5/5/2021

Mr. Scott McClelland, PE
City of Schertz
10 Commercial Place, Bldg. 2
Schertz, TX 78154

EXHIBIT
Exhibit A

Re: City of Schertz Animal Center
HVAC Installation
Bid Number: # 4016

Dear Mr. McClelland, PE;

We appreciate the opportunity to bid this Project. Our proposal is as follows:

I. DOCUMENTS:

- **Drawings – TMech and M&S Design**

II. SCOPE OF WORK:

Design Drawings

MEP – Develop overall design of MEP system

Mechanical Design

- Analyze heating and cooling loads in accordance with local energy code
- Specify packaged VAV and dedicated outside air HVAC equipment given heating and cooling loads, anticipated building occupancy/activity based on as-built conditions, and maintenance requirements
- Calculate exhaust and ventilation requirements, to verify existing equipment and specify new equipment required
- Design for new mechanical system. Provide a mechanical floor plan showing the locations of HVAC equipment, sized ductwork, condensate piping, and supply and return grilles
- Select and specify HVAC controls
- Complete code compliance documentation (COM Check) for mechanical systems

Electrical Design

- Analyze and compare the new air conditioning system with the existing electrical infrastructure. Engineer upgrades to the systems as required to accommodate the installation of the new air conditioning system
- Provide one-line diagram and applicable panel schedules
    - Conduit (number and size), number of spares, and wireway size
    - Size secondary feeder cables
- Provide electrical floor plans of power equipment connections

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131 Gattuso Rd. New Braunfels, TX 78132

Structural Design

- No scope will be inside the existing building. We will not connect to the existing building nor impose additional load on the existing building
- Mechanical equipment platform at back of building
    - Provide the foundation and steel superstructure design for an awning
    - This addition will be structurally separate from the existing building
    - Base plates and anchorage
    - Connection between beam and column, welded only
    - Connection between purlin and column/beam
    - W-shape columns, W-shape beams, 8" Cee or Zee purlins
    - Only designing framing
    - Foundation layout showing individual footers under each column
    - Show handrail around the edge with a single gate for maintenance access
    - Show location of access ladder and assist with the selection of a prefabricated ladder
    - Show loading criteria and construction notes on the plans
    -

Subsurface Utility Engineering (SUE):

- In support of the structural design the following services shall be included. SUE scope would be limited to the area of the mechanical equipment platform.

- All work described herein is based strictly upon "Standard Guideline for the Collection and Depiction of Existing Subsurface Utility Data (CI/ASCE 38-02)".

- Sherwood Surveying & SUE shall apply SUE Quality Levels B, C, and D of the area that will have a new equipment platform installed as described in the structural section above to deliver an accurate depiction of as many of the existing underground utilities near the new equipment platform as can be designated within one day's field investigation.

    i. Utility quality level B: Information obtained through the application of appropriate surface geophysical methods to determine the existence and approximate horizontal position of subsurface utilities. This information is surveyed to applicable tolerances defined by the project and reduced onto plan documents.
    ii. Utility quality level C: Information obtained by surveying and plotting visible above-ground utility features and by using professional judgment in correlating this information to quality level D information.
    iii. Utility quality level D: Information derived from existing records or oral recollections.
- There are limitations for utilities such as water & sewer which consist of non-metallic pipe, and therefore might not be obtainable. For the sewer lines, we can use a steel fish tape to pick up where the line is going, but this will be limited to how far down the line we can get the tape. Thus, we cannot provide any guarantee for locating these utilities.

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General Construction

- Furnish Structural Design Drawings for platform
- Furnish dumpsters and temporary restrooms
- Furnish labor and materials to install concrete footings/support
- Furnish labor and materials to install galvanized structural steel platform for AC Units
- Furnish and install metal exterior side panels to match existing roof
- Furnish labor and materials to protect existing floors
- Furnish labor to remove (as needed) ceiling grid and tile
- Furnish labor to reinstall existing ceiling grid and tile (if not damaged)
- Furnish labor and materials to replace all damaged ceiling grid and tile
- Furnish labor and materials to touch up walls that have been damage during construction
- Furnish roof support for new duct work
- Furnish labor and materials to dry in all roof penetrations

HVAC Construction

- Furnish labor to demo and remove all HVAC materials to from site
- Furnish labor and materials to install the following equipment:
    - One (1) VAV Package Unit
    - One (1) DOAS
    - Fifteen (15) Air Terminal Units
    - ID Tags/Labels
    - Air Devices
- Furnish labor and materials to install galvanized metal duct indoors
- Furnish labor and materials to install double wall insulated duct outdoors
- Furnish labor and materials to install flexible duct at supply air devices
- Furnish labor and materials to install condensate piping
- Furnish and install insulation for piping and duct as specified
- Furnish DDC Controls by Trane
- Furnish Certified Test and Balance
- Furnish Start – up and Owner Training on all new equipment
- Furnish as-built drawings and O&Ms

Electrical Construction

- Furnish and installation of new 225 Amp 42 circuit subpanel
- Furnish and installation of thermostat drops
- Furnish and installation of line voltage power to HVAC equipment
- Furnish fire caulking MES penetrations
- Furnish demolition of power to existing HVAC equipment being removed

III. CLARIFICATIONS

- All owner furniture, equipment, etc. shall be removed and reinstalled by others
- We have not provided any temporary cooling and/or heating during construction
- All animals shall be relocated except for animals in the outdoor kennels

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- Gas piping and gas heaters for kennels are not included in this proposal
- Davis Bacon Wages are included
- Payment and Performance Bond is included

IV. EXCLUSIONS:

- Any Temporary services
- No hazardous materials testing, removal or abatement
- Premium Time
- Work in the Dog Kennel Areas
- Landscaping
- Sales Tax

V. SUMMARY PRICING(Breakout pricing is for accounting purposes only):

Total Price $ 596,188.00

Adder for Gas to Building (no utility fees, no meter)	$ 19,150.00
Adder for Gas Furnace for AAON Unit	$ 3.105.00
Heat in Kennels	$ 16,350.00

We are basing our labor prices per the attached wage determination sheet.

Team Mechanical's bid is submitted with it being an express condition precedent that the parties mutually negotiate and agree on contract terms prior to any obligation by Team Mechanical to perform, and General Contractor should not rely on this bid to the extent General Contractor is not willing or able to negotiate the terms of the agreement.

If you should have any questions, please do not hesitate to give me a call.

Sincerely,
Team Mechanical of Texas, LLC.
Chris Humphries
Managing Partner
210-310-6363

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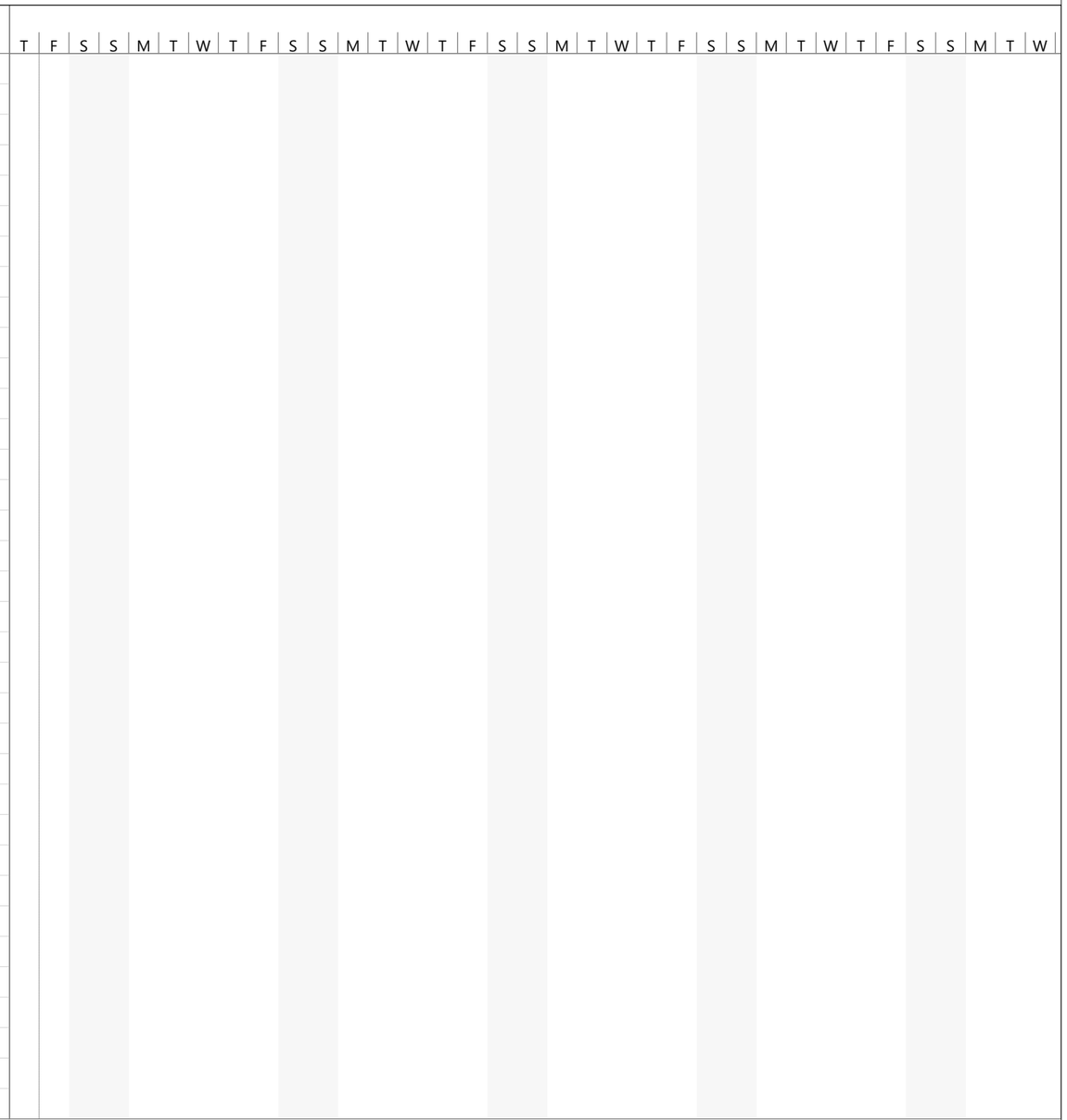
Schertz Animal Center
HVAC Replacement

ID	Task Mode	Task Name	Duration	Start	Finish	Predecess	Resource Names
1		Bid Award	1 day	Fri 5/28/21	Fri 5/28/21		
2		Design Durations	40 days	Tue 6/1/21	Mon 7/26/21		
3		Permit	25 days	Tue 7/27/21	Mon 8/30/21	2	
4		Pre-Constuction - submittals	10 days	Tue 8/31/21	Mon 9/13/21	3	
5		**Order Equipment (M&E)**	**45 days**	**Mon 7/5/21**	**Fri 9/3/21**		
6		Order VAVs	25 days	Tue 9/14/21	Mon 10/18/21	4	
7		Order RTU	40 days	Tue 9/14/21	Mon 11/8/21	4	
8		Order DOAS	45 days	Tue 9/14/21	Mon 11/15/21	4	
9		Order Steel for Platform	25 days	Tue 9/14/21	Mon 10/18/21	4	
10		Owner Remove Furniture/Equip	5 days	Mon 8/23/21	Fri 8/27/21		
11		Mobilization	3 days	Tue 8/31/21	Thu 9/2/21	3	
12		**Site Work - Structural Platform**	**33 days**	**Thu 7/8/21**	**Mon 8/23/21**		
13		Asphalt Removal	2 days	Tue 9/14/21	Wed 9/15/21	4	
14		Excavate Foundation/Footings	5 days	Thu 9/16/21	Wed 9/22/21	13	
15		Rebar, Concrete	5 days	Thu 9/23/21	Wed 9/29/21	14	
16		Erect Steel	12 days	Tue 10/19/21	Wed 11/3/21	9	
17		**HVAC**	**62 days**	**Tue 8/31/21**	**Wed 11/24/21**		
18		Protect Flooring	2 days	Tue 8/31/21	Wed 9/1/21	3	
19		Demo Partial Ceilings	3 days	Thu 9/2/21	Mon 9/6/21	18	
20		Demo HVAC Duct and Equipment	4 days	Tue 9/7/21	Fri 9/10/21	19	
21		Set new VAVs	3 days	Tue 10/19/21	Thu 10/21/21	6	
22		Set HVAC Equipment	1 day	Tue 11/9/21	Tue 11/9/21	7	
23		Rough In Duct	20 days	Mon 10/11/21	Fri 11/5/21		
24		Final Duct Connections (Outside)	5 days	Thu 11/11/21	Wed 11/17/21	22	
25		HVAC Trim Out	5 days	Fri 11/12/21	Thu 11/18/21	24	
26		Test and Balance	3 days	Fri 11/19/21	Tue 11/23/21	25	
27		**Electrical**	**39 days**	**Mon 9/20/21**	**Thu 11/11/21**		
28		Rough In Conduit and Wire	15 days	Mon 9/20/21	Fri 10/8/21		
29		Installation of Electrical Panels	5 days	Mon 10/11/21	Fri 10/15/21	28	
30		Termination to Equipment	5 days	Fri 11/5/21	Thu 11/11/21	22	
31		**Final General Construction**	**30 days**	**Thu 10/14/21**	**Wed 11/24/21**		
32		Reinsall Ceiling Grid/Tile	5 days	Thu 10/14/21	Wed 10/20/21	23	
33		Touch Up Paint	2 days	Wed 10/20/21	Thu 10/21/21	32	
34		Final Punch List	5 days	Fri 11/12/21	Thu 11/18/21	24	
35		Owner Final Acceptance	1 day	Wed 11/24/21	Wed 11/24/21	26	

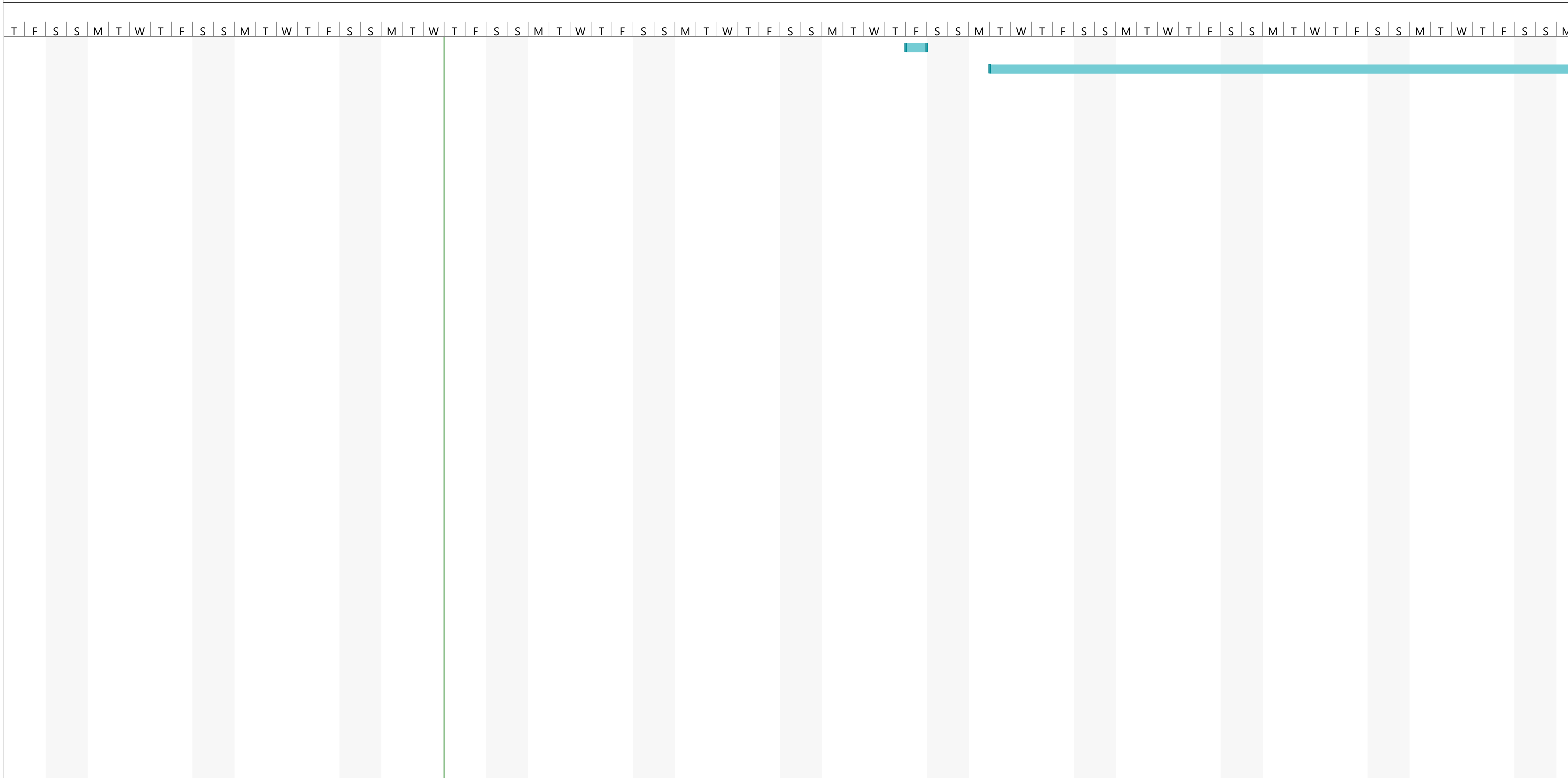


Project: Schertz Animal Center
Date: Thu 5/6/21

Task	Project Summary	Manual Task	Start-only	Deadline
Split	Inactive Task	Duration-only	Finish-only	Progress
Milestone	Inactive Milestone	Manual Summary Rollup	External Tasks	Manual Progress
Summary	Inactive Summary	Manual Summary	External Milestone	

Team Mechanical of TX
Construction Schedule

Schertz Animal Center
HVAC Replacement



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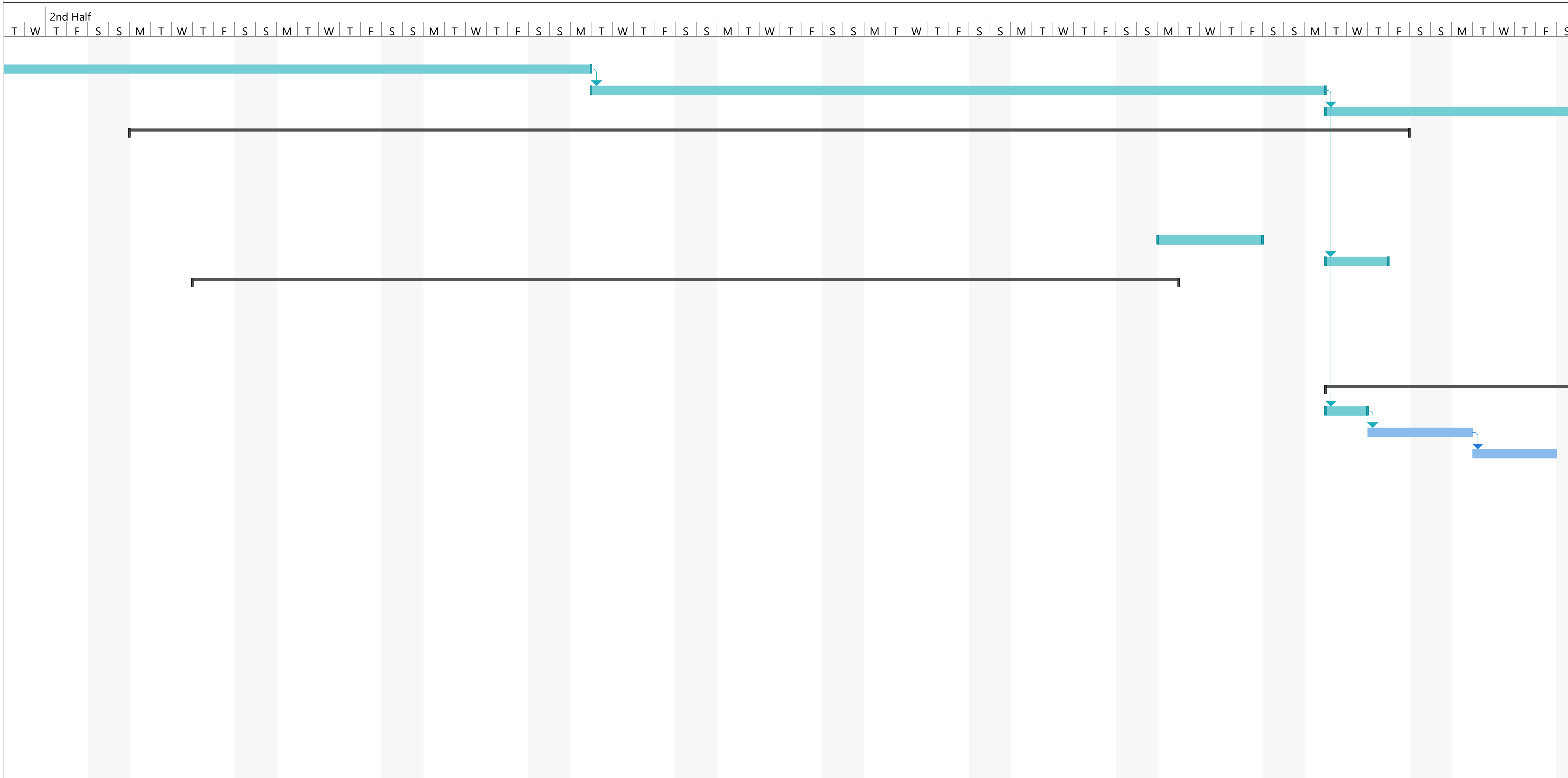
Schertz Animal Center
HVAC Replacement



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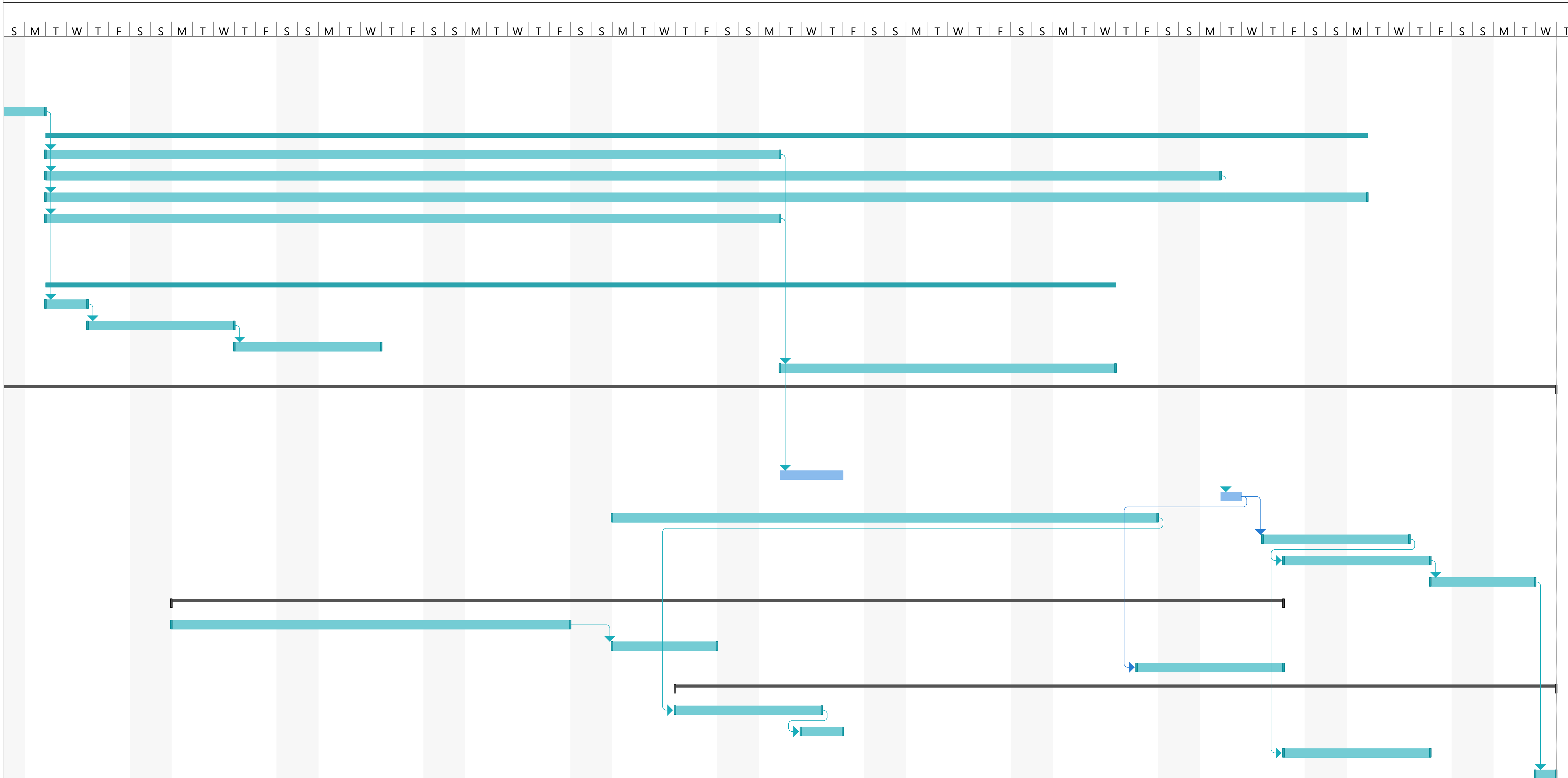
Team Mechanical of TX
Construction Schedule

Schertz Animal Center
HVAC Replacement



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Team Mechanical of TX
Construction Schedule

Exhibit B to Contract Agreement
Owner's Insurance Requirements of Design-Builder

1. Specific Insurance Requirements

The following insurance shall be maintained in effect with limits not less than those set forth below at all times during the term of this Agreement and thereafter as required:

Insurance	Coverage/Limits	Other Requirements
Commercial General Liability (Occurrence Basis)	Amounts of coverage shall be no less than: ▪ $1,000,000 Per Occurrence ▪ $2,000,000 General Aggregate ▪ $2,000,000 Products/Completed Operations Aggregate ▪ $1,000,000 Personal and Advertising Injury ▪ Designated Construction Project(s) General Aggregate Limit	▪ Current ISO edition of CG 00 01 ▪ Additional insured status shall be provided in favor of Owner Parties on a combination of ISO forms CG 20 10 04 13 and CG 20 37 04 13. ▪ This coverage shall be endorsed to provide primary and non-contributing liability coverage. It is the intent of the parties to this Agreement that all insurance coverage required herein shall be primary to and will not seek contribution from any other insurance held by Owner Parties, with Owner Parties' insurance being excess, secondary and non-contributing. ▪ Stop Gap coverage shall be provided if any work is to be performed in a monopolistic workers' compensation state. ▪ The following exclusions/limitations (or their equivalent(s), are prohibited: o Contractual Liability Limitation CG 21 39 o Amendment of Insured Contract Definition CG 24 26 o Limitation of Coverage to Designated Premises or Project, CG 21 44 o Exclusion-Damage to Work Performed by Subcontractors on Your Behalf, CG 22 94 or CG 22 95 o Exclusion-Explosion, Collapse and Underground Property Damage Hazard, CG 21 42 or CG 21 43 o Any Classification limitation o Any Construction Defect Completed Operations exclusion o Any endorsement modifying the Employer's Liability exclusion or deleting the exception to it o Any endorsement modifying or deleting Explosion, Collapse or Underground coverage o Any Habitational or Residential exclusion applicable to the Work o Any "Insured vs. Insured" exclusion except Named Insured vs. Named Insured o Any Punitive, Exemplary or Multiplied Damages exclusion o Any Subsidence exclusion

Business Auto Liability	Amount of coverage shall be no less than: ▪ $1,000,000 Per Accident	▪ Current ISO edition of CA 00 01 ▪ Arising out of any auto (Symbol 1), including owned, hired and non-owned
Workers' Compensation and Employer's Liability	Amounts of coverage shall be no less than: ▪ Statutory Limits ▪ $1,000,000 Each Accident and Disease ▪ Alternate Employer endorsement ▪ USL&H must be provided where such exposure exists.	▪ The State in which work is to be performed must listed under Item 3.A. on the Information Page ▪ Such insurance shall cover liability arising out of the Contractor's employment of workers and anyone for whom the Contractor may be liable for workers' compensation claims. Workers' compensation insurance is required, and no "alternative" forms of insurance shall be permitted. ▪ Where a Professional Employer Organization (PEO) or "leased employees" are utilized, Contractor shall require its leasing company to provide Workers' Compensation insurance for said workers and such policy shall be endorsed to provide an Alternate Employer endorsement in favor of Contractor and Owner. Where Contractor uses leased employees with Workers' Compensation insurance provided by a PEO or employee leasing company, Contractor is strictly prohibited from subletting any of its work without the express written agreement of Owner.
Excess Liability (Occurrence Basis)	Amounts of coverage shall be no less than: ▪ $5,000,000 Each Occurrence ▪ $5,000,000 Annual Aggregate	▪ Such insurance shall be excess over and be no less broad than all coverages described above. ▪ Drop-down coverage shall be provided for reduction and/or exhaustion of underlying aggregate limits and shall include a duty to defend any insured.
Professional Liability	Amounts of coverage shall be no less than: ▪ $1,000,000 Each Occurrence ▪ $2,000,000 Annual Aggregate ▪ If a combined Contractor's Pollution Liability and Professional Liability policy is utilized, the limits shall be $3,000,000 Each Loss and Aggregate. ▪ Such insurance shall cover all services rendered by the Contractor and its consultants under the Agreement, including but not limited to design or design/build services.	▪ Such insurance shall cover all services rendered by the Contractor and its subcontractors under the Agreement. ▪ This insurance is not permitted to include any type of exclusion or limitation of coverage applicable to claims arising from: o bodily injury or property damage where coverage is provided in behalf of design professionals or design/build contractors o habitational or residential operations o mold and/or microbial matter and/or fungus and/or biological substance o punitive, exemplary or multiplied damages. ▪ Any retroactive date must be effective prior to beginning of services for the Owner.

	▪ Policies written on a Claims-Made basis shall be maintained for at least two years beyond termination of the Agreement.	▪ Policies written on a Claims-Made basis shall have an extended reporting period of at least two years beyond termination of the Agreement. Vendor shall trigger the extended reporting period if identical coverage is not otherwise maintained with the expiring retroactive date.
Contractors Pollution Liability	Amounts of coverage shall be no less than: ▪ $1,000,000 Each Loss ▪ $2,000,000 Annual Aggregate ▪ If a combined Contractor's Pollution Liability and Professional Liability policy is utilized, the limits shall be $3,000,000 Each Loss and Aggregate. ▪ The policy must provide coverage for: o the full scope of the named insured's operations (on-going and completed) as described within the scope of work for this Agreement o loss arising from pollutants including but not limited to fungus, bacteria, biological substances, mold, microbial matter, asbestos, lead, silica and contaminated drywall o third party liability for bodily injury, property damage, clean up expenses, and defense arising from the operations; o diminution of value and Natural Resources damages o contractual liability o claims arising from non-owned disposal sites utilized in the performance of this Agreement.	▪ The policy must insure contractual liability, name Owner Parties as an Additional Insured, and be primary and noncontributory to all coverage available to the Additional Insured. ▪ This insurance is not permitted to include any type of exclusion or limitation of coverage applicable to claims arising from: o Insured vs. insured actions. However, exclusion for claims made between insured within the same economic family are acceptable. o impaired property that has not been physically injured o materials supplied or handled by the named insured. However, exclusions for the sale and manufacture of products are allowed. Exclusionary language pertaining to materials supplied by the insured shall be reviewed by the certificate holder for approval. o property damage to the work performed by the contractor o faulty workmanship as it relates to clean up costs o punitive, exemplary or multiplied damages o work performed by subcontractors ▪ If coverage is provided on a Claims Made basis, coverage will at least be retroactive to the earlier of the date of this Agreement or the commencement of contractor services relation to the Work. ▪ The policy will offer an extended discovery or extended reporting clause of at least three (3) years. ▪ Completed Operations coverage shall be maintained through the purchase of renewal policies to protect the insured and additional insured for at least two (2) years after the property owner accepts the project or this contract is terminated. The purchase of an extended discovery period or an extended reporting period on a Claims Made policy or the purchase of occurrence-based Contractors

		Environmental Insurance will not be sufficient to meet the terms of this provision.
Builders Risk	▪ Coverage shall be provided in an amount equal at all times to the full contract value, including change orders, and cost of debris removal for any single occurrence. ▪ Coverage shall be at least as broad as an unmodified ISO Special form, shall be provided on a completed-value basis, and shall be primary to any other insurance coverage available to the named insured parties, with that other insurance being excess, secondary and non-contributing. ▪ The policy must provide coverage for:	▪ Insureds shall include Owner, General Contractor, all Loss Payees and Mortgagees, and subcontractors of all tiers in the Work as Insureds. ▪ Such insurance shall cover: o all structure(s) under construction, including retaining walls, paved surfaces and roadways, bridges, glass, foundation(s), footings, underground pipes and wiring, excavations, grading, backfilling or filling; all temporary structures (e.g., fencing,

	○ Agreed Value ○ Damage arising from error, omission or deficiency in construction methods, design, specifications, workmanship or materials, including collapse ○ Debris removal additional limit ○ Earthquake and Earthquake Sprinkler Leakage ○ Flood ○ Freezing ○ Mechanical breakdown including hot & cold testing ○ Ordinance or law ○ Pollutant clean-up and removal ○ Preservation of property ○ Theft • Deductible shall not exceed ○ All Risks of Direct Damage, Per Occurrence, except ○ Named Storm, Earthquake and Earthquake Sprinkler Leakage, Per Occurrence ○ Flood, Per Occurrence or excess of NFIP if in Flood Zone A or V	Included Included $1,000,000 $5,000,000 $5,000,000 Included Included $1,000,000 $ 25,000 Included Included $10,000 2% subject to $50,000 minimum $100,000 $100,000	scaffolding, cribbing, false work, forms, site lighting, temporary utilities and buildings) located at the site; ○ all property including materials and supplies on site for installation; ○ all property including materials and supplies at other locations but intended for use at the site; ○ all property including materials and supplies in transit to the site for installation by all means of transportation other than ocean transit; and ○ other Work at the site identified in the Agreement to which this Exhibit is attached. • No protective safeguard warranty shall be permitted. • The termination of coverage provision shall be endorsed to permit occupancy of the covered property being constructed. This insurance shall be maintained in effect, unless otherwise provided for the Agreement Documents, until the earliest of: ○ the date on which all persons and organizations who are insureds under the policy agree that it shall be terminated; ○ occupancy, in whole or in part; ○ the date on which release of substantial completion is executed; or ○ the date on which the insurable interests of Contractor in the Covered Property has ceased. • A waiver of subrogation provision shall be provided in favor of all insureds.

2. <u>General Insurance Requirements</u>

A. <u>Definitions</u>. For purposes of this Agreement:

i. "ISO" means Insurance Services Office.

ii. "Contractor" shall include the Builder and its subcontractors of any tier.

iii. "Owner Parties" means (a) City of Schertz, Texas (collectively referred to as "Owner"), (b) the Project, (c) any lender whose loan is secured by a lien against the Work, (d) their respective shareholders, members, partners, joint venturers, affiliates, subsidiaries, successors and assigns, (e) any directors, officers, employees, or agents of such persons or entities, and (f) others as required by the Contract Documents.

B. Policies.

i. Contractor shall maintain such Excess Liability, Professional and Pollution insurance in identical coverage, form and amount, including required endorsements, for at least two (2) years following Date of Substantial Completion of the Work to be performed under this Agreement. Contractor shall maintain such General Liability insurance in identical coverage, form and amount, including required endorsements, for at least ten (10) years following Date of Substantial Completion of the Work to be performed under this Agreement. Contractor shall provide written representation to Owner stating Work completion date.

ii. All policies must:
   a. Be written through insurance companies authorized to do business in the State in which the work is to be performed and rated no less than A-: VII in the most current edition of A. M. Best's Key Rating Guide at all times Work is to be performed.
   b. Provide a waiver of subrogation in favor of Owner Parties on all insurance coverage carried by Contractor, whether required herein or not.
   c. Contain an endorsement providing for thirty (30) days prior written notice of cancellation to Owner.
   d. Be provided to the Owner Parties in compliance with the requirements herein and shall contain no endorsements that restrict, limit, or exclude coverage required herein in any manner without the prior express written approval of the Owner.

iii. Failure of any Owner Party to demand such certificate or other evidence of full compliance with these insurance requirements or failure of any Owner Party to identify a deficiency from evidence that is provided shall not be construed as a waiver of the Contractor's obligation to maintain such insurance.

iv. Contractor shall provide to the Owner a certified copy of all insurance policies required herein within ten (10) days of any such request. Renewal policies, if necessary, shall be delivered to the Owner prior to the expiration of the previous policy.

v. Commencement of Work without provision of the required certificate of insurance, evidence of insurance or required endorsements, or without compliance with any other provision of this Agreement, shall not constitute a waiver by any Owner Party of any rights. The Owner shall have the right, but not the obligation, of prohibiting the Contractor or any subcontractor from performing any Work until such certificate of insurance, evidence of insurance and/or required endorsements are received and approved by the Owner.

C. Limits, Deductibles and Retentions

i. The limits of liability may be provided by a single policy of insurance or by a combination of primary and excess policies, but in no event shall the total limits of liability available for any one occurrence or accident be less than the amount required herein.

ii. No deductible or self-insured retention shall exceed $25,000 without prior written approval of the Owner, except as otherwise specified herein. All deductibles or retentions shall be paid by, assumed by, for the account of, and at the Contractor's sole risk. The Contractor shall not be reimbursed for same.

D. Forms

i. If the forms of policies, endorsements, certificates or evidence of insurance required by this Exhibit A are superseded or discontinued, Owner will have the right to require other equivalent forms.

ii. Any policy or endorsement form other than a form specified in this Exhibit A must be approved in advance by Owner.

E. **Evidence of Insurance**. Insurance must be evidenced as follows:

i. ACORD Form 25 Certificate of Liability Insurance for liability coverages.

ii. ACORD Form 28 Evidence of Commercial Property Insurance for property coverages.

iii. Evidence shall be provided to Owner prior to commencing Work and prior to the expiration of any required coverage.

iv. ACORD Forms specify:
   a. Owner as certificate holder at Owner's mailing address;
   b. Insured's name, which must match that on this Agreement;

c. Insurance companies producing each coverage and the policy number and policy date of each coverage;
d. Producer of the certificate with correct address and phone number and have the signature of the authorized representative of the producer;
e. Additional Insured status in favor of Owner Parties;
f. Amount of any deductible or self-insured retention in excess of $25,000;
g. Designated Construction Project(s) General Aggregate Limit;
h. Primary and non-contributory status;
i. Waivers of subrogation; and
j. All exclusions and limitations added by endorsement to the General Liability coverage. This can be achieved by attachment of the Schedule of Forms and Endorsements page.

v. Copies of the following shall also be provided:
a. General Liability Additional insured endorsement(s);
b. General Liability Schedule of Forms and Endorsements page(s); and
c. 30 Day Notice of Cancellation endorsement applicable to all required policies.

