Materials	Total Budget
Gross Building Area =	4,486	SF		240		
	74	WKS		8,267		
Construction Duration =	17.1	MO	Labor			

GENERAL CONDITIONS		HOURS PER WEEK	QTY	UNIT	21,190	-	21,190
Staffing Costs							
00-1056	Project Director		8	HR	118.75	0	950
00-1040	Project Manager		96	HR	105.00	0	10,080
00-1045	Superintendent		16	HR	95.00	0	1,520
00-1043	Project Engineer		80	HR	72.50	0	5,800
00-1047	Project Coordinator		0	HR	60.00	0	0
00-1041	Project Accountant		40	HR	71.00	0	2,840
00-1053	Laborer		0	HR	45.00	0	0
00-1044	Safety Director		0	HR	98.75	0	0
Project Office Costs							
		Hourly Rate					
00-1060	Temp Internet/Phone	\$ -	17	MO	-	0	0
00-1070	Office Supplies and Equipment	\$ -	17	MO		0	0
00-1075	Drinking Water	\$ -	74	WKS		0	0
00-1094	First Aid	\$ -	1	LS		0	0
00-1300	Temp Utilities	\$ -	1	LS		0	0
00-1405	Field Office	\$ -	17	MO	-	0	0
00-1415	Storage Container	\$ -	74	WKS		0	0
00-1417	Hand Wash Station - \$62.50 per unit, per week	\$ -	74	WKS		0	0
00-5219	Temp. Toilets - \$40 per Unit, per week - Desert Services	\$ -	74	WKS	-	0	0
Vehicles and Equipment							
		Hourly Rate					
00-1072	Small Tools		74	WKS		0	0
00-1010	Project Pick Up Truck	\$ 4.56	74	WKS	12.32	0	0
00-1020	Project Fuel	\$ 5.63	74	WKS	15.22	0	0

Caliente Construction Inc.

General Construction - Construction Management - Design/Build - Facilities Management

Site Area =		872,002	SF	GRs \$ / MO Sales Tax 5.1%				Labor Materials Sub/Supplier Total Budget				
Gross Building Area =		4,486	SF									
Construction Duration =		74	WKS									
		17.1	MO									
GENERAL REQUIREMENTS				HOURS PER WEEK	QTY	UNIT	0			1,290	400	400
Misc. Site Services												
00-1080	Contract Drawing Reproduction				1 LS			0		0	400	400
	Drone Services				2 TRIP			0		0	500	
00-1097	Courier/Shipping				1 LS			0		0	400	
Temporary Construction												
00-1410	Temp Weather Protection				1 WKS			0	150	150	1,360	
00-1063	Temp. Protection				1 LS			0	150	150	2,720	
	Window Removal to load out trash				1 LS			0		0	2,500	
00-1096	Safety											
	Temp. Fire Extinguishers/Stands				3 EA			0	110	330		
	Temporary Stair Rails				20 LF			0	8	160	68	
Cleanup												
01-7410	Trash Dumpsters				37 PULLS			0		0	750	
01-7413	Progress Cleaning		4		295 HRS			0	2	500	85	

Caliente Construction Inc.

General Construction - Construction Management - Design/Build - Facilities Management

03-3800 Post-Tensioned Concrete

BUILDING SF (GROSS)
SITE SIZE

4486
872002

SPECIFICATION SECTIONS				CCI BUDGET	Restriction
SCOPE ITEMS					
BASE BID AMOUNT					
1 CFRP					
SCOPE ITEMS	QTY	UNIT	COST/UNIT		
2 Engineering Fees	1	LS	\$ 7,144.00	\$ -	\$ 7,144
3		LS		\$ -	
4		LS		\$ -	
5		LS		\$ -	
CCI MISC SCOPE					
CCI MISC SCOPE	QTY	UNIT	COST/UNIT		
BID TOTALS					
				\$ -	\$ 7,144
SALES TAX (IF NOT INCLUDED)			0.00%	\$ -	\$ -
TOTAL W/ TAXES				\$ -	\$ 7,144
TOTAL W/ BOND & TAXES (ESTIMATE VALUE)			Tot	\$ -	\$ 7,144



Joe Sanchez
2125 S. Priest Dr. Suite 302
Tempe, AZ 85282
480-347-5757
jsanchez@structural.net
www.structural.net

Proposal No. FY23-642033
Pecos SWTP FRP Strengthening
January 9, 2023

Chad Slaymaker
Caliente Construction Inc.
485 W. Vaughn St.
Tempe, AZ 85283

Re: FRP Slab Strengthening



Dear Mr. Slaymaker:

Thank you for giving Restruction, a division of Structural Preservation Systems, LLC ("Restruction"), the opportunity to prepare a proposal for the slab strengthening.

Restruction trusts that we have provided adequate detail for your evaluation and that we have expressed our desire to work with your company on this project. The following outlines the project scope of services, working conditions, exclusions and support by others, safety considerations, estimated schedule, financials, suggested next step and attachments as they relate to this project.

SCOPE OF WORK

1. Mobilize tools, equipment, crew, and material from our office and stage onsite.
2. Scan the concrete along the surfaces receiving the FRP to locate and mark the existing reinforcing.
3. Install shoring posts under the 36" wide (max) opening every 4' on center down to the slab on grade.
 - a) Assuming only 1 location with the 36" wide opening (max).
4. Infill hollow core planks with grout for the 36" wide opening (max) assuming 4 tendons will be cut.
 - a) 4 hollow core planks @ 22' long.
 - b) Roofing membrane will need to be removed to access the top side of the concrete planks.
 - c) Planks to be cleared of all roofing materials by others.
5. Prep top side of slab to receive FRP around each of the floor penetrations.
6. Install top side FRP (1 ply) around each penetration.
7. Prep bottom side of slab to receive FRP around each penetration.
8. Install bottom side FRP.
 - a) 3 ply's at areas with multiple penetrations.
 - b) 1 ply at areas with one penetration.
9. Install top slab intumescent paint over all FRP.
10. Install bottom slab cementitious fireproofing system 5" past all FRP at 1" thick.
11. Remove shoring posts from under the 36" wide opening.
 - a) Hollow core plank grout will need to be fully cured.
 - b) FRP will need to be fully cured.
12. Demobilize tools, equipment, crew, and material from the jobsite back to our office and perform final cleanup.

WORKING CONDITIONS

- 1) This proposal is based on performing all work in a maximum of 2 phases.
- 2) This proposal is based on the following working hour assumptions:
 - a) Daytime work hours.
 - b) Five (5) day week MTWTF.
- 3) This proposal is based on the following labor rate assumptions:
 - a) Open shop labor without prevailing wages

SUPPORT BY OTHERS (at no cost to Restruction) SHALL INCLUDE THE FOLLOWING

- 1) Site utilities, including but not limited to:
 - a) 110V, 220V, and/or 480V, 60 amp power electric available at existing outlets/panels.
 - b) Toilet facilities.
 - c) Payment for all required utility costs.
- 2) General site support, including but not limited to:
 - a) Parking for employees, service vehicles and 2nd tier sub-contractors.
 - b) Storage area, including location for dumpster.
 - c) Use of General Contractor's dumpster for general construction debris disposal.
 - d) Monitoring and maintenance of air quality outside of work areas.
 - e) Temporary heating of the work area if temperatures drop below 40°F, if necessary.
- 3) Active work support, including but not limited to:
 - a) Unloading services.

