

Reassessing Carbon Dioxide with Minimum Performance Testing for Aircraft Powerplant Halon Replacement

Presented to:

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Presentation Content...

- **Brief Review, Halon-Replacement Testing in the Civilian Powerplant Fire Zone (MPSHRe)**
 - ✈ Test Process
 - ✈ FAATC NFS Test Article
- **Review/Status, this MPSHRe Project**
 - ✈ Ownership & Obligations
 - ✈ Bases for Reconsideration
 - ✈ Status



Brief Review / Test Process

- **Process is fully described in MPSHRe**
 - In part, candidate equals halon 1301 in a NFS
 - Candidate faces several NFS challenges
 - “High”- & “low”-ventilation rates
 - Pool & spray combustion modes
 - Multiple fuel types burned in spray combustion
 - Observe/compare flame suppression behaviors
 - Visually-determining a fire extinction duration (RTD)
 - Comparing all observations to determine efficacy
 - Measure candidate distribution in non-fire flows

RTD = reignition time delay



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Brief Review / Test Process

- **Outcome(s) =**
 - A “recommendation for certification” = the largest candidate quantity attaining equivalence
 - A report of all applicable observations
- **Optional requirement of a “real-world” demonstration for atypical candidates**



Brief Review / Test Article

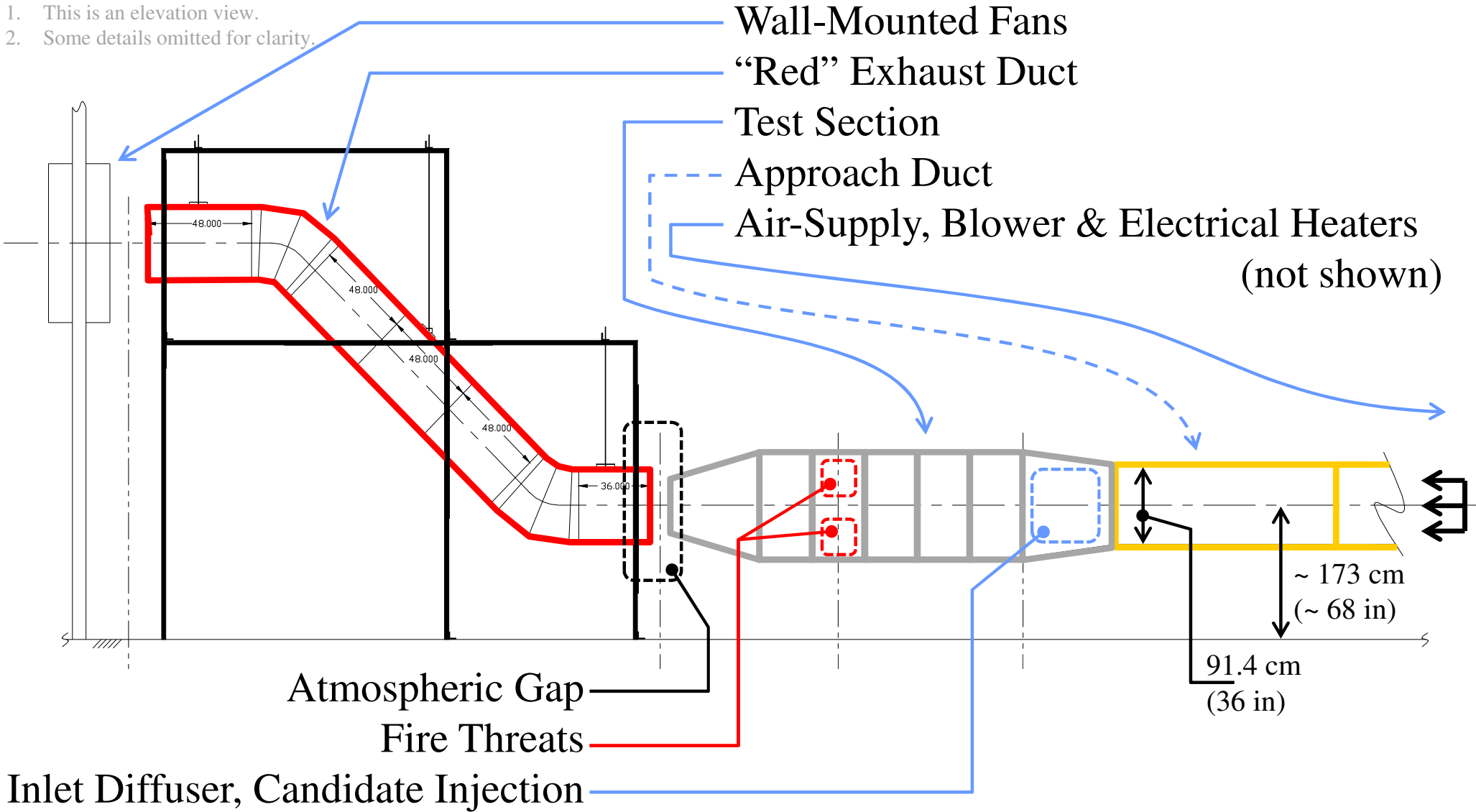
- **MPSHRe describes test article & abilities**
 - Concentric annular duct
 - Channels internal forced-flow through annulus
 - Contains 2 representative fire threats
 - Allows candidate injection into internal forced-flow
 - Monitored/recorded with visual/numerical telemetry