F. <u>Contractor Insurance Representations to Owner Parties</u>

i. It is expressly understood and agreed that the insurance coverages required herein (a) represent Owner Parties' minimum requirements and are not to be construed to void or limit the Contractor's indemnity obligations as contained in this Agreement nor represent in any manner a determination of the insurance coverages the Contractor should or should not maintain for its own protection; and (b) are being, or have been, obtained by the Contractor in support of the Contractor's liability and indemnity obligations under this Agreement. Irrespective of the requirements as to insurance to be carried as provided for herein, the insolvency, bankruptcy or failure of any insurance company carrying insurance of the Contractor, or the failure of any insurance company to pay claims accruing, shall not be held to affect, negate or waive any of the provisions of this Agreement.

ii. Failure to obtain and maintain the required insurance shall constitute a material breach of, and default under, this Agreement. If the Contractor shall fail to remedy such breach within five (5) business days after notice by the Owner, the Contractor will be liable for any and all costs, liabilities, damages and penalties resulting to the Owner Parties from such breach, unless a written waiver of the specific insurance requirement(s) is provided to the Contractor by the Owner. In the event of any failure by the Contractor to comply with the provisions of this Agreement, the Owner may, without in any way compromising or waiving any right or remedy at law or in equity, on notice to the Contractor, purchase such insurance, at the Contractor's expense, provided that the Owner shall have no obligation to do so and if the Owner shall do so, the Contractor shall not be relieved of or excused from the obligation to obtain and maintain such insurance amounts and coverages.

iii. This Exhibit A is an independent contract provision and shall survive the termination or expiration of the Contract Agreement.

G. <u>Insurance Requirements of Contractor's Subcontractors</u>

i. Insurance similar to that required of the Contractor shall be provided by all subcontractors (or provided by the Contractor on behalf of subcontractors) to cover operations performed under any subcontract agreement. The Contractor shall be held responsible for any modification in these insurance requirements as they apply to subcontractors. The Contractor shall maintain certificates of insurance from all subcontractors containing provisions similar to those listed herein (modified to recognize that the certificate is from subcontractor) enumerating, among other things, the waivers of subrogation, additional insured status, and primary liability as required herein, and make them available to the Owner upon request.

ii. The Contractor is fully responsible for loss and damage to its property on the site, including tools and equipment, and shall take necessary precautions to prevent damage to or vandalism, theft, burglary, pilferage and unexplained disappearance of property. Any insurance covering the Contractor's or its subcontractor's property shall be the Contractor's and its subcontractor's sole and complete means or recovery for any such loss. To the extent any loss is not covered by said insurance or subject to any deductible or co-insurance, the

Contractor shall not be reimbursed for same. Should the Contractor or its subcontractors choose to self-insure this risk, it is expressly agreed that the Contractor hereby waives, and shall cause its subcontractors to waive, any claim for damage or loss to said property in favor of the Owner Parties.

H. Use of the Owners Equipment

The Contractor, its agents, employees, subcontractors or suppliers shall use the Owners equipment only with express written permission of the Owners designated representative and in accordance with the Owners terms and condition for such use. IF THE CONTRACTOR OR ANY OF ITS AGENTS, EMPLOYEES, SUBCONTRACTORS OR SUPPLIERS UTILIZE ANY OF THE OWNERS EQUIPMENT FOR ANY PURPOSE, INCLUDING MACHINERY, TOOLS, SCAFFOLDING, HOISTS, LIFTS OR SIMILAR ITEMS OWNED, LEASED OR UNDER THE CONTROL OF THE OWNER, THE CONTRACTOR SHALL DEFEND, INDEMNIFY AND BE LIABLE TO THE OWNER PARTIES FOR ANY AND ALL LOSS OR DAMAGE WHICH MAY ARISE FROM SUCH USE.

I. Release and Waiver

The Contractor hereby releases, and shall cause its subcontractors to release, the Owner Parties from any and all claims or causes of action whatsoever which the Contractor or its subcontractors might otherwise now or hereafter possess resulting in or from or in any way connected with any loss covered by insurance, whether required herein or not, or which should have been covered by insurance required herein, including the deductible or uninsured portion thereof, maintained or required to be maintained by the Contractor or its subcontractors pursuant to this Agreement. **THE FOREGOING RELEASE AND WAIVER APPLY EVEN IF THE LOSS OR DAMAGE IS CAUSED IN WHOLE OR IN PART BY THE FAULT OR NEGLIGENCE OR STRICT LIABILITY OF THE OWNER PARTIES.**

Tom Green & Company
Engineers, Inc.

EXHIBIT
C-1

CITY OF SCHERTZ
ANIMAL ADOPTION CENTER

August 6, 2019

ENGINEERING INNOVATION | TROUBLESHOOTING & FORENSICS | FEASIBILITY STUDIES | MASTER PLANNING & PROGRAMMING | SUSTAINABLE SYSTEMS | CONSTRUCTION SUPPORT SERVICES | COMMISSIONING VERIFICATIONS

CITY OF SCHERTZ ANIMAL ADOPTION CENTER

HVAC Findings & Recommendations

Presented to:

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MEILANI B. LEOS	120259
DATE RELEASED	8/06/19

August 6, 2019

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EXECUTIVE SUMMARY

At the request of The Chapman Firm PLLC, Tom Green & Company Engineers, Inc. (TGCE) has investigated and prepared this report of the heating, ventilation, and air conditioning (HVAC) systems for the original construction, and for subsequent audits and repair plans of the City of Schertz Animal Adoption Center. Reported herein are TGCE's findings and opinions regarding the systems and conditions being experienced at the building.

The building consists of roughly 6,000 square feet of conditioned/occupied space served by 13 direct expansion (DX) variable refrigerant flow (VRF) heat pump indoor fan coil units manufactured by LG. There are two outdoor condensing units with a total capacity of 16 tons. All of the ducted units are installed in an attic/mezzanine area. Outside air (OA) is ducted from a roof mounted intake hood directly to each cassette or to the return air (RA) duct of the ducted units. Manual volume balancing dampers are provided at each OA and RA duct.

In addition to the conditioned space, approximately 6,000 square feet of kennel space is adjacent to the conditioned portions of the building.

Two main issues are present in the building: inadequate temperature/humidity control; and insufficient overall and zone-to-zone building pressurization. It is of this Engineer's opinion that the root cause of this building's issues is attributed to both design and construction.

Controls sequences were not available for review. However, project correspondence implies that the building was designed to be constant air volume with temperature control achieved by variable refrigerant volume cooling coils. This design approach is capable of maintaining proper building pressurization; however, the design would not properly condition the ventilation air, predictably resulting in building humidity issues.

As constructed, the building operates with variable air volume (VAV) for both the supply and outside air. This operation approach results in improper building pressurization and insufficient humidity control of the infiltration air introduced.

Further, the LG control system is somewhat of a "black box". Programmed control sequences were not apparent during TGCE's site observations and setpoints were not clear.

In addition to implementing/correcting some of the issues noted in DBR's Comprehensive Repair Plan, a full recommissioning and rebalance of the building is the first step recommended to improve building HVAC operation with confidence. After the recommissioning effort, if the systems in large part are found to be suitable for continued use, a further recommended approach to control building pressurization, temperature, and humidity is to provide a pretreatment dedicated VRF outside air unit (DOAU). Providing a DX DOAU and dedicated condensing unit will allow humidity control of the OA and allow the humidity control in the spaces in the building to be decoupled from the existing VRF units, while maintaining constant air volume in the OA system. Alternatively, if the recommissioning effort reveals additional operational problems not yet discovered during this study, a potential full system redesign and replacement may be warranted. The potential for this more extensive replacement can be further evaluated after the initial recommissioning effort.

1.0 BACKGROUND, OBJECTIVES, AND METHODS

At the request of The Chapman Firm PLLC, Tom Green & Company Engineers, Inc. (TGCE) has investigated and prepared this report of the heating, ventilation, and air conditioning (HVAC) systems for the original construction, and for subsequent audits and repair plans of the City of Schertz Animal Adoption Center. Available information suggests that the project was completed in 2014 in one phase.

Reported herein are TGCE's findings and opinions regarding the systems and conditions being experienced at the building. This report does not address Electrical or Plumbing related work, as those disciplines were not within the scope of the investigation, except where they are directly coupled to HVAC items.

TGCE's overall role to date has been to review the design documents, constructed conditions, TAB (Test, Adjust, Balance) reports, and occupancy conditions, so that design, construction, and potential operational concerns, if any, might be identified. The process to date has also included review of a Comprehensive Repair Plan provided by the design and construction team.

Mechanical drawings and select construction documentation (correspondence, TAB reports) were provided to TGCE. Architectural drawings, electrical drawings, project specifications, and submittals were not available for review.

Because it is logical to place some reasonable bounds on the scope and methods of review, TGCE has not attempted a detailed examination of all the documents provided to it. Likewise, it has not attempted review of all possible engineering items that might be considered, calculated, designed, or constructed in the course of such a project. Accordingly, a complete critique of all design, construction, and occupancy elements has not been attempted, though certainly some critique is inevitable in the course of the reviews performed.

It should also be understood that the focus of this review has primarily been on design issues and the proposed corrective actions provided in the Comprehensive Repair Plan. Typically the root cause of issues being experienced in buildings could be attributed to design, construction, or facility operation/maintenance. In the absence of having received any maintenance logs or protocol, it is of this Engineer's opinion through document review and site observations that the root cause of this building's temperature, humidity, and pressurization issues is attributed to both design and construction, rather than operation/maintenance (or lack thereof). Systems of this kind, however, do warrant maintenance and troubleshooting to be performed by a skilled technician familiar with not only variable refrigerant flow (VRF) systems in general, but this specific brand of system (LG).

As with any such work in progress, the author reserves the right to modify this report to respond to new or changing information.

2.0 REPORT FORMAT

In a review such as this one, it is reasonable that the results be presented as clearly yet as succinctly as possible. In an attempt to accomplish this objective, a list of identified items which most merit attention is presented in addition to the action items listed in the Engineer of Record's Comprehensive Repair Plan. Each item is discussed as extensively or as briefly as is deemed appropriate. The discussion emphasis is in the facts as observed by TGCE, the understandings reported to TGCE, and their resulting significance. Where professional opinions are offered, they are identified as such.

3.0 HVAC SYSTEM ASSESSMENT

3.1 Existing System Description

A. The City of Schertz Animal Adoption Center is a single story, roughly 12,000 square foot building. The building consists of roughly 6,000 square feet of conditioned/occupied space and roughly 6,000 square feet of unconditioned kennel areas and outdoor storage. The conditioned spaces are served by 13 variable refrigerant flow (VRF) heat pump indoor fan coil units (marked "DS-XX") manufactured by LG. There are two outdoor condensing units with a total capacity of 16 tons. Eight of the indoor units are ducted fan coil units and five of the indoor units are ceiling cassette type units. All of the ducted units are installed in an attic/mezzanine area. Outside air (OA) is ducted from a roof mounted intake hood directly to each cassette or to the return air (RA) duct of the ducted units. Manual volume balancing dampers are provided at each OA and RA duct. Refer to Table 1 below for a summary of each indoor unit.

Table 1: VRF Unit Summary

	AREA SERVED	UNIT TYPE	DESIGN SUPPLY AIRFLOW (1)	DESIGN OUTSIDE AIRFLOW (2)
DS-01	DOG QUARANTINE	CASSETTE	265	25
DS-02	BACK OF HOUSE	DUCTED	475	195
DS-03	BACK OF HOUSE	DUCTED	430	150
DS-04	ISOLATION	DUCTED	115	150
DS-05	ANIMAL AREAS	DUCTED	330	90

DS-06	ANIMAL CONTROL	CASSETTE	671	67
DS-07	OFFICE AREAS	DUCTED	420	150
DS-08	LOBBY/OFFICES	DUCTED	785	485
DS-09	LOBBY/FRONT OF HOUSE	DUCTED	1635	500
DS-10	ADOPTION AREAS	DUCTED	500	150
DS-11	STRAY CAT HOLDING	CASSETTE	307	30
DS-12	TRAINING	CASSETTE	265	25
DS-13	BREAK ROOM	CASSETTE	396	40
		TOTAL	6594	2057

Note 1: Design supply airflow indicated is the sum of room supply airflows from duct plans. In some cases the sum of room supply did not equal the scheduled supply airflow value for the respective unit.

Note 2: Design outside airflow indicated is the scheduled value for each unit.

3.2 Review of DBR's Comprehensive Repair Plan

A. On March 26, 2018, DBR, Inc. (the Engineer Firm of Record) provided a Comprehensive Repair Plan at the direction of the Owner. DBR's proposed action items are presented below, followed by TGCE's comments.

1. DBR Recommendation: The existing DS-02, DS-03, DS-09, and DS-10 are delivering significantly less airflow than intended per design. These four units will be removed and replaced with three new stand-alone DX split systems. DS-02 and DS-03 will be replaced with one DX split system. DS-09 and DS-10 will each be replaced with a single split system. Each of these three new split systems will have stand-alone programmable thermostats for ease of operation. Replace DS-02, DS-03, DS-09, and DS-10 with standalone DX split systems.

   TGCE Comment: Special consideration should be given to duct design of inlet conditions to eliminate any system effect (i.e., inordinately high pressure drop) issues that may be causing reduced fan flow. See discussion 3.3.C below. Additionally, replacement of said units would only address the issue of low airflow/not meeting

temperature setpoint. If the new split systems continue to operate in a constant volume manner, a continued lack of humidity control due to the high quantity of untreated OA supplied by these zones will result. Not addressed in the comprehensive repair plan is the replacement of DS-04 which was also underperforming per the original TAB report (see discussion 3.3.A below).

2. DBR Recommendation: Proposed throw pattern adjustments to various supply diffusers (refer to Appendix A for full Repair Plan).

   TGCE Comment: Engineer sees no harm in retrofitting throw pattern of supply air diffusers to avoid any possible short cycling. Minor thermal comfort improvement may result from the proposed alterations.

3. DBR Recommendation: Return air grilles will be added in the lobby clerestory space to reduce sensible heat gain in the lobby.

   TGCE Comment: It is this Engineer's opinion that retaining a condition of thermal stratification of the clerestory area alone would not result in substantial heat gain in the occupied zone. Returning this warm, stratified air would result in additional load on the VRF fan coils which may not have been accounted for in the original design. Recommend re-evaluating loads before making proposed change.

4. DBR Recommendation: The copy machine was not anticipated to be located in its current position in the Administration area. The current location of the thermostat may result in a false demand for cooling, resulting in over-cooling of the space. Because over-cooling of this space has not been a complaint, we believe that the thermostat may remain in this location

   TGCE Comment: Do not disagree.

5. DBR Recommendation: The existing outside air intake hood on the roof will be removed and a new make-up air fan will be installed in its place. Upon completion of the installation of this fan and the new DX split systems, the outside air flow rate to all fan coil units will be re-balanced.

   TGCE Comment: Two points are relevant to this recommendation.

   1. With respect to the outside air for the existing system: Correspondence indicates that initial TAB was performed with a single unit operating at a time, and therefore recorded OA airflows are likely not reliable even at full cooling operation. Furthermore, the installed VAV operation reduces the outdoor air as indoor units' fan speeds decrease, thereby creating greater pressurization issues. Also see the discussions in 3.2.A.6 and 3.3.A below regarding observed OA damper positions. The TAB part of the recommissioning process can quantify OA in current operation.

   2. With respect to the proposed OA fan addition: A fan alone may adequately address pressurization issues but will not address the temperature and humidity issues without proper conditioning of the large quantities of OA. A pretreatment dedicated outdoor air unit (DOAU) is needed in lieu of an OA fan in order to properly address the building humidity issues. See further discussion in 4.0 Recommended Improvements/Corrections below.

6. DBR Recommendation: Per LG's request (VRF manufacturer), the airflow of the problematic fan coil units was tested on March 15, 2018. The results are tabulated in this report. The testing indicated that there has been virtually no change to the airflow from these units since the previous testing in November, 2017. Any adjustments made by LG representatives in January of 2018 did not change the airflow.

   TGCE Comment: Report indicates that the fan coil units continue to operate in a variable volume mode while constant volume was intended by design. Operating the fan coil units in a variable volume manner as currently constructed results in variable volume OA, negative building pressurization, and building infiltration. Refer to 3.4A for further discussion on Building Pressurization and why variable volume OA operation is problematic.

7. DBR Recommendation: The refrigerant piping at the connection to the coil of DS-09 is currently not insulated. This unit will be removed and replaced with a new split system.

   TGCE Comment: Any missing or damaged piping insulation should be addressed as required.

8. DBR Recommendation: The control wiring is currently spliced at units DS-09 and DS-10. These units will both be removed and replaced with new split systems. The new DX split systems will have stand-alone programmable thermostats.

   TGCE Comment: Refer to TGCE Comment on 3.2.A.1 above.

9. DBR Recommendation: Gaskets will be added to the return air filter access panels at all the remaining ducted fan coil units in the mezzanine space (DS-04, 05, 07, 08).

   TGCE Comment: Concur, though gaskets alone will not close the large air bypass gaps between the filters and the units casing. Additionally, TGCE recommends bypass safing plates and thorough cleaning of coils (due to delayed filter maintenance and significant air bypass and coil fouling likely to have occurred). Not addressed in the DBR recommendation is the likely high static pressure loss associated with the size and location of the installed filters. See further discussion in 3.3.C.5 below.

10. DBR Recommendation: One training session of up to 4 hours will be provided for City of Schertz staff. The training will include hands on demonstrations of the operation and maintenance procedures for the LG VRF system and the new DX split systems. Documentation will be provided for future reference.

    TGCE Comment: Concur.

3.3 Variable Refrigerant Flow System Observations

The building HVAC system primarily consists of Variable Refrigerant Flow (VRF) air handling units (a combination of ducted indoor units and cassette type units).

A. Cooling & Dehumidification:

1. Leaving Air Temperatures: Initial unit test data (conducted on February 4, 2014) included in the original TAB report (dated May 19, 2014) indicated potential cooling/dehumidification problems with DS-02, 03, 04, and 09. With the outdoor ambient temperature at 63°F, the DS units were recording leaving air temperatures

ranging from 58°F to 63°F. Although design leaving air temperatures were not included in the equipment schedules, it is this Engineer's experience that a maximum leaving air temperature of 55°F would be desirable to maintain relative humidity below the normally accepted industry threshold of 60%. However, with unprocessed outside air being brought into these units, based on typical psychrometrics, a design leaving air temperature of 50-52°F would be a more appropriate target for proper dehumidification control.

2. Latent Capacity: VRF systems were selected by the Engineer of Record using ASHRAE 0.4% cooling condition (99°F DB/75°F WB) for the outside air. It is this Engineer's experience that although the sensible (space temperature) cooling peak will be driven by this condition, the latent (space humidity) cooling peak occurs at the ASHRAE 0.4% dehumidification condition (80.2°F DB/77°F WB) which results in a roughly 10% higher total cooling load on the system due to the increased dehumidification required. This difference is especially important in systems (such as this one) with high percentages of outdoor airflow.

3. Capacity & Diversity: Additionally, the total scheduled cooling load by design was 18 tons, while the total scheduled (and installed) outdoor units' capacity is 16 tons. It is not uncommon in a VAV system to design around some peak diversity, though given this building's size and that it was designed to operate in a constant air volume condition, a 12% diversity may be overly generous.

4. Site Observations: TGCE did not observe high room temperatures on site due to spot coolers being used throughout the occupied spaces. TGCE did observe, however, elevated levels of relative humidity (>60% RH), indicating the VRF system was not properly dehumidifying the building. TGCE also observed all OA dampers to be in the full closed position. With building exhaust running 23 hours per day, outside air finds its way into the building as infiltration through cracks around doors, windows, etc. This condition not only results in difficult control of building humidity, but also could lead to dirt/dust infiltration and moisture/condensation within exterior walls.

B. Airflow Controls:

1. Intended Sequences of Operation are Uncertain: Intended controls sequence of operations were not found in the documents provided to TGCE. Engineer of Record's correspondence indicates that a constant air volume (CAV) airflow system was intended for both the VRF units and the building exhaust fans, though the VRF units have been and continue to operate in a variable speed manner. TGCE on-site observations indicate the installed condition is consistent with the intended exhaust constant volume operation (exhaust fans are controlled by a programmable time clock and have no installed means of variable air volume operation). See further discussion of this subject in 3.4 Building Pressure Observations below.

2. Constant Volume without Pre-conditioning of Outdoor Air: With a constant air volume system, temperature control must be handled by the unit leaving air temperatures (in lieu of reducing airflow) or subcooling of zones would occur. No reheat capability was observed in this system design, indicating that the method for controlling leaving air temperatures would be to reduce the cooling capacity of the units (by reducing refrigerant flow). This control method would be appropriate if the OA were being acceptably preconditioned. However in the absence of any OA preconditioning, reduced cooling at the VRF units results in the inability to control building relative

humidity. The predictable result would be high humidity and temperature issues in the cooling season, consistent with what is occurring in the building.

3. Intended Airflows are Uncertain: Several of the scheduled airflow values were not consistent with the sum of the airflows indicated on the ductwork plans. It is unclear if the Engineer approved of the TAB contractor's airflow setpoints in cases where inconsistencies were present.

C. Duct Design & Construction:

1. Unit Inlet Conditions: Highly undesirable inlet conditions were observed at all of the ducted VRF units that may contribute to increased system effect and result in reduced airflow capability for the supply fans. The installation of ductwork is consistent with the original design documents. Refer to Figure 1 below.

2. OA Duct Design: Additionally, high static pressure loss conditions were observed with the ducted OA which may contribute to the reduced OA experienced by TAB. Per the original design documents, many of the OA branch ducts were sized with higher than desirable static pressure losses, especially for the equipment and systems used in the project. Standard engineering practice is to size low pressure ductwork not to exceed a pressure loss of 0.08 inches of water column (")/100 ft of duct (and often a lower value for return and outdoor air ducts). It is especially important for OA ducts to have low pressure drops when the OA system is absent of a dedicated fan and relies on induction, such as this system. OA ducts serving DS-03 and DS-04 have a pressure drop of 0.17"/100 ft (twice the standard loss). OA ducts serving DS-08 and DS-09 also have higher than desirable pressure drops at 0.13"/100 ft.

Figure 1: High Loss Elbow into Fan Inlet

3. Duct Liner: Return and supply ducts were not externally wrapped with insulation and site investigation indicated that the thermal insulation is achieved through lined ductwork. Lined ductwork is undesirable, especially in systems with humidity issues, as it can allow microbial growth. This finding is consistent with those in the report provided by Argus Environmental Consultants, LCC, dated June 24, 2016. It is this Engineer's opinion that microbial growth reported by Argus will, in the absence of a DOAU, continue to be an issue in the lined supply ductwork as the fan coil units deliver supply air at a nearly saturated condition on a regular basis.

4. Damper Design: Per the original design documents, OA ducts were to have one control damper at the main intake hood, and both control dampers and manual volume dampers in each branch to the VRF units. Additionally, by design, the RA ducts were to have only manual volume dampers in each branch serving the VRFs, located upstream of the OA duct connection.

Field observations indicated that there were no volume dampers (manual or control) present in the RA ductwork located in the mezzanine. Some RA grilles in the occupied spaces had dampers, while others did not. Only manual volume dampers were observed to be installed in the OA branches; no control dampers were found. Without volume dampers in the RA ductwork, it would be difficult to achieve design OA, even if operating as constant volume systems, since the OA ductwork system by design has a higher pressure drop than does the return air duct system. If operating as variable air volume as is currently done, without control dampers in the RA system, any reduction in system supply air would lead to a reduction in OA which would be undesirable paired with a constant volume exhaust system, as it would lead to a negatively pressurized building.

5. Insufficient Filter Access: Original design/construction did not allow for sufficient filter access. Field-built filter access doors were provided after occupancy. See Figure 2 below. Filter frames and access doors appear to be improperly constructed (access doors not sealed, filter trays not square) which will allow significant air bypass and has resulted in fouling of the coils. Additionally, the location and size of the filters results in an inordinately high pressure drop which may be contributing to reduced airflow capacity of the fan coil units. For example, based on the duct sizes indicated in the original construction documents, the filter location for DS-09 results in a filter velocity of over 1200 fpm at design condition. Standard recommended filter velocity is 500 fpm maximum.

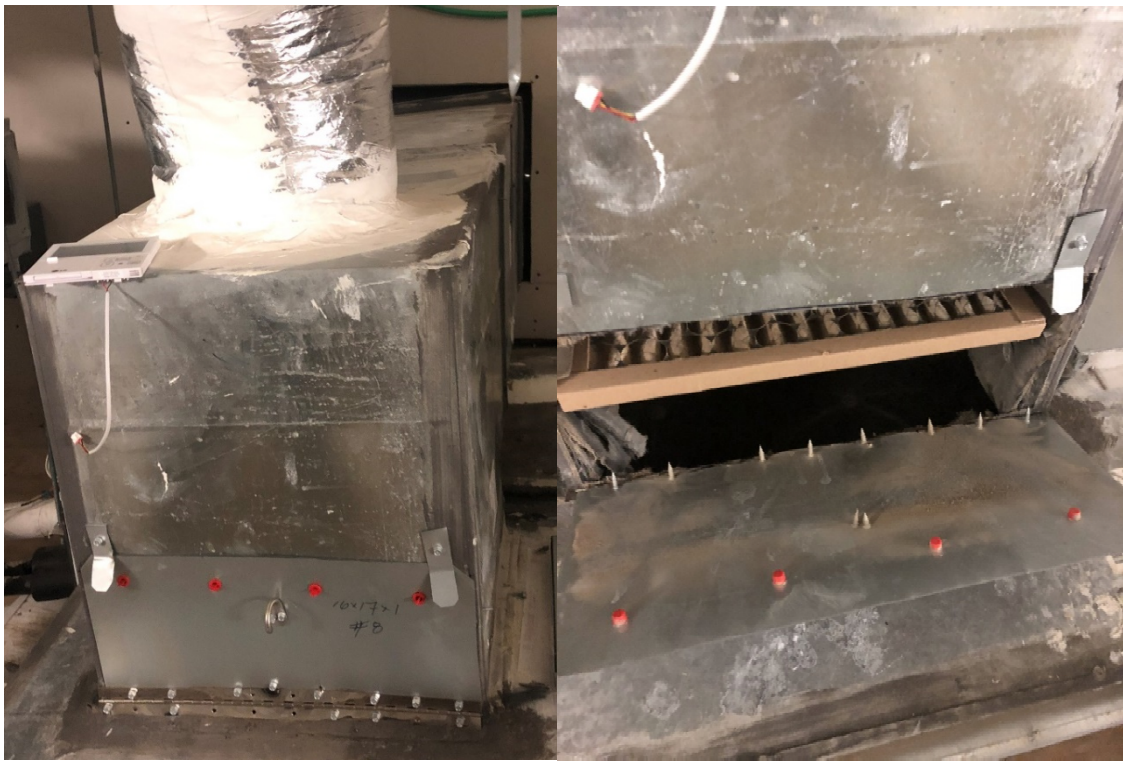

Figure 2: Field-Built Filter Access

3.4 Building Pressurization Observations

A. Pressurization Offset:

1. Marginal Positive Building Pressurization by Design: Original design and reported TAB airflows are tabulated below. The building was designed to be positively pressurized by roughly 1% to 3% (assuming constant volume OA and exhaust operation). The 3% is net positive pressurization, expressed as: (outdoor air cfm – exhaust air cfm) ÷ supply air cfm. Three percent (3%) is considered to be on the low end for this type of building in this climate.

2. Negative Building Pressurization by Operation: The latest full TAB audit (June 24, 2016) indicated much lower outside airflow rates than design, resulting in a highly negatively pressurized building (-22%). The subsequent TAB audit performed in November 2017 did not include OA or exhaust airflows. The November audit did also not include any of the cassette airflows. Due to the limited information provided, the November audit was not included in Table 2 below.

Table 2: Building Pressurization Summary

	SUPPY	OUTSIDE AIR	EXHAUST	NET. PRESS.
ORIGINAL DESIGN SCHEDULED	7273	2057	1960	1.3%
ORIGINAL DESIGN PLANS	6594	2057	1830	3.4%
INITIAL TAB	6131	1940(1)	1840	1.6%
TAB AUDIT 6/24/16	5095	480	1597	**(-21.9%)**

Note 1: DBR, Inc. reports that this outside air value is the sum of the OA to each VRF unit operating in isolation (not the total OA when all units are operating).

On-site building pressurization measurements taken on the May 30th site visit indicated nearly all pressurization readings were opposite of those which should be provided for this building and spaces within (spaces which were expected to be positive measured negative, and vice versa). Results are presented in Table 3 below.

Table 3: Building Pressurization Measurements

	EXPECTED PRESSURIZATION	ACTUAL MEASURED
MAIN ENTRY TO OUTSIDE	+0.05”	**(-0.008”)**
ANIMAL CORRIDOR TO LOBBY	**(-0.02”)**	+0.001
QUARANTINE 1 TO ANIMAL CORRIDOR	**(-0.02”)**	+0.001”
QUARANTINE 2 TO ANIMAL CORRIDOR	**(-0.02”)**	0”
QUARANTINE 3 TO ANIMAL CORRIDOR	**(-0.02”)**	**(-0.002”)**

BACK OF HOUSE TO ANIMAL CORRIDOR	+0.02”	**(-0.0004”)**
BACK OF HOUSE QUARANTINE 1 TO CORRIDOR	**(-0.02”)**	+0.002”
BACK OF HOUSE QUARANTINE 2 TO CORRIDOR	**(-0.02”)**	0”
BACK EXIT DOOR TO OUTSIDE	+0.03”	+0.002”

Note 1: Pressure reading indicates relative pressure from reference point to adjacent space. Pressurization measurements taken on the May 30th site visit during calm to low wind conditions.

3. Variable Speed Operation: The comprehensive repair plan from DBR, Inc. indicates that as of March 15, 2018, the VRF units were operating in a variable speed manner. Field measurements and observations by TGCE in July of 2018 indicate the building was operating in a neutral condition. Follow up site observations by TGCE in May 2019 indicated even with VRF units operating at maximum fan speed (as overridden by Dilmack technician upon our arrival) the building operates in a slightly negative condition (negative at the building entrance and positive at the back of the building, consistent with windward/leeward directions). Site measurements were taken with generally calm exterior wind conditions.

4. Recommended Pressurization: A properly constructed and (positively) pressurized building of this type should typically experience a positive pressurization of approximately 0.03” w.c. to 0.05” w.c. with respect to outside (correlates to roughly 10-15% net pressurization). Warm and humid climates merit pressurization on the upper part of the range. Any negative building pressure is undesirable.

   In order to contain odors and airborne particles from the animal holding and quarantine rooms, this building should operate with cascading pressurization. For example, quarantine rooms should operate negatively pressurized with respect to adjacent spaces, yet also positively pressurized with respect to the outdoors. Similarly, the animal holding areas should operate negatively pressurized with respect to the lobby and other common areas, and positively pressurized with respect to the outdoors. Follow-up site observations by TGCE in May 2019 indicated nearly all opposite pressurization readings than expected.

B. Airflow Controls:

1. Intended Control Sequence Unclear: Intended controls sequence of operations were not found in the documents provided to TGCE. Engineer of Record’s correspondence indicates that a constant air volume (CAV) airflow system was intended for both the VRF units and the building exhaust fans. Post construction correspondence indicates that VRF units are operating in a variable speed mode while exhaust fans were running at a constant speed 24/7. Site observation indicates building exhaust fans are

controlled off a timeclock and run 23 hours per day (with a one-hour shutdown occurring overnight) and VRF units operate in a variable speed manner.

2. Variable OA: The mechanical ductwork design consists of ducted OA from a common intake hood into each individual VRF unit. Because the OA is not decoupled or on a separate fan, any variable flow operation of the VRF units results in a reduction of OA supplied to the building for ventilation and pressurization and is therefore undesirable and improper.

4.0 RECOMMENDED IMPROVEMENTS/CORRECTIONS

4.1 Baseline Premise

While TGCE may have selected an engineering approach to the building different than the designed and installed system, a baseline premise is that the existing components be retained to the extent they can properly serve the long term needs of the building. This approach will generally be more cost-effective due not only to the HVAC system costs, but also the "dominoes" related to structural and architectural accommodations, electrical distribution, and building disruption or closures. The recommissioning process will either validate this premise or give rise to other considerations.

4.2 Building Recommissioning

Existing controls documentation were not provided to TGCE for review. Project correspondence documents indicated the intended program sequence to be constant air volume, however site investigations revealed current controls operation to be variable air volume. Further, the existing LG controllers are a bit of a black box and existing programmed controls are not apparent. Due to the lack of clarity from the existing controls and building operation, a full recommissioning and rebalance of the building is the first step recommended in order to improve building HVAC operation with confidence.

This recommissioning effort should be led by engineers experienced in field commissioning verifications and troubleshooting controls and supported by programmers and technicians skilled in LG VRF controls systems. TGCE's Opinion of Probable Construction Cost (OPCC) for the recommissioning and rebalance effort is estimated at $45,000 +/- 30%. This rough estimated cost includes on site commissioning by an Engineer, accompanied by an LG technician, and a full TAB audit and rebalance.

If the recommissioning effort reveals additional operational problems not yet identified, a potential full system redesign and replacement may be warranted. This more extensive replacement can be further evaluated (for both necessity and cost) after the initial recommissioning effort.

4.3 Building Pressurization, Cooling, & Dehumidification

The operation of the system must be corrected such that a constant volume of OA is supplied on the same schedule as the exhaust fans in order to maintain positive pressure in the building. It is predictably assured that modifying only the building pressurization offset alone will not be sufficient to remedy the humidity and cooling issues the building is currently experiencing. Assuming the recommissioning effort indicates existing system is mostly suitable for continued use (with modifications/repairs as indicated in the body of the report, plus others that may be identified in recommissioning), the primary recommendation for improving the building's

pressurization, humidity, and cooling issues is the installation of a Pretreatment Dedicated Outside Air Unit (DOAU).

A. Pretreatment Dedicated Outside Air Unit (DOAU)

The recommended approach to control building humidity is to provide a pretreatment dedicated outside air unit (DOAU). Providing a DX DOAU and dedicated condensing unit will allow humidity control of the OA and the spaces in the building to be decoupled from the VRF units. Site investigation in May 2019 revealed a possible location for a DOAU hung high in the attic/mezzanine above existing VRF units and ductwork. Preliminary calculations indicate a roughly 15-ton system would be needed for OA preconditioning. Structural modifications may accompany the DOAU installation. Selective demolition and re-construction of ceilings and partitions will likely be needed.

The system would include a DX VRF heat pump condensing unit and a custom air handling unit containing filters, wrap around heat pipe, cooling coil (potentially also a hot gas reheat coil), and a supply fan. This size DOAU correlates to roughly 80 amps of spare electrical capacity required. Site investigation and review of onsite electrical drawings indicate an original spare capacity of 140 amps, some of which has been consumed due to recent renovations (“big ass” fans). However, it is believed that there is enough spare electrical capacity to serve a DOAU.

If further engineering analysis warranted, consideration of a DOAU with active desiccant dehumidification could be an option.

4.4 Additional Recommendations

A. Lined Ductwork:

1. Removal of Lined Ductwork: As mentioned above, with the existing system’s supply air delivery near saturated conditions on a regular basis, microbial growth will continue to be encouraged especially in the supply ductwork. In the absence of a new DOAU, all lined supply ductwork should be removed and replaced with externally wrapped ductwork to avoid further microbial growth in the ductwork system. Replacement of ductwork may require de-occupying select spaces for a short duration, though due to minimal duct lengths over hard ceilings it would be feasible to replace all lined duct in stages (one or two zones at a time) over nights and/or weekends to minimize building occupancy disruption.

2. Clean/Coat Lined Ductwork: If a DOAU were provided, a lower cost and less disruptive option to remedy the microbial potential of lined ductwork would be to clean, disinfect, and treat the liner with an antimicrobial coating similar to Fosters 40-20 Fungicidal Protective Coating.

B. Filters Bypass and High Velocity:

1. Field-built filter access doors provided after occupancy appear to be improperly constructed (access doors not sealed, filter trays not square) which will allow significant air bypass and has resulted in fouling of the coils. It is recommended that gasketing be added to the new filter trays to minimize air bypass and fouling of coils. It is also recommended that a thorough coil cleaning be performed to improve the performance of the VRF units.

2. As discussed in 3.3.C.5, the location and size of the field built filters results in an inordinately high pressure drop which may be contributing to reduced airflow capacity of the fan coil units. It is recommended that return ducts be reconfigured to allow for larger face area for filters (reduced face velocity) in order to improve filter efficiency, decrease system pressure drop, and improve airflow capacity.

C. Rebalancing of Air Duct System: Several holding rooms and other spaces not originally designed to be used as Quarantine Rooms are currently being used in that manner. It is recommended that a full HVAC system air rebalance occur to properly pressurize all rooms to match their current operating needs.

D. It should be noted that the complex recommendations presented in 4.2 and 4.3 above necessitate not only a properly qualified and experienced engineering design, but just as necessary qualified construction implementation and commissioning of systems. Special care should be given to evaluating/selecting professionals to carry out the recommended actions presented in this report.

-END-

Tom Green & Company
Engineers, Inc.

EXHIBIT
C-2

STATE OF TEXAS
T. F. GREEN
51655
REGISTERED
PROFESSIONAL ENGINEER
8/7/2020

RETRO-COMMISSIONING REPORT

CITY OF SCHERTZ
ANIMAL ADOPTION CENTER

August 7, 2020

ENGINEERING INNOVATION | TROUBLESHOOTING & FORENSICS | FEASIBILITY STUDIES | MASTER PLANNING & PROGRAMMING | SUSTAINABLE SYSTEMS | CONSTRUCTION SUPPORT SERVICES | COMMISSIONING VERIFICATIONS

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1.0 EXECUTIVE SUMMARY

The City of Schertz sought professional retro-commissioning (Retro-Cx) services at the City of Schertz Animal Adoption Center to apply a systematic investigation process for evaluating the operation of the building's HVAC system.

TGCE's prior Assessment Phase report on "HVAC Findings and Recommendations" dated August 6, 2019, identified a number of conditions that would preclude the designed and installed system from properly serving the facility. An objective of this Retro-Cx project has therefore been to establish to what extent parts of the existing system could be retained in the envisioned improvements to occur.

Retro-Cx is an important early step in the HVAC improvement process. It typically precedes any pre-design or design efforts. Retro-Cx comes early because it provides an understanding of how closely the HVAC system comes to operating as intended and needed. It helps to identify improper equipment performance, equipment or system needs, actions to improve HVAC system performance, and sometimes opportunities to reduce operating expenses.

In the aforementioned Assessment Phase, Tom Green & Company Engineers, Inc. (TGCE) conducted a series of phone conversations and virtual web meetings, reviewed available building documentation, interviewed building stakeholders, performed building walk-throughs, and incorporated observations, spot measurements, and information into an Assessment Report.

The Retro-Cx Phase included the creation of a Cx Plan, on-site functional testing and measurements, and analysis of the data collected. Our analyses compared the actual building ("as-found") conditions and system performance with the design intent, while also comparing with standard engineering practices and applications. This report is the conclusion of the Retro-Cx Phase. It includes recommendations to replace the existing HVAC system in its entirety, excepting possibly duct systems beyond the mechanical mezzanine platform.

The Retro-Cx process used was systematic and documented. An overall summary of the activities are as follows:

- Prepare a Retro-Cx plan that describes the process for investigating and analyzing relevant building systems to verify if they are working as intended.

- Conduct field investigations and analysis; compile and review findings; conduct interviews of key staff members; utilize trend logs from building automation controls, portable testing instruments, and functional testing to evaluate the operational and performance capabilities of the existing HVAC system.