- b) Installation and removal of interior finishes protection, including floor and elevators from the exterior of the building to STRUCTURAL's work area.
- 4) All permits, including but not limited to: Building, Construction, Public Space, Maintenance of Traffic, and Sidewalk.
- 5) Third Party testing, engineering, and inspection, including scheduling, communication and coordination.
- 6) Unobstructed access to the work area, including but not limited to removal of mechanical and electrical appurtenances and/or removal and replacement of all interior finishes including, but not limited to paint, tile, grout, drop ceilings, insulation, rugs, etc. down to the bare concrete structural slab, column and wall surfaces of all areas to be repaired or strengthened with carbon fiber or glass reinforcing areas may be required by STRUCTURAL's crews.
- 7) Lead paint, asbestos, mold, and other hazardous material removal and abatement, if necessary.

SCOPE CLARIFICATIONS

- 1) Pricing is based on award of the full scope of work. Restruction reserves the right to modify pricing should a partial scope be awarded.
- 2) This proposal is based on the following documents prepared by Schaefer Engineering & Structural Technologies:
 - a) Drawings S101.1 dated 4/8/2022.
 - b) Preliminary FRP & Strengthening Design.
 - i) Engineering fees included for final design and stamp.
- 3) This proposal is based on a start date of TBD.
- 4) This proposal is based on a schedule of 5-6 weeks.
- 5) Pricing is based on site conditions and logistics as of 1/5/2023. If site conditions change prior to or during the work schedule that may affect, access, ventilation, phasing, material handling, additional costs may apply.
- 6) The repair quantities listed are based on a visual survey of the structure only.
- 7) This proposal is based on a preliminary design provided by Structural Technologies. Therefore, it is budgetary in nature and may need updating once the final stamped design is provided.
- 8) Openings in the same hollow core planks shall be aligned in a row to minimize cut tendons.
- 9) Openings that cut 3-4 tendons will require hollow cores to be installed with #9 grade 75 steel bars and filled with grout.
- 10) Service loads and ultimate demands shall be verified by the EOR for final FRP design.
- 11) Unobstructed access to the bottom and top side of the slabs receiving FRP will be required.
 - a) Includes the removal/relocation of mechanical, electrical, and plumbing items.
 - b) To be performed by other as it is not included in our scope of work.
- 12) Roofing membrane to be removed and installed by GC for access to the FRP locations.
- 13) Hollow core plank infill and FRP will need to be completed prior to cutting the penetrations.
- 14) Acceptance of anchoring into the FRP after installation is unknown at the moment.
- 15) All pricing given in this proposal represents current market prices and conditions for labor and materials. Increased costs due to changes in material prices, project delays due to material shortages and unexpected lead times, and labor rates at the time of delivery or during performance will be brought to the Client's attention when identified, and an equitable adjustment to the contract price will be made for the increased costs resulting from price and labor rate increases and extended project durations. Pricing and schedule also represents the current availability of materials, equipment and supplies needed for the proposed project. Changes in supply chain availability, once known, will be communicated to the client within three (3) business days, potential alternates will be proposed, if available, and the project schedule will be adjusted to correspond to material availability.

EXCLUSIONS

1. Permits and fees.
2. Testing and inspections.
3. Special insurance such as OCP, railroad, marine / longshoreman workers comp, builder's risk, etc.
4. Prevailing wages.
5. Teamsters, Operating Engineers or any other union personnel.
6. Bonds and associated costs.
7. Winter / temporary heating.
8. Asbestos and other hazardous waste removal.
9. Air quality monitoring.
10. Repair and painting of minor damage to drywall and other interior finishes that may be caused during Restruction's work, including removal and replacement of the existing interior wall cove bases.
11. Protection of finished work after crews have demobilized from the site.
12. Coordination between various trades, including those that may affect the scope of work performed under this proposal.
13. Any crack treatment where locations and quantities of cracks are hidden, such as under existing coatings or overlays, etc.
14. Painting
15. Roofing membrane removal and patching.
16. Cutting of penetrations.
17. Electrical, mechanical and sprinkler work, including the removal and installation of fixtures.
18. Any special safety requirements.
19. Any work specifically not included in this proposal.

PROJECT SAFETY CONSIDERATIONS

Safety is a core principle – there is nothing more important in what we do, 24/7. We owe it to our clients. We owe it to our employees. We owe it to the families of those that count on us. It's a moral and ethical requirement of our business.

Restruction's Frontline Safety Program in combination with a project-specific Safety Execution Plan will ensure that safety will be a primary measurement of success on this project.

SCHEDULE

As arranged between Caliente Construction Inc. and Restruction. Restruction anticipates a schedule of approximately 5-6 weeks.

PRICE

Procurement Sum (engineering fees) = \$7,144
Construction Sum = \$116,633
Lump Sum Total = \$123,777

PAYMENT TERMS

- 1) Invoices shall be submitted monthly and are payable within thirty (30) days from date of invoice. One and one-half percent (1.5%) interest per month is due on any unpaid balance after thirty (30) days.

Confidential: Any unauthorized use or distribution is prohibited.

I:\Estimating-Leads\233 - ResAZ\FY2023\642033 - Pecos SWTP FRP\Proposal\642033 Pecos SWTP FRP Proposal 1-9-2023 - Restruction.docx
01/09/23

CONTRACT TERMS

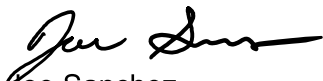
Please find below our proposed general conditions (Attachment A) for this agreement. If these are not acceptable, we are open to considering another form of agreement such as an AIA contract or the terms can be customized and mutually agreed upon.

EXPIRATION

This proposal may be withdrawn if not accepted within thirty (30) days of the date of this proposal.

Sincerely,

Restruction a division of STRUCTURAL PRESERVATION SYSTEMS, LLC.



Joe Sanchez
Estimator 2

ACCEPTANCE OF PROPOSAL:

The above Conditions, Specifications, Prices and General Conditions are hereby accepted. You are authorized to proceed to do this work and payment will be as stated above.

ACCEPTED BY:

Authorized Signature

Title

Date

Attachment A

General Terms and Conditions

1. Beginning Work:

Restruction, a division of Structural Preservation Systems, LLC ("Contractor"), shall be allowed reasonable time for delivery of materials and labor for required performance. Client shall use its best efforts to assure that the work area is accessible and appropriate for Contractor's work.

2. Bonds & Insurance:

- 2.1. The cost of bonds is not included. If Performance and Payment Bonds are required, Client is responsible for all associated premiums and will satisfy Contractor's bonding company underwriting requirements including confirmation of funding and use of standard AIA A311/A312 bond forms.
- 2.2. Contractor shall maintain the insurance coverages described below during the performance of the Services:
 - 2.2.1. Worker's Compensation as required by statute; Employer's Liability with a limit of liability of \$1,000,000.
 - 2.2.2. Comprehensive General Liability including Completed Operations with the following limits:
 - 2.2.2.1. Bodily Injury - \$2,000,000 each occurrence/\$4,000,000 Aggregate
 - 2.2.2.2. Property Damage - \$2,000,000 each occurrence/\$4,000,000 Aggregate
 - 2.2.2.3. Automobile Liability on all owned, leased and hired automobiles with the following limits:
 - 2.2.2.4. Bodily Injury - \$2,000,000 Each Occurrence
 - 2.2.2.5. Property Damage \$2,000,000 Each Occurrence.

