

CST-100  
**STARLINER**

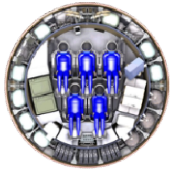
Cochise County  
Support for Starliner Landings  
November 2019

- Boeing is building Starliner as part of NASA's Commercial Crew Development Program
  - Return launch of astronauts to U.S. soil
- Starliner will launch on an Atlas V rocket from Cape Canaveral Air Force Station
- Docks to the International Space Station
- Remains on-orbit for up to 6 months
- Lands at one of 5 landing sites around the SW U.S.
  - Willcox Playa
  - Two sites on White Sands Missile Range
  - Dugway Proving Grounds
  - Edwards Air Force Base
- Schedule
  - Orbital Flight Test (OFT): first non-crewed test flight scheduled for December 17<sup>th</sup>
  - Crewed Flight Test (CFT): first crewed test flight scheduled for early spring timeframe

# Starliner & Launch Vehicle Overview

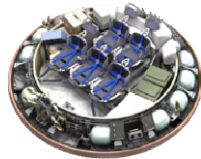
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## Boeing CST-100 Starliner spacecraft



### Seating for seven

5 crew + 2 crew equivalent of cargo shown



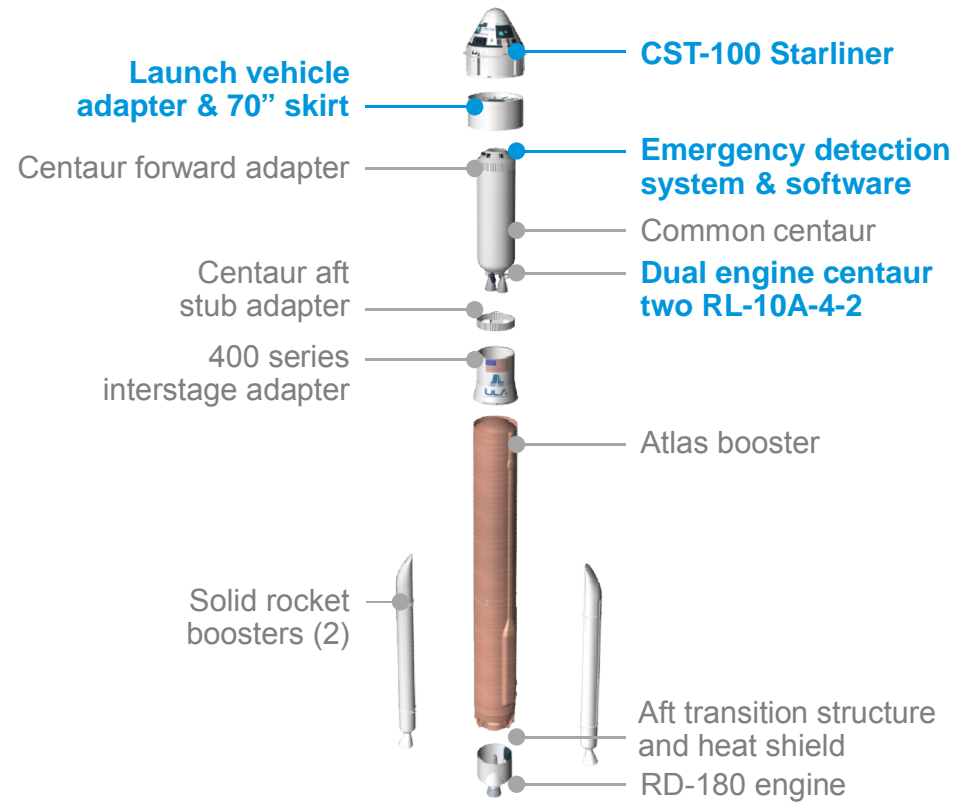
### Flexible cabin design

Accommodates mix of crew and cargo

## United Launch Alliance Atlas V rocket

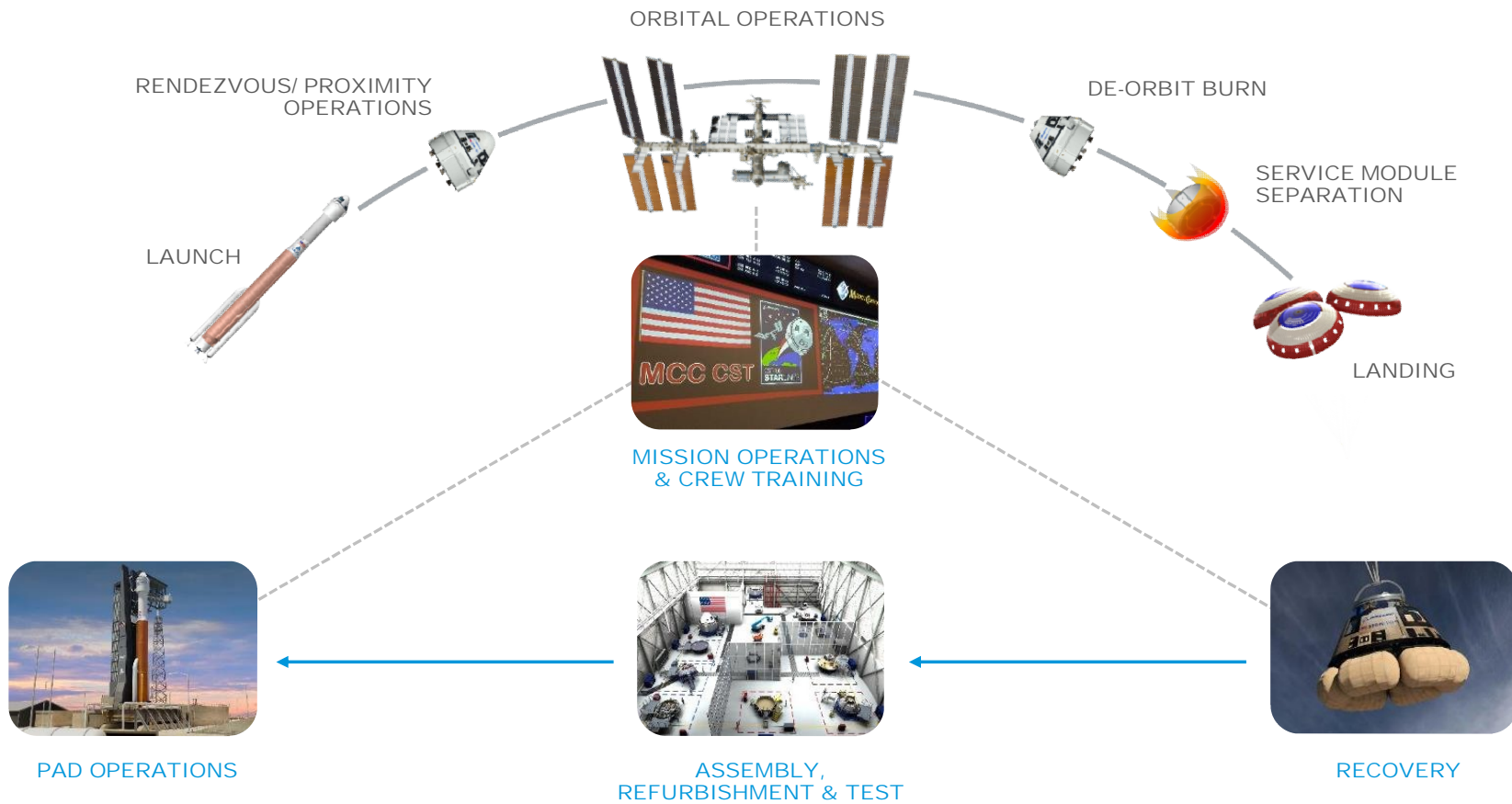
### LEGEND

● Heritage ● New systems



# Mission Overview

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- Nominal

- Planned end of mission landing approximately 6 months after launch
- Dates and primary and backup landing sites normally picked approximately 30 days prior to landing
- Full Boeing equipment and team available at prime site and a smaller team at the backup site
  - Some core team members travel from prime to backup, if a waive off occurs