- Identify and recommend building system improvement options and provide associated cost estimates.

Two replacement options have been recommended for further consideration. The Opinions of Probable Construction Cost (OPCC) for either option is $1,145,000 (+/- 30%).

2.0 OVERVIEW

2.1 Building Information

Owner/Agency:	City of Schertz
Project Name:	Animal Adoption Center

2.2 Retro-Cx Team

TEAM MEMBER	NAME/ADDRESS	CONTACT INFO
Owner's Representative	City of Schertz Animal Adoption Center 800 Community Circle Drive Schertz, TX 78154	Philip Gaudreau 214-673-7557 PGaudreau@schertz.com
Owner's Representative	City of Schertz Animal Adoption Center 800 Community Circle Drive Schertz, TX 78154	Brenda Spinelli BSpinelli@ntdmechanical.com
Owner's Representative	City of Schertz Animal Adoption Center 800 Community Circle Drive Schertz, TX 78154	Chad Lonsberry clonsberry@schertz.com
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TAB Contractor (TAB)	Air Technologies, Inc. P.O. Box 129 Manchaca, Texas 78652	Damian Albiter 512-947-0606 damian@airtechtx.com

2.3 Equipment Inventory

The following table summarizes the equipment tested during Retro-Cx activities. Note: This list is not all-inclusive; other mechanical equipment (e.g., fans and electric unit heaters) that were not the primary focus of Retro-Cx activities exist within this facility.

EQUIP. TAG	MANUF. IDU IDENTIFICATION	TYPE	AC SMART ZONE IDENTIFICATION	ROOM(S) SERVED
DS-01	IDU-2	Cassette	Rabies Observation	Dog Quar. 127
DS-02	IDU-13	Ducted	Intake Dog Grooming	Corridor 116B, E-Room/Freezer 125, Grooming Intake 126
DS-03	IDU-7	Ducted	Feeding Room	Laundry 119, Food Prep 122
DS-04	IDU-6	Ducted	Dog Quarantine	Jan./Stor. 121, Iso. 124
DS-05	IDU-8	Ducted	Cat Quarantine	Corridor 116C, Corridor 116D, Supp. Adopt. 130
DS-06	IDU-1	Cassette	ASO Office	Animal Control Officers 133
DS-07	IDU-9	Ducted	Manager's Office	Adopt. CNSL 105, Storage 114A, Shelter Manager 131
DS-08	IDU-11	Ducted	Admin	Admin. 101B, Lost & Found Lobby 102, Vestibule 103, Cat Adopt. 106
DS-09	IDU-12	Ducted	Lobby	Vestibule 100, Adopt. Lobby 101, Adopt. Serv. 101A, Dog Display 107, Get Acquainted Room 108, Men's RR 109, Women's RR 110
DS-10	IDU-10	Ducted	Retail Dog	Retail Dog Adoption 112, Corridor 113, Puppy Adoption 115, Staff T/R 120
DS-11	IDU-3	Cassette	Cat Intake	Stray Cat Holding 128
DS-12	IDU-4	Cassette	Training	Training 114
DS-13	IDU-5	Cassette	Break Room	Break Room 118

3.0 FACILITY PERFORMANCE ANALYSIS

The following analysis is intended, in part, to address findings and questions from TGCE's prior assessment, and to determine if existing equipment can be reused.

3.1 Building Pressurization

A. Marginal Positive Building Pressurization by Design: As a reminder from our Assessment Report dated 8/6/2019, we established that the building was designed to be positively pressurized by roughly 1% to 3% (assuming constant volume OA and EA operation), which is considered to be low for this type of building in the Schertz hot-humid climate.

B. Negative Building Pressurization by Operation: Similar to previous TAB Audits performed at the facility, a negative net pressurization (-12%) was found by our Team during Retro-Cx activities.

Table - 3.1.1: Building Pressurization Summary

$Net\ Pressurization\ \% = \frac{OA - EA}{SA}$	SUPPLY AIR (SA)	OUTSIDE AIR (OA)	EXHAUST AIR (EA)	NET PRESS.
Design (Scheduled)	7273	2057	1960	1.3%
Design (Sum of Devices)	6594	2057	1830	3.4%
Initial TAB	6131	1940 (1)	1840	1.6%
TAB Audit (6/24/16)	5095	480	1597	(-21.9%)
TAB Retro-Cx (6/23/20)	5165	459 (2)	1081 (3)	(-12%)

(1) DBR, Inc. reports that this outside air value is the sum of the OA to each VRF unit operating in isolation (not the total OA when all units are operating). It, therefore, is in error as it does not reflect normal building operation.
(2) All OA serving cassette type units were measured with negative/reverse airflow and, therefore, are subtracted from the system outside airflow total.
(3) Exhaust fans (EFs-1, 2, & 3) operate on a dedicated timeclock (independent of LG AC Smart control system). Facility managers indicate the timeclock is programmed to run 23 hours a day (with a one-hour shutdown occurring overnight).

C. Building Pressurization Measurements: Consistent with previous site visits, our pressurization measurements performed during Retro-Cx activities, in most cases, yielded the opposite of what should exist for this building and the spaces within. Results are provided on *page 6* of *Appendix C – Test and Balance (TAB) Report*.

A properly pressurized building in a hot-humid climate should generally experience exfiltration (leaks inside to outside) rather than infiltration (leaks outside to inside). Nearly all measurements taken at exterior doors were experiencing infiltration.

D. Recommended Pressurization: As previously communicated in our 8/6/2019 Assessment Report, we suggested 10-15% net pressurization. After a closer review of building conditions during Retro-Cx activities, a recommendation of ~18% is more likely to yield acceptable performance at this building.

3.2 System Capacities Comparisons

Detailed HVAC load calculations were not performed by TGCE to determine the appropriateness of the design capacities. Since actual cooling required in a building is dependent on a multitude of factors, including building shape and orientation, windows, occupancy quantity and types, and miscellaneous heat loads from equipment, among other things, an estimate of the cooling load in the building was beyond the scope of this effort.

However, a holistic analysis of system capacities, both sensible and latent, allows us to compare the scheduled design intent versus the actual measured and calculated performance. The tables below summarize these comparisons. *Note: Due to the inability to accurately measure supply and return airflows on the cassette type units, our analysis is limited to the ducted fan coil units only, although similar trends can likely be expected on the cassette units.*

A. Design Conditions

1. Overview: To properly examine the design condition information presented in *Table 3.2.1* below, we are reminded of the difference between sensible and latent capacities. Sensible capacity is the capacity required to lower the temperature while latent capacity is the capacity required to remove moisture from the air. By design, it is typical to see higher sensible capacities to serve building cooling loads. However, if latent loads are not adequately addressed, especially those from high quantities of outdoor air, increased humidity levels within the spaces result.

Table 3.2.1 – Design System Capacities

	DESIGN CONDITIONS									TOTALS
DESIGN	Ducted Unit Tags	DS-02	DS-03	DS-04	DS-05	DS-07	DS-08	DS-09	DS-10	-
	SA CFM (Scheduled) (1)	454	425	425	245	425	1335	1635	425	5369
	SA CFM (Sum of Devices) (2)	550	430	425	270	420	785	1125	500	4505
	Entering air condition (°F db/ %RH)	85 / 42	85 / 42	85 / 42	85 / 42	85 / 42	85 / 42	85 / 42	85 / 42	-
	Total Cooling (MBH)	18.4	11.1	11.8	6.7	10.6	39.9	50.0	10.8	159.3
ESTIMATED	Leaving air condition (°F db/ %RH) (3)	57.5 / 87	64 / 80	63 / 82	63.3 / 81	64 / 82	62 / 83	62 / 82	64 / 81	-
	Sensible capacity (MBH)	13.5	9.6	10.1	5.7	9.6	33.2	40.6	9.6	131.9
	Latent capacity (MBH)	4.9	1.5	1.7	1.0	1.0	6.7	9.4	1.2	27.4

(1) Supply air CFM used in calculations/selections within the Retro-Cx analysis.
(2) Supply air CFM presented to illustrate the discrepancy between some scheduled design values and the sum of air devices (diffusers) on Contract Documents.
(3) Estimated using psychrometric analysis and scheduled CFM, MBH, and Entering air (EA) conditions.

2. Discussion of total, sensible, and latent capacities

   Total Capacity: For the design condition, the total capacity is the scheduled value of each unit. This total capacity, along with entering air conditions, airflow rate, and typical coil performance curves, enables estimation of leaving air conditions. This is a straightforward psychrometric analysis.

   Sensible Capacity: Sensible capacity relates to the temperature (only) cooling. The sensible capacity excludes dehumidifying properties of the cooling coil. These values are readily estimated using airflow rates and "delta T," or difference between entering and leaving dry bulb temperature.

   Latent Capacity: The latent capacity relates to the dehumidifying properties of the cooling coil. These values were obtained by subtracting sensible capacity from the total capacity.

B. As-found Conditions

Table 3.2.2 – As-found System Capacities

	AS-FOUND CONDITIONS									TOTALS
MEASURED	Ducted Unit Tags	DS-02	DS-03	DS-04	DS-05	DS-07	DS-08	DS-09	DS-10	-
	SA CFM (Measured) (1)	272	260	129	369	446	630	772	383	3261 (2)
	Entering air condition (°F db/ %RH)	71.4 / 79.4	72 / 81.4	72.2 / 73.2	69.7 / 70.6	70.6 / 74.5	74.1 / 67.1	79.8 / 68.8	74.3 / 72.4	-
	Leaving air condition (°F db/ %RH)	55.0 / 92.1	55.0 / 94.7	55.2 / 92.9	53.9 / 92.6	56.0 / 96.5	54.5 / 100	57.7 / 94.5	58.2 / 93.6	-
ESTIMATED	Total Cooling (MBH)	11.1	11.2	4.8	11.4	13.1	23.0	39.5	13.3	127.4 (3)
	Sensible capacity (MBH)	4.8	4.8	2.4	6.3	7.0	13.3	18.4	6.7	63.7
	Latent capacity (MBH)	6.3	6.4	2.4	5.1	6.1	9.8	21.1	6.6	63.8

(1) Measured as-found CFM with fan speeds set to 'High'. Typical all units.
(2) A 40% shortfall below scheduled values in design.
(3) A 20% shortfall below scheduled values in design.

1. Discussion of as-found tests

   Leaving air temperatures (LATs) measured during Retro-Cx activities ranged from approx. 54-58°F, with an average close to 55°F. However, because the measured LATs occurred at deficient airflows (total and OA), the values are deceptive: they would be higher with greater airflows. TGCE maintains that a design LAT of approx. 50°F would be needed for proper dehumidification in the absence of processed outside air, assuming a VAV operation with reheat available (neither of which exists).

Additionally, consistent with previous TAB reports and assessments, our findings illustrate that airflow remains problematic. Several of these units are still underperforming as compared to intended design airflows. With fan speeds already set on "high," it is evident that this VRF system cannot adequately meet intended performance.

The lower airflows and higher entering humidities result in higher latent capacities than would be expected under acceptable operating conditions. This is purely a function of psychrometrics. The resulting latent capacities are therefore also deceptive: they would be lower under proper airflow and acceptable humidities. With higher latent capacities, humidity control is enhanced. However, our Retro-Cx findings addressed in *Appendix B – Functional Performance Tests (Forms)* show that all of the spaces served by ducted units exceed the normally accepted industry threshold of 60% relative humidity.

As a summary comparison to design conditions, our as-found conditions reflect a significant reduction in performance. In addition, with airflows at maximum condition, approximating the design performance with installed equipment will not be possible. Furthermore, there are other factors that contribute to our recommendations, such as filters access, filter bypass, duct lining, and duct leakage, all of which have been observed to exist.

C. High-heat Load Simulation

In an effort to reproduce cooling a "hot" building and evaluate max cooling capacities of each zone, an impromptu high-heat load simulation test was added to our functional performance testing script. In this scenario, all units were commanded to full heat for a period of approximately 1-hour. Once space temperatures neared approximately 80°F, a single zone was released to full cooling while the others remained in full heat. Sequentially, additional zones were released to full cooling, and system performance was logged and documented.

This simulation did not yield the max cooling capacity data envisioned. However, it did yield confirmation of the general operations of a VRF system. These operations allow simultaneous cooling and heating as expected, but do not provide high-level cooling simultaneously with heating. The VRF control system monitors the cooling and heating demands from each zone fan coil unit, and adjusts operation (e.g., EEV – electronic expansion valves) to balance refrigerant flow according to total system need. Consequently, the performance was very dynamic in this simulation, and specific units' spot test results could not be considered as useful for diagnosis and evaluation.

We have included the data and analysis from this simulation in *Table 3.2.3* as a matter of documentation of our testing. It can be noted that the calculated total capacities reasonably approximate the values from *Table 3.2.2*, and that both of these tables show a significantly lesser total capacity (approximately 20%) than intended by the design objectives illustrated in *Table 3.2.1*.

An important footnote to this discussion is that the design values of *Table 3.2.1* did not represent appropriate fan coil unit entering air design conditions, and hence the values shown are less than what is needed. Accordingly, the percentage shortfall in actual versus needed is likely higher than 20%.

Table 3.2.3 – High-Heat Load Simulation System Capacities

	HIGH-HEAT LOAD SIMULATION CONDITIONS									TOTALS
ACTUAL	Ducted Unit Tags	DS-02	DS-03 (4)	DS-04	DS-05	DS-07	DS-08	DS-09	DS-10	-
	SA CFM (Measured) (1)	272	260	129	369	446	630	772	383	3261 (2)
	Entering air condition (°F db/ %RH)	81.5 / 62.1	DNT	81.1 / 60.4	75.8 / 62	76.3 / 62.2	77 / 55.3	77.5 / 60.9	81.2 / 51	-
	Leaving air condition (°F db/ %RH)	58.6 / 89.5	DNT	58.6 / 86.8	58.0 / 92	61.8 / 94.8	58.5 / 90	59.7 / 91.6	59.2 / 91.7	
ESTIMATED	Total Cooling MBH	13.5	DNT	6.1	11.5	9.1	17.6	23.9	12.6	94.3 (3)

(1) Measured as-found CFM with fan speeds set to 'High'. Typical all units.
(2) A 40% shortfall below scheduled values in design.
(3) Excluding DS-03, a 19% shortfall below the scheduled values in design.
(4) Did Not Test. TGCE instrument malfunctioned during testing.

3.3 Outside Air

A. Outside Air Percentages

The table below is provided to point out that the typical allowable percentage of design OA for a system of this type is approximately 10%. These systems simply cannot perform sufficient dehumidification with a design range between 30-62% of OA. Pre-treatment of OA is essential to provide the appropriate dehumidification in order to process the latent loads present in the outdoor air. While some of the actual measured %OA is closer to that of typical range, the overall outside air is deficient, creating improper pressure relationships. In addition, the cooling/dehumidification capacity is not available in the existing system for processing continuous ventilation/outdoor loads.

Table 3.3.1 – Outside Air Percentage Summary

	% OA SUMMARY									TOTALS
DESIGN	Ducted Unit Tags	DS-02	DS-03	DS-04	DS-05	DS-07	DS-08	DS-09	DS-10	-
	SA CFM (Sum of Devices)	550	430	425	270	420	785	1125	500	4505
	OA CFM (Scheduled)	195	150	150	90	150	485	500	150	1870
	% OA	35%	35%	35%	33%	36%	62%	44%	30%	-
MEASURED	SA CFM (Measured)	272	260	129	369	446	630	772	383	3261
	OA CFM (Measured)	65	99	37	136	59	65	123	57	641
	% OA	24%	38%	29%	37%	13%	10%	16%	15%	-

B. Outside Air Performance

As noted in *Table 3.1.1* above, our Retro-Cx activities found that all OA ducts serving cassette units were measured with negative/reverse airflow, further contributing to negative building pressurization.

Upon review of LG's VRF building ventilation design guide (*Figure 3.3.2*), "inline fan(s) are required to push outdoor air to the indoor (cassette style) unit." Interestingly, the same document claims that "unconditioned outdoor air may affect indoor unit performance, which may necessitate oversizing the indoor unit." Although these statements seem logical from an engineering perspective and are also proven through TGCE's Assessment Report and herein, they appear to have been an oversight during the design and construction of this facility.

Figure 3.3.2 - LG's VRF Building Ventilation Design Guide (p. 180)

Method 3: Unconditioned Outdoor Air Ducted to Indoor Units

Untreated outdoor air is channeled through a duct system that is piped to the return air duct on Multi F ducted indoor units or to the frame of Multi F four-way cassettes.

Note:

Outside air may flow backward through the return air-filter grille when the indoor unit fan speed slows or stops in response to changes in the space load. This may result in captured particulate on the filter media being blown back into the conditioned space.

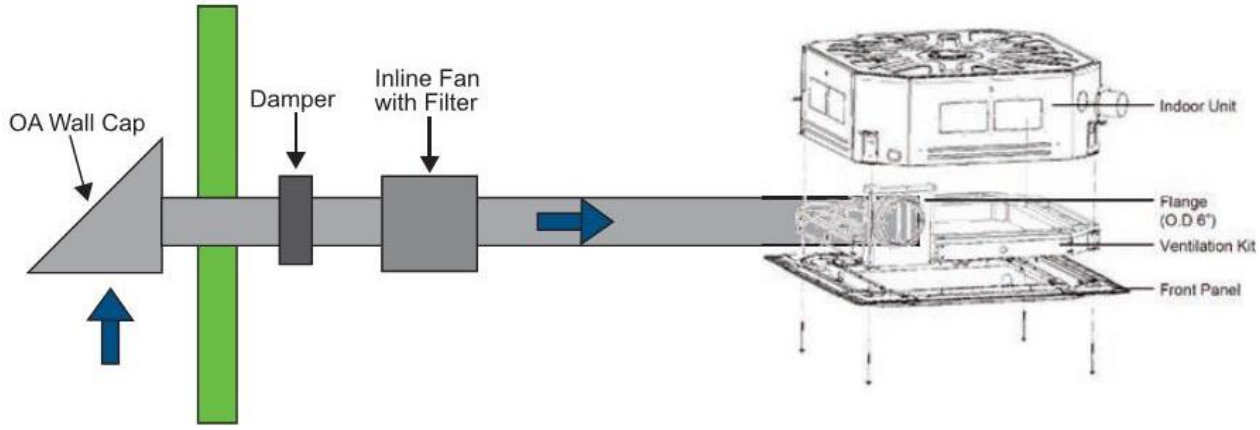
Advantages

- May require less ductwork if indoor units are placed near outdoor walls or a roof deck.
- Controls must be interlocked to shut off the outdoor air supply fan when the space is unoccupied.
- Third-party demand-control ventilation controls may be installed to regulate outdoor intake based on the CO_2 levels of the occupied space.

Disadvantages

- Fan(s) will be required to push outdoor air to the indoor unit to overcome the additional static pressure.
- Filter required to be added to the outdoor air duct.
- Ducted and four-way cassette models are the only indoor units that accept the connection of an outdoor air duct to the unit case.
- In most cases, in lieu of using the factory mounted return-air thermistor on indoor units, a remote wall temperature sensor or zone controller will be needed to provide an accurate reading of the conditioned area temperature.
- Unconditioned outdoor air may affect indoor unit performance, which may necessitate oversizing the indoor unit.

Figure 241: Unconditioned Outdoor Air Ducted to Indoor Units.



4.0 RECOMMENDED CORRECTIVE ACTIONS

4.1 Existing Systems Evaluations

A. Equipment Retainage

1. TGCE Assessment Report of 8/6/2019: The investigative findings previously illustrated underlying design and construction issues that present logical arguments that this system requires modifications. A summary of these findings includes, but is not limited to: undesirable unit inlet air conditions (due to absence of proper OA conditioning), high static pressure loss OA duct conditions, lined ductwork exhibiting potential microbial growth, inadequate manual and/or automatic damper provisions, insufficient filter access, filter bypass conditions, and exposed/damaged control wiring.

2. TGCE Retro-Cx Activities: As presented herein, TGCE believes that the existing system is incapable of providing the necessary capacities and airflows required to satisfy the facility demands, especially in hot-humid seasons.

   Refer also to *Appendix D - Cx Assist/Issues Log* for a quick list of zones not obtaining adequate airflows.

3. Summary: Retaining existing system components, even with the addition of a dedicated outside air unit (as previously discussed), would still, in TGCE's opinion, fall short of a system that would respond to the building's needs. Improvements would be seen to overall building pressurization and humidity control, but zone airflows would still suffer significantly as TGCE has established, based on the original design intent, the system zone air delivery is insufficient.

   Providing a dedicated outside air unit without the replacement of the fan coil units is, in the Author's opinion, ill-advised. It retains the shortcomings described in the existing system, including those related to performance, installation, and maintenance. Therefore, a warrantable full systems replacement is concluded.

4.2 Systems Replacement Recommendations

A. Option 1 – DX VAV/VRF AHU

Provide an approximately 35-ton split-system variable air volume (VAV), variable refrigerant flow (VRF), air handling unit (AHU) coupled with single-duct VAV terminal units with electric reheat, serving each zone. It is anticipated that the new AHU could be located on the existing mechanical mezzanine platform. The AHU would be fully-custom panelized construction that would allow all components to be delivered to the platform via strategic opening(s) not significantly larger than the existing pull-down stair opening. Zone terminal boxes would be located above the mechanical platform for ease of maintenance access. The DX VRF heat pump condensing unit(s) would be located in the rear of the building, in the same vicinity as the existing condensing unit. The existing ductwork systems would be replaced in the mechanical mezzanine. The objective would be to use existing ducts beyond the mezzanine if microbial testing indicated either no growth or growth that could be mitigated by cleaning and coating of the duct interior.

Envisioned features of this Option 1 would include: more conventional system approach using multi-party available controls systems and service options beyond the specialized service of VRF systems; more consolidated maintenance needs (e.g., filter changers, OA controls/dampers); N+1 redundancy

for supply fans; multi-circuit refrigeration systems for staging/modulation and absence of single point mechanical failures in the refrigeration system.

B. Option 2 – DX DOAU/VRF

Provide an approximately 16-ton split system constant air volume (CAV), variable refrigerant flow, dedicated outside air unit (DOAU) coupled with VRF terminal units totaling approximately 16-ton capacity. The DOAU would include a hot gas reheat coil for delivery of "neutral" temperature dehumidified outdoor air. This approach is similar to the existing systems, except a DOAU is added. Terminal units and condensing unit(s) would be replaced/upsized to satisfy facility load demands. Similarly to Option 1, the new DOAU would be located on the existing mechanical mezzanine platform. This Option may not be able to use fully-custom panelized construction and may require larger openings into the mechanical mezzanine to accommodate a section-by-section assembly. The zone terminal boxes and DX VRF heat pump condensing unit(s) would be placed in their respective existing "vicinities." The existing ductwork systems would be replaced in the mechanical mezzanine. The objective would be to use existing ducts beyond the mezzanine if microbial testing indicated either no growth or growth that could be mitigated by cleaning and coating of the duct interior.

Envisioned features of this Option 2 would include: a user-friendly control system that allowed Owner operation and adjustment of appropriate functions via mapping VRF control points to a third-party digital controls system; DOAU and VRF fan coil units (FCUs) system independence so that DOAU would not be affected by maintenance issues of the VRF FCUs, and vice-versa; and an improved system efficiency compared to Option 1.

C. Design Considerations

With either Option presented above, it is acknowledged that: conceptual design test fits are needed to determine if components will fit as conceived; ductwork outside the mezzanine is subject to being replaced; all mechanical equipment be replaced; existing electrical service capacity must be explored/verified and potentially upgraded; a structural analysis is performed, as modifications are likely required to support the additional equipment load; selective demolition and reconstruction of ceilings and partitions can be expected.

D. Pre-Design Phase

A decision regarding which Option to pursue will be needed. While both have some similarities, each also has distinct pros. Accordingly, a pre-design phase is recommended to assist this selection. It would address the items described in *"C. Design Considerations"* above, creating concept designs for either or both systems. It would also update the Opinion of Probable Construction Cost to achieve higher confidence (lower uncertainty) in the cost. Most importantly, it would involve facility stakeholders in the selection of the system.

5.0 OPINIONS OF PROBABLE CONSTRUCTION COST

5.1 Summary

Table 5.1.1 below presents a conceptual, or pre-program, Opinion of Probable Construction Cost (OPCC). The method used for the OPCCs is that which has been used successfully in our firm for 20-plus years. It uses project comparables with appropriate adjustments for the various differences in previous projects and the envisioned project. It also recognizes the uncertainties inherent with any cost estimate, those uncertainties being high in early phases. Please refer to *Appendix A – OPCC Uncertainties* for a more complete discussion of uncertainties.

It may be noted that only one OPCC is presented, yet two system options are presented. The single OPCC applies to both systems, as the relatively small differences in cost are contained within the stated uncertainties.

Table 5.1.1 – OPCC Summary Table

SCOPE SUMMARY	OPCC (1) (2)	
Mechanical and Plumbing	$633,000	+/- 35%
Electrical	$132,000	+/- 35%
Architectural	$117,000	+/- 35%
Structural	$93,000	+/- 35%
Subcontractor Cost of Work Subtotal	$975,000	+/- 35%
CM GCs & Fees	$170,000	+/- 35%
TOTAL	***$1,145,000***	+/- 30%

(1) Costs are presented in 2021 dollars. As illustrated, the uncertainty of each system is judged to be approximately +/-35%, and the total approximately +/-30%.
(2) Costs do not include additional expense incurred by Owner for project management, project design, TAB (Test Adjust Balance), commissioning, and/or building occupant disruption/displacement.

- End of Report -

Appendix A

OPCC UNCERTAINTIES

OPCC UNCERTAINTIES

A. Discussion of Uncertainties

There is a saying that occasionally is heard amongst those in almost any field of endeavor, including construction or design. It goes something like this:

> *"In any project there are three variables: quality, scope, and cost. If any two are fixed, the third varies according to the other two."*

A corollary in the case of building design and construction might go something like this:

> *"As design progresses and intended results are better defined, the costs of the construction project become progressively more certain."*

In short, the uncertainties in the cost of a construction project are high at the beginning phases and **diminish to zero only once the warranty is completed.**

So how might one describe this uncertainty in real, quantifiable terms? Our experience and judgment over the decades has shown that cost estimates can generally be characterized by the following uncertainties. Note that smaller projects have characteristically higher uncertainties.

These uncertainties might best be understood when looking at the construction documents phase. In a medium-sized renovation project, for example, the actual bids received commonly vary by 10 to 15%. Hence, ± 8% variations are experienced even by the contractors who do all the detailed estimating and investigation, and who have a very highly vested interest (their livelihood) in correctly estimating the work. It logically follows, then, that an engineering/architectural team is not likely able to present an estimate with accuracy better than ± 10% at this phase.

Uncertainties for MEP Project Sizes (at 95% Confidence Interval)

	Small (<$2 million)		Medium ($2-6 million)		Large (>$6 million)	
Project Status	***New***	***Renov.***	***New***	***Renov.***	***New***	***Renov.***
Pre-Program	±30%	±35%	±25%	±30%	±20%	±25%
Program	±25%	±30%	±20%	±25%	±15%	±20%
Sch. Design	±20%	±25%	±15%	±20%	±10%	±15%
Des. Dev.	±15%	±20%	±10%	±15%	±8%	±12%
Const. Doc.	±10%	±15%	±5%	±10%	±5%	±10%
Bidding +/- 5%	±8%	±3%	±5%	±3%	±5%	±5%
Const. Compl.	±1%	±2%	±1%	±1%	±1%	±1%
Warranty Compl.	±0%	±0%	±0%	±0%	±0%	±0%

Also, please note that the uncertainties might best be viewed as a normal distribution on the familiar bell curve. For example, a “two sigma” (two standard deviations) departure from the mean yields a confidence interval of roughly 95%, and a “one sigma” departure yields a confidence interval of roughly 68%. Hence, if the total judged uncertainty is ± 30%, 20% might be approximated as “one sigma”, and 29% as “two sigma”. Using this approach, it can be seen that the bell curve gets taller and thinner as design progresses because fewer uncertainties exist. This process is simply a natural evolution that applies to most all activities, even those outside the realm of construction.

All this being said, it may be important to also relay our track record in estimating construction costs. With few exceptions (usually on smaller projects), our MEP OPCC’s are within 10% of the MEP bids received. It is not uncommon for our estimates to be within five percent. We are able to accomplish these accuracies by properly judging the complexities of a given project and factoring them into the cost opinions.

Even so, we must not lose sight of the reality that “scope” and “detail” uncertainties in the early project phases can be high. Accordingly, cost uncertainties are equally real and it is our responsibility and duty not to ignore them.

Appendix B

FUNCTIONAL PERFORMANCE TESTS

Tom Green & Company
Engineers, Inc.

FUNCTIONAL PERFORMANCE TEST

VARIABLE REFRIGERANT FLOW (VRF) SPLIT SYSTEMS

Owner	City of Schertz	**Date**	6/23/20
Project	Animal Adoption Center Retro-Cx	**Project #**	1393.00

Personnel Present

Tom Green, PE	TGCE	Daniel Fitzpatrick	TAS
Cx Authority	Company	Mechanical Contractor	Company
Yin Ling Ng, PE	TGCE		
Cx Authority	Company	Mechanical Contractor	Company
Greg Maxwell, LEED AP	TGCE		
Cx Authority	Company	Electrical Contractor	Company
Phil Gaudreau	COS		
Owner's Representative	Company	Electrical Contractor	Company
Brenda Spinelli	COS		
Owner's Representative	Company	Controls Contractor	Company
Chad Lonsberry	COS		
Owner's Representative	Company	Controls Contractor	Company
		Victor Rodriguez	ATI
General Contractor	Company	Test and Balance	Company
		Damien Albiter	ATI
General Contractor	Company	Test and Balance	Company
General Contractor	Company		
General Contractor	Company		

Equipment Included

Equipment #: DS-01
LG Service Tool Identification: IDU-2
AC Smart Identification: Rabies Observation
Room(s) Served: Dog Quarantine 127

Pre-requisite Checklist

Mark 'Y' if the item is complete/acceptable. If not, mark 'N' and enter note/deficiency on Cx Assist/Issues Log.

Item	Pre-requisite Item Details to be verified prior to or coincidentally with Test Procedure	Y/N	Log #
1	All control system functions for this and all interlocking systems are programmed and operable per Contract Documents, including final setpoints and schedules set in AC Smart controller.	Y	
2	Pre-Functional Performance Checklists (PFPCs) are addressed for the specific system.	N/A	
3	Test and Balance (TAB) addressed for the system.	Y	
4	These Functional Performance Test (FPT) procedures have been reviewed, with select preliminary checks having already been performed by Contractors.	Y	
5	AC Smart is operational.	Y	

Test Procedure

Check each item as verified. Adjust specified time delays as directed by CxA at time of testing. Enter note/deficiency on Cx Assist/Issues Log.

No.	Test Procedure	Expected Result	Pass/ Fail	Log #
1	Verify communication, all IDUs are on AC Smart control screen. Record Ambient/Weather Conditions.	Front end communication with system equipment has been established. Actual: 89°F / 51%RH, Wind: WSW @ 4 mph AC Smart: 98.8°F	Pass	-
Notes:	a. IDU addresses on Laptop Service Tool are not mapped to equivalent equipment numbers (e.g., IDU-2 = DS-01). The LG software is unable to rename IDU addresses as it auto-assigns during system start-up. TGCE and TAS had to investigate via thermostat mapping in order to identify all systems.			1
	b. The AC Smart outside air sensor is located within the condensing unit cabinet which is picking up system heat rejection and therefore, is not an accurate representation of true ambient conditions. Additionally, the sensor only reads temperature.			2
2	'Heating Mode': Force/Override space temperature setpoint to 84°F from space (room) temperature sensor.	Does AC Smart show Temp change. After a 15-minute period, record the following AC Smart sensor feedback: Mixed air temp: _____ °F (db) Refrigerant In temp: _____ °F Refrigerant Out temp: _____ °F EEV (valve) position: _____ (40 min.-1350 max.)	DNT	-
Notes:	a. This Cx test was not performed on cassette style units. DNT = Did Not Test			-
3	'Cooling Mode': Force/Override space temperature setpoint to 64°F from space (room) temperature sensor. Time: 3:16 pm	Does AC Smart show Temp change. After a 15-minute period, record the following AC Smart sensor feedback: Fan Speed: High Mixed air temp: 71.2°F (db) Refrigerant In temp: 43.2°F Refrigerant Out temp: 51.8°F EEV (valve) position: 199 (40 min.-600 max.)	Pass	
Notes:	a. Measurements were taken at 66°F setpoint in lieu of 64°F.			-
	b. Observed excessive fan noise. Texas Air Systems believes the noise is caused by failing fan motors.			3

No.	Test Procedure	Expected Result	Pass/ Fail	Log #
4	Conduct 'Cooling Mode' TAB measurements/calculations and record results.	Return air temp/humidity: 65.3°F / 73.4%RH Outside air temp/humidity: DNM / DNM Mixed air temp/humidity: See notes below Supply air temp/humidity: 53.9°F / 85.9%RH Fan speed setting: High Return air CFM: 406 Approx. % of Outside air: 0% Outside air CFM: - 43 CFM	Fail	-
Notes:	a. Upon traverse of O/A, reverse airflow was observed and therefore, design outside airflow is not being obtained. This condition was typical for all cassette style units. The LG Engineering Manual states that inline fans are required to push outdoor air to the indoor cassette unit to overcome the static pressure. This building is not equipped with inline fans on the outside air ductwork.			4
	b. Supply airflow cannot be accurately measured on cassette style units.			5
	c. Mixed air conditions could not be measured on cassette style units.			6
5	**Return all changed/adjusted control parameters and conditions to their pre-test values per as-found conditions.**	**Verify all IDUs are in auto mode.**	Pass	-

- END OF TEST -

Tom Green & Company
Engineers, Inc.

FUNCTIONAL PERFORMANCE TEST

VARIABLE REFRIGERANT FLOW (VRF) SPLIT SYSTEMS

Owner	City of Schertz	**Date**	6/23/20
Project	Animal Adoption Center Retro-Cx	**Project #**	1393.00

Personnel Present

Tom Green, PE	TGCE	Daniel Fitzpatrick	TAS
Cx Authority	Company	Mechanical Contractor	Company
Yin Ling Ng, PE	TGCE		
Cx Authority	Company	Mechanical Contractor	Company
Greg Maxwell, LEED AP	TGCE		
Cx Authority	Company	Electrical Contractor	Company
Phil Gaudreau	COS		
Owner's Representative	Company	Electrical Contractor	Company
Brenda Spinelli	COS		
Owner's Representative	Company	Controls Contractor	Company
Chad Lonsberry	COS		
Owner's Representative	Company	Controls Contractor	Company
		Victor Rodriguez	ATI
General Contractor	Company	Test and Balance	Company
		Damien Albiter	ATI
General Contractor	Company	Test and Balance	Company
General Contractor	Company		
General Contractor	Company		

Equipment Included

Equipment #: DS-02
LG Service Tool Identification: IDU-13
AC Smart Identification: Intake Dog Grooming
Room(s) Served: Corridor 116B, E-Room/Freezer 125, Grooming Intake 126

Pre-requisite Checklist

Mark 'Y' if the item is complete/acceptable. If not, mark 'N' and enter note/deficiency on Cx Assist/Issues Log.

Item	Pre-requisite Item Details to be verified prior to or coincidentally with Test Procedure	Y/N	Log #
1	All control system functions for this and all interlocking systems are programmed and operable per Contract Documents, including final setpoints and schedules set in AC Smart controller.	Y	-
2	Pre-Functional Performance Checklists (PFPCs) are addressed for the specific system.	N/A	-
3	Test and Balance (TAB) addressed for the system.	Y	-
4	These Functional Performance Test (FPT) procedures have been reviewed, with select preliminary checks having already been performed by Contractors.	Y	-
5	AC Smart is operational.	Y	-

Test Procedure

Check each item as verified. Adjust specified time delays as directed by CxA at time of testing. Enter note/deficiency on Cx Assist/Issues Log.

No.	Test Procedure	Expected Result	Pass/ Fail	Log #
1	Verify communication, all IDUs are on AC Smart control screen. Record Ambient/Weather Conditions. Time: 11:28 am	Front end communication with system equipment has been established. Actual: 72°F / 92%RH, Wind: SE @ 9 mph AC Smart: 84°F	Pass	-
Notes:	a. IDU addresses on Laptop Service Tool are not mapped to equivalent equipment numbers (e.g., IDU-2 = DS-01). The LG software is unable to rename IDU addresses as it auto-assigns during system start-up. TGCE and TAS had to investigate via thermostat mapping in order to identify all systems.			1
	b. The AC Smart outside air sensor is located within the condensing unit cabinet which is picking up system heat rejection and therefor, is not an accurate representation of true ambient conditions. Additionally, the sensor only reads temperature.			2
2	'Heating Mode': Force/Override space temperature setpoint to 84°F from space (room) temperature sensor. Time: 4:18 pm	Does AC Smart show Temp change. After a 15-minute period, record the following AC Smart sensor feedback: Mixed air temp: 72.9°F (db) Refrigerant In temp: 112.2°F Refrigerant Out temp: 163.4°F EEV (valve) position: 220 (40 min.-1350 max.)	Pass	-
3	Conduct 'Heating Mode' TAB measurements/calculations and record results.	Return air temp/humidity: 76.8°F / 74.0%RH Supply air temp/humidity: 108.5°F / 35.0%RH	Pass	-
4	'Cooling Mode': Force/Override space temperature setpoint to 64°F from space (room) temperature sensor. Time: 11:40 am	Does AC Smart show Temp change. After a 15-minute period, record the following AC Smart sensor feedback: Fan Speed: High Mixed air temp: 72.4°F (db) Refrigerant In temp: 42.6°F Refrigerant Out temp: 56.02°F EEV (valve) position: 124 (40 min.-600 max.)	Pass	-
Notes:	a. Measurements were taken at 66°F setpoint in lieu of 64°F.			-

No.	Test Procedure	Expected Result	Pass/ Fail	Log #
5	Conduct 'Cooling Mode' TAB measurements/calculations and record results.	Return air temp/humidity: 71.9°F / 65.7%RH Outside air temp/humidity: 75.6°F / 78.4%RH Mixed air temp/humidity: 71.4°F / 79.4%RH Supply air temp/humidity: 55.0°F / 92.1%RH Fan speed setting: High Supply air CFM: 272 Approx. % of Outside air: 24% Outside air CFM: 65 CFM	Fail	-
Notes:	a. Design supply airflow of 454 CFM is not being obtained.			7
	b. Design outside airflow of 195 CFM is not being obtained.			8
6*	"High-Heat Load Simulation": Force all indoor units into 'Heating Mode' for a duration of 30 minutes to simulate a hot building. Command selected spaces to 'Cooling Mode' to verify proper cooling of space is achieved. Time: 8:22 pm	Spaces commanded to cooling properly meet cooling setpoint. Laptop Service Tool: Mixed air temp: 75.4°F (db) EEV (valve) position: 154 (40 min.-600 max.) TAB: Mixed air temp/humidity: 81.5°F / 62.1%RH Supply air temp/humidity: 58.6°F / 89.5%RH	*	-
Notes:	a. Mixed air temperature sensor feedback was not tracking with manual instrumentation measurement. This could be caused by a lag in sensor/instrument response times.			-
	b. VRF system struggled to meet zone cooling setpoint of 66°F within a timeframe of 1-hour. TGCE believes the struggle was caused by simultaneous cooling and heating demands (i.e., some zones calling for heat while some zones calling for cooling).			-
7	**Return all changed/adjusted control parameters and conditions to their pre-test values per as-found conditions.**	**Verify all IDUs are in auto mode.**	Pass	-

*Pass/Fail not assigned because conditions were not adequately represented by the test.