Upon request, Contractor will provide a certificate of insurance which will include the Client as additional insured. Any other insurance required will be furnished at Client's sole cost, if available.

- 2.3. Client (and/or Owner, if other than Client) shall insure, for their full insurable value, the Project site, and the Project itself against all losses and damages including, but not limited to, those which might result from risks insurable by a combination of a fire and extended coverage policy, a boiler and machinery policy, a business interruption policy, an ocean (and air) transit policy, and a broad form "All-Risks" policy, whichever coverage(s) are applicable to the Project. Client hereby waives all recovery and subrogation rights that it or its insurers may have against Contractor and its subcontractors for any losses or damages to the property to be insured under this subparagraph (c). If Client is not the Owner of the Project, it shall obtain a similar waiver from Owner for Contractor's benefit.

3. Payment:

- 3.1. Payment is a material issue. Payment by Client for Contractor's performance is not subject to any contingencies or conditions. If payment is not made within thirty (30) days, Contractor may stop work after three (3) days' written notice to client without prejudice to any other remedy it may have including the right to file a lien, claim, or notice thereof. No back charges or claims shall be valid unless agreed to in writing by Contractor. Retainage shall not exceed 5% for the duration of the project.
- 3.2. Client shall not withhold payments due to third party general liability claims if the liability for such claim(s) has been accepted by Contractor's insurer.

4. Warranty:

- 4.1. Contractor warrants to the Client that the work described herein will be free from defects in material and workmanship. If within one (1) year from date of Substantial Completion of Contractor's Work, or as otherwise mutually agreed upon in writing between Contractor and Client, Contractor receives from the Client prompt written notice that the material or workmanship does not meet such warranties, Contractor will cure, within a reasonable amount of time, each such defect including nonconformance with the specifications, weather-permitting. THERE ARE NO OTHER REMEDIES, LIABILITIES (INCLUDING NEGLIGENCE) OR WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE APPLICABLE TO THE MATERIAL AND/OR SERVICES. Contractor's sole responsibility and Client's exclusive remedy is limited to repair or replacement as above provided.
- 4.2. Any manufacturer's warranty provided for materials shall be provided as a direct warranty, which shall be enforceable only against the manufacturer. Client shall be solely responsible for enforcing any such warranty.
- 4.3. Restruction, a division of Structural Preservation Systems, LLC, does not provide a warranty for chemical grouting work.

5. Delays

- 5.1. Contractor is not responsible for, and is entitled to extensions of time for, weather delays and other delays out of its control, (including, without limitation, those caused by; the Client, Owner (if not the Client), General Contractor, other contractors and subcontractors, Architects, Engineers; terrorism, armed conflict or economic dislocation; embargoes of labor, unavailability of raw materials, production facilities or transportation; labor difficulties; civil disorders of any kind; action of civil or military authorities; vendor priorities and allocations; or fires, floods, accidents and acts of God). In addition, Contractor can stop work if it considers the jobsite conditions unsafe or if another contractor working at the Project site is being unsafe.
- 5.2. Contractor's liability for delay damages is limited to liquidated damages in an amount mutually agreed upon by Contractor and Client, if any, which shall be Client's sole and exclusive remedy for any damages resulting from Contractor's delay. In no event shall the aggregate amount of any liquidated damages exceed five percent (5%) of the contract price. Contractor shall not be liable for any other actual, punitive, indirect, incidental or consequential damages of any kind.
- 5.3. If Contractor is delayed in any manner by the acts, errors, or omissions of the Client or Owner (if not the Client), their separate contractors (of any tier), Architect, Engineer, or by an employee or agent of any of them, then, in addition to any applicable extension of time, Contractor shall be entitled to compensation for any reasonable damages caused by the delay.

6. Liability:

- 6.1. Contractor shall not be liable to any party for claims of any kind related to asbestos, lead paint or mold or any other hazardous materials. If Contractor encounters (1) hazardous materials, or (2) subsurface or latent physical conditions which differ from those disclosed to

Contractor in the Contract Documents or those ordinarily encountered at a site similar to the Project, then Contractor shall be entitled to an equitable price and schedule adjustment to compensate it for such conditions.

- 6.2. Liability or damages associated with water leakage shall be the responsibility of the Client unless caused by Contractor's sole negligence.
- 6.3. Client shall be responsible for any and all property damage and/or bodily injuries (including but not limited to injuries to Contractor's employees) that result from damage to interior and/or exterior underground/overhead/surface mounted/embedded utilities or structures unless caused by Contractor's sole negligence.
- 6.4. Contractor's responsibility for any claims, damages, losses or liabilities arising out of or related to its performance of this contract, including but not limited to any correction of defects under the Warranty, shall not exceed the contract price. Except to the limited extent provided in Section 5.b. above, in no event shall Contractor be liable for any special, indirect, incidental, consequential, delay or punitive damages of any character, including but not limited to: loss of use of productive facilities or equipment, lost profits, governmental fines or penalties, property damages, personal injuries or lost production, whether suffered by Client or any third party, irrespective of whether claims or actions for such damages are based upon contract, warranty, negligence, strict liability or otherwise.

7. Indemnification:

- 7.1. To the fullest extent permitted by law, Contractor shall indemnify and hold harmless the Client, its Engineer, and agents and employees of either of them from and against claims, damages, losses and expenses, including but not limited to attorney's fees, arising out of or resulting from performance of the Work, provided that such claim, damage, loss or expense is attributable to bodily injury, sickness, disease or death, or to injury to or destruction of tangible property (other than the Work itself), but only to the extent caused by negligent acts or omissions of Contractor, its subcontractor, anyone directly or indirectly employed by them or anyone for whose acts they may be liable.

8. Dispute Resolution & Governing Law:

- 8.1. All claims, disputes, and other matters and questions arising out of, or relating to this Contract or any breach which cannot be resolved through negotiation, may be submitted to mediation before the American Arbitration Association. If the dispute is not resolved through mediation, the parties may elect to proceed to binding arbitration before the American Arbitration Association in accordance with the Construction Industry Arbitration Rules then in effect. The prevailing party shall be entitled to recover all costs and reasonable attorney's fees incurred (whether pre-litigation, at mediation, arbitration or trial level and in any appeals).
- 8.2. Prior to exercising any remedies based on default, deficiency, delay or failure in the performance of the Work, the Client shall provide Contractor with prompt written notice and an opportunity to cure within a commercially reasonable time.
- 8.3. This contract shall be governed by the law of the jurisdiction in which the project is located.

9. Price Escalation:

- 9.1. All pricing given in this proposal represents current market prices and conditions for labor and materials. Increased costs due to changes in material prices, project delays due to material shortages and unexpected lead times, and labor rates at the time of delivery or during performance will be brought to the Client's attention when identified, and an equitable adjustment to the contract price will be made for the increased costs resulting from price and labor rate increases and extended project durations. Pricing and schedule also represents the current availability of materials, equipment and supplies needed for the proposed project. Changes in supply chain availability, once known, will be communicated to the client within three (3) business days, potential alternates will be proposed, if available, and the project schedule will be adjusted to correspond to material availability.
- 9.2. If the pricing for the Work includes unit prices, the unit prices specified assume that the designated quantities will be provided. If more or less than the specified quantities are actually provided, Contractor shall be entitled to an equitable adjust to the contract price to reflect loss of production efficiency, increased unit costs of production and/or installation and other similar factors.