  - Approximately 24 hour notice if waive off from prime to the backup site

- Emergency

- Three possible causes
  - Space Station issue requiring the crew to undock from the Station
  - Starliner issue that puts at risk its ability to stay in orbit
  - Crew medical issue
- Minimum time between declaring an emergency return and landing is about 4 hours
  - In all cases, the Starliner flight operations team will maintain the spacecraft on-orbit for as long as possible in order for the core Boeing team to travel to the site
  - Requires plan for minimal-to-no Boeing support, in case ASAP return needed to protect for loss of vehicle and/or crew (very low likelihood scenario, requires multiple failures)

## Key Requirements Driving Recovery Timeline

- Establishment of ground cooling within 30 minutes of landing (N/A for OFT)
  - Provided by HVAC/Generator and Ground Cooling Unit Trailers
- Recovery of flight crew within one hour of landing (N/A for OFT)
- Recovery of Time-Critical Cargo within one hour after crew egress (N/A for OFT)
- Provide medical evacuation of an ill or injured crewmember to a Level 1 Trauma Center within 1 hour of crew egress (N/A for OFT)
  - University of Arizona/Banner – Tucson for Willcox landings
  - Boeing contracting support from Air Center Helicopters for MEDEVAC
- Provide heating to propellant lines within 1 hour of landing if ambient temperature is below 40<sup>0</sup> F.
  - Provided by HVAC trailer and Environmental Enclosure
- Protect Crew Module from externally induced contamination
  - Provided by purge air line from HVAC trailer into hatch and Environmental Enclosure
- Transportation of crew, critical cargo, and up to 30 NASA personnel to airport within 2 hours of completion of crew medical assessment