- END OF TEST -

Tom Green & Company
Engineers, Inc.

FUNCTIONAL PERFORMANCE TEST

VARIABLE REFRIGERANT FLOW (VRF) SPLIT SYSTEMS

Owner	City of Schertz	**Date**	6/23/20
Project	Animal Adoption Center Retro-Cx	**Project #**	1393.00

Personnel Present

Tom Green, PE	TGCE	Daniel Fitzpatrick	TAS
Cx Authority	Company	Mechanical Contractor	Company
Yin Ling Ng, PE	TGCE		
Cx Authority	Company	Mechanical Contractor	Company
Greg Maxwell, LEED AP	TGCE		
Cx Authority	Company	Electrical Contractor	Company
Phil Gaudreau	COS		
Owner's Representative	Company	Electrical Contractor	Company
Brenda Spinelli	COS		
Owner's Representative	Company	Controls Contractor	Company
Chad Lonsberry	COS		
Owner's Representative	Company	Controls Contractor	Company
		Victor Rodriguez	ATI
General Contractor	Company	Test and Balance	Company
		Damien Albiter	ATI
General Contractor	Company	Test and Balance	Company
General Contractor	Company		
General Contractor	Company		

Equipment Included

Equipment #: DS-03
LG Service Tool Identification: IDU-7
AC Smart Identification: Feeding Room
Room(s) Served: Laundry 119, Food Prep 122

Pre-requisite Checklist

Mark 'Y' if the item is complete/acceptable. If not, mark 'N' and enter note/deficiency on Cx Assist/Issues Log.

Item	Pre-requisite Item Details to be verified prior to or coincidentally with Test Procedure	Y/N	Log #
1	All control system functions for this and all interlocking systems are programmed and operable per Contract Documents, including final setpoints and schedules set in AC Smart controller.	Y	-
2	Pre-Functional Performance Checklists (PFPCs) are addressed for the specific system.	N/A	-
3	Test and Balance (TAB) addressed for the system.	Y	-
4	These Functional Performance Test (FPT) procedures have been reviewed, with select preliminary checks having already been performed by Contractors.	Y	-
5	AC Smart is operational.	Y	-

Test Procedure

Check each item as verified. Adjust specified time delays as directed by CxA at time of testing. Enter note/deficiency on Cx Assist/Issues Log.

No.	Test Procedure	Expected Result	Pass/ Fail	Log #
1	Verify communication, all IDUs are on AC Smart control screen. Record Ambient/Weather Conditions. Time: 11:57 am	Front end communication with system equipment has been established. Actual: 72°F / 92%RH, Wind: SSE @ 8 mph AC Smart: 84°F	Pass	-
Notes:	a. IDU addresses on Laptop Service Tool are not mapped to equivalent equipment numbers (e.g., IDU-2 = DS-01). The LG software is unable to rename IDU addresses as it auto-assigns during system start-up. TGCE and TAS had to investigate via thermostat mapping in order to identify all systems.			1
	b. The AC Smart outside air sensor is located within the condensing unit cabinet which is picking up system heat rejection and therefor, is not an accurate representation of true ambient conditions. Additionally, the sensor only reads temperature.			2
2	'Heating Mode': Force/Override space temperature setpoint to 84°F from space (room) temperature sensor. Time: 4:19 pm	Does AC Smart show Temp change. After a 15-minute period, record the following AC Smart sensor feedback: Mixed air temp: 72.9°F (db) Refrigerant In temp: 109.5°F Refrigerant Out temp: 151.8°F EEV (valve) position: 200 (40 min.-1350 max.)	Pass	-
3	Conduct 'Heating Mode' TAB measurements/calculations and record results.	Return air temp/humidity: 76.4°F / 83.9%RH Supply air temp/humidity: 101.1°F / 40.0%RH	Pass	-
4	'Cooling Mode': Force/Override space temperature setpoint to 64°F from space (room) temperature sensor. Time: 11:55 am	Does AC Smart show Temp change. After a 15-minute period, record the following AC Smart sensor feedback: Fan Speed: High Mixed air temp: 71.2°F (db) Refrigerant In temp: 46.9°F Refrigerant Out temp: 51.8°F EEV (valve) position: 208 (40 min.-600 max.)	Pass	-
Notes:	a. Measurements were taken at 66°F setpoint in lieu of 64°F.			-

No.	Test Procedure	Expected Result	Pass/ Fail	Log #
5	Conduct 'Cooling Mode' TAB measurements/calculations and record results.	Return air temp/humidity: 69.6°F / 69.8%RH Outside air temp/humidity: 78.1°F / 75.9%RH Mixed air temp/humidity: 72.0°F / 81.4%RH Supply air temp/humidity: 55.0°F / 94.7%RH Fan speed setting: High Supply air CFM: 260 Approx. % of Outside air: 38% Outside air CFM: 99 CFM	Fail	-
Notes:	a. Design supply airflow of 425 CFM is not being obtained.			9
	b. Design outside airflow of 150 CFM is not being obtained.			10
6	"High-Heat Load Simulation": Force all indoor units into 'Heating Mode' for a duration of 30 minutes to simulate a hot building. Command selected spaces to 'Cooling Mode' to verify proper cooling of space is achieved.	Spaces commanded to cooling properly meet cooling setpoint. Laptop Service Tool: Mixed air temp: DNT EEV (valve) position: DNT TAB: Mixed air temp/humidity: DNT Supply air temp/humidity: DNT	DNT	-
Notes:	a. TGCE instrument malfunctioned during testing. Could not fully test and therefore, measurements not taken. DNT = Did not Test			-
7	**Return all changed/adjusted control parameters and conditions to their pre-test values per as-found conditions.**	**Verify all IDUs are in auto mode.**	Pass	-

- END OF TEST -

Tom Green & Company
Engineers, Inc.

FUNCTIONAL PERFORMANCE TEST

VARIABLE REFRIGERANT FLOW (VRF) SPLIT SYSTEMS

Owner	City of Schertz	**Date**	6/23/20
Project	Animal Adoption Center Retro-Cx	**Project #**	1393.00

Personnel Present

Tom Green, PE	TGCE	Daniel Fitzpatrick	TAS
Cx Authority	Company	Mechanical Contractor	Company
Yin Ling Ng, PE	TGCE		
Cx Authority	Company	Mechanical Contractor	Company
Greg Maxwell, LEED AP	TGCE		
Cx Authority	Company	Electrical Contractor	Company
Phil Gaudreau	COS		
Owner's Representative	Company	Electrical Contractor	Company
Brenda Spinelli	COS		
Owner's Representative	Company	Controls Contractor	Company
Chad Lonsberry	COS		
Owner's Representative	Company	Controls Contractor	Company
		Victor Rodriguez	ATI
General Contractor	Company	Test and Balance	Company
		Damien Albiter	ATI
General Contractor	Company	Test and Balance	Company
General Contractor	Company		
General Contractor	Company		

Equipment Included

Equipment #: DS-04
LG Service Tool Identification: IDU-6
AC Smart Identification: Dog Quarantine
Room(s) Served: Janitor 121, Isolation 124

Pre-requisite Checklist

Mark 'Y' if the item is complete/acceptable. If not, mark 'N' and enter note/deficiency on Cx Assist/Issues Log.

Item	Pre-requisite Item Details to be verified prior to or coincidentally with Test Procedure	Y/N	Log #
1	All control system functions for this and all interlocking systems are programmed and operable per Contract Documents, including final setpoints and schedules set in AC Smart controller.	Y	-
2	Pre-Functional Performance Checklists (PFPCs) are addressed for the specific system.	N/A	-
3	Test and Balance (TAB) addressed for the system.	Y	-
4	These Functional Performance Test (FPT) procedures have been reviewed, with select preliminary checks having already been performed by Contractors.	Y	-
5	AC Smart is operational.	Y	-

Test Procedure

Check each item as verified. Adjust specified time delays as directed by CxA at time of testing. Enter note/deficiency on Cx Assist/Issues Log.

No.	Test Procedure	Expected Result	Pass/ Fail	Log #
1	Verify communication, all IDUs are on AC Smart control screen. Record Ambient/Weather Conditions. Time: 12:20 pm	Front end communication with system equipment has been established. Actual: 74°F / 87%RH, Wind: SE @ 3 mph AC Smart: -°F	Pass	-
Notes:	a. IDU addresses on Laptop Service Tool are not mapped to equivalent equipment numbers (e.g., IDU-2 = DS-01). The LG software is unable to rename IDU addresses as it auto-assigns during system start-up. TGCE and TAS had to investigate via thermostat mapping in order to identify all systems.			1
	b. The AC Smart outside air sensor is located within the condensing unit cabinet which is picking up system heat rejection and therefor, is not an accurate representation of true ambient conditions. Additionally, the sensor only reads temperature.			2
2	'Heating Mode': Force/Override space temperature setpoint to 84°F from space (room) temperature sensor. Time: 4:27 pm	Does AC Smart show Temp change. After a 15-minute period, record the following AC Smart sensor feedback: Mixed air temp: 69.4°F (db) Refrigerant In temp: 115.1°F Refrigerant Out temp: 143.7°F EEV (valve) position: 130 (40 min.-1350 max.)	Pass	-
3	Conduct 'Heating Mode' TAB measurements/calculations and record results.	Return air temp/humidity: 79.3°F / 64.3%RH Supply air temp/humidity: 99.0°F / 39.7%RH	Pass	-
4	'Cooling Mode': Force/Override space temperature setpoint to 64°F from space (room) temperature sensor. Time: 12:06 pm	Does AC Smart show Temp change. After a 15-minute period, record the following AC Smart sensor feedback: Fan Speed: High Mixed air temp: 67.6°F (db) Refrigerant In temp: 49.4°F Refrigerant Out temp: 51.8°F EEV (valve) position: 139 (40 min.-600 max.)	Pass	-
Notes:	a. Measurements were taken at 66°F setpoint in lieu of 64°F.			-

No.	Test Procedure	Expected Result	Pass/ Fail	Log #
5	Conduct 'Cooling Mode' TAB measurements/calculations and record results.	Return air temp/humidity: 69.3°F / 62.4%RH Outside air temp/humidity: 79.7°F / 73.7%RH Mixed air temp/humidity: 72.2°F / 73.2%RH Supply air temp/humidity: 55.2°F / 92.9%RH Fan speed setting: High Supply air CFM: 129 Approx. % of Outside air: 29% Outside air CFM: 37 CFM	Fail	-
Notes:	a. Design supply airflow of 425 CFM is not being obtained.			11
	b. Design outside airflow of 150 CFM is not being obtained.			12
6*	"High-Heat Load Simulation": Force all indoor units into 'Heating Mode' for a duration of 30 minutes to simulate a hot building. Command selected spaces to 'Cooling Mode' to verify proper cooling of space is achieved. Time: 8:27 pm	Spaces commanded to cooling properly meet cooling setpoint. Laptop Service Tool: Mixed air temp: 71.2°F (db) EEV (valve) position: 116 (40 min.-600 max.) TAB: Mixed air temp/humidity: 81.1°F / 60.4%RH Supply air temp/humidity: 58.6°F / 86.8%RH	*	-
Notes:	a. Mixed air temperature sensor feedback was not tracking with manual instrumentation measurement. This could be caused by a lag in sensor/instrument response times.			-
	b. VRF system struggled to meet zone cooling setpoint of 66°F within a timeframe of 1-hour. TGCE believes the struggle was caused by simultaneous cooling and heating demands (i.e., some zones calling for heat while some zones calling for cooling).			-
7	**Return all changed/adjusted control parameters and conditions to their pre-test values per as-found conditions.**	**Verify all IDUs are in auto mode.**	Pass	-

*Pass/Fail not assigned because conditions were not adequately represented by the test.

- END OF TEST -

Tom Green & Company
Engineers, Inc.

FUNCTIONAL PERFORMANCE TEST

VARIABLE REFRIGERANT FLOW (VRF) SPLIT SYSTEMS

Owner	City of Schertz	**Date**	6/23/20
Project	Animal Adoption Center Retro-Cx	**Project #**	1393.00

Personnel Present

Tom Green, PE	TGCE	Daniel Fitzpatrick	TAS
Cx Authority	Company	Mechanical Contractor	Company
Yin Ling Ng, PE	TGCE		
Cx Authority	Company	Mechanical Contractor	Company
Greg Maxwell, LEED AP	TGCE		
Cx Authority	Company	Electrical Contractor	Company
Phil Gaudreau	COS		
Owner's Representative	Company	Electrical Contractor	Company
Brenda Spinelli	COS		
Owner's Representative	Company	Controls Contractor	Company
Chad Lonsberry	COS		
Owner's Representative	Company	Controls Contractor	Company
		Victor Rodriguez	ATI
General Contractor	Company	Test and Balance	Company
		Damien Albiter	ATI
General Contractor	Company	Test and Balance	Company
General Contractor	Company		
General Contractor	Company		

Equipment Included

Equipment #: DS-05
LG Service Tool Identification: IDU-8
AC Smart Identification: Cat Quarantine
Room(s) Served: Corridor 116C, Corridor 116D, Supp. Adopt. 130

Pre-requisite Checklist

Mark 'Y' if the item is complete/acceptable. If not, mark 'N' and enter note/deficiency on Cx Assist/Issues Log.

Item	Pre-requisite Item Details to be verified prior to or coincidentally with Test Procedure	Y/N	Log #
1	All control system functions for this and all interlocking systems are programmed and operable per Contract Documents, including final setpoints and schedules set in AC Smart controller.	Y	-
2	Pre-Functional Performance Checklists (PFPCs) are addressed for the specific system.	N/A	-
3	Test and Balance (TAB) addressed for the system.	Y	-
4	These Functional Performance Test (FPT) procedures have been reviewed, with select preliminary checks having already been performed by Contractors.	Y	-
5	AC Smart is operational.	Y	-

Test Procedure

Check each item as verified. Adjust specified time delays as directed by CxA at time of testing. Enter note/deficiency on Cx Assist/Issues Log.

No.	Test Procedure	Expected Result	Pass/ Fail	Log #
1	Verify communication, all IDUs are on AC Smart control screen. Record Ambient/Weather Conditions. Time: 12:30 pm	Front end communication with system equipment has been established. Actual: 74°F / 87%RH, Wind: SE @ 3 mph AC Smart: -°F	Pass	-
Notes:	a. IDU addresses on Laptop Service Tool are not mapped to equivalent equipment numbers (e.g., IDU-2 = DS-01). The LG software is unable to rename IDU addresses as it auto-assigns during system start-up. TGCE and TAS had to investigate via thermostat mapping in order to identify all systems.			1
	b. The AC Smart outside air sensor is located within the condensing unit cabinet which is picking up system heat rejection and therefor, is not an accurate representation of true ambient conditions. Additionally, the sensor only reads temperature.			2
2	'Heating Mode': Force/Override space temperature setpoint to 84°F from space (room) temperature sensor. Time: 4:28 pm	Does AC Smart show Temp change. After a 15-minute period, record the following AC Smart sensor feedback: Mixed air temp: 70.6°F (db) Refrigerant In temp: 101.8°F Refrigerant Out temp: 157.3°F EEV (valve) position: 273 (40 min.-1350 max.)	Pass	-
3	Conduct 'Heating Mode' TAB measurements/calculations and record results.	Return air temp/humidity: 75.2°F / 63.7%RH Supply air temp/humidity: 102.6°F / 29.0%RH	Pass	-
4	'Cooling Mode': Force/Override space temperature setpoint to 64°F from space (room) temperature sensor. Time: 12:25 pm	Does AC Smart show Temp change. After a 15-minute period, record the following AC Smart sensor feedback: Fan Speed: High Mixed air temp: 68.8°F (db) Refrigerant In temp: 44.5°F Refrigerant Out temp: 56.6°F EEV (valve) position: 166 (40 min.-600 max.)	Pass	-
Notes:	a. Measurements were taken at 66°F setpoint in lieu of 64°F.			-

No.	Test Procedure	Expected Result	Pass/ Fail	Log #
5	Conduct 'Cooling Mode' TAB measurements/calculations and record results.	Return air temp/humidity: 69.3°F / 64.0%RH Outside air temp/humidity: 84.8°F / 61.3%RH Mixed air temp/humidity: 69.7°F / 70.6%RH Supply air temp/humidity: 53.9°F / 92.6%RH Fan speed setting: High Supply air CFM: 369 Approx. % of Outside air: 37% Outside air CFM: 136 CFM	Fail	-
Notes:	a. Design supply airflow of 245 CFM is exceeded.			13
	b. Design outside airflow of 90 CFM is exceeded.			14
6*	"High-Heat Load Simulation": Force all indoor units into 'Heating Mode' for a duration of 30 minutes to simulate a hot building. Command selected spaces to 'Cooling Mode' to verify proper cooling of space is achieved. Time: 8:31 pm	Spaces commanded to cooling properly meet cooling setpoint. Laptop Service Tool: Mixed air temp: 72.9°F (db) EEV (valve) position: 213 (40 min.-600 max.) TAB: Mixed air temp/humidity: 75.8°F / 62.0%RH Supply air temp/humidity: 58.0°F / 92.0%RH	*	-
Notes:	a. Mixed air temperature sensor feedback was not tracking with manual instrumentation measurement. This could be caused by a lag in sensor/instrument response times.			-
	b. VRF system struggled to meet zone cooling setpoint of 66°F within a timeframe of 1-hour. TGCE believes the struggle was caused by simultaneous cooling and heating demands (i.e., some zones calling for heat while some zones calling for cooling).			-
7	**Return all changed/adjusted control parameters and conditions to their pre-test values per as-found conditions.**	**Verify all IDUs are in auto mode.**	Pass	-

*Pass/Fail not assigned because conditions were not adequately represented by the test.

- END OF TEST -

Tom Green & Company
Engineers, Inc.

FUNCTIONAL PERFORMANCE TEST

VARIABLE REFRIGERANT FLOW (VRF) SPLIT SYSTEMS

Owner	City of Schertz	**Date**	6/23/20
Project	Animal Adoption Center Retro-Cx	**Project #**	1393.00

Personnel Present

Tom Green, PE	TGCE	Daniel Fitzpatrick	TAS
Cx Authority	Company	Mechanical Contractor	Company
Yin Ling Ng, PE	TGCE		
Cx Authority	Company	Mechanical Contractor	Company
Greg Maxwell, LEED AP	TGCE		
Cx Authority	Company	Electrical Contractor	Company
Phil Gaudreau	COS		
Owner's Representative	Company	Electrical Contractor	Company
Brenda Spinelli	COS		
Owner's Representative	Company	Controls Contractor	Company
Chad Lonsberry	COS		
Owner's Representative	Company	Controls Contractor	Company
		Victor Rodriguez	ATI
General Contractor	Company	Test and Balance	Company
		Damien Albiter	ATI
General Contractor	Company	Test and Balance	Company
General Contractor	Company		
General Contractor	Company		

Equipment Included

Equipment #: DS-06
LG Service Tool Identification: IDU-1
AC Smart Identification: ASO Office
Room(s) Served: Animal Control Officers 133

Pre-requisite Checklist

Mark 'Y' if the item is complete/acceptable. If not, mark 'N' and enter note/deficiency on Cx Assist/Issues Log.

Item	Pre-requisite Item Details to be verified prior to or coincidentally with Test Procedure	Y/N	Log #
1	All control system functions for this and all interlocking systems are programmed and operable per Contract Documents, including final setpoints and schedules set in AC Smart controller.	Y	
2	Pre-Functional Performance Checklists (PFPCs) are addressed for the specific system.	N/A	
3	Test and Balance (TAB) addressed for the system.	Y	
4	These Functional Performance Test (FPT) procedures have been reviewed, with select preliminary checks having already been performed by Contractors.	Y	
5	AC Smart is operational.	Y	

Test Procedure

Check each item as verified. Adjust specified time delays as directed by CxA at time of testing. Enter note/deficiency on Cx Assist/Issues Log.

No.	Test Procedure	Expected Result	Pass/ Fail	Log #
1	Verify communication, all IDUs are on AC Smart control screen. Record Ambient/Weather Conditions. Time: 3:49 pm	Front end communication with system equipment has been established. Actual: 90°F / 49%RH, Wind: SW @ 7 mph AC Smart: 99.5°F	Pass	-
Notes:	a. IDU addresses on Laptop Service Tool are not mapped to equivalent equipment numbers (e.g., IDU-2 = DS-01). The LG software is unable to rename IDU addresses as it auto-assigns during system start-up. TGCE and TAS had to investigate via thermostat mapping in order to identify all systems.			1
	b. The AC Smart outside air sensor is located within the condensing unit cabinet which is picking up system heat rejection and therefore, is not an accurate representation of true ambient conditions. Additionally, the sensor only reads temperature.			2
2	'Heating Mode': Force/Override space temperature setpoint to 84°F from space (room) temperature sensor.	Does AC Smart show Temp change. After a 15-minute period, record the following AC Smart sensor feedback: Mixed air temp: _____ °F (db) Refrigerant In temp: _____ °F Refrigerant Out temp: _____ °F EEV (valve) position: _____ (40 min.-1350 max.)	DNT	-
Notes:	a. This Cx test was not performed on cassette style units. DNT = Did Not Test			-
3	'Cooling Mode': Force/Override space temperature setpoint to 64°F from space (room) temperature sensor. Time: 3:49 pm	Does AC Smart show Temp change. After a 15-minute period, record the following AC Smart sensor feedback: Fan Speed: High Mixed air temp: 67.6°F (db) Refrigerant In temp: 47.6°F Refrigerant Out temp: 49.9°F EEV (valve) position: 165 (40 min.-600 max.)	Pass	-
Notes:	a. Measurements were taken at 66°F setpoint in lieu of 64°F.			-

No.	Test Procedure	Expected Result	Pass/ Fail	Log #
4	Conduct 'Cooling Mode' TAB measurements/calculations and record results.	Return air temp/humidity: 65.1°F / 71.6%RH Outside air temp/humidity: DNM / DNM Mixed air temp/humidity: See notes below Supply air temp/humidity: 52.0°F / 94.6%RH Fan speed setting: High Return air CFM: 634 Approx. % of Outside air: 0% Outside air CFM: - 56 CFM	Fail	-
Notes:	a. Upon traverse of O/A, reverse airflow was observed and therefore, design outside airflow is not being obtained. This condition was typical for all cassette style units. The LG Engineering Manual states that inline fans are required to push outdoor air to the indoor cassette unit to overcome the static pressure. This building is not equipped with inline fans on the outside air ductwork.			4
	b. Supply airflow cannot be accurately measured on cassette style units.			5
	c. Mixed air conditions could not be measured on cassette style units.			6
5	**Return all changed/adjusted control parameters and conditions to their pre-test values per as-found conditions.**	**Verify all IDUs are in auto mode.**	Pass	-

- END OF TEST -

Tom Green & Company
Engineers, Inc.

FUNCTIONAL PERFORMANCE TEST

VARIABLE REFRIGERANT FLOW (VRF) SPLIT SYSTEMS

Owner	City of Schertz	**Date**	6/23/20
Project	Animal Adoption Center Retro-Cx	**Project #**	1393.00

Personnel Present

Tom Green, PE	TGCE	Daniel Fitzpatrick	TAS
Cx Authority	Company	Mechanical Contractor	Company
Yin Ling Ng, PE	TGCE		
Cx Authority	Company	Mechanical Contractor	Company
Greg Maxwell, LEED AP	TGCE		
Cx Authority	Company	Electrical Contractor	Company
Phil Gaudreau	COS		
Owner's Representative	Company	Electrical Contractor	Company
Brenda Spinelli	COS		
Owner's Representative	Company	Controls Contractor	Company
Chad Lonsberry	COS		
Owner's Representative	Company	Controls Contractor	Company
		Victor Rodriguez	ATI
General Contractor	Company	Test and Balance	Company
		Damien Albiter	ATI
General Contractor	Company	Test and Balance	Company
General Contractor	Company		
General Contractor	Company		

Equipment Included

Equipment #: DS-07
LG Service Tool Identification: IDU-9
AC Smart Identification: Manager's Office
Room(s) Served: Adopt. Cnsl 105, Storage 114A, Shelter Manager 131

Pre-requisite Checklist

Mark 'Y' if the item is complete/acceptable. If not, mark 'N' and enter note/deficiency on Cx Assist/Issues Log.

Item	Pre-requisite Item Details to be verified prior to or coincidentally with Test Procedure	Y/N	Log #
1	All control system functions for this and all interlocking systems are programmed and operable per Contract Documents, including final setpoints and schedules set in AC Smart controller.	Y	-
2	Pre-Functional Performance Checklists (PFPCs) are addressed for the specific system.	N/A	-
3	Test and Balance (TAB) addressed for the system.	Y	-
4	These Functional Performance Test (FPT) procedures have been reviewed, with select preliminary checks having already been performed by Contractors.	Y	-
5	AC Smart is operational.	Y	-

Test Procedure

Check each item as verified. Adjust specified time delays as directed by CxA at time of testing. Enter note/deficiency on Cx Assist/Issues Log.

No.	Test Procedure	Expected Result	Pass/ Fail	Log #
1	Verify communication, all IDUs are on AC Smart control screen. Record Ambient/Weather Conditions. Time: 1:30 pm	Front end communication with system equipment has been established. Actual: 82°F / 64%RH, Wind: SSE @ 5 mph AC Smart: 91°F	Pass	-
Notes:	a. IDU addresses on Laptop Service Tool are not mapped to equivalent equipment numbers (e.g., IDU-2 = DS-01). The LG software is unable to rename IDU addresses as it auto-assigns during system start-up. TGCE and TAS had to investigate via thermostat mapping in order to identify all systems.			1
	b. The AC Smart outside air sensor is located within the condensing unit cabinet which is picking up system heat rejection and therefor, is not an accurate representation of true ambient conditions. Additionally, the sensor only reads temperature.			2
2	'Heating Mode': Force/Override space temperature setpoint to 84°F from space (room) temperature sensor. Time: 4:43 pm	Does AC Smart show Temp change. After a 15-minute period, record the following AC Smart sensor feedback: Mixed air temp: 68.8°F (db) Refrigerant In temp: 101.0°F Refrigerant Out temp: 150.1°F EEV (valve) position: 300 (40 min.-1350 max.)	Pass	-
3	Conduct 'Heating Mode' TAB measurements/calculations and record results.	Return air temp/humidity: 79.5°F / 71.1%RH Supply air temp/humidity: 96.5°F / 42.8%RH	Pass	-
4	'Cooling Mode': Force/Override space temperature setpoint to 64°F from space (room) temperature sensor. Time: 1:30 pm	Does AC Smart show Temp change. After a 15-minute period, record the following AC Smart sensor feedback: Fan Speed: High Mixed air temp: 67.0°F (db) Refrigerant In temp: 46.3°F Refrigerant Out temp: 56.0°F EEV (valve) position: 177 (40 min.-600 max.)	Pass	-
Notes:	a. Measurements were taken at 66°F setpoint in lieu of 64°F.			-

No.	Test Procedure	Expected Result	Pass/ Fail	Log #
5	Conduct 'Cooling Mode' TAB measurements/calculations and record results.	Return air temp/humidity: 66.0°F / 71.0%RH Outside air temp/humidity: 89.5°F / 48.6%RH Mixed air temp/humidity: 70.6°F / 74.5%RH Supply air temp/humidity: 56.0°F / 96.5%RH Fan speed setting: High Supply air CFM: 446 Approx. % of Outside air: 13% Outside air CFM: 59 CFM	Fail	-
Notes:	a. Design supply airflow of 425 CFM is exceeded.			15
	b. Design outside airflow of 150 CFM is not being obtained.			16
6*	"High-Heat Load Simulation": Force all indoor units into 'Heating Mode' for a duration of 30 minutes to simulate a hot building. Command selected spaces to 'Cooling Mode' to verify proper cooling of space is achieved. Time: 8:01 pm	Spaces commanded to cooling properly meet cooling setpoint. Laptop Service Tool: Mixed air temp: 75.4°F (db) EEV (valve) position: 395 (40 min.-600 max.) TAB: Mixed air temp/humidity: 76.3°F / 62.2%RH Supply air temp/humidity: 61.8°F / 94.8%RH	*	-
Notes:	a. Mixed air temperature sensor feedback was not tracking with manual instrumentation measurement. This could be caused by a lag in sensor/instrument response times.			-
	b. VRF system struggled to meet zone cooling setpoint of 66°F within a timeframe of 1-hour. TGCE believes the struggle was caused by simultaneous cooling and heating demands (i.e., some zones calling for heat while some zones calling for cooling).			-
7	**Return all changed/adjusted control parameters and conditions to their pre-test values per as-found conditions.**	**Verify all IDUs are in auto mode.**	Pass	-

*Pass/Fail not assigned because conditions were not adequately represented by the test.

- END OF TEST -

Tom Green & Company
Engineers, Inc.

FUNCTIONAL PERFORMANCE TEST

VARIABLE REFRIGERANT FLOW (VRF) SPLIT SYSTEMS

Owner	City of Schertz	**Date**	6/23/20
Project	Animal Adoption Center Retro-Cx	**Project #**	1393.00

Personnel Present

Tom Green, PE	TGCE	Daniel Fitzpatrick	TAS
Cx Authority	Company	Mechanical Contractor	Company
Yin Ling Ng, PE	TGCE		
Cx Authority	Company	Mechanical Contractor	Company
Greg Maxwell, LEED AP	TGCE		
Cx Authority	Company	Electrical Contractor	Company
Phil Gaudreau	COS		
Owner's Representative	Company	Electrical Contractor	Company
Brenda Spinelli	COS		
Owner's Representative	Company	Controls Contractor	Company
Chad Lonsberry	COS		
Owner's Representative	Company	Controls Contractor	Company
		Victor Rodriguez	ATI
General Contractor	Company	Test and Balance	Company
		Damien Albiter	ATI
General Contractor	Company	Test and Balance	Company
General Contractor	Company		
General Contractor	Company		

Equipment Included

Equipment #: DS-08
LG Service Tool Identification: IDU-11
AC Smart Identification: Admin
Room(s) Served: Admin 101B, Lobby 102, Vestibule 103, Cat Adopt. 106

Pre-requisite Checklist

Mark 'Y' if the item is complete/acceptable. If not, mark 'N' and enter note/deficiency on Cx Assist/Issues Log.

Item	Pre-requisite Item Details to be verified prior to or coincidentally with Test Procedure	Y/N	Log #
1	All control system functions for this and all interlocking systems are programmed and operable per Contract Documents, including final setpoints and schedules set in AC Smart controller.	Y	-
2	Pre-Functional Performance Checklists (PFPCs) are addressed for the specific system.	N/A	-
3	Test and Balance (TAB) addressed for the system.	Y	-
4	These Functional Performance Test (FPT) procedures have been reviewed, with select preliminary checks having already been performed by Contractors.	Y	-
5	AC Smart is operational.	Y	-

Test Procedure

Check each item as verified. Adjust specified time delays as directed by CxA at time of testing. Enter note/deficiency on Cx Assist/Issues Log.

No.	Test Procedure	Expected Result	Pass/ Fail	Log #
1	Verify communication, all IDUs are on AC Smart control screen. Record Ambient/Weather Conditions. Time: 1:43 pm	Front end communication with system equipment has been established. Actual: 87°F / 63%RH, Wind: SSE @ 5 mph AC Smart: 93.7°F	Pass	-
Notes:	a. IDU addresses on Laptop Service Tool are not mapped to equivalent equipment numbers (e.g., IDU-2 = DS-01). The LG software is unable to rename IDU addresses as it auto-assigns during system start-up. TGCE and TAS had to investigate via thermostat mapping in order to identify all systems.			1
	b. The AC Smart outside air sensor is located within the condensing unit cabinet which is picking up system heat rejection and therefor, is not an accurate representation of true ambient conditions. Additionally, the sensor only reads temperature.			2
2	'Heating Mode': Force/Override space temperature setpoint to 84°F from space (room) temperature sensor. Time: 4:43 pm	Does AC Smart show Temp change. After a 15-minute period, record the following AC Smart sensor feedback: Mixed air temp: 70.6°F (db) Refrigerant In temp: 105.9°F Refrigerant Out temp: 165.5°F EEV (valve) position: 500 (40 min.-1350 max.)	Pass	-
3	Conduct 'Heating Mode' TAB measurements/calculations and record results.	Return air temp/humidity: 79.3°F / 73.4%RH Supply air temp/humidity: 106.3°F / 33.7%RH	Pass	-
4	'Cooling Mode': Force/Override space temperature setpoint to 64°F from space (room) temperature sensor. Time: 1:42 pm	Does AC Smart show Temp change. After a 15-minute period, record the following AC Smart sensor feedback: Fan Speed: High Mixed air temp: 70.1°F (db) Refrigerant In temp: 50.6°F Refrigerant Out temp: 54.2°F EEV (valve) position: 174 (40 min.-600 max.)	Pass	-
Notes:	a. Measurements were taken at 66°F setpoint in lieu of 64°F.			-

No.	Test Procedure	Expected Result	Pass/ Fail	Log #
5	Conduct 'Cooling Mode' TAB measurements/calculations and record results.	Return air temp/humidity: 68.0°F / 71.1%RH Outside air temp/humidity: 89.6°F / 48.2%RH Mixed air temp/humidity: 74.1°F / 67.1%RH Supply air temp/humidity: 54.5°F / 100%RH Fan speed setting: High Supply air CFM: 630 Approx. % of Outside air: 10% Outside air CFM: 65 CFM	Fail	-
Notes:	a. Design supply airflow of 1335 CFM is not being obtained.			17
	b. Design outside airflow of 485 CFM is not being obtained.			18
6*	"High-Heat Load Simulation": Force all indoor units into 'Heating Mode' for a duration of 30 minutes to simulate a hot building. Command selected spaces to 'Cooling Mode' to verify proper cooling of space is achieved. Time: 7:44 pm	Spaces commanded to cooling properly meet cooling setpoint. Laptop Service Tool: Mixed air temp: 79.1°F (db) EEV (valve) position: 331 (40 min.-600 max.) TAB: Mixed air temp/humidity: 77.0°F / 55.3%RH Supply air temp/humidity: 58.5°F / 90.0%RH	*	-
Notes:	a. Mixed air temperature sensor feedback was not tracking with manual instrumentation measurement. This could be caused by a lag in sensor/instrument response times.			-
	b. VRF system struggled to meet zone cooling setpoint of 66°F within a timeframe of 1-hour. TGCE believes the struggle was caused by simultaneous cooling and heating demands (i.e., some zones calling for heat while some zones calling for cooling).			-
7	**Return all changed/adjusted control parameters and conditions to their pre-test values per as-found conditions.**	**Verify all IDUs are in auto mode.**	Pass	-

*Pass/Fail not assigned because conditions were not adequately represented by the test.

- END OF TEST -

Tom Green & Company
Engineers, Inc.

FUNCTIONAL PERFORMANCE TEST

VARIABLE REFRIGERANT FLOW (VRF) SPLIT SYSTEMS

Owner	City of Schertz	**Date**	6/23/20
Project	Animal Adoption Center Retro-Cx	**Project #**	1393.00

Personnel Present

Tom Green, PE	TGCE	Daniel Fitzpatrick	TAS
Cx Authority	Company	Mechanical Contractor	Company
Yin Ling Ng, PE	TGCE		
Cx Authority	Company	Mechanical Contractor	Company
Greg Maxwell, LEED AP	TGCE		
Cx Authority	Company	Electrical Contractor	Company
Phil Gaudreau	COS		
Owner's Representative	Company	Electrical Contractor	Company
Brenda Spinelli	COS		
Owner's Representative	Company	Controls Contractor	Company
Chad Lonsberry	COS		
Owner's Representative	Company	Controls Contractor	Company
		Victor Rodriguez	ATI
General Contractor	Company	Test and Balance	Company
		Damien Albiter	ATI
General Contractor	Company	Test and Balance	Company
General Contractor	Company		
General Contractor	Company		

Equipment Included

Equipment #: DS-09
LG Service Tool Identification: IDU-12
AC Smart Identification: Lobby
Room(s) Served: Vestibule 100, Adoption Lobby 101, Adopt. Serv. 101A, Dog Display 107, Get Acquainted Room 108, Men's RR 109, Women's RR 110

Pre-requisite Checklist

Mark 'Y' if the item is complete/acceptable. If not, mark 'N' and enter note/deficiency on Cx Assist/Issues Log.

Item	Pre-requisite Item Details to be verified prior to or coincidentally with Test Procedure	Y/N	Log #
1	All control system functions for this and all interlocking systems are programmed and operable per Contract Documents, including final setpoints and schedules set in AC Smart controller.	Y	-
2	Pre-Functional Performance Checklists (PFPCs) are addressed for the specific system.	N/A	-
3	Test and Balance (TAB) addressed for the system.	Y	-
4	These Functional Performance Test (FPT) procedures have been reviewed, with select preliminary checks having already been performed by Contractors.	Y	-
5	AC Smart is operational.	Y	-

Test Procedure

Check each item as verified. Adjust specified time delays as directed by CxA at time of testing. Enter note/deficiency on Cx Assist/Issues Log.

No.	Test Procedure	Expected Result	Pass/ Fail	Log #
1	Verify communication, all IDUs are on AC Smart control screen. Record Ambient/Weather Conditions. Time: 2:15 pm	Front end communication with system equipment has been established. Actual: 86°F / 56%RH, Wind: WSW @ 5 mph AC Smart: 95.9°F	Pass	-
Notes:	a. IDU addresses on Laptop Service Tool are not mapped to equivalent equipment numbers (e.g., IDU-2 = DS-01). The LG software is unable to rename IDU addresses as it auto-assigns during system start-up. TGCE and TAS had to investigate via thermostat mapping in order to identify all systems.			1
	b. The AC Smart outside air sensor is located within the condensing unit cabinet which is picking up system heat rejection and therefor, is not an accurate representation of true ambient conditions. Additionally, the sensor only reads temperature.			2
2	'Heating Mode': Force/Override space temperature setpoint to 84°F from space (room) temperature sensor. Time: 4:45 pm	Does AC Smart show Temp change. After a 15-minute period, record the following AC Smart sensor feedback: Mixed air temp: 71.2°F (db) Refrigerant In temp: 105.1°F Refrigerant Out temp: 161.3°F EEV (valve) position: 440 (40 min.-1350 max.)	Pass	-
3	Conduct 'Heating Mode' TAB measurements/calculations and record results.	Return air temp/humidity: 80.8°F / 68.5%RH Supply air temp/humidity: 106.7°F / 33.3%RH	Pass	-
4	'Cooling Mode': Force/Override space temperature setpoint to 64°F from space (room) temperature sensor. Time: 2:15 pm	Does AC Smart show Temp change. After a 15-minute period, record the following AC Smart sensor feedback: Fan Speed: High Mixed air temp: 68.8°F (db) Refrigerant In temp: 51.2°F Refrigerant Out temp: 56.6°F EEV (valve) position: 176 (40 min.-600 max.)	Pass	-
Notes:	a. Measurements were taken at 66°F setpoint in lieu of 64°F.			-

No.	Test Procedure	Expected Result	Pass/ Fail	Log #
5	Conduct 'Cooling Mode' TAB measurements/calculations and record results.	Return air temp/humidity: 68.4°F / 67.3%RH Outside air temp/humidity: 93.2°F / 43.7%RH Mixed air temp/humidity: 79.8°F / 68.8%RH Supply air temp/humidity: 57.7°F / 94.5%RH Fan speed setting: High Supply air CFM: 772 Approx. % of Outside air: 16% Outside air CFM: 123 CFM	Fail	-
Notes:	a. Design supply airflow of 1635 CFM is not being obtained.			19
	b. Design outside airflow of 500 CFM is not being obtained.			20
6*	"High-Heat Load Simulation": Force all indoor units into 'Heating Mode' for a duration of 30 minutes to simulate a hot building. Command selected spaces to 'Cooling Mode' to verify proper cooling of space is achieved. Time: 7:30 pm	Spaces commanded to cooling properly meet cooling setpoint. Laptop Service Tool: Mixed air temp: 77.2°F (db) EEV (valve) position: 415 (40 min.-600 max.) TAB: Mixed air temp/humidity: 77.5°F / 60.9%RH Supply air temp/humidity: 59.7°F / 91.6%RH	*	-
Notes:	a. Mixed air temperature sensor feedback was not tracking with manual instrumentation measurement. This could be caused by a lag in sensor/instrument response times.			-
	b. VRF system struggled to meet zone cooling setpoint of 66°F within a timeframe of 1-hour. TGCE believes the struggle was caused by simultaneous cooling and heating demands (i.e., some zones calling for heat while some zones calling for cooling).			-
7	**Return all changed/adjusted control parameters and conditions to their pre-test values per as-found conditions.**	**Verify all IDUs are in auto mode.**	Pass	-

*Pass/Fail not assigned because conditions were not adequately represented by the test.