10. Mock-ups (if applicable):

- 10.1. Contractor will prepare a mock-up based on the specified work scope for each repair item to set the quality and aesthetic standards for repair. Should the desired results not be achieved, further investigation and continued work may necessitate additional costs for the specified repairs. If the Client does not approve the mock-up, Contractor reserves the right to terminate the contract and recover all actual, incurred costs in completing the mock-up.

11. General Contractor Clients (if applicable):

- 11.1. If Restruction is contracting as a Subcontractor to a General Contractor, a copy of the prime contract and an electronic copy of the overall project schedule will need to be provided for review prior to contract execution and commencement of work.

General Construction - Construction Management - Design/Build - Facilities Management

05-5000 Metal Fabrications				4486 872002		CCI BUDGET		R-N-R	
BUILDING SF (GROSS)									
SITE SIZE									
SPECIFICATION SECTIONS									
05 12 00 Structural Steel Framing									
05 31 00 Steel Decking									
05 50 00 Metal Fabrications									
05 51 00 Metal Stairs									
05 52 13 Pipe and Tube Railings									
SCOPE ITEMS				QTY	UNIT	COST/UNIT			
BASE BID AMOUNT									
1 Structural									
2 Engineering & Shop Drawings						\$	-	\$	21,600
3						\$	-		
4						\$	-		
5						\$	-		
20						\$	-		
21						\$	-		
CCI MISC SCOPE				QTY	UNIT	COST/UNIT			
BID TOTALS									
						\$	-	\$	21,600
SALES TAX (IF NOT INCLUDED)									
TOTAL W/ TAXES						\$	-	\$	21,600
TOTAL W/ BOND & TAXES (ESTIMATE VALUE)				Tot		\$	-	\$	21,600

Chad Slaymaker

From: Robert VanBeekum <rvanbeekum@msn.com>
Sent: Tuesday, January 10, 2023 9:41 PM
To: Chad Slaymaker
Subject: Re: Chandler SWTP

Sorry Chad late day in the field. I guess I could have just told you detailing is away about 10% of the project.
Detailed shop drawings \$ 21,600.00
On another note, we only have a 15-day lock on our steel prices with our suppliers still & we seem to still be getting increases.

Thank You,
Robert VanBeekum
R-N-R STEEL LLC AZ ROC 207615
c(480)818-3184 o(480)987-1927 EXT#1
Mail 7534 W. Dove Roost Rd Queen Creek, AZ. 85142
Shop 2333 W. Houston AVE. Apache Junction, AZ 85120
Clark County & City of Phoenix certified steel fabricator.



From: Robert VanBeekum <rvanbeekum@msn.com>
Sent: Monday, January 9, 2023 4:31 PM
To: Chad Slaymaker <CSlaymaker@calienteconstruction.com>
Subject: Re: Chandler SWTP

Some of these items use some equipment for install so if they get changed, I will have to reprice sir.
The stair has the largest of the steel cost because of the size of the crane required to set this steel & the custom shoring we have to build to temp hold one side as we install.
Let me know if there is anything else I may help you with.

Thank You,
Robert VanBeekum
R-N-R STEEL LLC AZ ROC 207615
c(480)818-3184 o(480)987-1927 EXT#1
Mail 7534 W. Dove Roost Rd Queen Creek, AZ. 85142
Shop 2333 W. Houston AVE. Apache Junction, AZ 85120
Clark County & City of Phoenix certified steel fabricator.



From: Chad Slaymaker <CSlaymaker@calienteconstruction.com>
Sent: Friday, January 6, 2023 11:18 AM

To: rvanbeekum@msn.com <rvanbeekum@msn.com>

Subject: Chandler SWTP

Hi Robert,

Can you break out a submittal package for this project? We are revising our GMP to include a procurement package for long lead items and want to include shop drawings for the steel to get those worked out before hand.

Let me know if you have any questions on this.

Thank you,

Chad Slaymaker | Project Manager

Caliente Construction Inc.

485 W Vaughn St. Tempe, AZ 85283

Office: 480.894.5500

Cell: 319.270.8844

cslaymaker@calienteconstruction.com



AZ ROC091625 AZ ROC164561 AZ ROC 098769 CA 770323 NV 0051507 NM 85371 UT 4741522-5501 CO 233580 ID C183584 MT 159637 WY CT-14-27508

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General Construction - Construction Management - Design/Build - Facilities Management

4486
872002

	SALES TAX (IF NOT INCLUDED)	\$	0.00%	\$	-	\$	-
	TOTAL W/ TAXES	\$		\$	-	\$	85,870
	TOTAL W/ BOND & TAXES (ESTIMATE VALUE)	\$	Total	\$	-	\$	85,870

Scope Letter**139215.1**

AZ Contractors License: ROC 074615 B-1

December 2, 2022

David Rockwood
Caliente Construction Inc.
485 W. Vaughn St.
Tempe, AZ 85283

Re: Pecos SWTP Water Renov – Phase 1
Chandler, AZ

Dear David:

We are pleased to quote the above-referenced project based on plans and specifications by DFDG Architecture dated 5/11/2022. We received PB-RFI-01.

11 53 00 - LABORATORY EQUIPMENTInclude

1. [1] Labconco Steam Scrubber.
2. [1] Market Forge 16" Sterilmatic Benchtop Sterilizer
3. Installation of OF/CI Undercounter Fridges and Freestanding Fridges.

Exclude

4. Backing, blocking or bracing in walls or ceilings.
5. Structural or miscellaneous steel supports in walls or ceilings.
6. Recesses and openings in walls.
7. Floors that exceed a non-accumulative tolerance of ¼" in 10'-0" will need to be floated or brushed by others.
8. Mechanical, electrical, and plumbing connections of any type.
9. Mechanical, plumbing, electrical, and ventilation materials. For example, but not limited to, valves, shut offs, traps, piping, drains, conduit, wiring, j-boxes, transitions, ductwork, devices, sheet metal, fittings, or any other related materials for this work.
10. Site-acceptance (SAT) and factory-acceptance (FAT) testing.

11 53 13 - LABORATORY FUME HOODS & EXTRACTION ARMSInclude

1. 1 each 6' wide Kewaunee Venturi standing-height fume hood (E07)– CAV Bypass, laminated safety glass– V05F282472GN-G1,F1,SK-C,L,R1,U-ZZ24842 (ZZ24842 is for Air Alarm cutout).
2. 1 each 4' wide Kewaunee Venturi standing-height fume hood (E04)– CAV Bypass, laminated safety glass– V05F282448GN-G1,F1,SK-C,L,R1,U-ZZ24842 (ZZ24842 is for Air Alarm cutout).
3. 1 each 6' wide Kewaunee Venturi ADA-height fume hood (E63)– CAV Bypass, laminated safety glass– V15F282472GN-G1,F2,SK-C,L,R1,U-ZZ24842 (ZZ24842 is for Air Alarm cutout). Cup sink and faucet.