## ▪ Nominal Landing

### – Roadblocks

- Needed for landing zone extension shown on next chart
  - Area where up to 6 small jettisoned parts could land depending on wind conditions on landing day
- Prevent large influx of people into this area who might try to access to watch the landing
- Establish approx. 2 hours before landing through 1 hour post landing or as determined by sheriffs
- County to define what roads should be blocked
- Right of Way Permit needed
  - POC: Jackie Watkins

### – Medical Support

- Ambulance (1) on standby at landing site in case a member of the Boeing team has a medical issue
- Ambulance (2) at landing site for possible astronaut transport
- Company/POC: Healthcare Innovations
  - For nominal landings Boeing will have a contract for MEDEVAC support

### – Public Affairs

- Discussed on chart 6

- Emergency Landing
  - Roadblocks
    - Same as nominal landing if time permits
  - Starliner staffing and crew extraction
    - Hydrazine sniff checks in personal protection gear
    - Hydrazine mitigation (water spray) if needed
    - Grounding of vehicle
    - Installation of stabilization equipment
    - Configuration of HVAC/Generator to provide cooling air into hatch
    - Establish ground cooling to vehicle (TBD, Boeing determining if necessary for emergency landings)
    - Hatch access and opening (assume via back of pickup)
    - Crew extraction and transport to ambulance or life flight
    - Hatch closure
    - Installation of environmental enclosure
    - Collection and bagging of parachutes

- Emergency Landing (cont)
  - Medical Support
    - Call in life flight support
      - NASA requests all personnel be MEDEVACed to Banner-University of Arizona Med Center for evaluation
    - Ambulance at landing site for support of astronaut transport
    - Company/POC: Healthcare Innovations
  - Cochise/Ft. Huachuca training will be provided for all of the above tasks
    - Currently planned for Feb timeframe

- Boeing Plans
  - Pre-mission media conferences on NASA TV at L-7 and L-2
  - Live coverage of launch, docking, undocking and landing on NASA TV
  - Live social media updates – both nominal and contingency
  - Developed crisis plan in the event of an emergency, landing sites are first to be contacted and coordinated with after NASA
- Options for Cochise County
  - Town hall meeting ahead of Starliner flights
  - Notifications to stakeholders, if Willcox identified as primary or secondary landing site
  - Designated viewing areas for VIP's/media/public
  - Use digital toolkit Boeing made for partners/suppliers
  - Media handouts – fact sheet, b-roll, etc.
  - Cochise/Ft. Huachuca representative interview on NASA TV show or available for media interviews post landing
- Help needed
  - High resolution map of landing site for media handout
  - Any details, talking points or key messages you would like included in our products

- Hydrazine sniffing monitors
- Grounding Equipment
- Stabilization Equipment
- HVAC/Generator Trailer (TBD, might be supplied by Ft. Huachuca)
- Ground Cooling Unit (TBD)
- Environmental Enclosure and Blowers
- Parachute bags
- Satellite phones (2 TBD) for comm with Mission Control Center Houston
  - Cell phones also work well on the playa

# Boeing Equipment – Hydrazine Sniff Check and Grounding



## MultiRAE (Hydrazine)

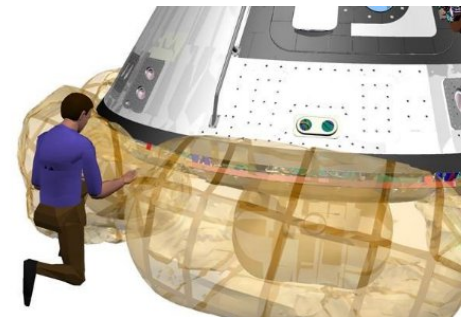
Handheld hydrazine monitor, used by Gold Team for initial safety check near the CM thrusters



Grounding Kit includes 6-6ft. Grounding Rods



Fluke Meter



# Boeing Equipment – Stabilization, Ground Cooling, HVAC/Generator

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# Boeing Equipment – Environmental Enclosure and Parachute Retrieval

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- Boeing will add Starliner landings to a contract with Clean Harbors for hazardous waste cleanup
  - Clean Harbors crew will be on site the day before, the day of, and the day after the landing
  - Will be responsible for decon of equipment affected by any hydrazine leaks
  - Will transport and dispose of any waste generated from the decon process

# Backup

- Boeing has established wind limits for landings at Willcox Playa
  - All large parts must be projected to land within the 4km radius landing zone
  - Per agreements with NASA, FAA, and Ft. Huachuca, up to six small jettisoned part may exceed this 4km radius but must remain within an 8km radius wedge between 38<sup>o</sup> and 190<sup>o</sup> true north
- Ft. Huachuca will launch weather balloons beginning at landing -24 hours
  - Mission Operations personnel will use balloon and forecast data to forecast weather conditions at landing
  - Data used in model to determine projected landing box for each jettisoned part
  - Location of landing boxes will determine go/no-go for landing

# Jettisoned Parts That Could Land in Extension for Certain Wind Cases **STARLINER**



Mortar Lids - 2 sizes:  
7.4 in. diameter/4 oz.  
16 in. diameter/12 oz.