- END OF TEST -

Tom Green & Company
Engineers, Inc.

FUNCTIONAL PERFORMANCE TEST

VARIABLE REFRIGERANT FLOW (VRF) SPLIT SYSTEMS

Owner	City of Schertz	**Date**	6/23/20
Project	Animal Adoption Center Retro-Cx	**Project #**	1393.00

Personnel Present

Tom Green, PE	TGCE	Daniel Fitzpatrick	TAS
Cx Authority	Company	Mechanical Contractor	Company
Yin Ling Ng, PE	TGCE		
Cx Authority	Company	Mechanical Contractor	Company
Greg Maxwell, LEED AP	TGCE		
Cx Authority	Company	Electrical Contractor	Company
Phil Gaudreau	COS		
Owner's Representative	Company	Electrical Contractor	Company
Brenda Spinelli	COS		
Owner's Representative	Company	Controls Contractor	Company
Chad Lonsberry	COS		
Owner's Representative	Company	Controls Contractor	Company
		Victor Rodriguez	ATI
General Contractor	Company	Test and Balance	Company
		Damien Albiter	ATI
General Contractor	Company	Test and Balance	Company
General Contractor	Company		
General Contractor	Company		

Equipment Included

Equipment #: DS-10
LG Service Tool Identification: IDU-10
AC Smart Identification: Retail Dog
Room(s) Served: Retail Dog Adopt. 112, Corridor 113, Puppy Adoption 115, Staff T/R 120

Pre-requisite Checklist

Mark 'Y' if the item is complete/acceptable. If not, mark 'N' and enter note/deficiency on Cx Assist/Issues Log.

Item	Pre-requisite Item Details to be verified prior to or coincidentally with Test Procedure	Y/N	Log #
1	All control system functions for this and all interlocking systems are programmed and operable per Contract Documents, including final setpoints and schedules set in AC Smart controller.	Y	-
2	Pre-Functional Performance Checklists (PFPCs) are addressed for the specific system.	N/A	-
3	Test and Balance (TAB) addressed for the system.	Y	-
4	These Functional Performance Test (FPT) procedures have been reviewed, with select preliminary checks having already been performed by Contractors.	Y	-
5	AC Smart is operational.	Y	-

Test Procedure

Check each item as verified. Adjust specified time delays as directed by CxA at time of testing. Enter note/deficiency on Cx Assist/Issues Log.

No.	Test Procedure	Expected Result	Pass/ Fail	Log #
1	Verify communication, all IDUs are on AC Smart control screen. Record Ambient/Weather Conditions. Time: 2:03 pm	Front end communication with system equipment has been established. Actual: 85°F / 57%RH, Wind: SSE @ 6 mph AC Smart: 93.7°F	Pass	-
Notes:	a. IDU addresses on Laptop Service Tool are not mapped to equivalent equipment numbers (e.g., IDU-2 = DS-01). The LG software is unable to rename IDU addresses as it auto-assigns during system start-up. TGCE and TAS had to investigate via thermostat mapping in order to identify all systems.			1
	b. The AC Smart outside air sensor is located within the condensing unit cabinet which is picking up system heat rejection and therefor, is not an accurate representation of true ambient conditions. Additionally, the sensor only reads temperature.			2
2	'Heating Mode': Force/Override space temperature setpoint to 84°F from space (room) temperature sensor. Time: 4:45 pm	Does AC Smart show Temp change. After a 15-minute period, record the following AC Smart sensor feedback: Mixed air temp: 71.2°F (db) Refrigerant In temp: 101.9°F Refrigerant Out temp: 151.8°F EEV (valve) position: 244 (40 min.-1350 max.)	Pass	-
3	Conduct 'Heating Mode' TAB measurements/calculations and record results.	Return air temp/humidity: 75.7°F / 54.5%RH Supply air temp/humidity: 94.8°F / 36.7%RH	Pass	-
4	'Cooling Mode': Force/Override space temperature setpoint to 64°F from space (room) temperature sensor. Time: 2:03 pm	Does AC Smart show Temp change. After a 15-minute period, record the following AC Smart sensor feedback: Fan Speed: High Mixed air temp: 71.2°F (db) Refrigerant In temp: 48.2°F Refrigerant Out temp: 56.6°F EEV (valve) position: 185 (40 min.-600 max.)	Pass	-
Notes:	a. Measurements were taken at 66°F setpoint in lieu of 64°F.			-

No.	Test Procedure	Expected Result	Pass/ Fail	Log #
5	Conduct 'Cooling Mode' TAB measurements/calculations and record results.	Return air temp/humidity: 70.5°F / 63.4%RH Outside air temp/humidity: 92.8°F / 43.3%RH Mixed air temp/humidity: 74.3°F / 72.4%RH Supply air temp/humidity: 58.2°F / 93.6%RH Fan speed setting: High Supply air CFM: 383 Approx. % of Outside air: 15% Outside air CFM: 57 CFM	Fail	-
Notes:	a. Design supply airflow of 425 CFM is not being obtained.			21
	b. Design outside airflow of 150 CFM is not being obtained.			22
6*	"High-Heat Load Simulation": Force all indoor units into 'Heating Mode' for a duration of 30 minutes to simulate a hot building. Command selected spaces to 'Cooling Mode' to verify proper cooling of space is achieved. Time: 7:30 pm	Spaces commanded to cooling properly meet cooling setpoint. Laptop Service Tool: Mixed air temp: 73.5°F (db) EEV (valve) position: 245 (40 min.-600 max.) TAB: Mixed air temp/humidity: 81.2°F / 51.0%RH Supply air temp/humidity: 59.2°F / 91.7%RH	*	-
Notes:	a. Mixed air temperature sensor feedback was not tracking with manual instrumentation measurement. This could be caused by a lag in sensor/instrument response times.			-
	b. VRF system struggled to meet zone cooling setpoint of 66°F within a timeframe of 1-hour. TGCE believes the struggle was caused by simultaneous cooling and heating demands (i.e., some zones calling for heat while some zones calling for cooling).			-
7	**Return all changed/adjusted control parameters and conditions to their pre-test values per as-found conditions.**	**Verify all IDUs are in auto mode.**	Pass	-

*Pass/Fail not assigned because conditions were not adequately represented by the test.

- END OF TEST -

Tom Green & Company
Engineers, Inc.

FUNCTIONAL PERFORMANCE TEST

VARIABLE REFRIGERANT FLOW (VRF) SPLIT SYSTEMS

Owner	City of Schertz	**Date**	6/23/20
Project	Animal Adoption Center Retro-Cx	**Project #**	1393.00

Personnel Present

Tom Green, PE	TGCE	Daniel Fitzpatrick	TAS
Cx Authority	Company	Mechanical Contractor	Company
Yin Ling Ng, PE	TGCE		
Cx Authority	Company	Mechanical Contractor	Company
Greg Maxwell, LEED AP	TGCE		
Cx Authority	Company	Electrical Contractor	Company
Phil Gaudreau	COS		
Owner's Representative	Company	Electrical Contractor	Company
Brenda Spinelli	COS		
Owner's Representative	Company	Controls Contractor	Company
Chad Lonsberry	COS		
Owner's Representative	Company	Controls Contractor	Company
		Victor Rodriguez	ATI
General Contractor	Company	Test and Balance	Company
		Damien Albiter	ATI
General Contractor	Company	Test and Balance	Company
General Contractor	Company		
General Contractor	Company		

Equipment Included

Equipment #: DS-11
LG Service Tool Identification: IDU-3
AC Smart Identification: Cat Intake
Room(s) Served: Stray Cat Holding 128

Pre-requisite Checklist

Mark 'Y' if the item is complete/acceptable. If not, mark 'N' and enter note/deficiency on Cx Assist/Issues Log.

Item	Pre-requisite Item Details to be verified prior to or coincidentally with Test Procedure	Y/N	Log #
1	All control system functions for this and all interlocking systems are programmed and operable per Contract Documents, including final setpoints and schedules set in AC Smart controller.	Y	
2	Pre-Functional Performance Checklists (PFPCs) are addressed for the specific system.	N/A	
3	Test and Balance (TAB) addressed for the system.	Y	
4	These Functional Performance Test (FPT) procedures have been reviewed, with select preliminary checks having already been performed by Contractors.	Y	
5	AC Smart is operational.	Y	

Test Procedure

Check each item as verified. Adjust specified time delays as directed by CxA at time of testing. Enter note/deficiency on Cx Assist/Issues Log.

No.	Test Procedure	Expected Result	Pass/ Fail	Log #
1	Verify communication, all IDUs are on AC Smart control screen. Record Ambient/Weather Conditions.	Front end communication with system equipment has been established. Actual: AC Smart:	DNT	-
Notes:	a. IDU addresses on Laptop Service Tool are not mapped to equivalent equipment numbers (e.g., IDU-2 = DS-01). The LG software is unable to rename IDU addresses as it auto-assigns during system start-up. TGCE and TAS had to investigate via thermostat mapping in order to identify all systems.			1
2	'Heating Mode': Force/Override space temperature setpoint to 84°F from space (room) temperature sensor.	Does AC Smart show Temp change. After a 15-minute period, record the following AC Smart sensor feedback: Mixed air temp: _____ °F (db) Refrigerant In temp: _____ °F Refrigerant Out temp: _____ °F EEV (valve) position: _____ (40 min.-1350 max.)	DNT	-
Notes:	a. This Cx test was not performed on cassette style units. DNT = Did Not Test			-
3	'Cooling Mode': Force/Override space temperature setpoint to 64°F from space (room) temperature sensor.	Does AC Smart show Temp change. After a 15-minute period, record the following AC Smart sensor feedback: Fan Speed: High Mixed air temp: _____ °F (db) Refrigerant In temp: _____ °F Refrigerant Out temp: _____ °F EEV (valve) position: _____ (40 min.-600 max.)	DNT	-
Notes:	a. EEV (electronic expansion valve) was found failed – Unit is currently not cooling and could not be commissioned. DNT = Did Not Test			23

No.	Test Procedure	Expected Result	Pass/ Fail	Log #
4	Conduct 'Cooling Mode' TAB measurements/calculations and record results.	Return air temp/humidity: _____°F / _____%RH Outside air temp/humidity: _____°F / _____%RH Mixed air temp/humidity: _____°F / _____%RH Supply air temp/humidity: _____°F / _____%RH Fan speed setting: _____ Return air CFM: _____ Approx. % of Outside air: _____ % Outside air CFM: _____	DNT	-
5	**Return all changed/adjusted control parameters and conditions to their pre-test values per as-found conditions.**	**Verify all IDUs are in auto mode.**	DNT	-

- END OF TEST -

Tom Green & Company
Engineers, Inc.

FUNCTIONAL PERFORMANCE TEST

VARIABLE REFRIGERANT FLOW (VRF) SPLIT SYSTEMS

Owner	City of Schertz	**Date**	6/23/20
Project	Animal Adoption Center Retro-Cx	**Project #**	1393.00

Personnel Present

Tom Green, PE	TGCE	Daniel Fitzpatrick	TAS
Cx Authority	Company	Mechanical Contractor	Company
Yin Ling Ng, PE	TGCE		
Cx Authority	Company	Mechanical Contractor	Company
Greg Maxwell, LEED AP	TGCE		
Cx Authority	Company	Electrical Contractor	Company
Phil Gaudreau	COS		
Owner's Representative	Company	Electrical Contractor	Company
Brenda Spinelli	COS		
Owner's Representative	Company	Controls Contractor	Company
Chad Lonsberry	COS		
Owner's Representative	Company	Controls Contractor	Company
		Victor Rodriguez	ATI
General Contractor	Company	Test and Balance	Company
		Damien Albiter	ATI
General Contractor	Company	Test and Balance	Company
General Contractor	Company		
General Contractor	Company		

Equipment Included

Equipment #: DS-12
LG Service Tool Identification: IDU-4
AC Smart Identification: Training
Room(s) Served: Training 114

Pre-requisite Checklist

Mark 'Y' if the item is complete/acceptable. If not, mark 'N' and enter note/deficiency on Cx Assist/Issues Log.

Item	Pre-requisite Item Details to be verified prior to or coincidentally with Test Procedure	Y/N	Log #
1	All control system functions for this and all interlocking systems are programmed and operable per Contract Documents, including final setpoints and schedules set in AC Smart controller.	Y	
2	Pre-Functional Performance Checklists (PFPCs) are addressed for the specific system.	N/A	
3	Test and Balance (TAB) addressed for the system.	Y	
4	These Functional Performance Test (FPT) procedures have been reviewed, with select preliminary checks having already been performed by Contractors.	Y	
5	AC Smart is operational.	Y	

Test Procedure

Check each item as verified. Adjust specified time delays as directed by CxA at time of testing. Enter note/deficiency on Cx Assist/Issues Log.

No.	Test Procedure	Expected Result	Pass/ Fail	Log #
1	Verify communication, all IDUs are on AC Smart control screen. Record Ambient/Weather Conditions. Time: 2:59 pm	Front end communication with system equipment has been established. Actual: 88°F / 52%RH, Wind: SSW @ 5 mph AC Smart: 96.6°F	Pass	-
Notes:	a. IDU addresses on Laptop Service Tool are not mapped to equivalent equipment numbers (e.g., IDU-2 = DS-01). The LG software is unable to rename IDU addresses as it auto-assigns during system start-up. TGCE and TAS had to investigate via thermostat mapping in order to identify all systems.			1
	b. The AC Smart outside air sensor is located within the condensing unit cabinet which is picking up system heat rejection and therefore, is not an accurate representation of true ambient conditions. Additionally, the sensor only reads temperature.			2
2	'Heating Mode': Force/Override space temperature setpoint to 84°F from space (room) temperature sensor.	Does AC Smart show Temp change. After a 15-minute period, record the following AC Smart sensor feedback: Mixed air temp: _____ °F (db) Refrigerant In temp: _____ °F Refrigerant Out temp: _____ °F EEV (valve) position: _____ (40 min.-1350 max.)	DNT	-
Notes:	a. This Cx test was not performed on cassette style units. DNT = Did Not Test			-
3	'Cooling Mode': Force/Override space temperature setpoint to 64°F from space (room) temperature sensor. Time: 3:00 pm	Does AC Smart show Temp change. After a 15-minute period, record the following AC Smart sensor feedback: Fan Speed: High Mixed air temp: 67.6°F (db) Refrigerant In temp: 47.6°F Refrigerant Out temp: 54.2°F EEV (valve) position: 184 (40 min.-600 max.)	Pass	-

No.	Test Procedure	Expected Result	Pass/ Fail	Log #
4	Conduct 'Cooling Mode' TAB measurements/calculations and record results.	Return air temp/humidity: 63.8°F / 76.8%RH Outside air temp/humidity: DNM / DNM Mixed air temp/humidity: See notes below Supply air temp/humidity: 49.7°F / 99.0%RH Fan speed setting: High Return air CFM: 406 Approx. % of Outside air: 0% Outside air CFM: - 43 CFM	Fail	-
Notes:	a. Upon traverse of O/A, reverse airflow was observed and therefore, design outside airflow is not being obtained. This condition was typical for all cassette style units. The LG Engineering Manual states that inline fans are required to push outdoor air to the indoor cassette unit to overcome the static pressure. This building is not equipped with inline fans on the outside air ductwork.			4
	b. Supply airflow cannot be accurately measured on cassette style units.			5
	c. Mixed air conditions could not be measured on cassette style units.			6
5	**Return all changed/adjusted control parameters and conditions to their pre-test values per as-found conditions.**	**Verify all IDUs are in auto mode.**	Pass	-

- END OF TEST -

Tom Green & Company
Engineers, Inc.

FUNCTIONAL PERFORMANCE TEST

VARIABLE REFRIGERANT FLOW (VRF) SPLIT SYSTEMS

Owner	City of Schertz	**Date**	6/23/20
Project	Animal Adoption Center Retro-Cx	**Project #**	1393.00

Personnel Present

Tom Green, PE	TGCE	Daniel Fitzpatrick	TAS
Cx Authority	Company	Mechanical Contractor	Company
Yin Ling Ng, PE	TGCE		
Cx Authority	Company	Mechanical Contractor	Company
Greg Maxwell, LEED AP	TGCE		
Cx Authority	Company	Electrical Contractor	Company
Phil Gaudreau	COS		
Owner's Representative	Company	Electrical Contractor	Company
Brenda Spinelli	COS		
Owner's Representative	Company	Controls Contractor	Company
Chad Lonsberry	COS		
Owner's Representative	Company	Controls Contractor	Company
		Victor Rodriguez	ATI
General Contractor	Company	Test and Balance	Company
		Damien Albiter	ATI
General Contractor	Company	Test and Balance	Company
General Contractor	Company		
General Contractor	Company		

Equipment Included

Equipment #: DS-13
LG Service Tool Identification: IDU-5
AC Smart Identification: Break Room
Room(s) Served: Break Room 118

Pre-requisite Checklist

Mark 'Y' if the item is complete/acceptable. If not, mark 'N' and enter note/deficiency on Cx Assist/Issues Log.

Item	Pre-requisite Item Details to be verified prior to or coincidentally with Test Procedure	Y/N	Log #
1	All control system functions for this and all interlocking systems are programmed and operable per Contract Documents, including final setpoints and schedules set in AC Smart controller.	Y	
2	Pre-Functional Performance Checklists (PFPCs) are addressed for the specific system.	N/A	
3	Test and Balance (TAB) addressed for the system.	Y	
4	These Functional Performance Test (FPT) procedures have been reviewed, with select preliminary checks having already been performed by Contractors.	Y	
5	AC Smart is operational.	Y	

Test Procedure

Check each item as verified. Adjust specified time delays as directed by CxA at time of testing. Enter note/deficiency on Cx Assist/Issues Log.

No.	Test Procedure	Expected Result	Pass/ Fail	Log #
1	Verify communication, all IDUs are on AC Smart control screen. Record Ambient/Weather Conditions. Time: 3:30 pm	Front end communication with system equipment has been established. Actual: 89°F / 50%RH, Wind: SSW @ 6 mph AC Smart: 101.1°F	Pass	-
Notes:	a. IDU addresses on Laptop Service Tool are not mapped to equivalent equipment numbers (e.g., IDU-2 = DS-01). The LG software is unable to rename IDU addresses as it auto-assigns during system start-up. TGCE and TAS had to investigate via thermostat mapping in order to identify all systems.			1
	b. The AC Smart outside air sensor is located within the condensing unit cabinet which is picking up system heat rejection and therefore, is not an accurate representation of true ambient conditions. Additionally, the sensor only reads temperature.			2
2	'Heating Mode': Force/Override space temperature setpoint to 84°F from space (room) temperature sensor.	Does AC Smart show Temp change. After a 15-minute period, record the following AC Smart sensor feedback: Mixed air temp: _____ °F (db) Refrigerant In temp: _____ °F Refrigerant Out temp: _____ °F EEV (valve) position: _____ (40 min.-1350 max.)	DNT	-
Notes:	a. This Cx test was not performed on cassette style units. DNT = Did Not Test			-
3	'Cooling Mode': Force/Override space temperature setpoint to 64°F from space (room) temperature sensor. Time: 3:30 pm	Does AC Smart show Temp change. After a 15-minute period, record the following AC Smart sensor feedback: Fan Speed: High Mixed air temp: 67.6°F (db) Refrigerant In temp: 46.9°F Refrigerant Out temp: 55.4°F EEV (valve) position: 126 (40 min.-600 max.)	Pass	
Notes:	a. Measurements were taken at 66°F setpoint in lieu of 64°F.			-
	b. Observed excessive fan noise. Texas Air Systems believes the noise is caused by failing fan motor.			3

No.	Test Procedure	Expected Result	Pass/ Fail	Log #
4	Conduct 'Cooling Mode' TAB measurements/calculations and record results.	Return air temp/humidity: 64.6°F / 70.2%RH Outside air temp/humidity: DNM / DNM Mixed air temp/humidity: See notes below Supply air temp/humidity: 53.6°F / 100%RH Fan speed setting: High Return air CFM: 514 Approx. % of Outside air: 0% Outside air CFM: - 27 CFM	Fail	-
Notes:	a. Upon traverse of O/A, reverse airflow was observed and therefore, design outside airflow is not being obtained. This condition was typical for all cassette style units. The LG Engineering Manual states that inline fans are required to push outdoor air to the indoor cassette unit to overcome the static pressure. This building is not equipped with inline fans on the outside air ductwork.			4
	b. Supply airflow cannot be accurately measured on cassette style units.			5
	c. Mixed air conditions could not be measured on cassette style units.			6
5	**Return all changed/adjusted control parameters and conditions to their pre-test values per as-found conditions.**	**Verify all IDUs are in auto mode.**	Pass	-

- END OF TEST -

Appendix C

TEST AND BALANCE (TAB) REPORT

CERTIFIED TEST, ADJUST, AND BALANCE REPORT

JOB #: 6834

DATE: 6/25/20

PROJECT: **SCHERTZ ANIMAL ADOPTION CENTER**

ADDRESS: 800 COMMUNITY CIRCLE
SCHERTZ, TX 78156

ARCHITECT: N/A

ENGINEER: N/A

HVAC CONTRACTOR: N/A

TAB FIRM: ***AIR TECHNOLOGIES, INC.***
P. O. BOX 129
MANCHACA, TX 78652-0129

Phone: (512) 280-3398

PROJECT: **SCHERTZ ANIMAL ADOPTION CENTER**
ADDRESS: **SCHERTZ, TEXAS**

"THE DATA PRESENTED IN THIS REPORT IS A RECORD OF SYSTEM MEASUREMENTS AND FINAL ADJUSTMENTS THAT HAVE BEEN OBTAINED IN ACCORDANCE WITH THE CURRENT EDITION OF THE NEBB *PROCEDURAL STANDARDS FOR TESTING, ADJUSTING, AND BALANCING OF ENVIRONMENTAL SYSTEMS*. ANY VARIANCES FROM DESIGN QUANTITIES, WHICH EXCEED NEBB TOLERANCES, ARE NOTED IN THE TEST-ADJUST-BALANCE REPORT PROJECT SUMMARY."

ADJUSTMENTS MADE IN ACCORDANCE WITH NEBB "PROCEDURAL STANDARDS FOR TESTING, ADJUSTING, BALANCING OF ENVIRONMENTAL SYSTEMS" AND THE PROJECT SPECIFICATIONS.

NEBB TAB FIRM	**AIR TECHNOLOGIES, INC.**	REG. NO.	**3035**
CERTIFIED BY	**MICHAEL J. HUBER**	DATE	**6/25/20**

NEBB TAB FIRM	**AIR TECHNOLOGIES, INC.**	REG. NO.	**3035**
TAB SUPERVISOR	**MICHAEL J. HUBER**	DATE	**6/25/20**

SIGNATURE 

CERTIFICATION EXPIRATION DATE **3/31/2021**

TABLE OF CONTENTS

SCHERTZ ANIMAL ADOPTION CENTER

INSTRUMENT CALIBRATION
REPORT

PROJECT: **SCHERTZ ANIMAL ADOPTION CENTER**

INSTRUMENT / SERIAL #	APPLICATION	DATES OF USE	CALIBRATION DATE
SHORTRIDGE ADM / M98217	VELOCITY / DIFF. PRESS.	6/23/20	4/29/20
SHORTRIDGE FLOWHOOD / M19285	AIRFLOW / CFM	6/23/20	6/25/19

DATE: 6/23/20 READINGS BY: VR / DA

ACT.	ACTUAL
AF	AIRFOIL FAN WHEEL
AHU	AIR HANDLING UNIT
AVG.	AVERAGE
AX	AXIAL FAN WHEEL
BC	BACKWARD CURVE (FAN BLADE TYPE)
BI	BACKWARD INCLINE (FAN BLADE TYPE)
CD	CEILING DIFFUSER
CF	CORRECTION FACTOR
CFM	CUBIC FEET PER MINUTE
DB	DRY BULB
DDC	DIRECT DIGITAL CONTROLS
DES.	DESIGN
DIA.	DIAMETER
DIFF.	DIFFERENTIAL
DISP.	DISPOSABLE
Δh	DIFFERENTIAL ENTHALAPY
ΔP	DIFFERENTIAL PRESSURE
ΔT	DIFFERENTIAL TEMPERATURE
E/A	EXHAUST AIR
EAT	ENTERING AIR TEMPERTURE
ENT	ENTERING
EXT	EXTERNAL
EXT. S.P.	EXTERNAL STATIC PRESSURE
F/S	FIRE / SMOKE
FC	FORWARD CURVE (FAN BLADE TYPE)
FCU	FAN COIL UNIT
FL	FULL LOAD
FOC	FULL OPEN CORRECTION FACTOR
FPB	FAN POWERED TERMINAL BOX
FPM	FEET PER MINUTE
FT.	FEET
GPM	GALLONS PER MINUTE
H_20	WATER
HG	MERCURY
HP	HORSEPOWER
HRU	HEAT RECOVERY UNIT
HZ	HERTZ
IN	INCH(ES)
KW	KILOWATT
LAT	LEAVING AIR TEMPERATURE
LD	LINEAR DIFFUSER
LID	LAY IN DIFFUSER
LT	LIGHT TROFFER DIFFUSER
LVG	LEAVING
MAX.	MAXIMUM
MAX. FC	MAXIMUM FLOW CORRECTION FACTOR
MIN.	MINIMUM
MIN. FC	MINIMUM FLOW CORRECTION FACTOR
ML	MIXING LATERAL
MD	MOTORIZE DAMPER
N/A	NOT APPLICABLE
NG	NOT GIVEN
NO.	NUMBER
O.D.	OUTSIDE DIAMETER
O/A	OUTSIDE AIR
OBD	OPPOSED BLADE DAMPER
ODP	OPEN DRIP PROOF
PD	PITCH DIAMETER
PERF.	PERFORATED
PF	PERFORMANCE FACTOR
PG	PICKUP GAIN
PRD	PRESSURE DEPENDENT TERMINAL UNIT
PRI	PRESSURE INDEPENDENT TERMINAL UNIT
CO	COOLING ONLY
RH	COOLING W/ REHEAT
PFP	PARALLEL FAN POWERED
SFP	SERIES FAN POWERED
PROP	PROPELLER (FAN BLADE TYPE)
PSI	POUNDS PER SQUARE INCH
R/A	RETURN AIR
REFRIG.	REFRIGERANT
RND	ROUND
RPM	REVOLUTIONS PER MINUTE
RTU	ROOFTOP UNIT
S.P.	STATIC PRESSURE
SA	SUPPLY AIR
SC	FLOW CALIBRATION FACTOR
SF	SERVICE FACTOR
SQ. FT.	SQUARE FEET
SURF.	SURFACE MOUNT DIFFUSER
SW	SIDEWALL DIFFUSER
TA	TUBE AXIAL (FAN BLADE TYPE)
TEMP.	TEMPERATURE
VA	VANE AXIAL FAN WHEEL
VAV	VARIABLE AIR VOLUME TERMINAL BOX
VDC	VOLTS DIRECT CURRENT
VFD	VARIABLE FREQUENCY DRIVE
VP	VELOCITY PRESSURE
W.C.	WATER COLUMN
WASH.	WASHABLE
WB	WET BULB

PROJECT: SCHERTZ ANIMAL ADOPTION CENTER

DESCRIPTION:

THE SCOPE OF WORK CONSISTED OF PERFORMING AN AUDIT OF THE HVAC SYSTEMS AIR QUANTITIES AND PRESSURES IN AN EFFORT TO AID IN TROUBLESHOOTING OF INDOOR COMFORT COMPLAINTS. THE SYSTEMS TESTED CONSIST OF 13 SPLIT DX FAN COIL UNITS THAT ARE PART OF A VARIABLE REFRIGERANT SYSTEM ALONG WITH 3 EXHAUST FANS AND ALL ASSOCIATED AIR DEVICES.

TESTING PROCEDURES

FAN COIL UNITS

EACH FAN COIL UNIT SUPPLY AIR SYSTEM WAS TRAVERSED TO DETERMINE TOTAL CFM. SUPPLY OUTLET AIRFLOWS WERE MEASURED AND RECORDED VIA FLOW HOOD READINGS. OUTSIDE AIR AND STATIC PRESSURES WERE ALSO MEASURED AND RECORDED. EXHAUST SYSTEMS WERE TESTED IN A SIMILAR MANNER.

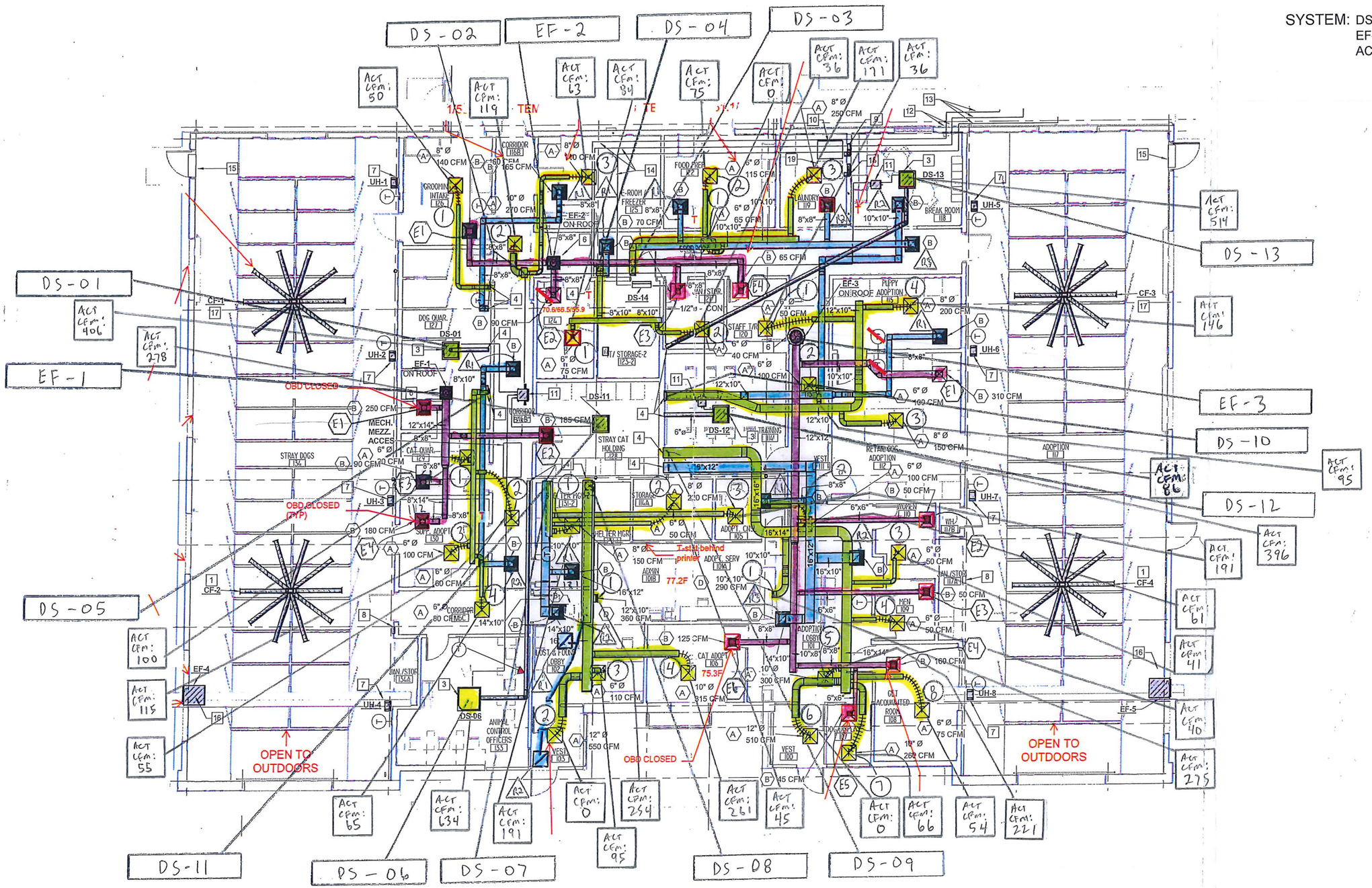
ALL AIR TEMPERATURES MEASURED WERE RECORDED ELSEWHERE BY THE COMMISSIONING TEAM.

SYSTEM DIAGRAM

PROJECT: **SCHERTZ ANIMAL ADOPTION CENTER**

LOCATION: **ENTIRE BUILDING**

SYSTEM: DS-01 THRU DS-13,
EF-1 THRU EF-3 &
ACTUAL SUPPLY OUTLETS CFM

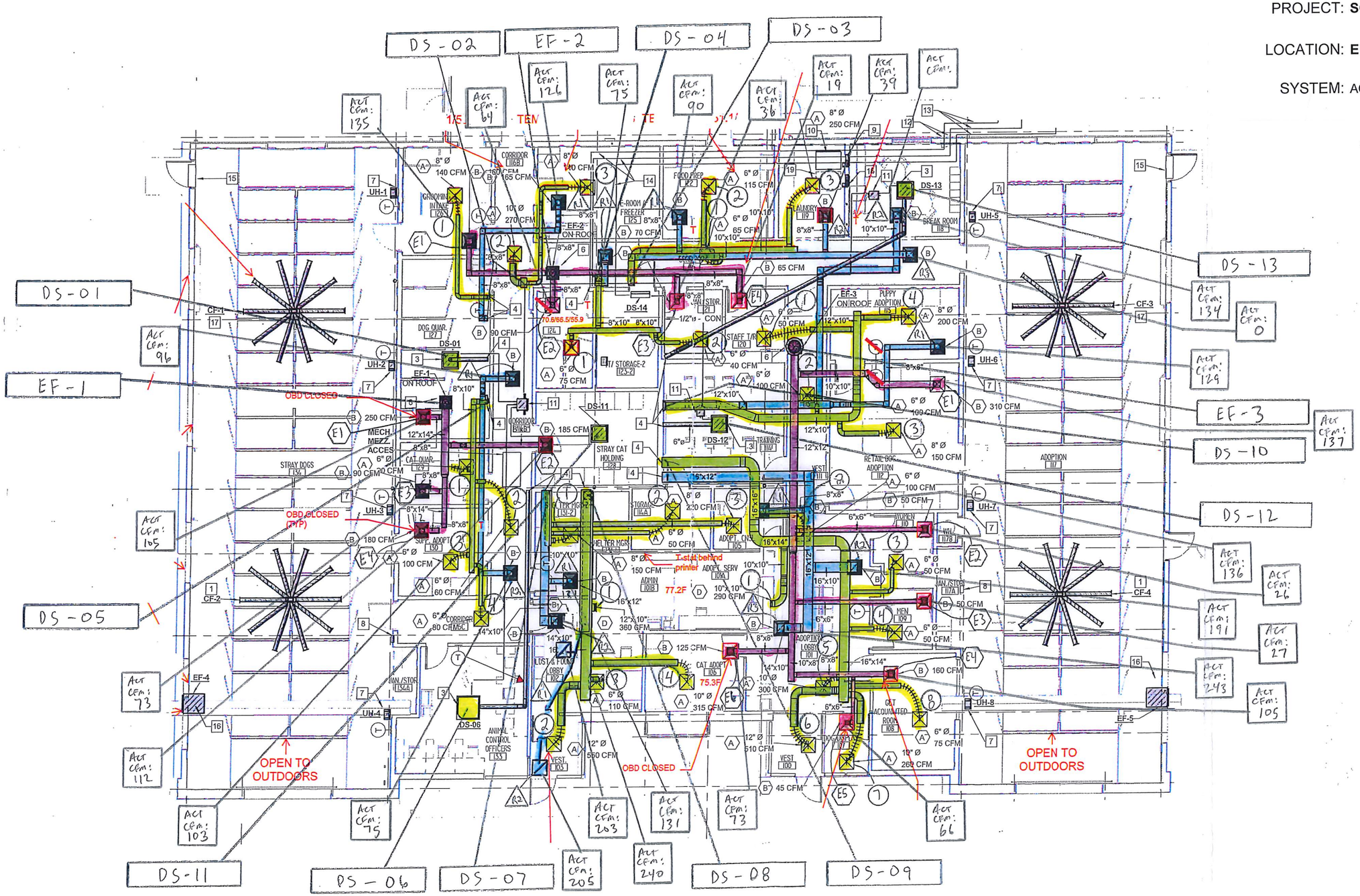


SYSTEM DIAGRAM

PROJECT: **SCHERTZ ANIMAL ADOPTION CENTER**

LOCATION: **ENTIRE PROJECT**

SYSTEM: ACTUAL EXHAUST & RETURN INLET CFM



ago by Big Ass fans and ...ical done by Jerad Electric.