4. 1 each 6' wide Vertical Laminar Flow Trace Metals Fume Hood (E42) – Regular Polypropylene construction, Lexan front sliding sash, cup sink with Polypro Faucet. Polypropylene vented base cabinets with adjustable front air intake slots.
5. Vertical Exhausting Laminar Flow Workstations have been tested to ISO 14644 standard (clean air for the HEPA filter component) and ASHRAE110 (exhaust).
6. 1805 UL classified for Kewaunee Venturi fume hoods, not Polypropylene fume hood.
7. Standard version Movex MET 1350-100 (E83 & E86 snorkels) and Movex 1150-100 (E82 & E85). Assumed extracting temps not exceeding 176°
8. Factory pre-wiring to junction box on top of hood.
9. Factory pre-piping to top of hood for each individual fixture.
10. Above-ceiling support for Movex extraction arms.

Exclude

11. Flame retardant polypropylene on Laminar fume hood and poly tall cabinets.
12. Field testing.
13. Seismic engineering, calculations and stamps.
14. Fixtures on E04 and E07 fume hoods – none shown.
15. Ceiling enclosures.
16. Explosion Proof and Vapor Proof lights
17. Backing, blocking or bracing in walls or ceilings.
18. Structural or miscellaneous steel supports in walls or ceilings.
19. Recesses and openings in walls.
20. Floors that exceed a non-accumulative tolerance of ¼" in 10'-0" will need to be floated or brushed by others.
21. Mechanical, electrical, and plumbing connections of any type.
22. Mechanical, plumbing, electrical, and ventilation materials. For example, but not limited to, valves, shut offs, traps, piping, drains, conduit, wiring, j-boxes, transitions, ductwork, devices, sheet metal, fittings, or any other related materials for this work.
23. Blowers, blower support system, mounting pads, and vibration isolators.
24. Waste lines and traps from rough-in to sink.
25. Alarms, monitors, sash position sensors (provided & installed by VAV controls contractor).
26. Explosion proof wiring (must be performed in the field by electrical contractor).

12 31 00 – MANUFACTURED METAL CASEWORK

Include

1. Standard Kewaunee Full Overlay Steel Casework with chrome plated wire pulls in Chlorine Analyzer Room A1106.
2. 316 Stainless Steel worktop with splash in Chlorine Analyzer Room A1106.
3. Elkay sink model EWNSF83724, 72X28 4H 3B SS Scullery Sink in Chlorine Analyzer Room A1106.
4. Steel Reagent uprights with Durcon Chem Grade SPC shelves, to support cabinets at islands – as shown on drawings.
5. Steel free-standing adjustable height tables 30" to 37" high on one-inch increments with phenolic resin tops.
6. Steel Single-Sided bench with RW and 10' cord with straight blade plug, at Laboratory 6/310.1.
7. [1] Justright 892200 Tall Flammable cabinets, 22G, Manual Close Door, 23.25"w x 18"D x 65"H.
8. Cabinet locks.

Exclude

9. Label holders.

10. Backing, blocking, or bracing in walls or ceilings.
11. Structural or miscellaneous steel supports in walls or ceilings.
12. Scribing to floor conditions. Floors that exceed a non-accumulative tolerance of ¼" in 10'-0" will need to be floated or brushed by others.
13. Caulking.
14. Vinyl and/or rubber base molding.
15. Soffits or sloping tops.
16. Seismic engineering, calculations, and stamps.

12 32 00 – MANUFACTURED WOOD CASEWORK

Include

1. Kewaunee Full Overlay Signature Series standard materials and configurations, FSC/NAUF White Maple Casework with chrome plated wire pulls.
2. All tops 1" Durcon SPC, CHEM Grade, Durcon Solid Gray, marine edge around sinks surfaces only.
3. [1] Durcon Gray 30x30" Pegboard with Stainless drip tray.
4. [6] U-58E, Undermount Sink, 27.8x14.8x8", Gray, with poly outlet, overflow and stopper.
5. [1] Durcon CS4-R Poly cup sink 6x2 Gray for worktop.
6. Cabinet locks.
7. Removable backs at fixed locations, Finished backs at Moveable Casework.
8. Levelers where indicated as Movable Casework, in lieu of four [4] removable tubing leg assemblies and removable casters.
9. 4-drawer Moveable Casework in lieu of 3-drawer.
10. [2] 21" Wide 4-drawer cabs in lieu of a 42" wide at 9/A310.
11. [2] 24" Wide 4-drawer cabs in lieu of a 48" wide at 6/A310.
12. 48"W Swinging glazed upper door cabinets on Evolution bench, not [2] 24"W cabinets, at Laboratory 6/A310.1.
13. 1-door, 5 drawer at 3/A311 in lieu of 1-door, 4 drawer.
14. Corner cabinets with Lazy Susan.
15. Standard Justrite Flammable Cab Model 892200 Manual Close Door, 23.25"w x 18"D x 65"H.
16. Standard Kewaunee Grey Kemresin Balance Table 30"H x 24"D x 35" Long.
17. Sink cabinets provided with lowered back for plumbing access, not removable back.
18. Bobrick Stainless Coat Hook Strip B-232x24.
19. Galvanized steel plate to the cabinet behind the base molding.
20. Grade A/Grade 1 standard Kewaunee plywood.
21. Providing standard M-2 particle board.
22. FSC Chain of Custody: ISEC, Inc. is FSC Chain of Custody Certified, and provides materials manufactured by FSC certified manufacturers when FSC is required.
23. AWI Quality Certification.
24. Stain grade interior finish carpentry to be factory finished.

Exclude

25. Label holders.
26. Drawer interlocks – not specified.
27. Grade A/A plywood.
28. Anti-Tip Counterweight on all-drawer cabs. Available as an Alternate Add.
29. Relocating VAC pump.

30. Ceiling Service Panels.
31. Ceiling access panel.
32. Removing and refurbishing existing casework.
33. Utility columns at each sink. Per P402.1, piping at sink locations is up through floor or in wall. No utility columns shown on plans and elevations.
34. Stainless steel corner guards.
35. Exterior adjustable shelves with retaining rails – none shown.
36. Standard and bracket shelving – none shown.
37. Task lights – none shown.
38. Thermostatic mixing valves.
39. Slope tops – none shown.
40. DI filtered water line with tee/valve and adjacent GFCI receptacle.
41. Paper towel and soap dispensers.
42. White Boards.
43. POU Neutralization tanks
44. Fire Rated cores and UV inhibitors.
45. Grain direction running lengthwise.
46. Drawer fronts with 4mm solid hardwood edge banding.
47. Grade M-3 Exterior Particle Board. Providing standard M-2 particle board.
48. LEED V4 Environmental Product Declarations, Health Product Declarations, Life Cycle Assessments, and Regional Materials.
49. Finishes identified as “match architect’s sample” are carried as an allowance and may require a price revision if a sample cannot be provided at bid time.
50. Backing, blocking, or bracing in walls or ceilings.
51. Structural or miscellaneous steel supports in walls or ceilings.
52. Scribing to floor conditions. Floors that exceed a non-accumulative tolerance of ¼” in 10’-0” will need to be floated or brushed by others.
53. Caulking and puttying of paint-grade materials (by painter).
54. Caulking of stain-grade materials (by painter).
55. Vinyl and/or rubber base molding.
56. Seismic engineering, calculations, and stamps.

BID PROPOSAL

1. TOTAL PRICE: including Premium Grade Wood, WaterSaver Fixtures, installation and freight; excluding tax and bond:

Less upfront costs for PM Admin, Engineering etc.