Brief Review / Test Article

NOTES :

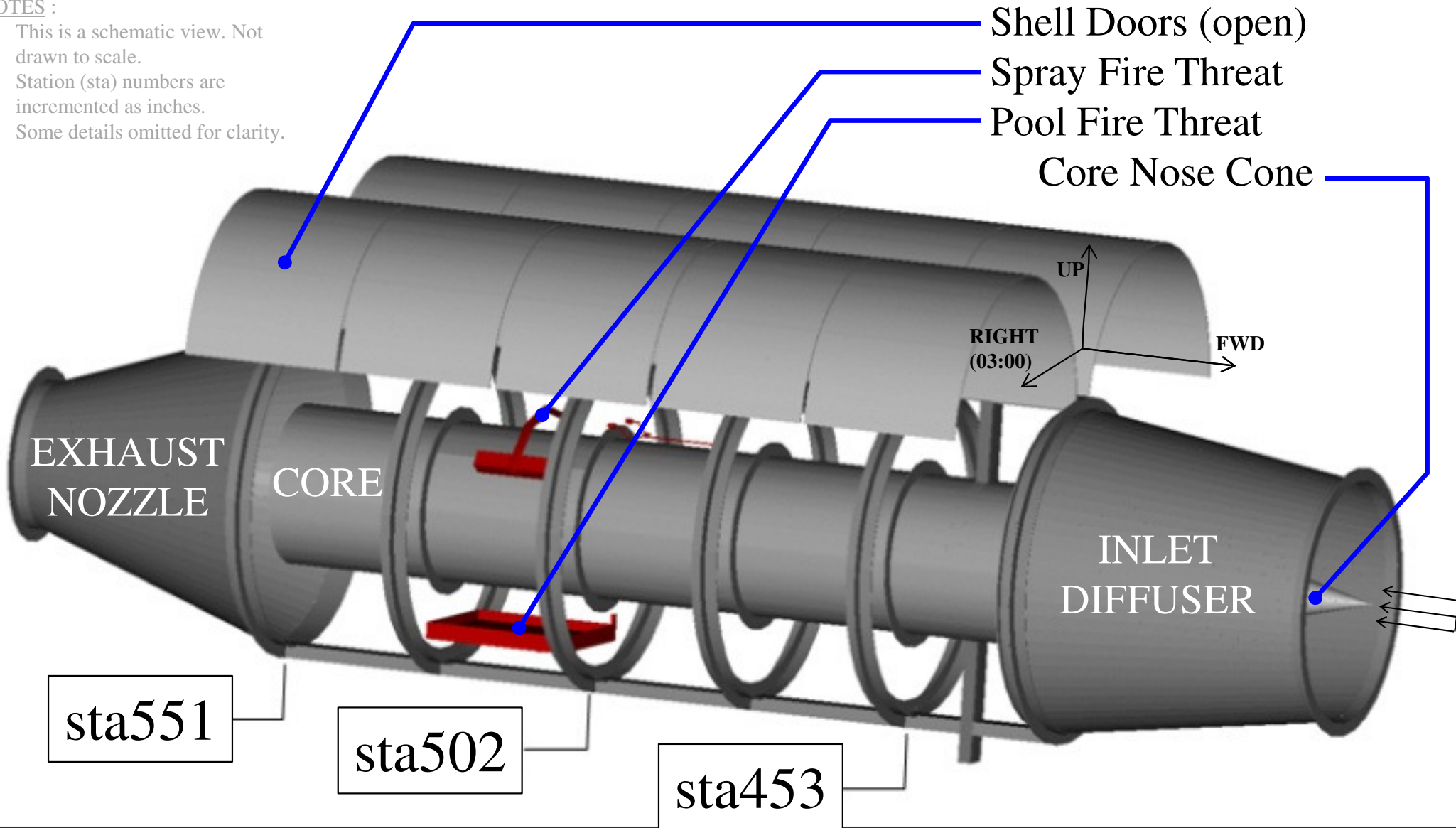
1. This is an elevation view.
2. Some details omitted for clarity.