SYSTEM DIAGRAM

PROJECT: **SCHERTZ ANIMAL ADOPTION CENTER**

LOCATION: **ENTIRE BUILDING**

SYSTEM: BUILDING & ROOM PRESSURES

TEMPS: 78.1/58.2/62.5 TEMPS: 78.9/59.8/69.3 TEMPS: 75.4/61.1/61.3

74.5/63.1/60.0

BEHIND FRIDGE

.010" .010" .009"

.036" .001" .0008" .002"

.004" .0001" .003"

.001" .001" .003"

.052" .056" .0002" .004" .001"

ALL LOUVERS OPEN TO OUTDOORS

MOVED TO HIGH CENTER OF WALL

OPEN TO OUTDOORS

OPEN TO OUTDOORS

OBD CLOSED

OBD CLOSED (TYP)

OBD CLOSED

OBD partially open

T-stat behind printer

77.2F

SALLY PORT 135

CORRIDOR 116B

GROOMING INTAKE 126

FOOD PREP 122

E-ROOM / FREEZER 125

LAUNDRY 119

BREAK ROOM 118

CORRIDOR 116

JAN./STOR. 121

PUPPY ADOPTION 115

DOG QUAR. 127

T/ STORAGE-2 123-2

STAFF T/R 120

CORRIDOR 116B

TRAINING 114

DS-12

STRAY DOGS 134

CAT QUAR. 129

STRAY CAT HOLDING 128

RETAIL DOG ADOPTION 112

ADOPTION 117

SHELTER MGR-2 131-2

STORAGE 114A

WOMEN 110

SUPP. ADOPT. 130

SHELTER MGR 131

ADOPT. CNTR 105

ADOPT. SERV 101A

ADMIN 101B

WH 117B

JAN./STOR 117A

MEN 109

CORRIDOR 116C

LOST & FOUND LOBBY 102

CAT ADOPT 106

ADOPTION LOBBY 101

JAN./STOR 134A

ANIMAL CONTROL OFFICERS 133

VEST. 103

VEST 100

DOG DIRECTOR 107

CAT ACCLIMATED ROOM 108

DSCU-A

DSCU-B

DS-13

DS-01

DS-14

DS-11

DS-06

UH-1

UH-2

UH-3

UH-4

UH-5

UH-6

UH-7

UH-8

EF-1 ON ROOF

EF-2 ON ROOF

EF-3 ON ROOF

EF-4

EF-5

CF-1

CF-2

CF-3

CF-4

MECH. MEZZ. ACCES

AIR APPARATUS
TEST REPORT

PROJECT: SCHERTZ ANIMAL ADOPTION CENTER
LOCATION: MEZZANINE
SYSTEM/UNIT: DS-02
AREA SERVED: VARIOUS AREAS

UNIT DATA	
Make/Type	LG / FC
Model No.	ARNU183BHA2
Serial No.	306KAAE0008
Arrangement	(1)
Discharge	HORIZONTAL
Make Sheave	DIRECT DRIVE
Sheave Diam/Bore	DIRECT DRIVE
No. Belts/Make/Size	DIRECT DRIVE
No. Filters/Type/Size	(1)

MOTOR DATA	
Make/Frame	(1)
H.P./RPM	(1)
Volts/Phase/Hertz	(1)
F.L. Amps/S.F.	(1)
Make Sheave	DIRECT DRIVE
Sheave Diam/Bore	DIRECT DRIVE
Sheave Ctr. Distance	DIRECT DRIVE
Sheave Operating P.D.	DIRECT DRIVE
Motor Speed	HIGH
Static Press. Setpoint	N/A

TEST DATA	DESIGN	ACTUAL
Total CFM	454	272
Outlet CFM	550	232
Fan RPM	DIRECT DRIVE	DIRECT DRIVE
Motor Volts	(1)	(1)
Motor Amps	(1)	(1)
Outside Air CFM	195	65
Return Air CFM	355	207

TEST DATA	DESIGN	ACTUAL
Discharge S.P.	NOT GIVEN	(1)
Suction S.P.	NOT GIVEN	(1)
Total S.P.	NOT GIVEN	(1)
Ext. S.P.	NOT GIVEN	(2) .49
Reheat Coil Diff. S.P.	N/A	N/A
Cooling Coil Diff. S.P.	NOT GIVEN	(1)
Preheat Coil Diff. S.P.	N/A	N/A
Filters Diff. S.P.	NOT GIVEN	(1)
O/A Damper Pos.	NOT GIVEN	(1)
R/A Damper Pos.	NOT GIVEN	(1)

REMARKS: (1) DATA AND READINGS NOT OBTAINED.
(2) ENTERING STATIC PRESSURE WAS OBTAINED DOWNSTREAM OF FILTER.

TEST DATE: 6/23/20
READINGS BY: VR / DA

RECTANGULAR DUCT
TRAVERSE REPORT

PROJECT: SCHERTZ ANIMAL ADOPTION CENTER
LOCATION/ZONE: MEZZANINE
INSTRUMENT: SHORTRIDGE AIR DATA METER

SYSTEM/UNIT: DS-02
AIRSTREAM: TOTAL SUPPLY

DUCT				REQUIRED				ACTUAL			
WIDTH	10	SQ FT	0.83	FPM	660	CFM	550	FPM	326	CFM	272
HEIGHT	12	S.P.	0.01								

POSITION	1	2	3	4	5	6	7	8	9	10	11	12
1	347	321	264	0								
2	410	398	469	309								
3	397	455	344	531								
4	300	359	317	0								
5												
6												
7												
8												
9												
10												
11												
12												
13												
	1454	1533	1394	840								

TOTAL FPM	/ NO. READINGS = AVG. FPM		x SQ FT.	= CFM
5221	16	326	0.83	272

REMARKS:

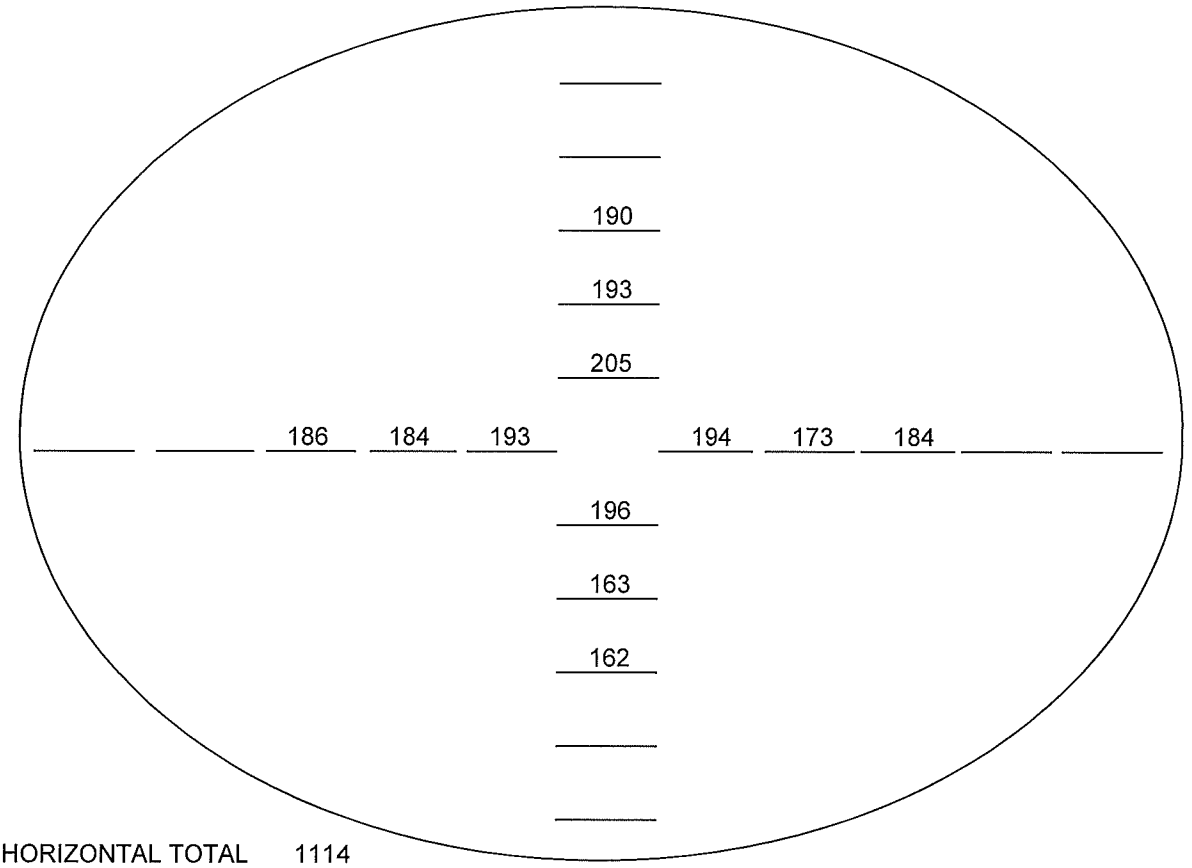
TEST DATE: 6/23/20
READINGS BY: VR / DA

ROUND DUCT TRAVERSE REPORT

PROJECT: SCHERTZ ANIMAL ADOPTION CENTER
LOCATION/ZONE: MEZZANINE
INSTRUMENT: SHORTRIDGE AIR DATA METER

SYSTEM/UNIT: DS-02
AIRSTREAM: O/A

DUCT				REQUIRED				ACTUAL			
SIZE	8 "(DIA)	SQ FT	0.349	FPM	559	CFM	195	FPM	185	CFM	65
		S.P.	-0.04								



HORIZONTAL TOTAL	1114
VERTICAL TOTAL	1109
TOTAL FPM	2223

NO. READINGS 12 AVG. FPM 185 X SQ. FT. 0.349 = CFM 65

REMARKS:

TEST DATE: 6/23/20
READINGS BY: VR / DA

RECTANGULAR DUCT
TRAVERSE REPORT

PROJECT: SCHERTZ ANIMAL ADOPTION CENTER
LOCATION/ZONE: MEZZANINE
INSTRUMENT: SHORTRIDGE AIR DATA METER

SYSTEM/UNIT: DS-02
AIRSTREAM: RETURN AIR

DUCT				REQUIRED				ACTUAL			
WIDTH	8	SQ FT	0.44	FPM	630	CFM	280	FPM	320	CFM	142
HEIGHT	8	S.P.	-0.05								

POSITION	1	2	3	4	5	6	7	8	9	10	11	12
1	185	317	303	161								
2	384	417	359	327								
3	313	402	380	309								
4	299	391	365	215								
5												
6												
7												
8												
9												
10												
11												
12												
13												
	1181	1527	1407	1012								

TOTAL FPM	/ NO. READINGS = AVG. FPM		x SQ FT.	= CFM
5127	16	320	0.44	142

REMARKS:

TEST DATE: 6/23/20
READINGS BY: VR / DA

AIR OUTLET
TEST REPORT

PROJECT: SCHERTZ ANIMAL ADOPTION CENTER SYSTEM: DS-02

AREA SERVED	OUTLET NO.	OUTLET TYPE	OUTLET SIZE (INCH)	DESIGN CFM	PRELIMINARY CFM	FINAL CFM	PERCENT OF DESIGN	NOTES
GROOMING INT. 126	1	LID	8	140	50	50	36%	
CORRIDOR 116B	2	LID	10	270	119	119	44%	
E. RM. / FREEZER 125	3	LID	8	140	63	63	45%	
				550	232	232	42%	
E. RM. / FREEZER 125	R1	LID	8X8	NOT GIVEN	126	126		

REMARKS:

TEST DATE: 6/23/20
READINGS BY: VR / DA

AIR APPARATUS
TEST REPORT

PROJECT: SCHERTZ ANIMAL ADOPTION CENTER
LOCATION: MEZZANINE
SYSTEM/UNIT: DS-03
AREA SERVED: VARIOUS AREAS

UNIT DATA	
Make/Type	LG / FC
Model No.	ARNU123BHA2
Serial No.	303KANY00151
Arrangement	(1)
Discharge	HORIZONTAL
Make Sheave	DIRECT DRIVE
Sheave Diam/Bore	DIRECT DRIVE
No. Belts/Make/Size	DIRECT DRIVE
No. Filters/Type/Size	(1)

MOTOR DATA	
Make/Frame	(1)
H.P./RPM	(1)
Volts/Phase/Hertz	(1)
F.L. Amps/S.F.	(1)
Make Sheave	DIRECT DRIVE
Sheave Diam/Bore	DIRECT DRIVE
Sheave Ctr. Distance	DIRECT DRIVE
Sheave Operating P.D.	DIRECT DRIVE
Motor Speed	HIGH
Static Press. Setpoint	N/A

TEST DATA	DESIGN	ACTUAL
Total CFM	425	260
Outlet CFM	430	246
Fan RPM	DIRECT DRIVE	DIRECT DRIVE
Motor Volts	(1)	(1)
Motor Amps	(1)	(1)
Outside Air CFM	150	99
Return Air CFM	280	161

TEST DATA	DESIGN	ACTUAL
Discharge S.P.	NOT GIVEN	(1)
Suction S.P.	NOT GIVEN	(1)
Total S.P.	NOT GIVEN	(1)
Ext. S.P.	NOT GIVEN	(2) .48
Reheat Coil Diff. S.P.	N/A	N/A
Cooling Coil Diff. S.P.	NOT GIVEN	(1)
Preheat Coil Diff. S.P.	N/A	N/A
Filters Diff. S.P.	NOT GIVEN	(1)
O/A Damper Pos.	NOT GIVEN	(1)
R/A Damper Pos.	NOT GIVEN	(1)

REMARKS: (1) DATA AND READINGS NOT OBTAINED.
(2) ENTERING STATIC PRESSURE WAS OBTAINED DOWNSTREAM OF FILTER.

TEST DATE: 6/23/20
READINGS BY: VR / DA

RECTANGULAR DUCT
TRAVERSE REPORT

PROJECT: SCHERTZ ANIMAL ADOPTION CENTER
LOCATION/ZONE: MEZZANINE
INSTRUMENT: SHORTRIDGE AIR DATA METER

SYSTEM/UNIT: DS-03
AIRSTREAM: TOTAL SUPPLY

DUCT				REQUIRED				ACTUAL			
WIDTH	10	SQ FT	0.69	FPM	619	CFM	430	FPM	375	CFM	260
HEIGHT	10	S.P.	0.11								

POSITION	1	2	3	4	5	6	7	8	9	10	11	12
1	370	370	346	379								
2	381	435	383	398								
3	330	431	342	411								
4	309	398	331	382								
5												
6												
7												
8												
9												
10												
11												
12												
13												
	1390	1634	1402	1570								

TOTAL FPM	/ NO. READINGS = AVG. FPM		x SQ FT.	= CFM
5996	16	375	0.69	260

REMARKS:

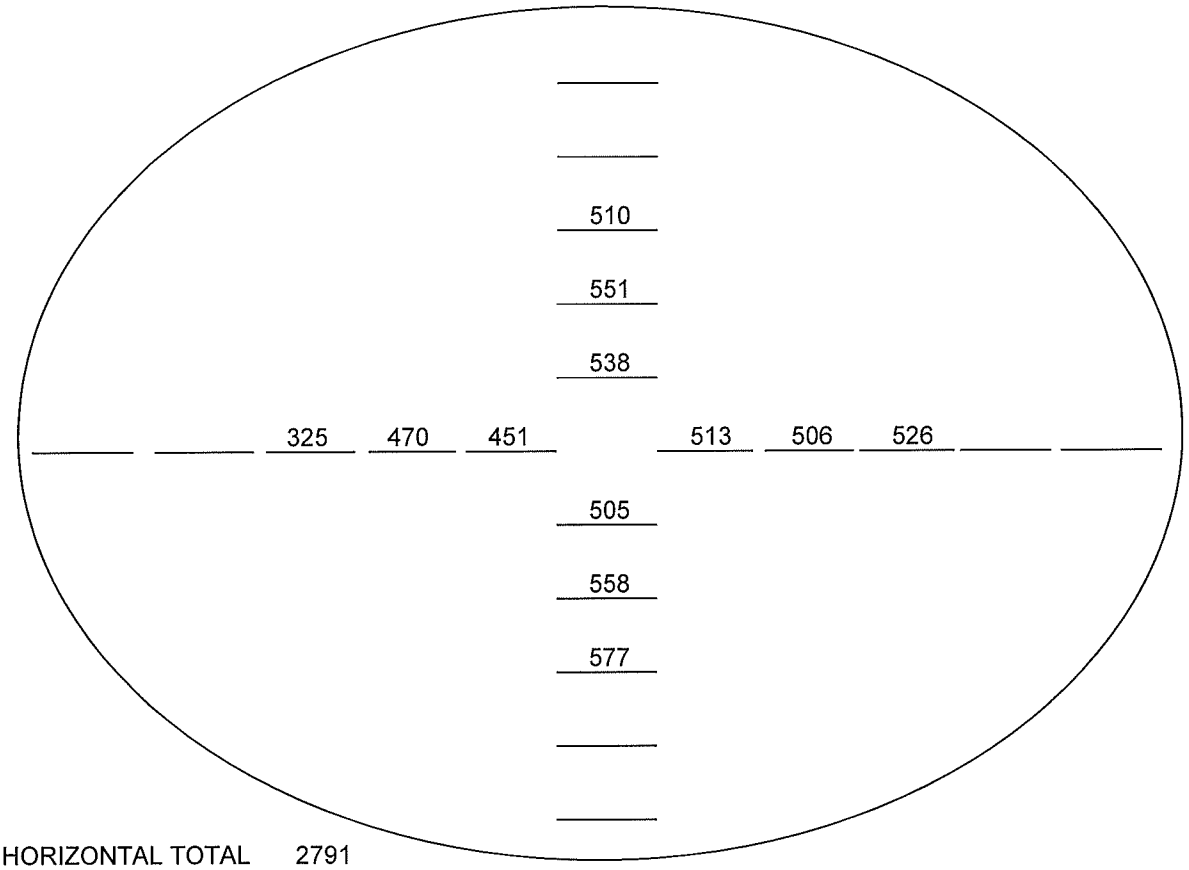
TEST DATE: 6/23/20
READINGS BY: VR / DA

ROUND DUCT TRAVERSE REPORT

PROJECT: SCHERTZ ANIMAL ADOPTION CENTER
LOCATION/ZONE: MEZZANINE
INSTRUMENT: SHORTRIDGE AIR DATA METER

SYSTEM/UNIT: DS-03
AIRSTREAM: O/A

DUCT				REQUIRED				ACTUAL			
SIZE	6 "(DIA)	SQ FT	0.196	FPM	764	CFM	150	FPM	503	CFM	99
		S.P.	-0.06								



HORIZONTAL TOTAL 2791
VERTICAL TOTAL 3239
TOTAL FPM 6030
NO. READINGS 12 AVG. FPM 503 X SQ. FT. 0.196 = CFM 99

REMARKS:

TEST DATE: 6/23/20
READINGS BY: VR / DA

RECTANGULAR DUCT
TRAVERSE REPORT

PROJECT: SCHERTZ ANIMAL ADOPTION CENTER
LOCATION/ZONE: MEZZANINE
INSTRUMENT: SHORTRIDGE AIR DATA METER

SYSTEM/UNIT: DS-03
AIRSTREAM: RETURN AIR

DUCT				REQUIRED				ACTUAL			
WIDTH	8	SQ FT	0.44	FPM	630	CFM	280	FPM	296	CFM	132
HEIGHT	8	S.P.	-0.06								

POSITION	1	2	3	4	5	6	7	8	9	10	11	12
1	263	267	293	264								
2	302	321	345	332								
3	226	329	335	315								
4	176	299	355	312								
5												
6												
7												
8												
9												
10												
11												
12												
13												
	967	1216	1328	1223								

TOTAL FPM	/ NO. READINGS = AVG. FPM		x SQ FT.	= CFM
4734	16	296	0.44	132

REMARKS:

TEST DATE: 6/23/20
READINGS BY: VR / DA

AIR OUTLET
TEST REPORT

PROJECT: SCHERTZ ANIMAL ADOPTION CENTER SYSTEM: DS-03

AREA SERVED	OUTLET NO.	OUTLET TYPE	OUTLET SIZE (INCH)	DESIGN CFM	PRELIMINARY CFM	FINAL CFM	PERCENT OF DESIGN	NOTES
CORRIDOR 116	1	LID	6	65	0	0		
FOOD PREP 122	2	LID	6	115	75	75	65%	
LAUNDRY 119	3	LID	8	250	171	171	68%	
				430	246	246	57%	
FOOD PREP 122	R1	LID	8X8	70	90	90	129%	
LAUNDRY 119	R2	LID	8X8	NOT GIVEN	39	39		
CORRIDOR 116	R3	LID	10X10	NOT GIVEN				(1)
				NOT GIVEN	129	129		

REMARKS: (1) EXISTING RETURN INLET IS NOT INSTALLED.

TEST DATE: 6/23/20
READINGS BY: VR / DA

AIR APPARATUS
TEST REPORT

PROJECT: SCHERTZ ANIMAL ADOPTION CENTER
LOCATION: MEZZANINE

SYSTEM/UNIT: DS-04
AREA SERVED: QUARANTINE 124 / JAN. / STOR. 121

UNIT DATA	
Make/Type	LG / FC
Model No.	ARNU123BHA2
Serial No.	303KAWQ00153
Arrangement	(1)
Discharge	HORIZONTAL
Make Sheave	DIRECT DRIVE
Sheave Diam/Bore	DIRECT DRIVE
No. Belts/Make/Size	DIRECT DRIVE
No. Filters/Type/Size	(1)

MOTOR DATA	
Make/Frame	(1)
H.P./RPM	(1)
Volts/Phase/Hertz	(1)
F.L. Amps/S.F.	(1)
Make Sheave	DIRECT DRIVE
Sheave Diam/Bore	DIRECT DRIVE
Sheave Ctr. Distance	DIRECT DRIVE
Sheave Operating P.D.	DIRECT DRIVE
Motor Speed	HIGH
Static Press. Setpoint	N/A

TEST DATA	DESIGN	ACTUAL
Total CFM	425	129
Outlet CFM	115	120
Fan RPM	DIRECT DRIVE	DIRECT DRIVE
Motor Volts	(1)	(1)
Motor Amps	(1)	(1)
Outside Air CFM	150	37
Return Air CFM	(3)	92

TEST DATA	DESIGN	ACTUAL
Discharge S.P.	NOT GIVEN	(1)
Suction S.P.	NOT GIVEN	(1)
Total S.P.	NOT GIVEN	(1)
Ext. S.P.	NOT GIVEN	(2) .25
Reheat Coil Diff. S.P.	N/A	N/A
Cooling Coil Diff. S.P.	NOT GIVEN	(1)
Preheat Coil Diff. S.P.	N/A	N/A
Filters Diff. S.P.	NOT GIVEN	(1)
O/A Damper Pos.	NOT GIVEN	(1)
R/A Damper Pos.	NOT GIVEN	(1)

REMARKS: (1) DATA AND READINGS NOT OBTAINED.
(2) ENTERING STATIC PRESSURE WAS OBTAINED DOWNSTREAM OF FILTER.
(3) DESIGN OUTLET CFM IS LOWER THAN DESIGN OUTSIDE AIR CFM.

TEST DATE: 6/24/20
READINGS BY: VR / DA

RECTANGULAR DUCT
TRAVERSE REPORT

PROJECT: SCHERTZ ANIMAL ADOPTION CENTER
LOCATION/ZONE: MEZZANINE
INSTRUMENT: SHORTRIDGE AIR DATA METER

SYSTEM/UNIT: DS-04
AIRSTREAM: TOTAL SUPPLY

DUCT				REQUIRED				ACTUAL			
WIDTH	10	SQ FT	0.69	FPM	166	CFM	115	FPM	186	CFM	129
HEIGHT	10	S.P.	0.17								

POSITION	1	2	3	4	5	6	7	8	9	10	11	12
1	52	194	223	205								
2	76	198	202	218								
3	105	197	245	206								
4	172	235	247	200								
5												
6												
7												
8												
9												
10												
11												
12												
13												
	405	824	917	829								

TOTAL FPM	/ NO. READINGS = AVG. FPM		x SQ FT.	= CFM
2975	16	186	0.69	129

REMARKS:

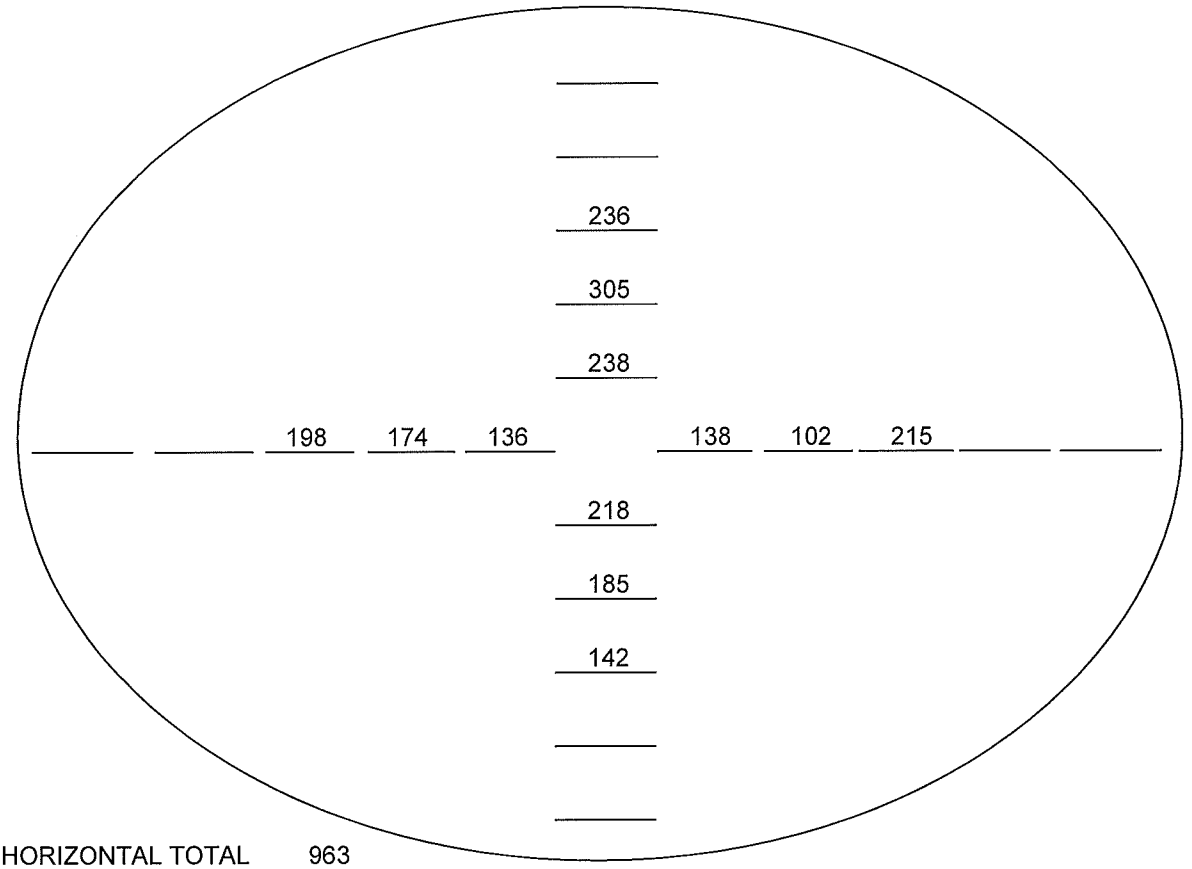
TEST DATE: 6/23/20
READINGS BY: VR / DA

ROUND DUCT TRAVERSE REPORT

PROJECT: SCHERTZ ANIMAL ADOPTION CENTER
LOCATION/ZONE: MEZZANINE
INSTRUMENT: SHORTRIDGE AIR DATA METER

SYSTEM/UNIT: DS-04
AIRSTREAM: O/A

DUCT				REQUIRED				ACTUAL			
SIZE	6 "(DIA)	SQ FT	0.196	FPM	764	CFM	150	FPM	191	CFM	37
		S.P.	-0.03								



HORIZONTAL TOTAL	963
VERTICAL TOTAL	1324
TOTAL FPM	2287

NO. READINGS 12 AVG. FPM 191 X SQ. FT. 0.196 = CFM 37

REMARKS:

TEST DATE: 6/23/20
READINGS BY: VR / DA

RECTANGULAR DUCT
TRAVERSE REPORT

PROJECT: SCHERTZ ANIMAL ADOPTION CENTER
LOCATION/ZONE: MEZZANINE
INSTRUMENT: SHORTRIDGE AIR DATA METER

SYSTEM/UNIT: DS-04
AIRSTREAM: RETURN AIR

DUCT				REQUIRED				ACTUAL			
WIDTH	10	SQ FT	0.83	FPM	(1)	CFM	(1)	FPM	75	CFM	62
HEIGHT	12	S.P.	-0.02								

POSITION	1	2	3	4	5	6	7	8	9	10	11	12
1	63	77	87	75								
2	77	93	88	83								
3	63	70	66	78								
4	55	68	73	81								
5												
6												
7												
8												
9												
10												
11												
12												
13												
	258	308	314	317								

TOTAL FPM	/ NO. READINGS = AVG. FPM		x SQ FT.	= CFM
1197	16	75	0.83	62

REMARKS: (1) DESIGN OUTLET CFM LOWER THAN DESIGN OUTSIDE AIR CFM.

TEST DATE: 6/23/20
READINGS BY: VR / DA

AIR OUTLET
TEST REPORT

PROJECT: SCHERTZ ANIMAL ADOPTION CENTER SYSTEM: DS-04

AREA SERVED	OUTLET NO.	OUTLET TYPE	OUTLET SIZE (INCH)	DESIGN CFM	PRELIMINARY CFM	FINAL CFM	PERCENT OF DESIGN	NOTES
QUARANTINE 124	1	LID	6	75	84	84	112%	
JAN. / STOR. 121	2	LID	6	40	36	36	90%	
				115	120	120	104%	
CORRIDOR 116	R1	LID	10X10X	NOT GIVEN	75	75		

REMARKS: (1) UNIT SCHEDULED FOR 425.

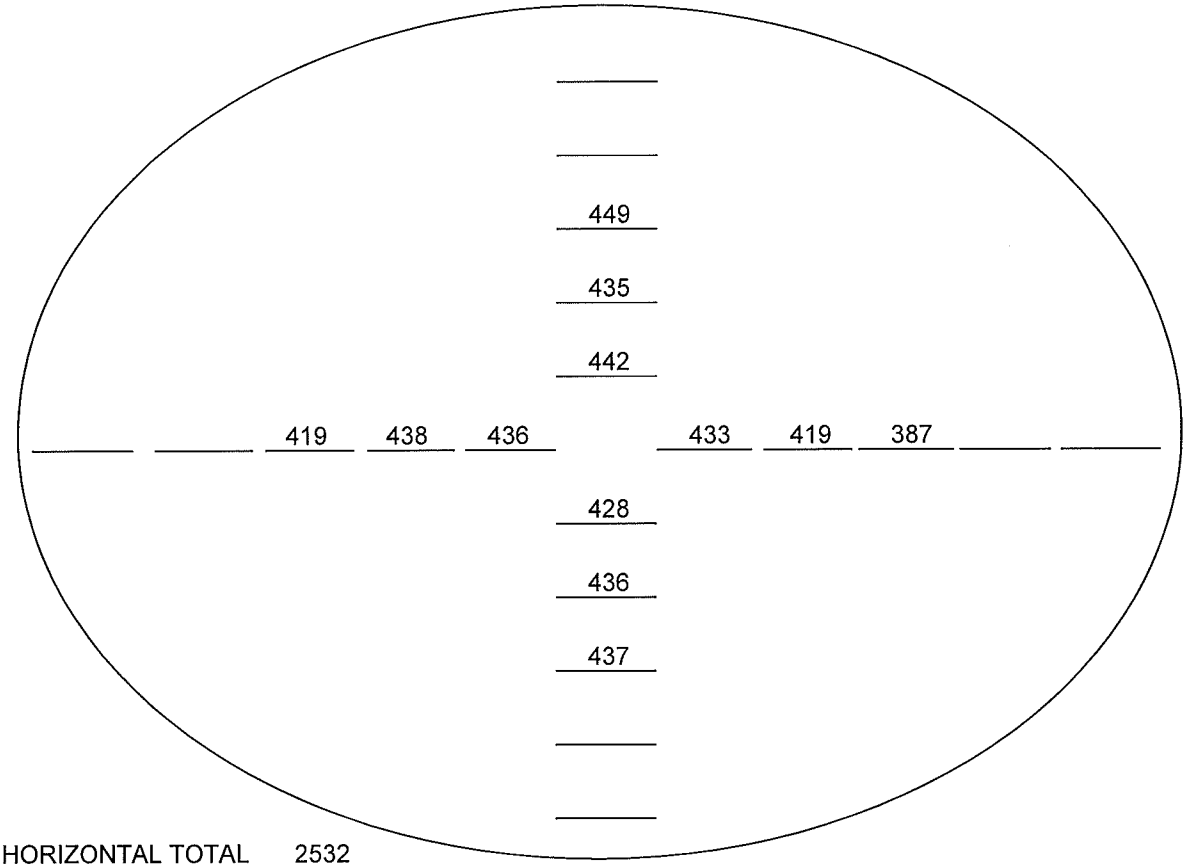
TEST DATE: 6/23/20
READINGS BY: VR / DA

ROUND DUCT TRAVERSE REPORT

PROJECT: SCHERTZ ANIMAL ADOPTION CENTER
LOCATION/ZONE: MEZZANINE
INSTRUMENT: SHORTRIDGE AIR DATA METER

SYSTEM/UNIT: DS-04
AIRSTREAM: OUTLET 1

DUCT				REQUIRED				ACTUAL			
SIZE	6 "(DIA)	SQ FT	0.196	FPM	382	CFM	75	FPM	430	CFM	84
		S.P.	0.05								



HORIZONTAL TOTAL 2532
VERTICAL TOTAL 2627
TOTAL FPM 5159
NO. READINGS 12 AVG. FPM 430 X SQ. FT. 0.196 = CFM 84

REMARKS:

TEST DATE: 6/23/20
READINGS BY: VR / DA

PROJECT: SCHERTZ ANIMAL ADOPTION CENTER
LOCATION: MEZZANINE
SYSTEM/UNIT: DS-05
AREA SERVED: VARIOUS AREAS

UNIT DATA	
Make/Type	LG / FC
Model No.	ARNU073BHA2
Serial No.	304KAKN00013
Arrangement	(1)
Discharge	HORIZONTAL
Make Sheave	DIRECT DRIVE
Sheave Diam/Bore	DIRECT DRIVE
No. Belts/Make/Size	DIRECT DRIVE
No. Filters/Type/Size	(1)

MOTOR DATA	
Make/Frame	(1)
H.P./RPM	(1)
Volts/Phase/Hertz	(1)
F.L. Amps/S.F.	(1)
Make Sheave	DIRECT DRIVE
Sheave Diam/Bore	DIRECT DRIVE
Sheave Ctr. Distance	DIRECT DRIVE
Sheave Operating P.D.	DIRECT DRIVE
Motor Speed	HIGH
Static Press. Setpoint	N/A

TEST DATA	DESIGN	ACTUAL
Total CFM	245	369
Outlet CFM	270	335
Fan RPM	DIRECT DRIVE	DIRECT DRIVE
Motor Volts	(1)	(1)
Motor Amps	(1)	(1)
Outside Air CFM	90	136
Return Air CFM	180	233

TEST DATA	DESIGN	ACTUAL
Discharge S.P.	NOT GIVEN	(1)
Suction S.P.	NOT GIVEN	(1)
Total S.P.	NOT GIVEN	(1)
Ext. S.P.	NOT GIVEN	(2) .33
Reheat Coil Diff. S.P.	N/A	N/A
Cooling Coil Diff. S.P.	NOT GIVEN	(1)
Preheat Coil Diff. S.P.	N/A	N/A
Filters Diff. S.P.	NOT GIVEN	(1)
O/A Damper Pos.	NOT GIVEN	(1)
R/A Damper Pos.	NOT GIVEN	(1)

REMARKS: (1) DATA AND READINGS NOT OBTAINED.
(2) ENTERING STATIC PRESSURE WAS OBTAINED DOWNSTREAM OF FILTER.