~~\$ 429,350~~
< \$85,870
\$ 18,245

- a. ALTERNATE ADD: Sales Tax
- b. ALTERNATE ADD: Textura Fee
- c. ALTERNATE ADD: Payment & Performance Bond:
- d. Any Alternate, Breakout or VE Pricing that is not accepted at time of contract must be exercised in 90 days in order to be price protected.

\$ 940

\$ 3,549

2. We acknowledge Addendum(s): PB-RFI-1

3. MWBE/DVBE/WBE/SBA/HUB Percentage of Participation:

0%

4. Schedule of values:

- a. 10% of contract value for engineering, billable upon submission for approval.
- b. 10% of contract value for project management, billed equally by month until completion.
- c. Other specific line items for coordination, BIM, layout, field dimensions, seismic anchorage, mobilization, bonds, mockups, and project site office costs will be itemized and billed as incurred.
- d. The General Contractor will be responsible for payment of these funds regardless of Owner's reimbursement of payment.
- e. ISEC, Inc. shall be paid monthly progress payments for the value of the work performed, including all material manufactured or purchased in accordance with construction schedule and delivered to the jobsite or suitably stored at an off-site location.

5. Lead Times:

- a. Submittals, samples, and shop drawings lead times are (6) weeks after receipt of mutually acceptable purchase agreement, deposit, and architectural drawings in CAD format (DWG or RVT). Submittal will be delivered in phases for multi-floor and multi-building projects.
 - i. If engineered shop drawings are required, they will be provided in standard 11x17 PDF format only and shall include typical details, elevations, & model numbers for installation purposes. Typical initial submittal shop drawing lead time starts when ISEC receives the CAD or RVT files. CAD (DWG or RVT) files should include any floorplans, ceiling plans, interior elevations, & details pertaining to the covered areas in this contract. If required CAD (DWG or RVT) files are NOT available and ISEC must complete the shop drawing initial submittal from scratch, a change order will be required for the extra engineering and lead time for shop drawings will extend out. Note: if you know CAD files may not be available prior to the start of this project, please let ISEC know so we can account for the additional cost and time in this estimate/contract.
- b. Manufacturing lead times are (12-16) weeks after return and approval of all submittals, incorporating any coordination and field dimensions required for a clean release for production.

TERMS AND CONDITIONS

- 1. Prices shall be considered firm for a period of (30) days with later acceptance subject to ISEC, Inc.'s approval, or as required by specifications.
- 2. Due to the volatile nature of raw material costs (i.e. stainless steel, steel, copper, aluminum, petroleum-based products), tariffs, and fuel costs, pricing shall only be held through the acceptance period stated in our proposal. ISEC, Inc. reserves the right for additional compensation based on any surcharges or increases received after the acceptance period.
- 3. Professional Liability Insurance (Errors and Omissions Insurance) is not included.
- 4. Water damage due to water piping incorrectly located in framed walls. General contractor is responsible for coordinating all trades to properly locate piping in walls.
- 5. ISEC, Inc. shall be given timely notice (no less than 48 hours) and reasonable time to respond to deficiencies prior to General Contractor issuing any back charges.
- 6. ISEC, Inc. will not accept charges for undefinable damages during punch list work without proper notification to and acceptance by ISEC, Inc.
- 7. Retention on ISEC, Inc.'s subcontracts will not exceed 5%. Retention shall be reduced to 0% withheld at 50% complete for remaining billings. No retention will be withheld on subcontract values less than fifty thousand dollars (\$50,000.00).
- 8. Purchase orders to ISEC, Inc. will be paid net 30 days, no retention.

9. No right of setoff will be allowed in the subcontract.
10. ISEC, Inc. will not be liable to General Contractor or Owner for any incidental, consequential or other undefined damages.
11. If the Contract Documents provide an amount for liquidated damages, liquidated damages shall be assessed only to the extent caused by negligence or willful misconduct of the Subcontractor. If delays are caused by circumstances out of ISEC, Inc.'s control, liquidated damages shall not be assessed.
12. If the General Contractor fails to receive a certificate for payment from the architect or does not receive payment for any cause which is not the fault of ISEC, Inc., then the General Contractor shall pay ISEC, Inc. on demand any progress payment and/or final payment that is due. ISEC, Inc. shares no risk of Owner not paying General Contractor. It is agreed that payments from the Owner in no way constitute the exclusive fund from which ISEC, Inc., may receive payment for the work performed on this project.
13. If ISEC, Inc. does not receive a progress payment from the General Contractor within 10 days after the date such payment is due, then ISEC, Inc., upon giving an additional 2 days' notice to the Contractor and without prejudice to and in addition to any other legal remedies, may stop work until payment of the full amount owing to ISEC, Inc., has been received. The contract price shall be increased by the amount of ISEC, Inc.'s reasonable cost of shut-down, delay, and start-up by appropriate change order.
14. If the Architect, Owner, or General Contractor requires ISEC, Inc. to perform any additional work pursuant to this contract, then ISEC, Inc. will provide a change order proposal for the work. ISEC, Inc. will not proceed without written directive, approval of change order proposal, and receipt of subcontract change order.
15. If the General Contractor requires ISEC, Inc. to perform any additional work pursuant to this contract that will be submitted to any type of Insurance claim, i.e. Builder's Risk or other, then ISEC, Inc. will provide a change order proposal for the work and will not proceed without written directive, approval of change order proposal, receipt of subcontract change order prior to starting additional work. Payment will not be contingent on General Contractor's risk to recover reimbursement from the insurance company.
16. Notwithstanding any other provision of subcontract agreement to the contrary, ISEC, Inc. does not waive any lien rights or surety bond rights provided by law or contract.
17. ISEC, Inc. will provide a schedule identifying the sequence and duration of the work, for approval by the General Contractor. ISEC, Inc. shall be entitled to equitable adjustments of the contract time and the contract price due to delays, accelerations, compressions, out-of-sequence work, and disruptions resulting from schedule changes.
18. ISEC, Inc. will perform all work during the normal working hours at the project site. All overtime required will be authorized at an agreed-upon rate and reimbursed by the General Contractor on a monthly basis.
19. ISEC, Inc. will clean up and remove debris, dirt, and rubbish accumulated as a result of installation. Clean-up is interpreted as broom clean and orderly, which does not include wiping down any surfaces, nor any final cleaning. ISEC, Inc. will not be required to contribute to a weekly composite clean-up crew.
20. Hoisting and/or elevator with an operator to be provided by General Contractor at no charge to ISEC, Inc., during normal working hours. Under no circumstances will ISEC, Inc. move material up or down stairways.
21. General Contractor to provide site Logistics plan identifying unload path, loading dock, cranes, elevators, material hoist prior to subcontractor bid. If such a plan is not available or changes, ISEC, Inc. reserves the right to reprice any impact to the material movement plan.
22. General Contractor to accommodate full 53' truck deliveries.
23. General Contractor to accommodate off-hours dedicated elevator/material lift time and personnel at no additional cost to ISEC, Inc.
24. General Contractor to allow for staging of materials in areas of installation. In the event staged materials are to be rehandled and relocated, General Contractor is responsible to reimburse ISEC, Inc.
25. General Contractor shall be responsible for maintaining openings into buildings, corridors, and rooms large enough to accommodate movement of materials, providing ISEC, Inc., has provided coordination of work in adequate time to allow Contractor to schedule work properly.
26. Humidity and temperature control requirements for maintaining heating, ventilation, and cooling systems to obtain relative humidity necessary to maintain optimum moisture content of the architectural woodwork in the installation area is the responsibility of the General Contractor or Owner. Air conditioning shall be operative for two weeks and a relative humidity range of 25-55% shall be maintained prior to installation.