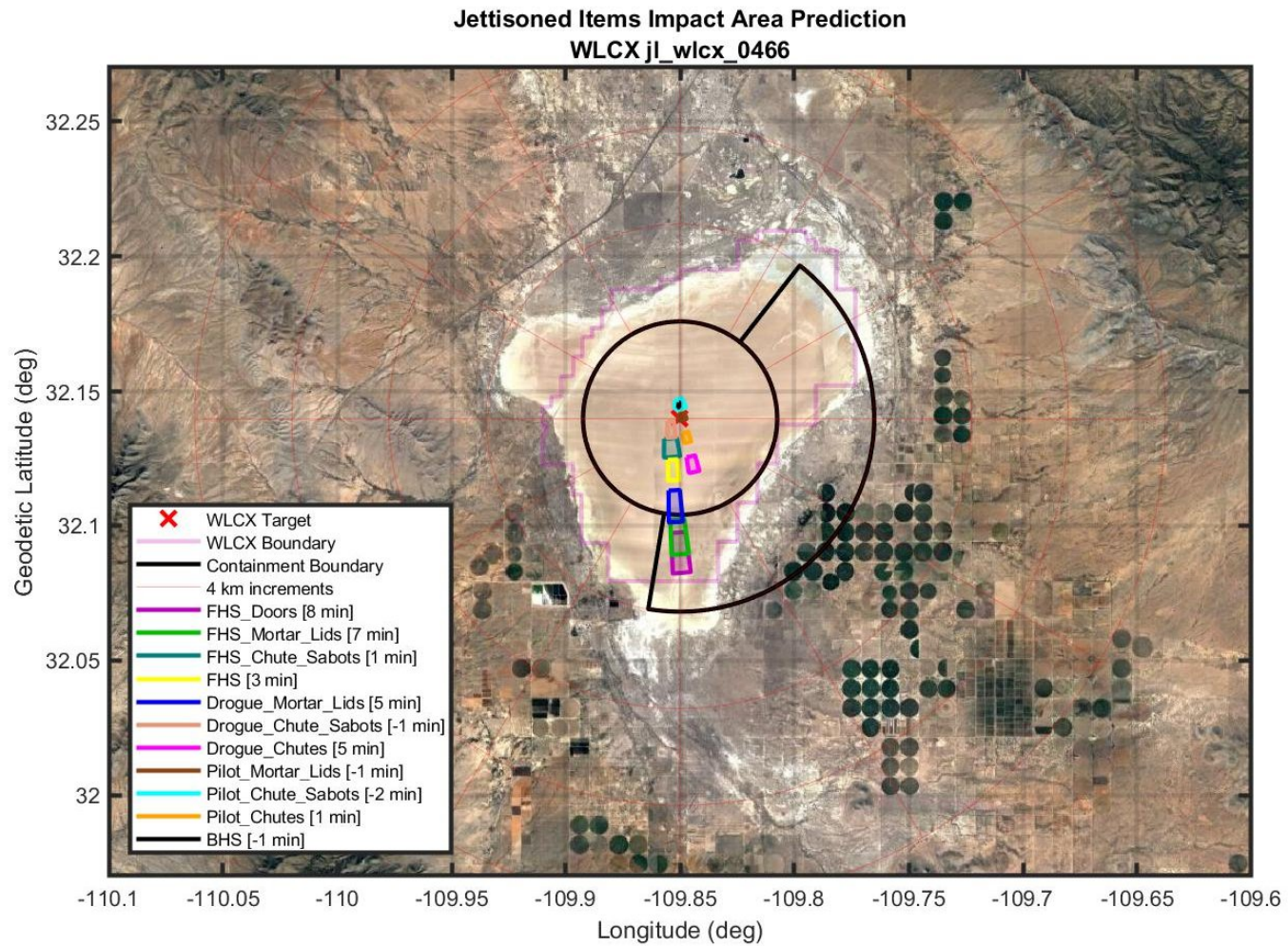


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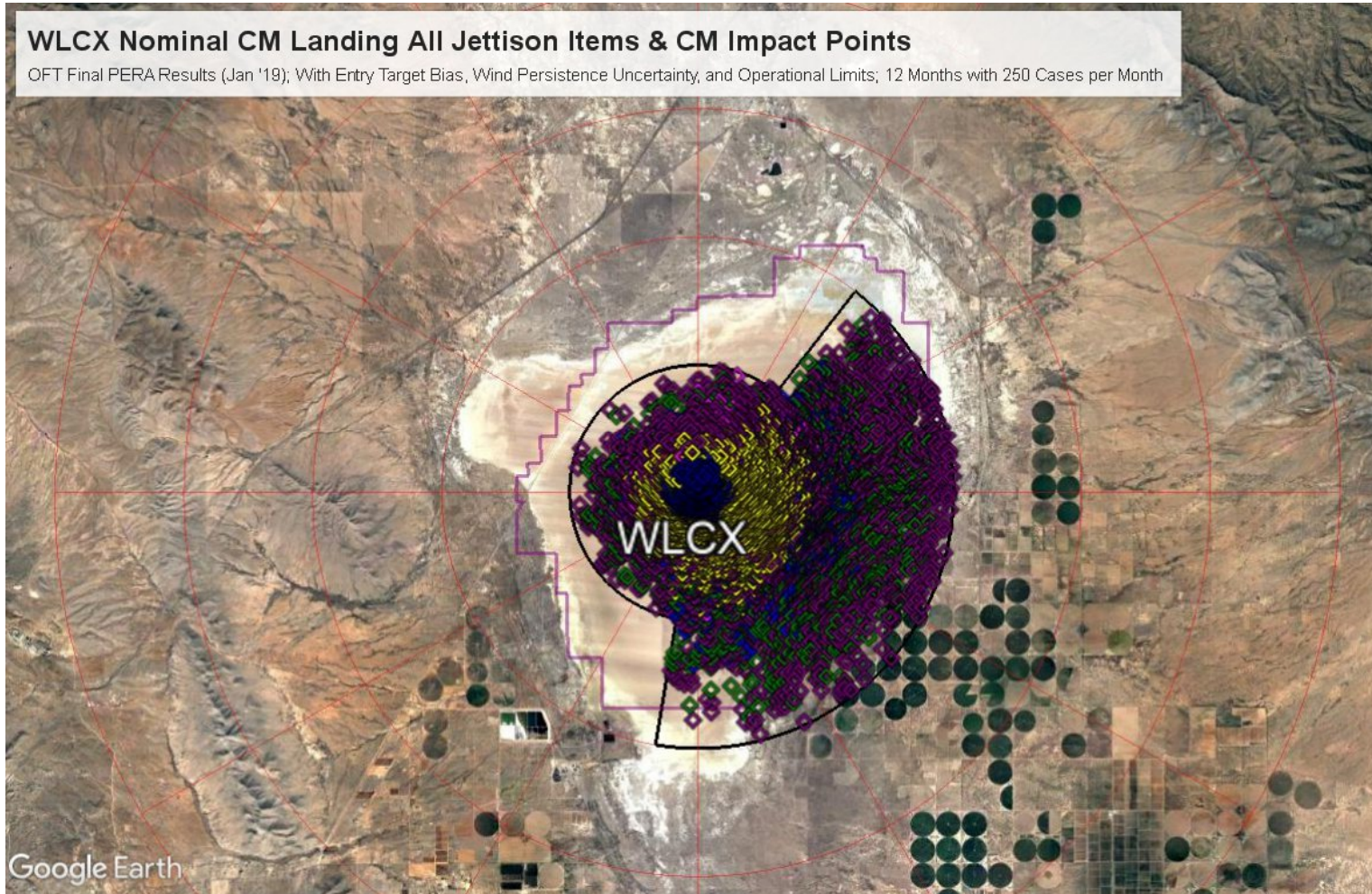