TEST DATE: 6/23/20
READINGS BY: VR / DA

RECTANGULAR DUCT
TRAVERSE REPORT

PROJECT: SCHERTZ ANIMAL ADOPTION CENTER
LOCATION/ZONE: MEZZANINE
INSTRUMENT: SHORTRIDGE AIR DATA METER

SYSTEM/UNIT: DS-05
AIRSTREAM: TOTAL SUPPLY

DUCT				REQUIRED				ACTUAL			
WIDTH	8	SQ FT	0.44	FPM	608	CFM	270	FPM	830	CFM	369
HEIGHT	8	S.P.	0.13								

POSITION	1	2	3	4	5	6	7	8	9	10	11	12
1	991	974	1003	816								
2	965	700	802	820								
3	805	697	729	790								
4	904	747	782	753								
5												
6												
7												
8												
9												
10												
11												
12												
13												
	3665	3118	3316	3179								

TOTAL FPM	/ NO. READINGS = AVG. FPM		x SQ FT.	= CFM
13278	16	830	0.44	369

REMARKS:

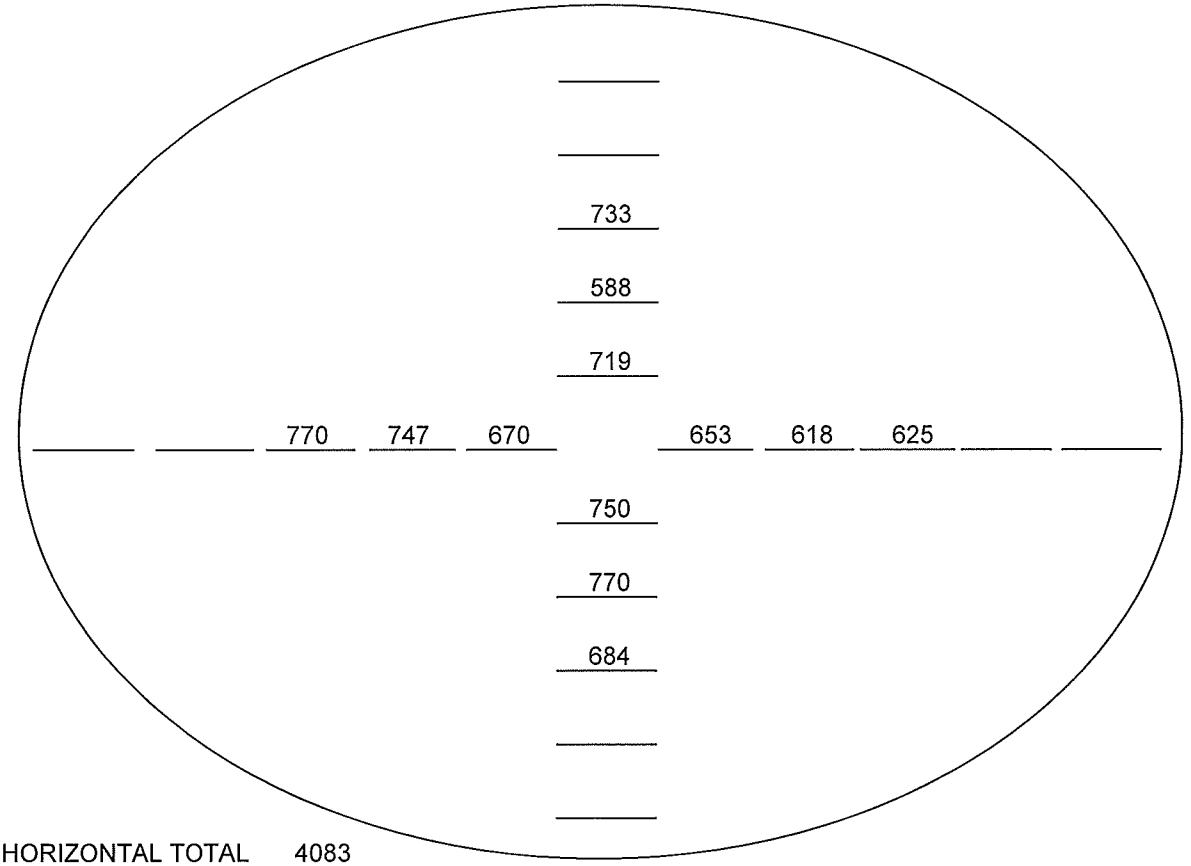
TEST DATE: 6/23/20
READINGS BY: VR / DA

ROUND DUCT TRAVERSE REPORT

PROJECT: SCHERTZ ANIMAL ADOPTION CENTER
LOCATION/ZONE: MEZZANINE
INSTRUMENT: SHORTRIDGE AIR DATA METER

SYSTEM/UNIT: DS-05
AIRSTREAM: O/A

DUCT				REQUIRED				ACTUAL			
SIZE	6 "(DIA)	SQ FT	0.196	FPM	458	CFM	90	FPM	694	CFM	136
		S.P.	-0.10								



HORIZONTAL TOTAL 4083
VERTICAL TOTAL 4244
TOTAL FPM 8327
NO. READINGS 12 AVG. FPM 694 X SQ. FT. 0.196 = CFM 136

REMARKS:

TEST DATE: 6/23/20
READINGS BY: VR / DA

RECTANGULAR DUCT
TRAVERSE REPORT

PROJECT: SCHERTZ ANIMAL ADOPTION CENTER
LOCATION/ZONE: MEZZANINE
INSTRUMENT: SHORTRIDGE AIR DATA METER

SYSTEM/UNIT: DS-05
AIRSTREAM: RETURN AIR

DUCT				REQUIRED				ACTUAL			
WIDTH	8	SQ FT	0.44	FPM	80	CFM	180	FPM	374	CFM	166
HEIGHT	8	S.P.	-0.05								

POSITION	1	2	3	4	5	6	7	8	9	10	11	12
1	212	424	341	320								
2	390	414	443	372								
3	405	326	477	366								
4	311	380	455	342								
5												
6												
7												
8												
9												
10												
11												
12												
13												
	1318	1544	1716	1400								

TOTAL FPM	/ NO. READINGS = AVG. FPM		x SQ FT.	= CFM
5978	16	374	0.44	166

REMARKS:

TEST DATE: 6/23/20
READINGS BY: VR / DA

AIR OUTLET
TEST REPORT

PROJECT: SCHERTZ ANIMAL ADOPTION CENTER SYSTEM: DS-05

AREA SERVED	OUTLET			DESIGN	PRELIMINARY	FINAL	PERCENT	NOTES
	NO.	TYPE	SIZE (INCH)	CFM	CFM	CFM	OF DESIGN	
CAT. QUA. 129	1	LID	6	30	100	100	333%	
CORRIDOR 116C	2	LID	6	60	55	55	92%	
SUPP. ADOPT 130	3	LID	6	100	115	115	115%	
CORRIDOR 116C	4	LID	6	80	65	65	81%	
				270	335	335	124%	
CORRIDOR 116C	R1	LID	8X8	NOT GIVEN		96		
CORRIDOR 116C	R2	LID	8X8	NOT GIVEN		75		
				NOT GIVEN		171		

REMARKS:

TEST DATE: 6/23/20
READINGS BY: VR / DA

PROJECT: SCHERTZ ANIMAL ADOPTION CENTER
LOCATION: MEZZANINE
SYSTEM/UNIT: DS-07
AREA SERVED: VARIOUS AREAS

UNIT DATA	
Make/Type	LG / FC
Model No.	ARNU123BHA2
Serial No.	303KAN00149
Arrangement	(1)
Discharge	HORIZONTAL
Make Sheave	DIRECT DRIVE
Sheave Diam/Bore	DIRECT DRIVE
No. Belts/Make/Size	DIRECT DRIVE
No. Filters/Type/Size	(1)

MOTOR DATA	
Make/Frame	(1)
H.P./RPM	(1)
Volts/Phase/Hertz	(1)
F.L. Amps/S.F.	(1)
Make Sheave	DIRECT DRIVE
Sheave Diam/Bore	DIRECT DRIVE
Sheave Ctr. Distance	DIRECT DRIVE
Sheave Operating P.D.	DIRECT DRIVE
Motor Speed	HIGH
Static Press. Setpoint	N/A

TEST DATA	DESIGN	ACTUAL
Total CFM	425	446
Outlet CFM	420	427
Fan RPM	DIRECT DRIVE	DIRECT DRIVE
Motor Volts	(1)	(1)
Motor Amps	(1)	(1)
Outside Air CFM	150	59
Return Air CFM	270	387

TEST DATA	DESIGN	ACTUAL
Discharge S.P.	NOT GIVEN	(1)
Suction S.P.	NOT GIVEN	(1)
Total S.P.	NOT GIVEN	(1)
Ext. S.P.	NOT GIVEN	(2) .43
Reheat Coil Diff. S.P.	N/A	N/A
Cooling Coil Diff. S.P.	NOT GIVEN	(1)
Preheat Coil Diff. S.P.	N/A	N/A
Filters Diff. S.P.	NOT GIVEN	(1)
O/A Damper Pos.	NOT GIVEN	(1)
R/A Damper Pos.	NOT GIVEN	(1)

REMARKS: (1) DATA AND READINGS NOT OBTAINED.
(2) ENTERING STATIC PRESSURE WAS OBTAINED DOWNSTREAM OF FILTER.

TEST DATE: 6/23/20
READINGS BY: VR / DA

RECTANGULAR DUCT
TRAVERSE REPORT

PROJECT: SCHERTZ ANIMAL ADOPTION CENTER
LOCATION/ZONE: MEZZANINE
INSTRUMENT: SHORTRIDGE AIR DATA METER

SYSTEM/UNIT: DS-07
AIRSTREAM: TOTAL SUPPLY

DUCT				REQUIRED				ACTUAL			
WIDTH	10	SQ FT	0.69	FPM	605	CFM	420	FPM	643	CFM	446
HEIGHT	10	S.P.	0.08								

POSITION	1	2	3	4	5	6	7	8	9	10	11	12
1	0	560	676	158								
2	607	758	891	906								
3	759	672	743	885								
4	656	632	704	680								
5												
6												
7												
8												
9												
10												
11												
12												
13												
	2022	2622	3014	2629								

TOTAL FPM	/ NO. READINGS = AVG. FPM		x SQ FT.	= CFM
10287	16	643	0.69	446

REMARKS:

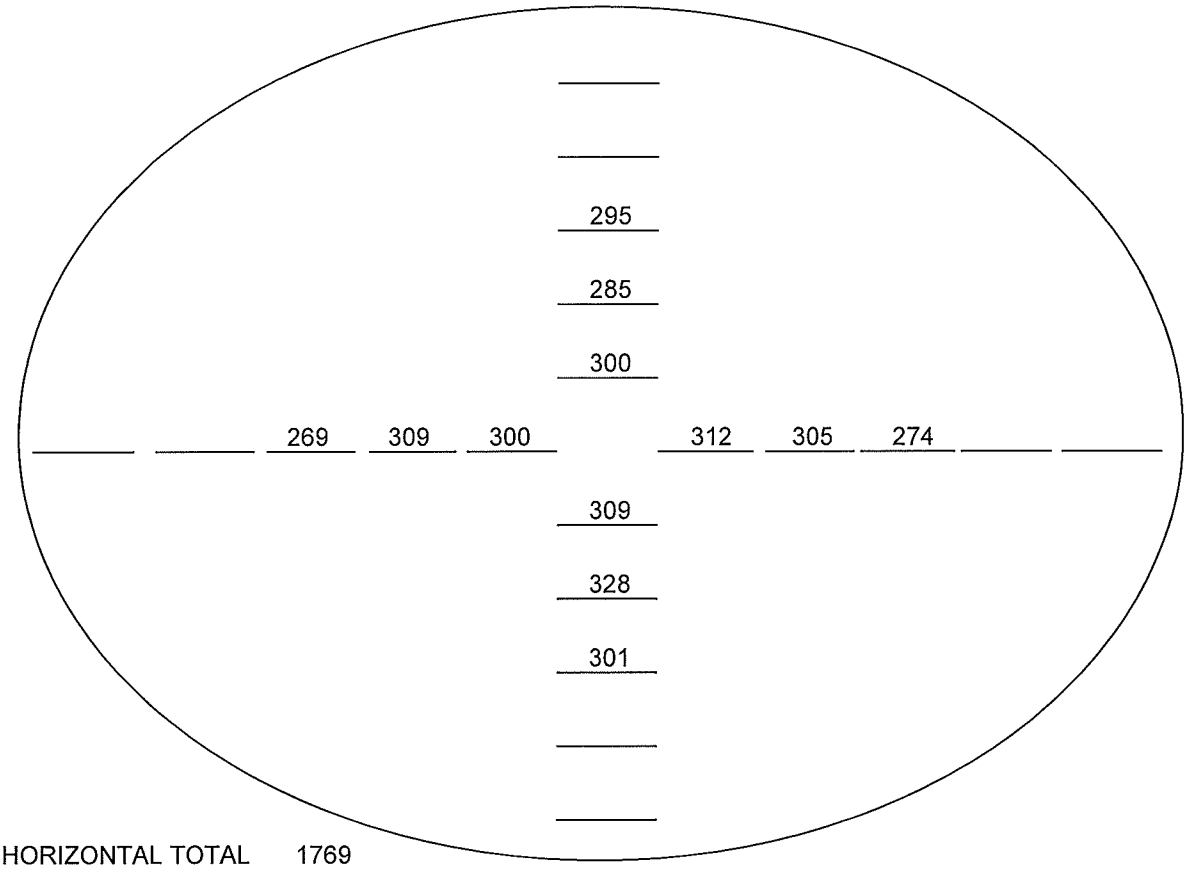
TEST DATE: 6/23/20
READINGS BY: VR / DA

ROUND DUCT TRAVERSE REPORT

PROJECT: SCHERTZ ANIMAL ADOPTION CENTER
LOCATION/ZONE: MEZZANINE
INSTRUMENT: SHORTRIDGE AIR DATA METER

SYSTEM/UNIT: DS-07
AIRSTREAM: O/A

DUCT				REQUIRED				ACTUAL			
SIZE	6 "(DIA)	SQ FT	0.196	FPM	764	CFM	150	FPM	299	CFM	59
		S.P.	-0.08								



HORIZONTAL TOTAL 1769
VERTICAL TOTAL 1818
TOTAL FPM 3587
NO. READINGS 12 AVG. FPM 299 X SQ. FT. 0.196 = CFM 59

REMARKS:

TEST DATE: 6/23/20
READINGS BY: VR / DA

RECTANGULAR DUCT
TRAVERSE REPORT

PROJECT: SCHERTZ ANIMAL ADOPTION CENTER
LOCATION/ZONE: MEZZANINE
INSTRUMENT: SHORTRIDGE AIR DATA METER

SYSTEM/UNIT: DS-07
AIRSTREAM: RETURN AIR

DUCT				REQUIRED				ACTUAL			
WIDTH	14	SQ FT	0.97	FPM	263	CFM	270	FPM	360	CFM	350
HEIGHT	10	S.P.	-0.09								

POSITION	1	2	3	4	5	6	7	8	9	10	11	12
1	313	397	340	270								
2	356	407	406	355								
3	333	391	390	382								
4	372	382	367	306								
5												
6												
7												
8												
9												
10												
11												
12												
13												
	1374	1577	1503	1313								

TOTAL FPM	/ NO. READINGS = AVG. FPM		x SQ FT.	= CFM
5767	16	360	0.97	350

REMARKS:

TEST DATE: 6/23/20
READINGS BY: VR / DA

AIR OUTLET
TEST REPORT

PROJECT: SCHERTZ ANIMAL ADOPTION CENTER SYSTEM: DS-07

AREA SERVED	OUTLET NO.	OUTLET TYPE	OUTLET SIZE (INCH)	DESIGN CFM	PRELIMINARY CFM	FINAL CFM	PERCENT OF DESIGN	NOTES
SHELTER 131-2	1	LID	8	150	191	191	127%	
STORAGE 114A	2	LID	6	50	45	45	90%	
ADOPT. CNSL 105	3	LID	8	220	191	191	87%	
				420	427	427	102%	
SHELTER 131-2	R1	LID	8X8	NOT GIVEN	131	131		
LOST & FOUND LOBBY 102	R2	LID	10X10	NOT GIVEN	240	240		
				NOT GIVEN	371	371		

REMARKS:

TEST DATE: 6/23/20
READINGS BY: VR / DA

PROJECT: SCHERTZ ANIMAL ADOPTION CENTER SYSTEM/UNIT: DS-08
LOCATION: MEZZANINE AREA SERVED: VARIOUS AREAS

UNIT DATA	
Make/Type	LG / FC
Model No.	ARNU363BGA2
Serial No.	305KACA00059
Arrangement	(1)
Discharge	HORIZONTAL
Make Sheave	DIRECT DRIVE
Sheave Diam/Bore	DIRECT DRIVE
No. Belts/Make/Size	DIRECT DRIVE
No. Filters/Type/Size	(1)

MOTOR DATA	
Make/Frame	(1)
H.P./RPM	(1)
Volts/Phase/Hertz	(1)
F.L. Amps/S.F.	(1)
Make Sheave	DIRECT DRIVE
Sheave Diam/Bore	DIRECT DRIVE
Sheave Ctr. Distance	DIRECT DRIVE
Sheave Operating P.D.	DIRECT DRIVE
Motor Speed	HIGH
Static Press. Setpoint	N/A

TEST DATA	DESIGN	ACTUAL
Total CFM	1335	630
Outlet CFM	(3) 785	610
Fan RPM	DIRECT DRIVE	DIRECT DRIVE
Motor Volts	(1)	(1)
Motor Amps	(1)	(1)
Outside Air CFM	485	65
Return Air CFM	300	565

TEST DATA	DESIGN	ACTUAL
Discharge S.P.	NOT GIVEN	(1)
Suction S.P.	NOT GIVEN	(1)
Total S.P.	NOT GIVEN	(1)
Ext. S.P.	NOT GIVEN	(2) .33
Reheat Coil Diff. S.P.	N/A	N/A
Cooling Coil Diff. S.P.	NOT GIVEN	(1)
Preheat Coil Diff. S.P.	N/A	N/A
Filters Diff. S.P.	NOT GIVEN	(1)
O/A Damper Pos.	NOT GIVEN	(1)
R/A Damper Pos.	NOT GIVEN	(1)

REMARKS: (1) DATA AND READINGS NOT OBTAINED.
(2) ENTERING STATIC PRESSURE WAS OBTAINED DOWNSTREAM OF FILTER.
(3) EXISTING OUTLET TWO IS NOT INSTALLED AND HAS A DESIGN CFM OF 550, ESSENTIALLY REDUCING TOTAL DESIGN CFM OF SYSTEM.

TEST DATE: 6/23/20
READINGS BY: VR / DA

RECTANGULAR DUCT
TRAVERSE REPORT

PROJECT: SCHERTZ ANIMAL ADOPTION CENTER
LOCATION/ZONE: ABOVE CEILING SHELTER MNGR. 131-2
INSTRUMENT: SHORTRIDGE AIR DATA METER

SYSTEM/UNIT: DS-08
AIRSTREAM: TOTAL SUPPLY

DUCT				REQUIRED				ACTUAL			
WIDTH	16	SQ FT	1.56	FPM	505	CFM	785	FPM	405	CFM	630
HEIGHT	14	S.P.	0.07								

POSITION	1	2	3	4	5	6	7	8	9	10	11	12
1	0	0	484	419								
2	444	507	532	509								
3	337	522	525	504								
4	253	487	504	455								
5												
6												
7												
8												
9												
10												
11												
12												
13												
	1034	1516	2045	1887								

TOTAL FPM	/ NO. READINGS = AVG. FPM		x SQ FT.	= CFM
6482	16	405	1.56	630

REMARKS:

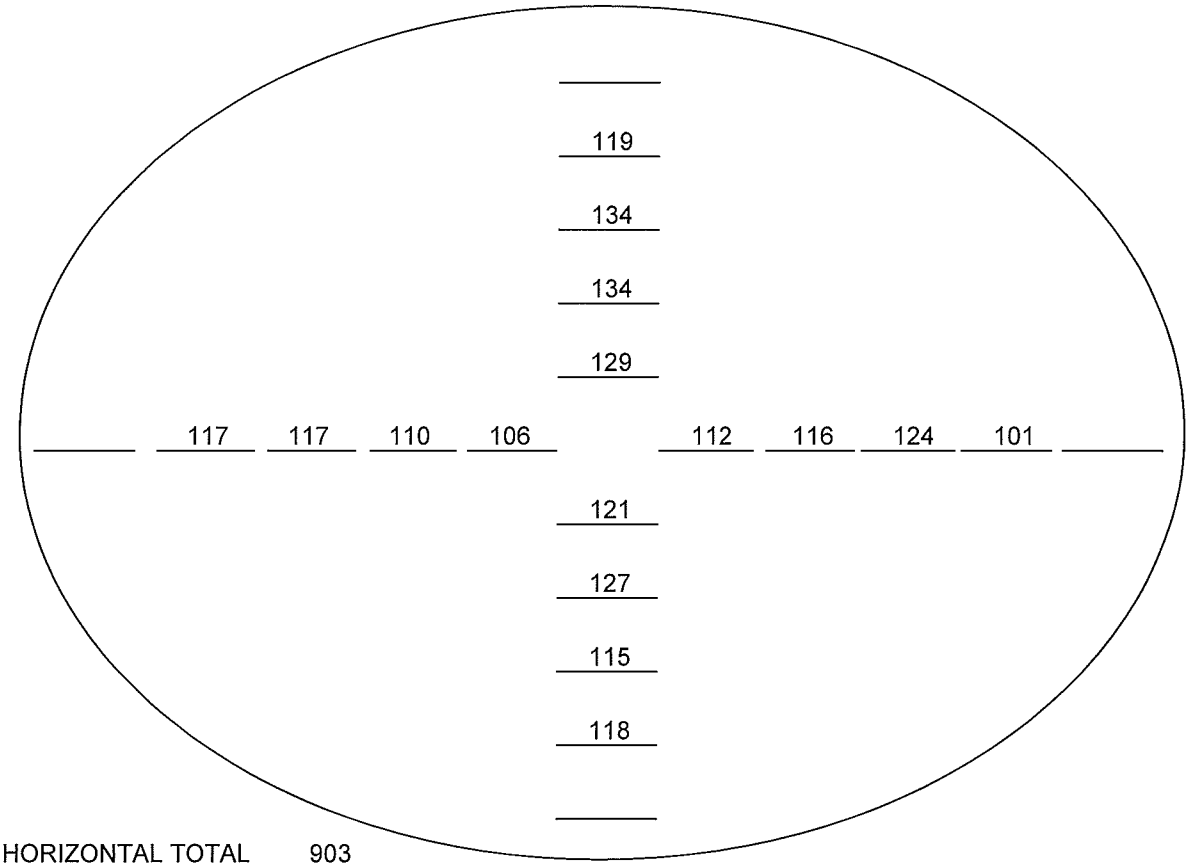
TEST DATE: 6/23/20
READINGS BY: VR / DA

ROUND DUCT TRAVERSE REPORT

PROJECT: SCHERTZ ANIMAL ADOPTION CENTER
LOCATION/ZONE: MEZZANINE
INSTRUMENT: SHORTRIDGE AIR DATA METER

SYSTEM/UNIT: DS-08
AIRSTREAM: O/A

DUCT				REQUIRED				ACTUAL			
SIZE	10 "(DIA)	SQ FT	0.545	FPM	889	CFM	485	FPM	119	CFM	65
		S.P.	-0.05								



HORIZONTAL TOTAL 903
VERTICAL TOTAL 997
TOTAL FPM 1900
NO. READINGS 16 AVG. FPM 119 X SQ. FT. 0.545 = CFM 65

REMARKS:

TEST DATE: 6/23/20
READINGS BY: VR / DA

RECTANGULAR DUCT
TRAVERSE REPORT

PROJECT: SCHERTZ ANIMAL ADOPTION CENTER
LOCATION/ZONE: MEZZANINE
INSTRUMENT: SHORTRIDGE AIR DATA METER

SYSTEM/UNIT: DS-08
AIRSTREAM: RETURN AIR

DUCT				REQUIRED				ACTUAL			
WIDTH	16	SQ FT	1.56	FPM	193	CFM	300	FPM	303	CFM	471
HEIGHT	14	S.P.	-0.05								

POSITION	1	2	3	4	5	6	7	8	9	10	11	12
1	194	362	319	279								
2	221	380	369	318								
3	181	427	390	357								
4	93	324	318	316								
5												
6												
7												
8												
9												
10												
11												
12												
13												
	689	1493	1396	1270								

TOTAL FPM	/ NO. READINGS = AVG. FPM		x SQ FT.	= CFM
4848	16	303	1.56	471

REMARKS:

TEST DATE: 6/23/20
READINGS BY: VR / DA

AIR OUTLET
TEST REPORT

PROJECT: SCHERTZ ANIMAL ADOPTION CENTER SYSTEM: DS-08

AREA SERVED	OUTLET NO.	OUTLET TYPE	OUTLET SIZE (INCH)	DESIGN CFM	PRELIMINARY CFM	FINAL CFM	PERCENT OF DESIGN	NOTES
ADMIN 108B	1	SW	12X10	360	254	254	71%	
VESTIBULE 103	2	LID	12	550				(1)
LOST & FOUND 102	3	LID	6	110	95	95	86%	
CAT ADOPT 106	4	LID	10	315	261	261	83%	
				1335	610	610	46%	
LOST & FOUND LOBBY 102	R1	LID	12	NOT GIVEN	203	203		
VESTIBULE 103	R2	LID	12	NOT GIVEN	235	235		
				NOT GIVEN	438	438		

REMARKS: (1) EXISTING OUTLET NOT INSTALLED, ENTIRE ROOM IS MISSING.

TEST DATE: 6/23/20
READINGS BY: VR / DA

AIR APPARATUS
TEST REPORT

PROJECT: SCHERTZ ANIMAL ADOPTION CENTER SYSTEM/UNIT: DS-09
LOCATION: MEZZANINE AREA SERVED: VARIOUS AREAS

UNIT DATA	
Make/Type	LG / FC
Model No.	ARNU423BGA2
Serial No.	306KANY00031
Arrangement	(1)
Discharge	HORIZONTAL
Make Sheave	DIRECT DRIVE
Sheave Diam/Bore	DIRECT DRIVE
No. Belts/Make/Size	DIRECT DRIVE
No. Filters/Type/Size	(1)

MOTOR DATA	
Make/Frame	(1)
H.P./RPM	(1)
Volts/Phase/Hertz	(1)
F.L. Amps/S.F.	(1)
Make Sheave	DIRECT DRIVE
Sheave Diam/Bore	DIRECT DRIVE
Sheave Ctr. Distance	DIRECT DRIVE
Sheave Operating P.D.	DIRECT DRIVE
Motor Speed	HIGH
Static Press. Setpoint	N/A

TEST DATA	DESIGN	ACTUAL
Total CFM	1635	772
Outlet CFM	(3) 1125	758
Fan RPM	DIRECT DRIVE	DIRECT DRIVE
Motor Volts	(1)	(1)
Motor Amps	(1)	(1)
Outside Air CFM	500	123
Return Air CFM	625	649

TEST DATA	DESIGN	ACTUAL
Discharge S.P.	NOT GIVEN	(1)
Suction S.P.	NOT GIVEN	(1)
Total S.P.	NOT GIVEN	(1)
Ext. S.P.	NOT GIVEN	(2) .44
Reheat Coil Diff. S.P.	N/A	N/A
Cooling Coil Diff. S.P.	NOT GIVEN	(1)
Preheat Coil Diff. S.P.	N/A	N/A
Filters Diff. S.P.	NOT GIVEN	(1)
O/A Damper Pos.	NOT GIVEN	(1)
R/A Damper Pos.	NOT GIVEN	(1)

REMARKS: (1) DATA AND READINGS NOT OBTAINED.
(2) ENTERING STATIC PRESSURE WAS OBTAINED DOWNSTREAM OF FILTER.
(3) EXISTING OUTLET TWO IS NOT INSTALLED AND HAS A DESIGN CFM OF 510, ESSENTIALLY REDUCING TOTAL DESIGN CFM OF SYSTEM.

TEST DATE: 6/23/20
READINGS BY: VR / DA

RECTANGULAR DUCT
TRAVERSE REPORT

PROJECT: SCHERTZ ANIMAL ADOPTION CENTER
LOCATION/ZONE: MEZZANINE
INSTRUMENT: SHORTRIDGE AIR DATA METER

SYSTEM/UNIT: DS-09
AIRSTREAM: TOTAL SUPPLY

DUCT				REQUIRED				ACTUAL			
WIDTH	16	SQ FT	1.56	FPM	723	CFM	1125	FPM	496	CFM	772
HEIGHT	14	S.P.	0.05								

POSITION	1	2	3	4	5	6	7	8	9	10	11	12
1	411	0	0	0								
2	552	665	920	1028								
3	511	545	953	903								
4	331	522	599	0								
5												
6												
7												
8												
9												
10												
11												
12												
13												
	1805	1732	2472	1931								

TOTAL FPM	/ NO. READINGS = AVG. FPM		x SQ FT.	= CFM
7940	16	496	1.56	772

REMARKS:

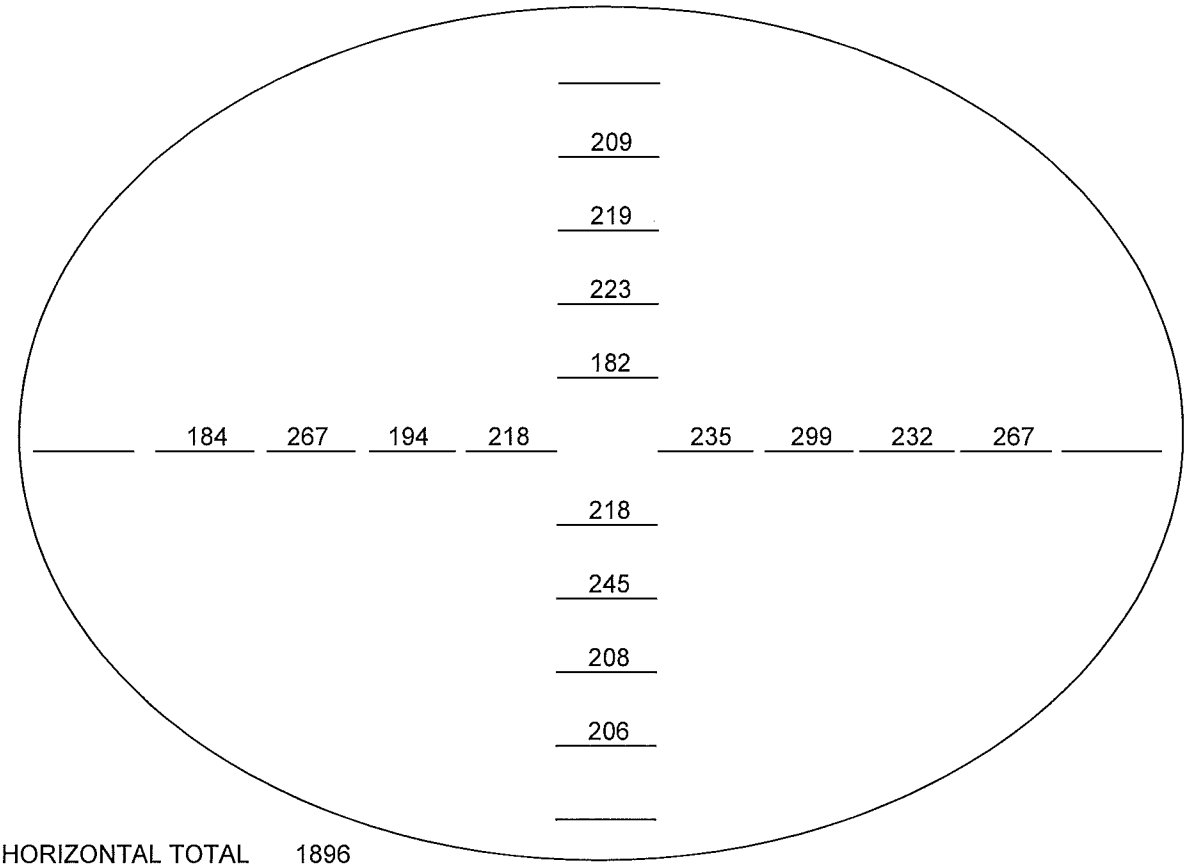
TEST DATE: 6/23/20
READINGS BY: VR / DA

ROUND DUCT TRAVERSE REPORT

PROJECT: SCHERTZ ANIMAL ADOPTION CENTER
LOCATION/ZONE: MEZZANINE
INSTRUMENT: SHORTRIDGE AIR DATA METER

SYSTEM/UNIT: DS-09
AIRSTREAM: O/A

DUCT				REQUIRED				ACTUAL			
SIZE	10 "(DIA)	SQ FT	0.545	FPM	917	CFM	500	FPM	225	CFM	123
		S.P.	-0.10								



HORIZONTAL TOTAL 1896
VERTICAL TOTAL 1710
TOTAL FPM 3606
NO. READINGS 16 AVG. FPM 225 X SQ. FT. 0.545 = CFM 123

REMARKS:

TEST DATE: 6/23/20
READINGS BY: VR / DA

RECTANGULAR DUCT
TRAVERSE REPORT

PROJECT: SCHERTZ ANIMAL ADOPTION CENTER
LOCATION/ZONE: MEZZANINE
INSTRUMENT: SHORTRIDGE AIR DATA METER

SYSTEM/UNIT: DS-09
AIRSTREAM: RETURN AIR

DUCT				REQUIRED				ACTUAL			
WIDTH	16	SQ FT	1.33	FPM	469	CFM	625	FPM	411	CFM	548
HEIGHT	12	S.P.	-0.11								

POSITION	1	2	3	4	5	6	7	8	9	10	11	12
1	294	486	514	356								
2	522	565	557	257								
3	365	528	545	255								
4	337	397	382	214								
5												
6												
7												
8												
9												
10												
11												
12												
13												
	1518	1976	1998	1082								

TOTAL FPM	/ NO. READINGS = AVG. FPM		x SQ FT.	= CFM
6574	16	411	1.33	548

REMARKS:

TEST DATE: 6/23/20
READINGS BY: VR / DA

AIR OUTLET
TEST REPORT

PROJECT: SCHERTZ ANIMAL ADOPTION CENTER SYSTEM: DS-09

AREA SERVED	OUTLET NO.	OUTLET TYPE	OUTLET SIZE (INCH)	DESIGN CFM	PRELIMINARY CFM	FINAL CFM	PERCENT OF DESIGN	NOTES
ADOPT SERVE 101A	1	SW	10X10	290	275	275	95%	
VESTIBULE 111	2	LID	6	100	61	61	61%	
WOMEN 110	3	LID	6	50	41	41	82%	
MEN 109	4	LID	6	50	40	40	80%	
ADOPTION LOBBY 101	5	LID	10	300	221	221	74%	
VESTIBULE 100	6	LID	12	510				(1)
DOG DISP. 107	7	LID	10	260	66	66	25%	
GET ACQ. RM. 108	8	LID	6	75	54	54	72%	
				1635	758	758	46%	
ADOPT CAGE 105	R1	LID	8X8	NOT GIVEN	136	136		
ADOPTION LOBBY 101	R2	LID	16X10	NOT GIVEN	191	191		
ADOPTION LOBBY 101	R3	LID	16X10	NOT GIVEN	243	243		
				NOT GIVEN	570	570		

REMARKS: (1) EXISTING OUTLET NOT INSTALLED, ENTIRE ROOM IS MISSING.

TEST DATE: 6/23/20
READINGS BY: VR / DA

PROJECT: SCHERTZ ANIMAL ADOPTION CENTER SYSTEM/UNIT: DS-10
LOCATION: MEZZANINE AREA SERVED: VARIOUS AREAS

UNIT DATA	
Make/Type	LG / FC
Model No.	ARNU123BHA2
Serial No.	303KLAC00144
Arrangement	(1)
Discharge	HORIZONTAL
Make Sheave	DIRECT DRIVE
Sheave Diam/Bore	DIRECT DRIVE
No. Belts/Make/Size	DIRECT DRIVE
No. Filters/Type/Size	(1)

MOTOR DATA	
Make/Frame	(1)
H.P./RPM	(1)
Volts/Phase/Hertz	(1)
F.L. Amps/S.F.	(1)
Make Sheave	DIRECT DRIVE
Sheave Diam/Bore	DIRECT DRIVE
Sheave Ctr. Distance	DIRECT DRIVE
Sheave Operating P.D.	DIRECT DRIVE
Motor Speed	HIGH
Static Press. Setpoint	N/A

TEST DATA	DESIGN	ACTUAL
Total CFM	425	383
Outlet CFM	500	363
Fan RPM	DIRECT DRIVE	DIRECT DRIVE
Motor Volts	(1)	(1)
Motor Amps	(1)	(1)
Outside Air CFM	150	57
Return Air CFM	350	326

TEST DATA	DESIGN	ACTUAL
Discharge S.P.	NOT GIVEN	(1)
Suction S.P.	NOT GIVEN	(1)
Total S.P.	NOT GIVEN	(1)
Ext. S.P.	NOT GIVEN	(2) .21
Reheat Coil Diff. S.P.	N/A	N/A
Cooling Coil Diff. S.P.	NOT GIVEN	(1)
Preheat Coil Diff. S.P.	N/A	N/A
Filters Diff. S.P.	NOT GIVEN	(1)
O/A Damper Pos.	NOT GIVEN	(1)
R/A Damper Pos.	NOT GIVEN	(1)

REMARKS: (1) DATA AND READINGS NOT OBTAINED.
(2) ENTERING STATIC PRESSURE WAS OBTAINED DOWNSTREAM OF FILTER.

TEST DATE: 6/23/20
READINGS BY: VR / DA

RECTANGULAR DUCT
TRAVERSE REPORT

PROJECT: SCHERTZ ANIMAL ADOPTION CENTER
LOCATION/ZONE: ABOVE CEILING TRAINING 114
INSTRUMENT: SHORTRIDGE AIR DATA METER

SYSTEM/UNIT: DS-10
AIRSTREAM: TOTAL SUPPLY

DUCT				REQUIRED				ACTUAL			
WIDTH	12	SQ FT	0.83	FPM	600	CFM	500	FPM	460	CFM	383
HEIGHT	10	S.P.	0.06								

POSITION	1	2	3	4	5	6	7	8	9	10	11	12
1	442	525	511	510								
2	450	529	501	515								
3	437	474	455	477								
4	297	402	391	439								
5												
6												
7												
8												
9												
10												
11												
12												
13												
	1626	1930	1858	1941								

TOTAL FPM	/ NO. READINGS = AVG. FPM		x SQ FT.	= CFM
7355	16	460	0.83	383

REMARKS:

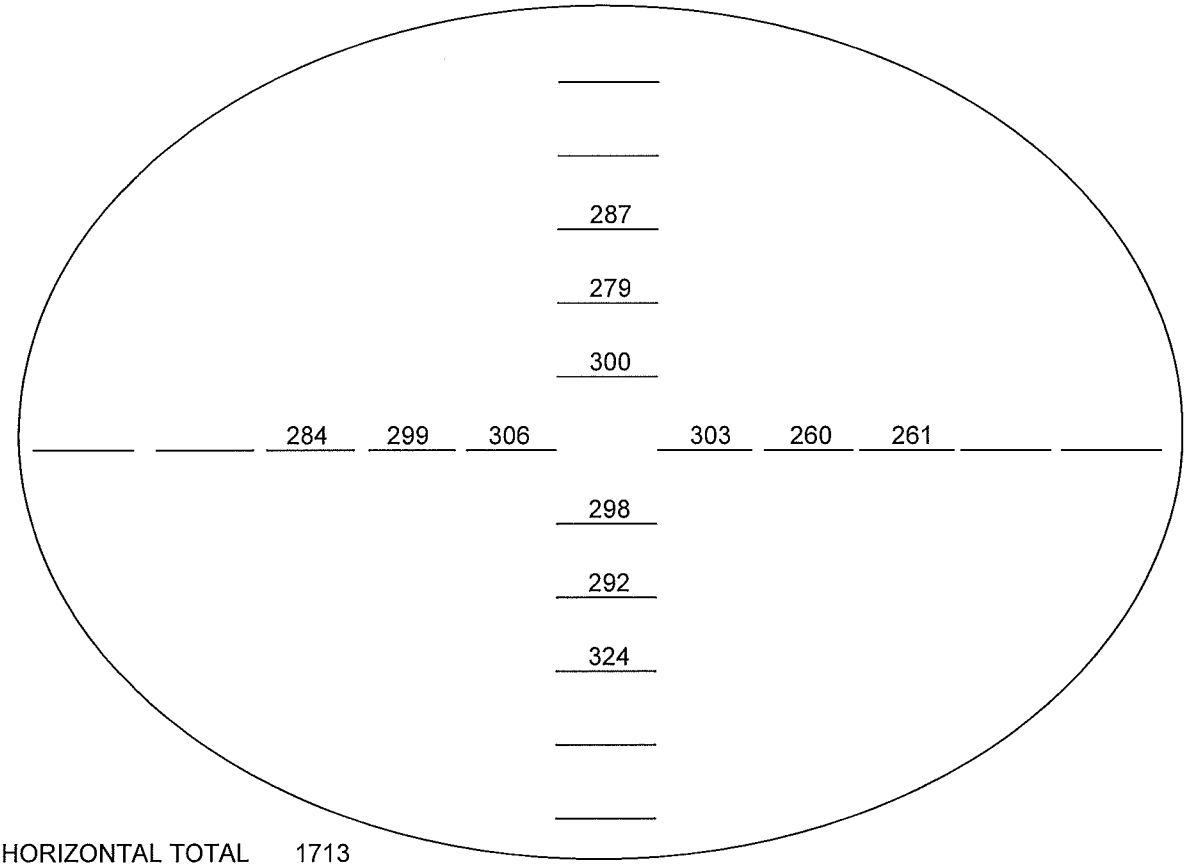
TEST DATE: 6/23/20
READINGS BY: VR / DA

ROUND DUCT TRAVERSE REPORT

PROJECT: SCHERTZ ANIMAL ADOPTION CENTER
LOCATION/ZONE: MEZZANINE
INSTRUMENT: SHORTRIDGE AIR DATA METER

SYSTEM/UNIT: DS-10
AIRSTREAM: O/A

DUCT				REQUIRED				ACTUAL			
SIZE	6 "(DIA)	SQ FT	0.196	FPM	764	CFM	150	FPM	291	CFM	57
		S.P.	-0.07								



HORIZONTAL TOTAL 1713
VERTICAL TOTAL 1780
TOTAL FPM 3493
NO. READINGS 12 AVG. FPM 291 X SQ. FT. 0.196 = CFM 57

REMARKS:

TEST DATE: 6/23/20
READINGS BY: VR / DA

RECTANGULAR DUCT
TRAVERSE REPORT

PROJECT: SCHERTZ ANIMAL ADOPTION CENTER
LOCATION/ZONE: MEZZANINE
INSTRUMENT: SHORTRIDGE AIR DATA METER

SYSTEM/UNIT: DS-10
AIRSTREAM: RETURN AIR

DUCT				REQUIRED				ACTUAL			
WIDTH	16	SQ FT	1.56	FPM	225	CFM	350	FPM	188	CFM	292
HEIGHT	14	S.P.	-0.08								

POSITION	1	2	3	4	5	6	7	8	9	10	11	12
1	151	224	236	286								
2	229	320	359	328								
3	158	142	203	217								
4	0	0	50	99								
5												
6												
7												
8												
9												
10												
11												
12												
13												
	538	686	848	930								

TOTAL FPM	/ NO. READINGS = AVG. FPM		x SQ FT.	= CFM
3002	16	188	1.56	292

REMARKS:

TEST DATE: 6/23/20
READINGS BY: VR / DA

AIR OUTLET
TEST REPORT

PROJECT: SCHERTZ ANIMAL ADOPTION CENTER SYSTEM: DS-09

AREA SERVED	OUTLET NO.	OUTLET TYPE	OUTLET SIZE (INCH)	DESIGN CFM	PRELIMINARY CFM	FINAL CFM	PERCENT OF DESIGN	NOTES
STAFF T/R 120	1	LID	6	50	36	36	72%	
VESTIBULE 111	2	LID	6	100	86	86	86%	
RETAIL DOG ADOPTION 112	3	LID	8	150	95	95	63%	
PUPPY ADOPTION 115	4	LID	8	200	146	146	73%	
				500	363	363	73%	
PUPPY ADOPTION 115	R1	LID	8X8	NOT GIVEN	129	129		
BREAK RM. 118	R2	LID	16X10	NOT GIVEN	134	134		
				NOT GIVEN	263	263		

REMARKS:

TEST DATE: 6/23/20
READINGS BY: VR / DA

AHU SUMMARY
REPORT

PROJECT: SCHERTZ ANIMAL ADOPTION CENTER

UNIT DESIGNATION	MAKE	MODEL NO.	SERIAL NO.	DESIGN CFM	ACTUAL CFM	DES O/A CFM	ACT O/A CFM	NOTES
DS-01	LG	ARNU123TRC2	306KARW0038	265	406	25	0	(1)
DS-06	LG	ARNU203TPC2	306KAUN00006	671	634	67	0	(1) (2)
DS-11	LG	ARNU073TRC2	306KACA00019	307	278	30	0	(1)
DS-12	LG	ARNU073TRC2	306KAPB00016	265	396	25	0	(1)
DS-13	LG	ARNU183TQC2	306KAUU0030	396	514	40	0	(1)

REMARKS: (1) TRAVERSE READINGS INDICATE OUTSIDE AIR IS LEAVING UNIT INSTEAD OF ENTERING UNIT.
(2) ACTUAL CFM SHOWN READ VIA FLOW HOOD.