27. All major modifications or amendments issued by the Owner, whether they specifically apply to our Scope of Work or not, will be provided to ISEC, Inc. They may affect extensions of time, and as ISEC, Inc., will be one of the last trades on the project, any delays in the job due to extensions of time will affect our cost for materials, extended overhead, and labor.
28. In the event either General Contractor or Subcontractor institutes legal proceedings whether by court action, arbitration or otherwise, against the other party or against the surety of the other party, in connection with any dispute or matter arising under the subcontract governing this project, the party prevailing in that proceeding shall be entitled to recover from the other its actual attorneys/arbitration fees.
29. If the General Contractor uses, relies on, lists or directs ISEC, Inc. to proceed as a Subcontractor it acknowledges that they have read, understood and agree to all terms and conditions of ISEC, Inc.'s offer to sell and will incorporate these terms and conditions in ISEC, Inc.'s subcontract.

Sincerely,
ISEC, Inc.

Mitch Cullen
Southwest Region
828 East Isabella Avenue
Mesa, Arizona 85204
480-926-1667

Caliente Construction Inc.

General Construction - Construction Management - Design/Build - Facilities Management

23-6000 Central Cooling System

BUILDING SF (GROSS) 4486
SITE SIZE 872002

SPECIFICATION SECTIONS				CCI BUDGET		Midstate
SCOPE ITEMS	QTY	UNIT	COST/UNIT			
BASE BID AMOUNT						
1 HVAC				\$	-	878,049
18 Equipment Early Release Package				\$	-	
19 VAV Make Up Air Unit				\$	-	included
20 Air Cooled Chiller				\$	-	included
21 Air Handling Unit				\$	-	included
22 Split System Units				\$	-	included
23 CRAC Units				\$	-	included
24 Lab Exhaust Plume				\$	-	Included
25				\$	-	
26				\$	-	
27				\$	-	
28				\$	-	
29				\$	-	
30				\$	-	
31				\$	-	
32				\$	-	
33				\$	-	
34				\$	-	
CCI MISC SCOPE						
46 Textura Fee				\$	-	1,932
BID TOTALS				\$	-	879,981

SALES TAX (IF NOT INCLUDED)	\$	-	\$	-	\$	-
TOTAL W/ TAXES	\$	-	\$	-	\$	879,981
TOTAL W/ BOND & TAXES (ESTIMATE VALUE)	\$	-	\$	-	\$	879,981



1900 E. Riverview Drive • Phoenix, Arizona 85034 • 602.470.1920 (Phone) • 602.452.8606 (Fax)
www.midstatemechanical.com

January 13, 2023

Chad Slaymaker
Caliente Construction
485 West Vaughn Street
Tempe, Arizona 85283

RE: City of Chandler Pecos SWTP Renovation –
Proposal Number: 22-0413 EP

Below is the Early HVAC Equipment proposal of devices that have known long lead shipping Estimates. This offers the following HVAC proposal. Our price includes equipment in accordance with the plans and specifications listed below.

BID DOCUMENTS

Specifications: Construction Documents Phase 1 – Pecos SWTP Water Quality Lab: 230500, 230513, 230514, 230515, 230517, 230518, 230519, 230520, 230523, 230529, 230548.13, 230553, 230593, 230713, 230719, 230800, 230900, 230900.10, 232113, 232115, 232123, 232500, 232501, 233113, 233116.10, 233300, 233416, 233423, 233713, 234100, 237433, 238216.11 by DFDG Architecture dated March 11, 2022.

100% Construction Documents Phase 2 – Pecos SWTP Admin Building: 230500, 230501, 230513, 230514, 230515, 230517, 230518, 230519, 230520, 230523, 230529, 230553, 230593, 230713, 230716, 230719, 230800, 230900, 232113, 232115, 232123, 232300, 232500, 232501, 233113, 233300, 233416, 233600, 233713, 236423, 237313, 238123, 238126 by DFDG Architecture dated July 29, 2022.

Plans: Construction Documents Phase 1 – Pecos SWTP Water Quality Lab: M001.1, ~~M101.1~~, M102.1, ~~M201.1~~, M202.1, M301.1, M302.1, M303.1, M401.1, ~~M501.1~~, ~~M502.1~~, M601.1, M602.1, M603.1, ~~M701.1~~ and by DFDG Architecture dated February 11, 2022.

Delta 3 ASI 001 – Design Coordination: M101.1, M201.1, M501.1, M502.1, and M701.1 by DFDG Architecture dated May 11, 2022.

Construction Documents Phase 2 – Pecos SWTP Admin Building: M001.2, M101.2, M102.2, M103.2, M201.2, M202.2, M203.2, M301.2, M401.2, M402.2, M501.2, M502.2, M601.2, M602.2, M603.2, M604.2, M701.2 and P001.2 by DFDG Architecture dated September 01, 2022.

Addenda: None

GENERAL CLARIFICATIONS

- The General Contractor is responsible for taxes and, therefore all taxes are excluded from our bid. Special request is required If, this project is classified as an MRRRA project and retail transaction privilege tax.
- If this project is classified as a taxable modification activity, please provide a project specific prime contractor certificate 5005 upon award.
- Work Hours Based on 8 hours daytime Monday thru Friday Excludes Weekends and Holidays Unless Noted Otherwise.
- All pricing Valid for 30 days. Due to the volatile market and delays in shipping, we reserve the right to confirm pricing and lead times with factory and suppliers prior to any contract execution.
- The basis of this proposal; is on two phases of project scope working consecutively in the scheduled. We reserve the right to review and reprice the phases if alternative schedule is issued.

- Early Release and procurement cost proposal is based on an approved and accept submittal processes. Therefore, subject to cost impacts for items and or options required and deviates from the bases of design intend.
- Deadline for early release and Price Lock. To avoid additional cost impact, issuing a contract as soon as possible allows us to issued the manufacture a PO or Letter of intent to order place hold pricing. Current deadline for Trane has passed as of Jan 12,2023. The new deadline is 2-15-2023.
- All Shipping dates are Estimated and subject to change. Manufacturer confirm date at PO entry is not a guaranteed date of delivery but an estimated date of the shipment. Manufacturers will provide a production Estimate schedule after confirmation of the order entry and verified inventory components from its third party product suppliers. Due to supplier and product delays and shortage the Equipment order may have additional delays beyond their control. Manufacturer must issue notice within 48 hrs of any delays that further impacts shipment. Manufacturer also not responsible for transit and or Carrier delivery services delay or damage cause by the transportation company.