Forward Heat Shield Door  
10X12 in./1 lb.

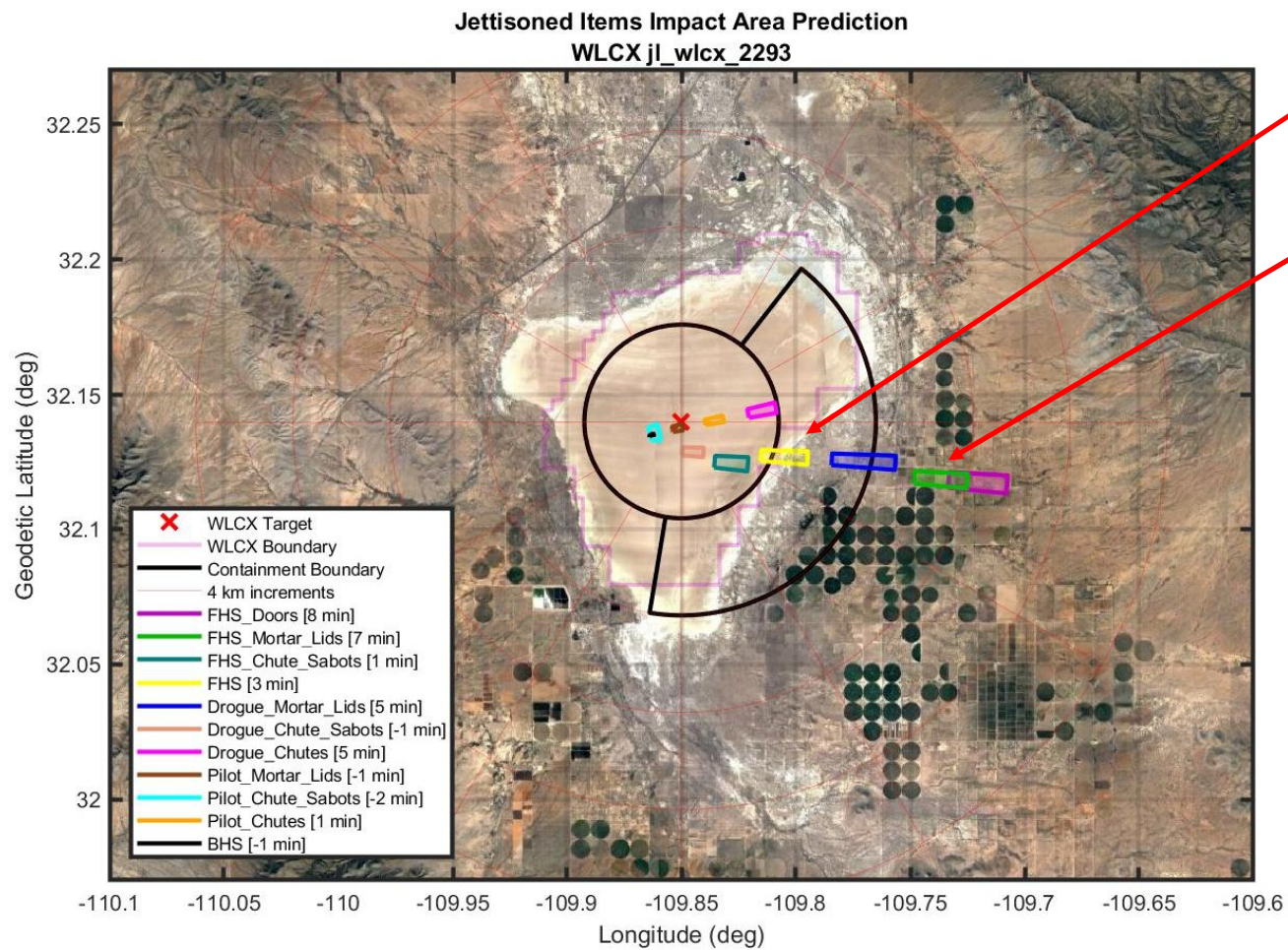
# Jettisoned Parts Wind Case - No Violation