TEST DATE: 6/23/20
READINGS BY: VR / DA

FACE VELOCITY REPORT

PROJECT: SCHERTZ ANIMAL ADOPTION CENTER
LOCATION/ZONE: DOG QUARANTINE 127
INSTRUMENT: SHORTRIDGE AIR DATA METER

SYSTEM/UNIT: DS-01
AIRSTREAM: RETURN AIR

FACE OPENING				REQUIRED				ACTUAL			
WIDTH	12	SQ FT	1.00	FPM	240	CFM	240	FPM	406	CFM	406
HEIGHT	12										

POSITION	1	2	3	4	5	6	7	8	9	10	11	12
1	410	391										
2	410	412										
3												
4												
5												
6												
7												
8												
9												
10												
11												
12												
13												
	820	803										

TOTAL FPM	/ NO. READINGS = AVG. FPM		x SQ FT.	= CFM
1623	4	406	1.00	406

REMARKS:

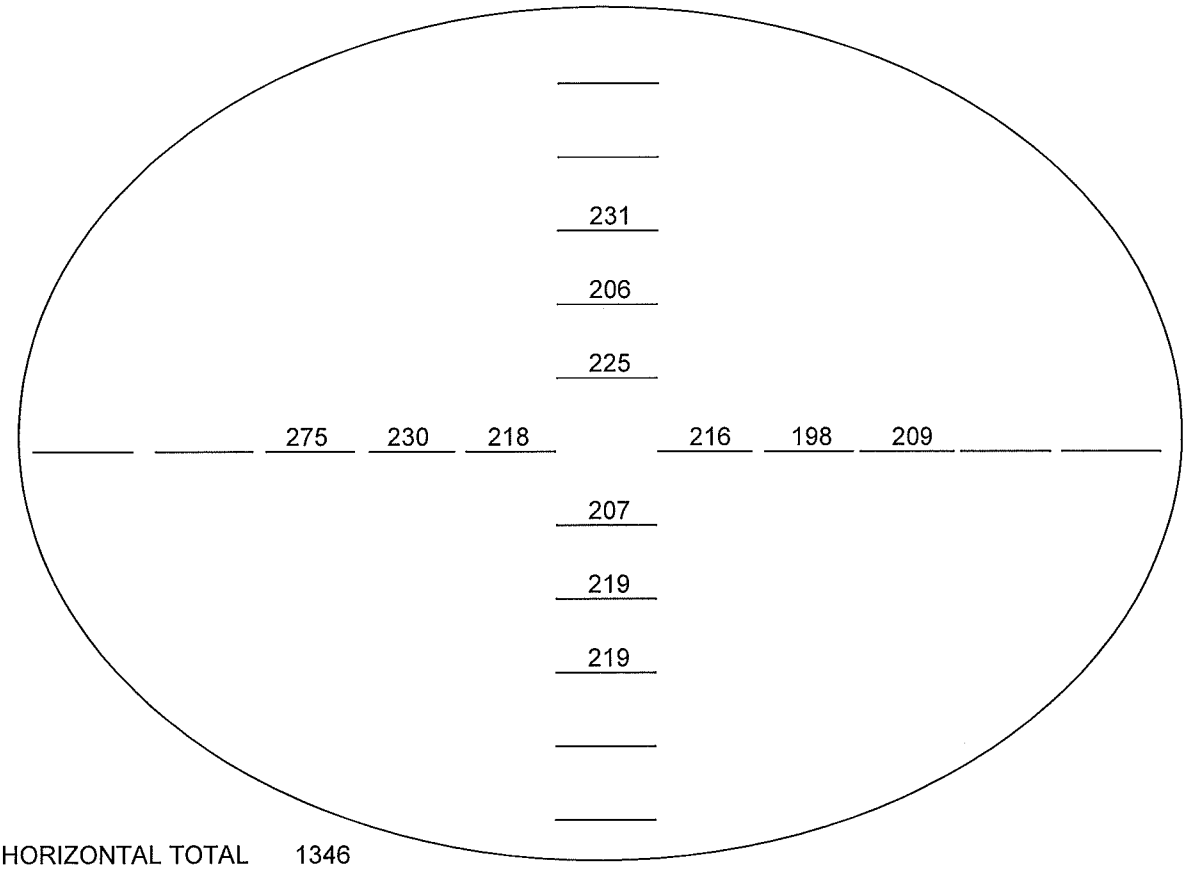
TEST DATE: 6/23/20
READINGS BY: VR / DA

ROUND DUCT TRAVERSE REPORT

PROJECT: SCHERTZ ANIMAL ADOPTION CENTER
LOCATION/ZONE: MEZZANINE
INSTRUMENT: SHORTRIDGE AIR DATA METER

SYSTEM/UNIT: DS-01
AIRSTREAM: O/A

DUCT				REQUIRED				ACTUAL			
SIZE	6 "(DIA)	SQ FT	0.196	FPM	127	CFM	25	FPM	221	CFM	43
		S.P.	-0.04								



HORIZONTAL TOTAL 1346
VERTICAL TOTAL 1307
TOTAL FPM 2653
NO. READINGS 12 AVG. FPM 221 X SQ. FT. 0.196 = CFM 43

REMARKS: (1) READINGS INDICATE OUTSIDE AIR IS LEAVING UNIT INSTEAD OF ENTERING UNIT.

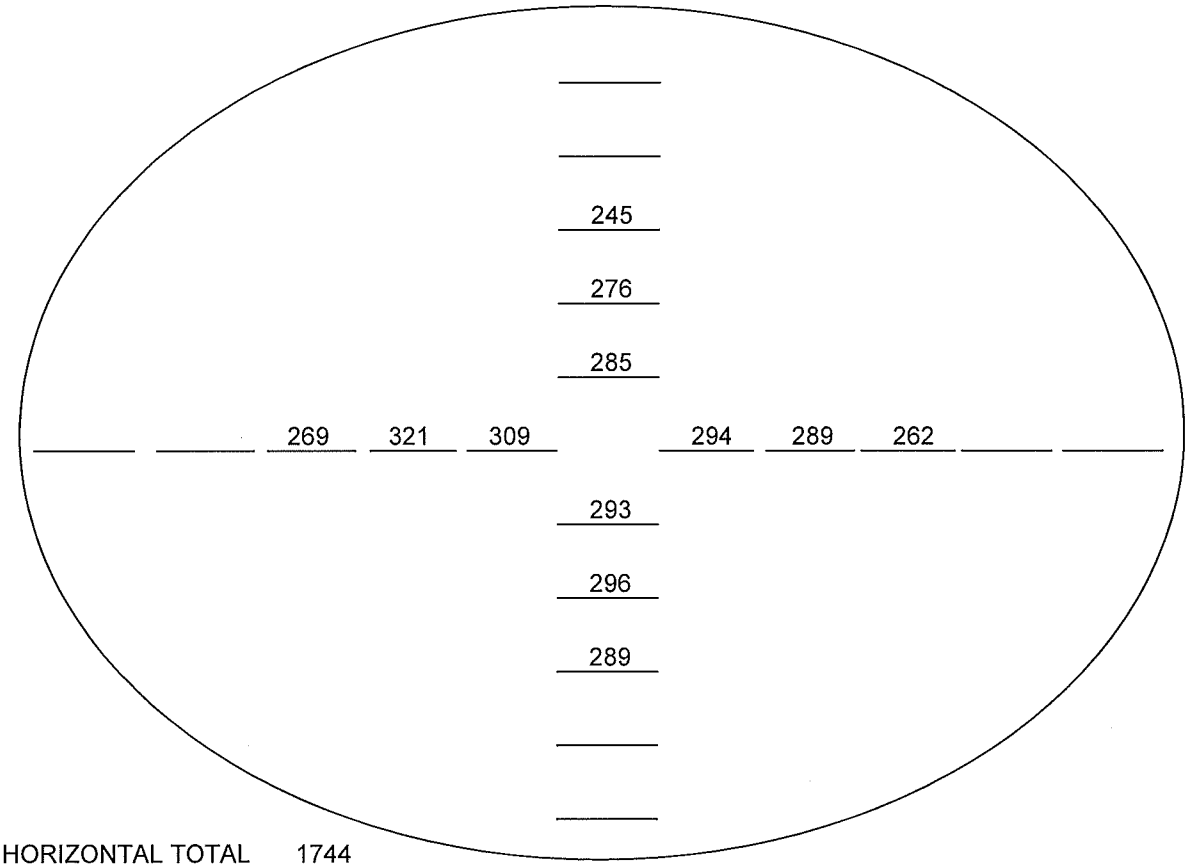
TEST DATE: 6/23/20
READINGS BY: VR / DA

ROUND DUCT TRAVERSE REPORT

PROJECT: SCHERTZ ANIMAL ADOPTION CENTER
LOCATION/ZONE: MEZZANINE
INSTRUMENT: SHORTRIDGE AIR DATA METER

SYSTEM/UNIT: DS-06
AIRSTREAM: O/A

DUCT				REQUIRED				ACTUAL			
SIZE	6 "(DIA)	SQ FT	0.196	FPM	341	CFM	67	FPM	286	CFM	56
		S.P.	-0.05								



HORIZONTAL TOTAL 1744
VERTICAL TOTAL 1684
TOTAL FPM 3428
NO. READINGS 12 AVG. FPM 286 X SQ. FT. 0.196 = CFM 56

REMARKS: (1) READINGS INDICATE OUTSIDE AIR IS LEAVING UNIT INSTEAD OF ENTERING UNIT.

TEST DATE: 6/23/20
READINGS BY: VR / DA

FACE VELOCITY REPORT

PROJECT: SCHERTZ ANIMAL ADOPTION CENTER
LOCATION/ZONE: STRAY CAT HOLDING 128
INSTRUMENT: SHORTRIDGE AIR DATA METER

SYSTEM/UNIT: DS-11
AIRSTREAM: RETURN AIR

FACE OPENING				REQUIRED				ACTUAL			
WIDTH	12	SQ FT	1.00	FPM	277	CFM	277	FPM	278	CFM	278
HEIGHT	12										

POSITION	1	2	3	4	5	6	7	8	9	10	11	12
1	276	272										
2	292	270										
3												
4												
5												
6												
7												
8												
9												
10												
11												
12												
13												
	568	542										

TOTAL FPM	/ NO. READINGS = AVG. FPM		x SQ FT.	= CFM
1110	4	278	1.00	278

REMARKS:

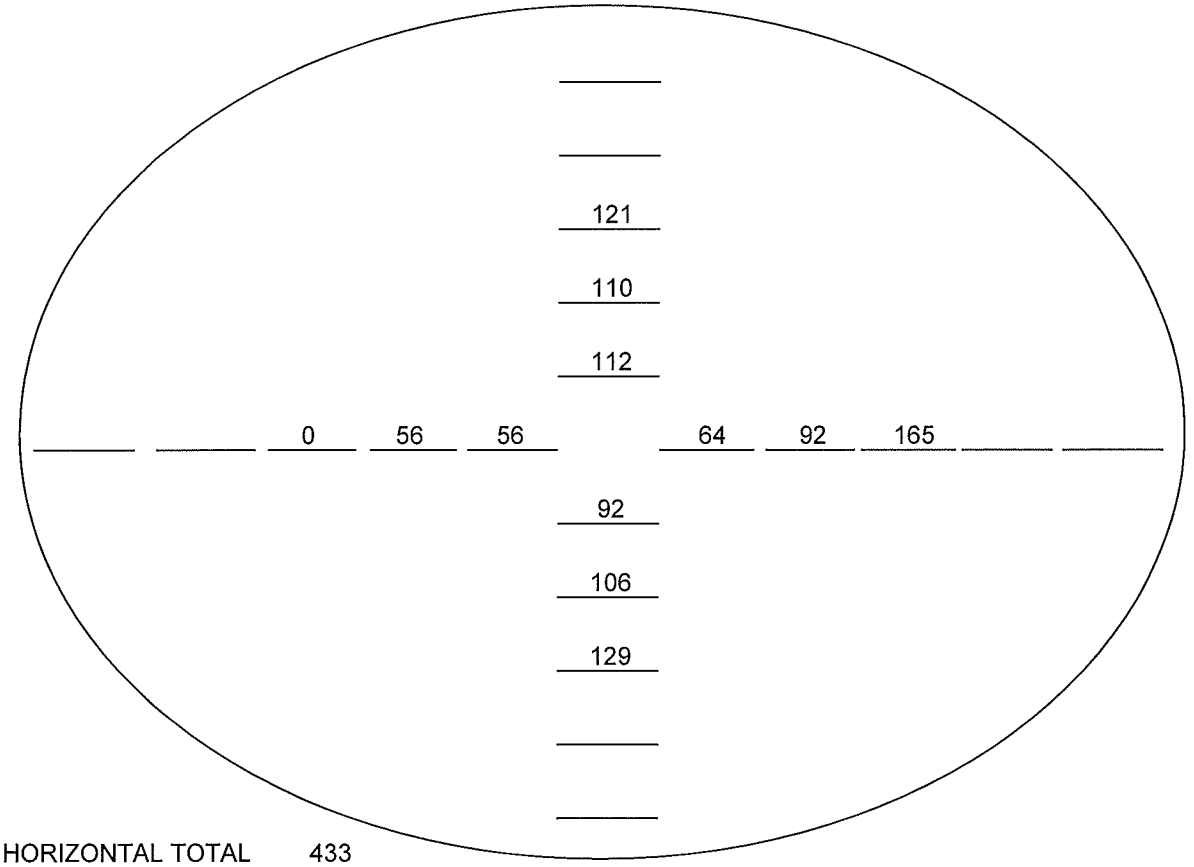
TEST DATE: 6/23/20
READINGS BY: VR / DA

ROUND DUCT TRAVERSE REPORT

PROJECT: SCHERTZ ANIMAL ADOPTION CENTER
LOCATION/ZONE: MEZZANINE
INSTRUMENT: SHORTRIDGE AIR DATA METER

SYSTEM/UNIT: DS-11
AIRSTREAM: O/A

DUCT				REQUIRED				ACTUAL			
SIZE	6 "(DIA)	SQ FT	0.196	FPM	153	CFM	30	FPM	92	CFM	18
		S.P.	-0.01								



HORIZONTAL TOTAL 433
VERTICAL TOTAL 670
TOTAL FPM 1103
NO. READINGS 12 AVG. FPM 92 X SQ. FT. 0.196 = CFM 18

REMARKS:

TEST DATE: 6/23/20
READINGS BY: VR / DA

FACE VELOCITY REPORT

PROJECT: SCHERTZ ANIMAL ADOPTION CENTER
LOCATION/ZONE: TRAINING 114
INSTRUMENT: SHORTRIDGE AIR DATA METER

SYSTEM/UNIT: DS-12
AIRSTREAM: RETURN AIR

FACE OPENING				REQUIRED				ACTUAL			
WIDTH	12	SQ FT	1.00	FPM	240	CFM	240	FPM	396	CFM	396
HEIGHT	12										

POSITION	1	2	3	4	5	6	7	8	9	10	11	12
1	398	393										
2	404	389										
3												
4												
5												
6												
7												
8												
9												
10												
11												
12												
13												
	802	782										

TOTAL FPM	/ NO. READINGS = AVG. FPM		x SQ FT.	= CFM
1584	4	396	1.00	396

REMARKS:

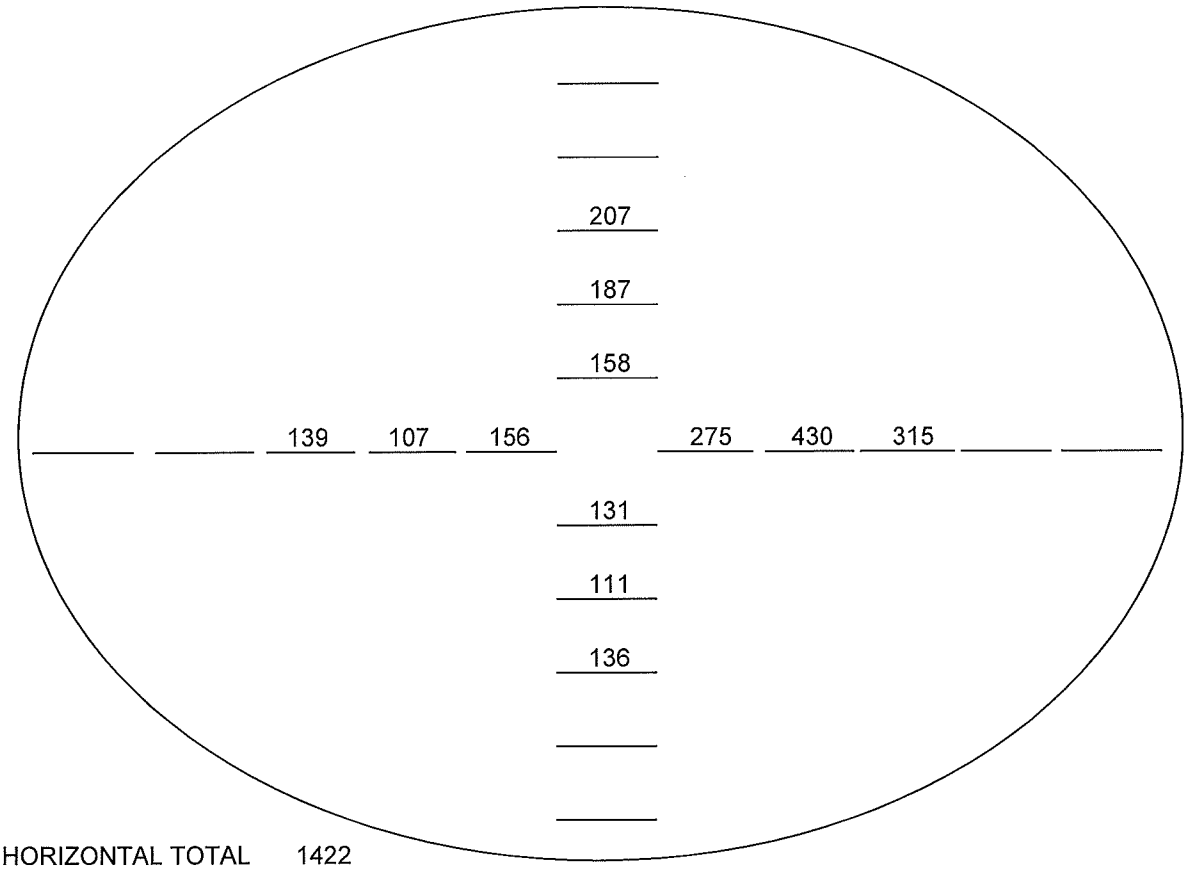
TEST DATE: 6/23/20
READINGS BY: VR / DA

ROUND DUCT TRAVERSE REPORT

PROJECT: SCHERTZ ANIMAL ADOPTION CENTER
LOCATION/ZONE: MEZZANINE
INSTRUMENT: SHORTRIDGE AIR DATA METER

SYSTEM/UNIT: DS-12
AIRSTREAM: O/A

DUCT				REQUIRED				ACTUAL			
SIZE	6 "(DIA)	SQ FT	0.196	FPM	127	CFM	25	FPM	196	CFM	38
		S.P.	0.01								



HORIZONTAL TOTAL 1422
VERTICAL TOTAL 930
TOTAL FPM 2352

NO. READINGS 12 AVG. FPM 196 X SQ. FT. 0.196 = CFM 38

REMARKS: (1) READINGS INDICATE OUTSIDE AIR IS LEAVING UNIT INSTEAD OF ENTERING UNIT.

TEST DATE: 6/23/20
READINGS BY: VR / DA

FACE VELOCITY REPORT

PROJECT: SCHERTZ ANIMAL ADOPTION CENTER
LOCATION/ZONE: BREAK RM. 118
INSTRUMENT: SHORTRIDGE AIR DATA METER

SYSTEM/UNIT: DS-13
AIRSTREAM: RETURN AIR

FACE OPENING				REQUIRED				ACTUAL			
WIDTH	12	SQ FT	1.00	FPM	356	CFM	356	FPM	514	CFM	514
HEIGHT	12										

POSITION	1	2	3	4	5	6	7	8	9	10	11	12
1	512	519										
2	514	511										
3												
4												
5												
6												
7												
8												
9												
10												
11												
12												
13												
	1026	1030										

TOTAL FPM	/ NO. READINGS = AVG. FPM		x SQ FT.	= CFM
2056	4	514	1.00	514

REMARKS:

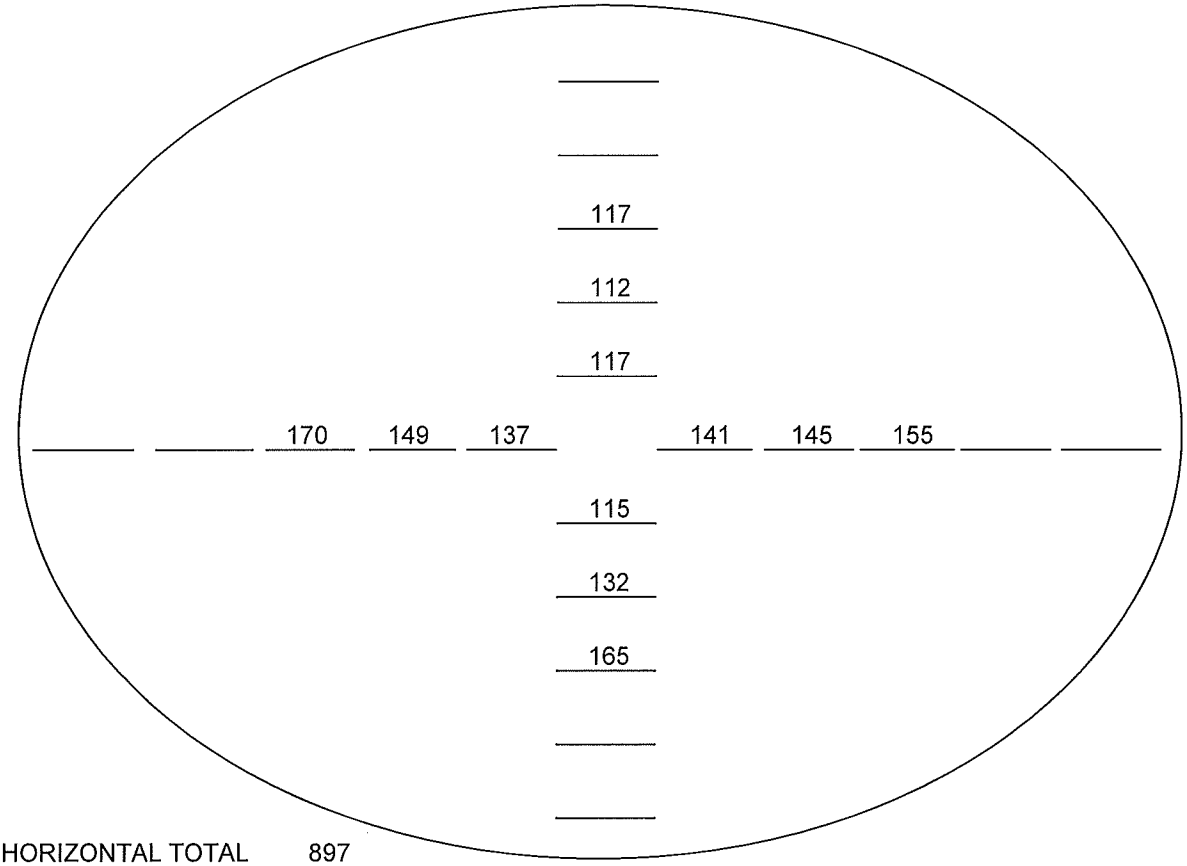
TEST DATE: 6/23/20
READINGS BY: VR / DA

ROUND DUCT TRAVERSE REPORT

PROJECT: SCHERTZ ANIMAL ADOPTION CENTER
LOCATION/ZONE: MEZZANINE
INSTRUMENT: SHORTRIDGE AIR DATA METER

SYSTEM/UNIT: DS-13
AIRSTREAM: O/A

DUCT				REQUIRED				ACTUAL			
SIZE	6 "(DIA)	SQ FT	0.196	FPM	204	CFM	40	FPM	138	CFM	27
		S.P.	0.15								



HORIZONTAL TOTAL 897
VERTICAL TOTAL 758
TOTAL FPM 1655
NO. READINGS 12 AVG. FPM 138 X SQ. FT. 0.196 = CFM 27

REMARKS: (1) READINGS INDICATE OUTSIDE AIR IS LEAVING UNIT INSTEAD OF ENTERING UNIT.

TEST DATE: 6/23/20
READINGS BY: VR / DA

PROJECT: SCHERTZ ANIMAL ADOPTION CENTER

FAN DATA	FAN NO. EF-1		FAN NO. EF-2		FAN NO. EF-3	
Location	ROOF		ROOF		ROOF	
Service	VARIOUS AREAS		VARIOUS AREAS		VARIOUS AREAS	
Manufacturer/Type	(1)		(1)		(1)	
Model Number	(1)		(1)		(1)	
Serial Number	(1)		(1)		(1)	
Motor Make/Frame	(1)		(1)		(1)	
Motor H.P./RPM	(1)		(1)		(1)	
Volts/Phase/Hertz	(1)		(1)		(1)	
F.L. Amps/S.F.	(1)		(1)		(1)	
Motor Sheave Make	(1)		(1)		(1)	
Motor Sheave Diam./Bore	(1)		(1)		(1)	
Fan Sheave Make	(1)		(1)		(1)	
Fan Sheave Diam./Bore	(1)		(1)		(1)	
No. Belts/Make/Size	(1)		(1)		(1)	
Sheave Center Distance	(1)		(1)		(1)	
Sheave Operating P.D.	(1)		(1)		(1)	
Fan Speed / HZ	(1)		(1)		(1)	
TEST DATA	DESIGN	ACTUAL	DESIGN	ACTUAL	DESIGN	ACTUAL
CFM Total	525	414	490	300	945	483
CFM Inlet / Outlet	705	393	385	254	740	434
Fan RPM	(1)	(1)	(1)	(1)	(1)	(1)
S.P. In	NOT GIVEN	(1)	NOT GIVEN	(1)	NOT GIVEN	(1)
S.P. Out	NOT GIVEN	(1)	NOT GIVEN	(1)	NOT GIVEN	(1)
Total S.P.	0.5	(1)	0.5	(1)	0.5	(1)
Voltage	(1)	(1)	(1)	(1)	(1)	(1)
Amperage	(1)	(1)	(1)	(1)	(1)	(1)

REMARKS: (1) DATA AND READINGS NOT OBTAINED.

TEST DATE: 6/23/20
READINGS BY: VR / DA

RECTANGULAR DUCT
TRAVERSE REPORT

PROJECT: SCHERTZ ANIMAL ADOPTION CENTER
LOCATION/ZONE: ABOVE CEILING DOG QUARANTINE 127
INSTRUMENT: SHORTRIDGE AIR DATA METER

SYSTEM/UNIT: EF-1
AIRSTREAM: TOTAL EXHAUST

DUCT				REQUIRED				ACTUAL			
WIDTH	12	SQ FT	1.17	FPM	604	CFM	705	FPM	355	CFM	414
HEIGHT	14	S.P.	-0.07								

POSITION	1	2	3	4	5	6	7	8	9	10	11	12
1	426	410	379	408								
2	407	389	380	334								
3	218	343	330	297								
4	343	325	362	326								
5												
6												
7												
8												
9												
10												
11												
12												
13												
	1394	1467	1451	1365								

TOTAL FPM	/ NO. READINGS = AVG. FPM		x SQ FT.	= CFM
5677	16	355	1.17	414

REMARKS:

TEST DATE: 6/23/20
READINGS BY: VR / DA

AIR OUTLET
TEST REPORT

PROJECT: SCHERTZ ANIMAL ADOPTION CENTER SYSTEM: EF-1

AREA SERVED	OUTLET NO.	OUTLET TYPE	OUTLET SIZE (INCH)	DESIGN CFM	PRELIMINARY CFM	FINAL CFM	PERCENT OF DESIGN	NOTES
DOG QUAR. 127	E1	LID	8X8	250	105	105	42%	
STRAY CAT HOLDING 128	E2	LID	8X8	185	103	103	56%	
CAT QUAR. 129	E3	LID	8X8	90	73	73	81%	
SUPP. ADOPT. 130	E4	LID	8X8	180	112	112	62%	
				705	393	393	56%	

REMARKS:

TEST DATE: 6/23/20
READINGS BY: VR / DA

RECTANGULAR DUCT
TRAVERSE REPORT

PROJECT: SCHERTZ ANIMAL ADOPTION CENTER
LOCATION/ZONE: ABOVE CEILING DOG QUARANTINE 127
INSTRUMENT: SHORTRIDGE AIR DATA METER

SYSTEM/UNIT: EF-1
AIRSTREAM: INLET E1

DUCT				REQUIRED				ACTUAL			
WIDTH	8	SQ FT	0.44	FPM	563	CFM	250	FPM	236	CFM	105
HEIGHT	8	S.P.	0.06								

POSITION	1	2	3	4	5	6	7	8	9	10	11	12
1	184	188	140	184								
2	232	163	176	220								
3	258	282	259	269								
4	311	308	317	291								
5												
6												
7												
8												
9												
10												
11												
12												
13												
	985	941	892	964								

TOTAL FPM	/ NO. READINGS = AVG. FPM		x SQ FT.	= CFM
3782	16	236	0.44	105

REMARKS:

TEST DATE: 6/23/20
READINGS BY: VR / DA

RECTANGULAR DUCT
TRAVERSE REPORT

PROJECT: SCHERTZ ANIMAL ADOPTION CENTER
LOCATION/ZONE: ABOVE CEILING CORRIDOR 116
INSTRUMENT: SHORTRIDGE AIR DATA METER

SYSTEM/UNIT: EF-2
AIRSTREAM: TOTAL EXHAUST

DUCT				REQUIRED				ACTUAL			
WIDTH	12	SQ FT	1.00	FPM	385	CFM	385	FPM	300	CFM	300
HEIGHT	12	S.P.	-0.08								

POSITION	1	2	3	4	5	6	7	8	9	10	11	12
1	246	258	346	390								
2	254	221	264	418								
3	287	226	181	411								
4	337	248	315	400								
5												
6												
7												
8												
9												
10												
11												
12												
13												
	1124	953	1106	1619								

TOTAL FPM	/ NO. READINGS = AVG. FPM		x SQ FT.	= CFM
4802	16	300	1.00	300

REMARKS:

TEST DATE: 6/23/20
READINGS BY: VR / DA

AIR OUTLET
TEST REPORT

PROJECT: SCHERTZ ANIMAL ADOPTION CENTER SYSTEM: EF-2

AREA SERVED	OUTLET NO.	OUTLET TYPE	OUTLET SIZE (INCH)	DESIGN CFM	PRELIMINARY CFM	FINAL CFM	PERCENT OF DESIGN	NOTES
GROOMING INT. 126	E1	LID	8X8	160	135	135	84%	
QUARANTINE 124	E2	LID	8X8	90	64	64	71%	
JAN / STOR. 121	E3	LID	8X8	70	36	36	51%	
STAFF T / R 120	E4	LID	8X8	65	19	19	29%	
				385	254	254	66%	

REMARKS:

TEST DATE: 6/23/20
READINGS BY: VR / DA

RECTANGULAR DUCT
TRAVERSE REPORT

PROJECT: SCHERTZ ANIMAL ADOPTION CENTER
LOCATION/ZONE: ABOVE CEILING VESTIBULE 111
INSTRUMENT: SHORTRIDGE AIR DATA METER

SYSTEM/UNIT: EF-3
AIRSTREAM: TOTAL EXHAUST

DUCT				REQUIRED				ACTUAL			
WIDTH	12	SQ FT	1.00	FPM	740	CFM	740	FPM	483	CFM	483
HEIGHT	12	S.P.	-0.11								

POSITION	1	2	3	4	5	6	7	8	9	10	11	12
1	498	604	574	481								
2	548	623	532	474								
3	608	559	453	394								
4	457	330	250	344								
5												
6												
7												
8												
9												
10												
11												
12												
13												
	2111	2116	1809	1693								

TOTAL FPM	/ NO. READINGS = AVG. FPM		x SQ FT.	= CFM
7729	16	483	1.00	483

REMARKS:

TEST DATE: 6/23/20
READINGS BY: VR / DA

AIR OUTLET
TEST REPORT

PROJECT: SCHERTZ ANIMAL ADOPTION CENTER SYSTEM: EF-3

AREA SERVED	OUTLET NO.	OUTLET TYPE	OUTLET SIZE (INCH)	DESIGN CFM	PRELIMINARY CFM	FINAL CFM	PERCENT OF DESIGN	NOTES
RETAIL DOG ADOPT 112	E1	LID	10X10	310	137	137	44%	
WOMEN 110	E2	LID	6X6	50	26	26	52%	
MEN 109	E3	LID	6X6	50	27	27	54%	
GET ACQUAINTED RM. 108	E4	LID	8X8	160	105	105	66%	
DOG DISP. 107	E5	LID	6X6	45	66	66	147%	(1)
CAT ADOPT 106	E6	LID	8X8	125	73	73	58%	
				740	434	434	59%	

REMARKS: (1) INLET LOCATION IS OUTSIDE OF ROOM.

TEST DATE: 6/23/20
READINGS BY: VR / DA

Appendix D

Cx ASSIST/ISSUES LOG

23	Open Items
0	Pending
0	Closed Items
23	Total Items

CITY OF SCHERTZ - ANIMAL ADOPTION CENTER - RETRO-Cx ASSIST LOG

TGCE PROJECT #: 1393.00

Item	Status	Type	Subtype	Room / Location	Equip./ System Ident.	Description	Date Open	Opened By	Date Closed	Closed By	Notes*
1	Open	Mech-Ctrls	Observation	N/A	All	IDU addresses on Laptop Service Tool are not mapped to equivalent equipment numbers (e.g., IDU-2 = DS-01). The LG software is unable to rename IDU addresses as it auto-assigns during system start-up. TGCE and TAS had to investigate via thermostat mapping in order to identify all systems.	6/23/20	TG			
2	Open	Mech-Ctrls	Observation	N/A	DSCU-A	The AC Smart outside air sensor is located within the condensing unit cabinet which is picking up system heat rejection and therefore, is not an accurate representation of true ambient conditions. Additionally, the sensor only reads temperature.	6/23/20	TG			
3	Open	Mech-Equip.	Observation	127	DS-01	Observed excessive fan noise. Texas Air Systems believes the noise is caused by failing fan motors.	6/23/20	TG			
4	Open	Mech-Equip.	Observation	Various	Cassettes	Upon traverse of O/A, reverse airflow was observed and therefore, design outside airflow is not being obtained. This condition was typical for all cassette style units. The LG Engineering Manual states that inline fans are required to push outdoor air to the indoor cassette unit to overcome the static pressure. This building is not equipped with inline fans on the outside air ductwork.	6/23/20	TG			
5	Open	Mech-Equip.	Observation	Various	Cassettes	Supply airflow cannot be accurately measured on cassette style units.	6/23/20	TG			
6	Open	Mech-Equip.	Observation	Various	Cassettes	Mixed air conditions could not be measured on cassette style units.	6/23/20	TG			
7	Open	Mech-Equip.	Observation	Platform	DS-02	Design supply airflow of 454 CFM is not being obtained.	6/23/20	TG			
8	Open	Mech-Equip.	Observation	Platform	DS-02	Design outside airflow of 195 CFM is not being obtained.	6/23/20	TG			
9	Open	Mech-Equip.	Observation	Platform	DS-03	Design supply airflow of 425 CFM is not being obtained.	6/23/20	TG			
10	Open	Mech-Equip.	Observation	Platform	DS-03	Design outside airflow of 150 CFM is not being obtained.	6/23/20	TG			
11	Open	Mech-Equip.	Observation	Platform	DS-04	Design supply airflow of 425 CFM is not being obtained.	6/23/20	TG			
12	Open	Mech-Equip.	Observation	Platform	DS-04	Design outside airflow of 150 CFM is not being obtained.	6/23/20	TG			
13	Open	Mech-Equip.	Observation	Platform	DS-05	Design supply airflow of 245 CFM is exceeded.	6/23/20	TG			
14	Open	Mech-Equip.	Observation	Platform	DS-05	Design outside airflow of 90 CFM is exceeded.	6/23/20	TG			
15	Open	Mech-Equip.	Observation	Platform	DS-07	Design supply airflow of 425 CFM is exceeded.	6/23/20	TG			
16	Open	Mech-Equip.	Observation	Platform	DS-07	Design outside airflow of 150 CFM is not being obtained.	6/23/20	TG			
17	Open	Mech-Equip.	Observation	Platform	DS-08	Design supply airflow of 1335 CFM is not being obtained.	6/23/20	TG			
18	Open	Mech-Equip.	Observation	Platform	DS-08	Design outside airflow of 485 CFM is not being obtained.	6/23/20	TG			
19	Open	Mech-Equip.	Observation	Platform	DS-09	Design supply airflow of 1635 CFM is not being obtained.	6/23/20	TG			
20	Open	Mech-Equip.	Observation	Platform	DS-09	Design outside airflow of 500 CFM is not being obtained.	6/23/20	TG			
21	Open	Mech-Equip.	Observation	Platform	DS-10	Design supply airflow of 425 CFM is not being obtained.	6/23/20	TG			
22	Open	Mech-Equip.	Observation	Platform	DS-10	Design outside airflow of 150 CFM is not being obtained.	6/23/20	TG			
23	Open	Mech-Equip.	Observation	128	DS-11	EEV (electronic expansion valve) was found failed – Unit is currently not cooling and could not be commissioned.	6/23/20	TG			