HVAC EQUIP Package for Early Release (Base per schedule)

- (1) VAV Makeup Air Unit with VFD and Energy Recovery Coil (Innovent-Trane) (MUA) as scheduled on the drawings. (36 WEEKS Estimated)
- (1) Air Cooled Chiller (TRANE) (ACH-1) as scheduled on the drawings. (40 to42 weeks)
- (1) 1 Semi custom Chilled Water VAV Air Handling Unit (Trane) (AHU-1) (52-55 weeks) as scheduled
- (2) Ductless Split System Units (Mitsubishi- Trane) as scheduled on the drawings. (8 -12weeks)
- (2) CRAC Units (VERITIV (Liebert) as scheduled on the drawings. (55 Weeks)
- Includes 1 one Part and Labor Warranty

Base Package per above Manufacturers	*\$ 845,245.00
Subject to order deposit fees- invoiced on release date	25% deposit \$ 210,000.00
Alternate Manufacturers Package If Approved by owner and engineering) Deduct Daikin : Package – AHU 1 and Air Cooled Chiller and ductless splits – Annexair: Make -UP Air Unit – Package includes 2 year warranty Parts and labor	**<\$ 35,800>
Alternate for (Liebert VERITIV) CRAC unit -Use STULZ (Varitec-Daikin package) estimate 44 weeks in lieu of 55weeks	**Deduct < \$8,000.00>
*Subject to cancelations fees after approved release dated	
** Pricing subject to package breakout or breakup with mixed vendors	

Thank you,

Jim Stultz

Senior Estimator

Project : Pecos Chandler WTP			Midstate Mechanical		Date2-9-2023
Brand	EQ TAG	Description	QTY	PricingBrkdwn	Lead Times
Innovent/Trane	Phase 1	MUA -1	1	\$ 326,681	36-38 wks
TRANE	Phase 2	Chiller	1	\$ 333,359	40-42wks
TRANE	Phase 2	AHU 1	1	Pkg w Chrl	52-55wks
TRANE/MITSU	Phase 2	Mini split	2	Pkg w Chrl	8-12weeks
VERITIV	Phase 2	Liebert	2	\$ 104,378	55 weeks
		All equip		\$ 23,147	
		Precon		\$ 57,680	2weeks

**** Total Equipment Procurement \$ 845,245 ****

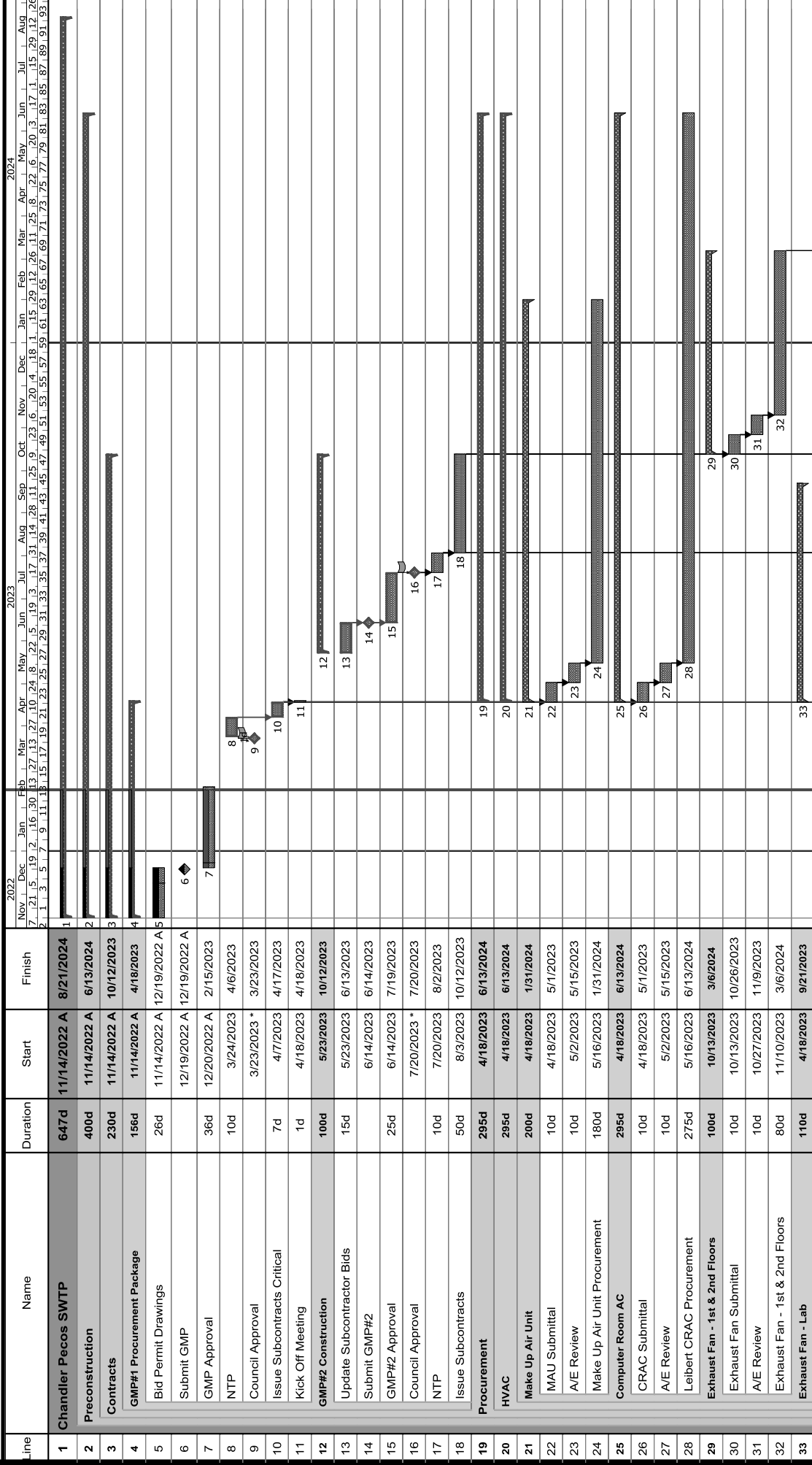
Optional Items to consider EP			QTY		Lead Times	
ANTEC	Phase 1	LAB AFV	8	\$ 30,000	12-14 weeks	
GreenHeck	Phase 1	LAB EXH	3	\$ 32,804	28 Weeks	

**** Note: All Equip Pricing can hold valid until March 20th 2023 for PO
Beyond this date cost Increases will occur**

Potential Est amount 5% \$ 38,600



Chandler Pecos SWTP



2/13/2023



Chandler Pecos SWTP

Line	Name	Duration	Start	Finish	2022												2023												2024																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
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2/13/2023



5 of 6

2/13/2023

EXHIBIT E



PECOS SURFACE WATER TREATMENT PLANT ADMINISTRATION BUILDING HVAC AND WATER QUALITY LAB
RENOVATION
Project No. WA2106.401

SUBCONTRACTOR'S LIST FORM

If CM@Risk intends to subcontract any portion of this Agreement, the CM@Risk must submit the name, address, and contractor's license number (if applicable) of each subcontractor, including the work component of such subcontracting. Include the form with the bid submittal documents. CM@Risk may make multiple copies of this form as needed.

Company Name:	
Contact Name:	
Contact Email:	
Contact Phone:	
Work Component:	
Percentage of Total Work Performed:	

Company Name:	
Contact Name:	
Contact Email:	
Contact Phone:	
Work Component:	
Percentage of Total Work Performed:	

Company Name:	
Contact Name:	
Contact Email:	
Contact Phone:	
Work Component:	
Percentage of Total Work Performed:	

Company Name:	
Contact Name:	
Contact Email:	
Contact Phone:	
Work Component:	
Percentage of Total Work Performed:	

Company Name:	
Contact Name:	
Contact Email:	
Contact Phone:	
Work Component:	
Percentage of Total Work Performed:	

Company Name:	
Contact Name:	
Contact Email:	
Contact Phone:	
Work Component:	
Percentage of Total Work Performed:	

EXHIBIT F

N/A