# Jettisoned Parts Landing Points With Wind Restrictions



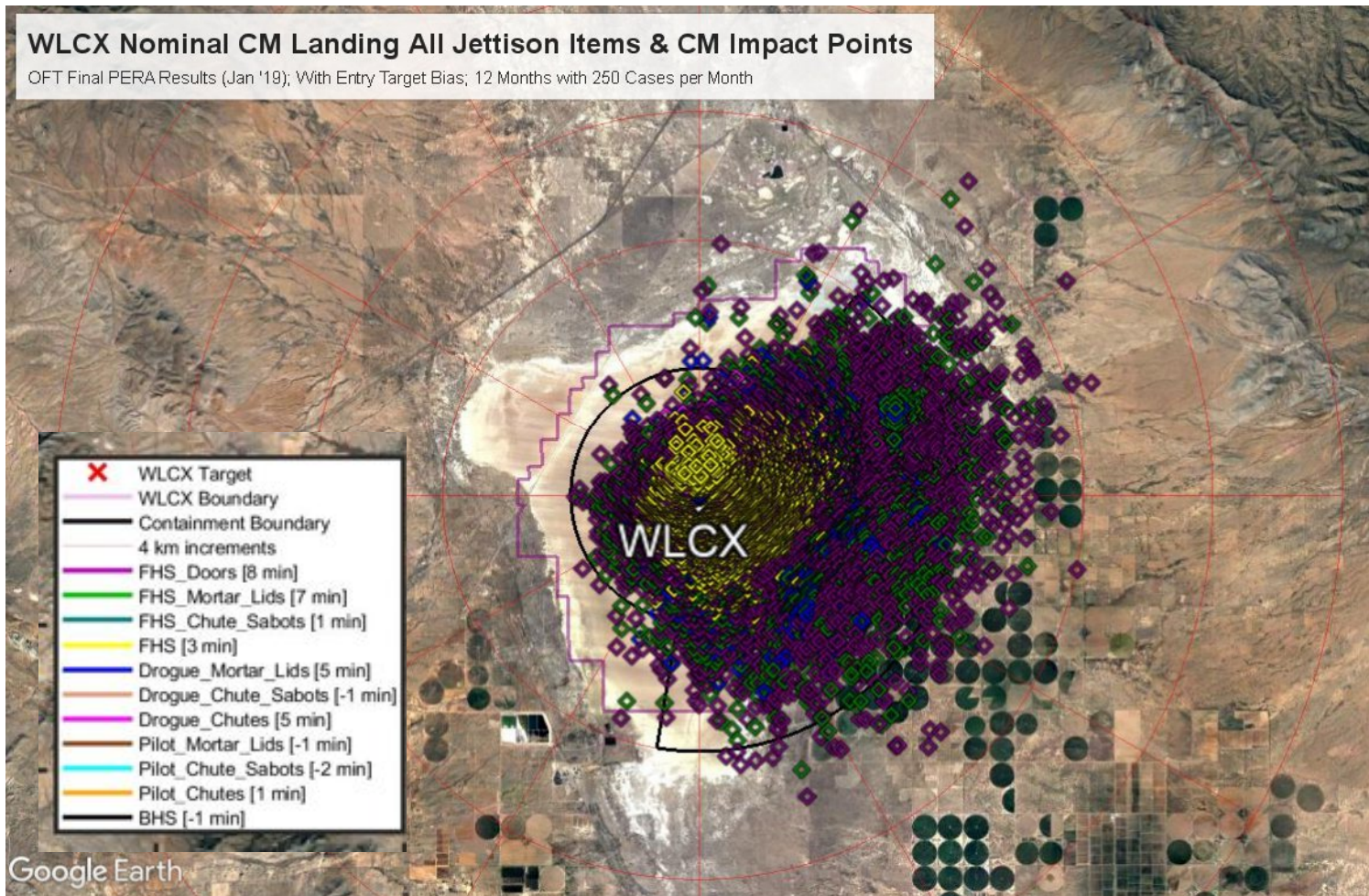
# Jettisoned Parts Wind Case - With Violation



Forward Heat Shield violates 4km limit

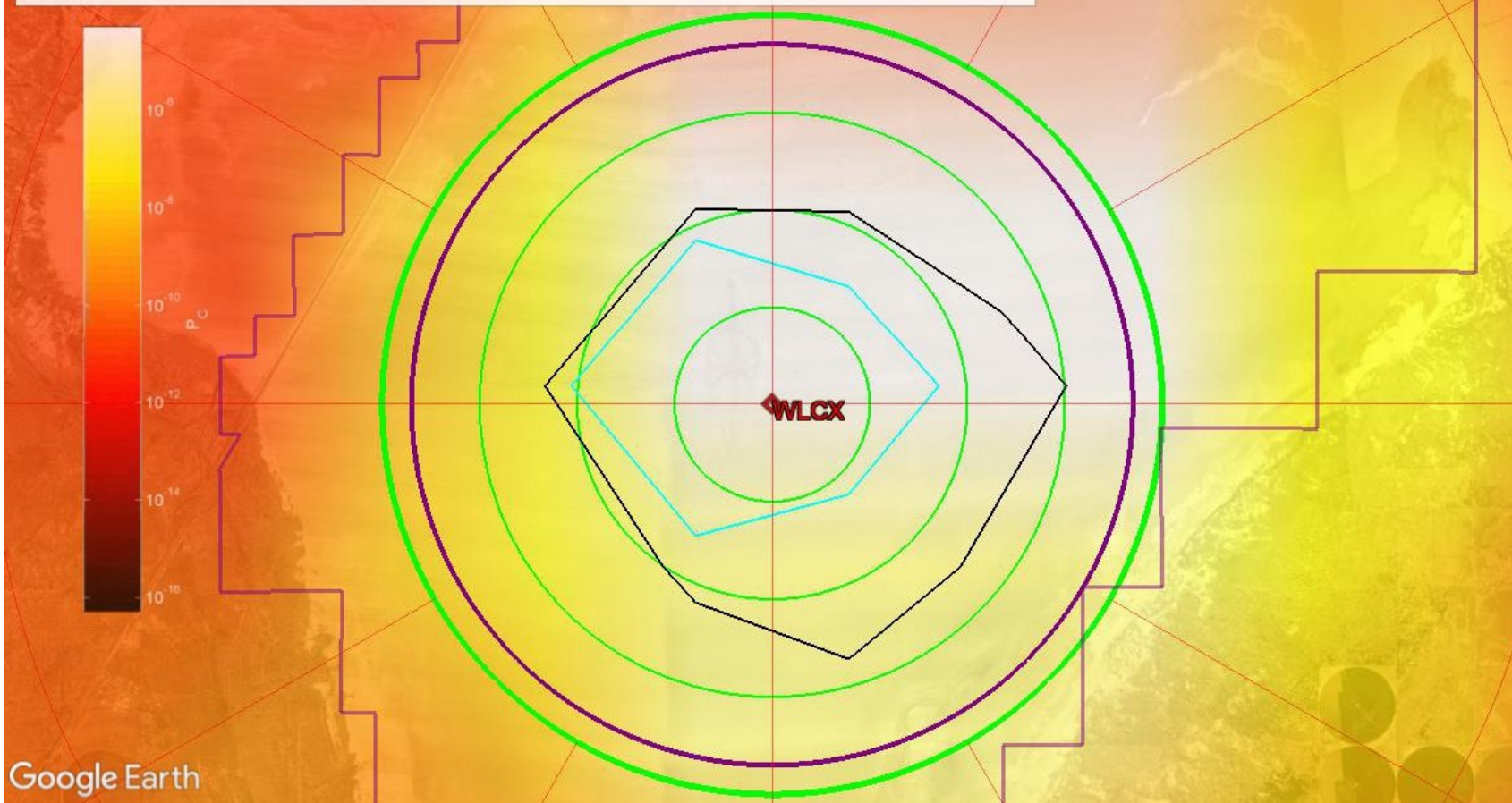
Mortar lids and doors violate 8 km limit

# Jettisoned Parts Landing Points With No Wind Restrictions



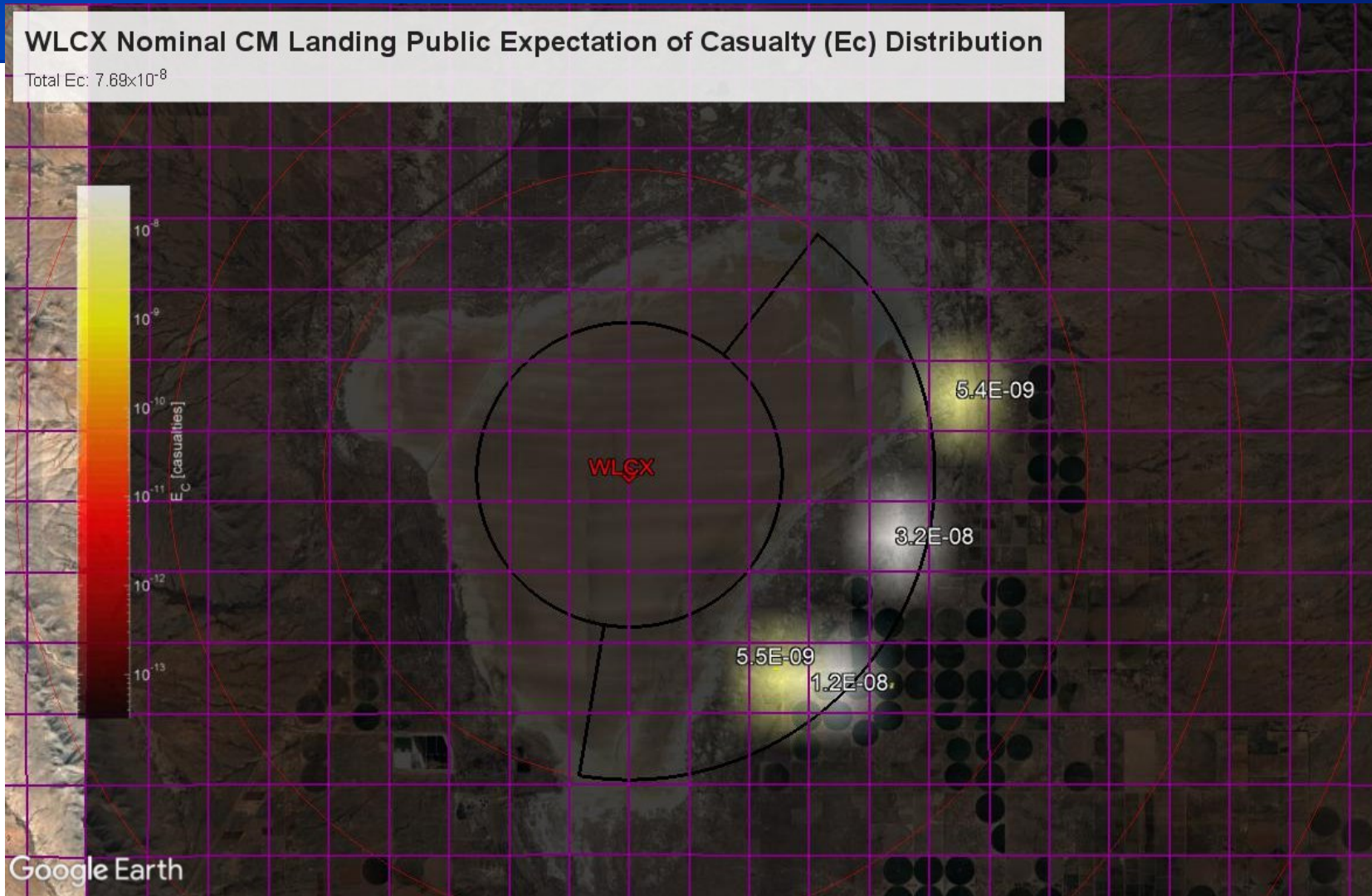
### WLCX Probability of Casualty (Pc) Risk Limit Contours

Green circles indicate distance from the landing target in 1 km increments; bold circle is the 4 km landing area boundary.  
Black boundary indicates best estimate public risk limit ( $10^{-6}$ ).  
Cyan boundary indicates best estimate mission essential personnel risk limit ( $10^{-5}$ ).  
Purple circle indicates 3.7 km radius circular restricted area for Pc risk mitigation.



WLCX Nominal CM Landing Public Expectation of Casualty ( $E_c$ ) Distribution

Total  $E_c$ :  $7.69 \times 10^{-8}$



Collective  $E_c$ : The total combined risk to all individuals exposed to one or more particular hazards during a specific period of time or event (a specific phase of flight).

Unless otherwise noted, collective risk for a range operation is the mean number of casualties expected ( $E_c$ ) during an established period (e.g., landing) due to the combination of all hazards associated with the operation.

Google Earth