Brief Review / Test Article

NOTES :

1. This is a schematic view. Not drawn to scale.
2. Station (sta) numbers are incremented as inches.
3. Some details omitted for clarity.



Some Dimensional Information.

Inlet Diffuser Exit Flange to Exhaust Nozzle Entrance Flange,
 3.1 m x 1.22 m outside diameter x 0.6096 m inside diameter, volume $\approx 2.74 \text{ m}^3$ (96.6 ft³)



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Project Review, Ownership

- **Owners**
 - FAA TC
- **Responsibilities**
 - FAA Fire Safety Branch: all candidate & NFS preparation/testing; procedural decision-making



Project Review, Reconsideration

- **Several aspects of halon 1301 & CO₂ offset**
 - Density : 1301 > CO₂
 - Vapor, 25°C, 1 atmosphere : 6.2 & 1.8 kg/m³
 - Liquid, 25°C & respective vapor pressures : 1538 & 710 kg/m³
 - Design concentration : 1301 < CO₂; 6 & 37%v/v
- **CO₂ is a recognized fire extinguishing agent**
 - Ground- & aircraft-based fire extinguishment systems
 - Available in the market place now



Project Review, Reconsideration

- **Literature & FAA design criteria for CO₂ differ**
 - Consider halon 1301 :
 - FAA AC 20-100 = 6% v/v halon 1301 for ½ sec
 - FAA-DS-70-3, inerting n-heptane in air ≈ 6% v/v halon 1301
 - Observations about CO₂
 - FAA AC 20-100 = 37% v/v CO₂ for ½ sec
 - BoM Bulletin 627, inerting n-heptane in air ≈ 28% v/v CO₂
- **Powerplant fire zone is not normally occupied**

Project Review, Reconsideration

- **Cautious reconsideration required**
 - Fire extinction by O₂-deprivation
 - CO₂ is toxic to & can/does asphyxiate O₂-based life
 - Cryogenic/electrostatic hazards result from discharge
 - Noteworthy P-T behavior for contained CO₂/N₂ mix
 - Roughly 2-3X larger than halon 1301/N₂ mix

Project Review, Status

- **Planning to :**
 - Create ability to work with CO₂ in the FAATC NFS
 - Bring test article & local gas analyzer on line
 - Create firex vessel, servicing/conditioning, & delivery capabilities
 - Put CO₂ through modified MPSHRe rev04 project
 - JP-8 will be the sole fuel used in all fire threats
 - Will measure CO₂ fire extinction & dispersion behaviors
 - Preference is to bracket MPSHRe thresholds
 - Assess if outcomes permit shift in FAA AC 20-100



Project Review, Status

- **Check test article for consistent environment**
 - Completed 2 of 4 threshold checks; 3 tests each
 - Current fire extinction durations 16-21% larger than thresholds
 - Thresholds require closer review; error in ops? a real shift?

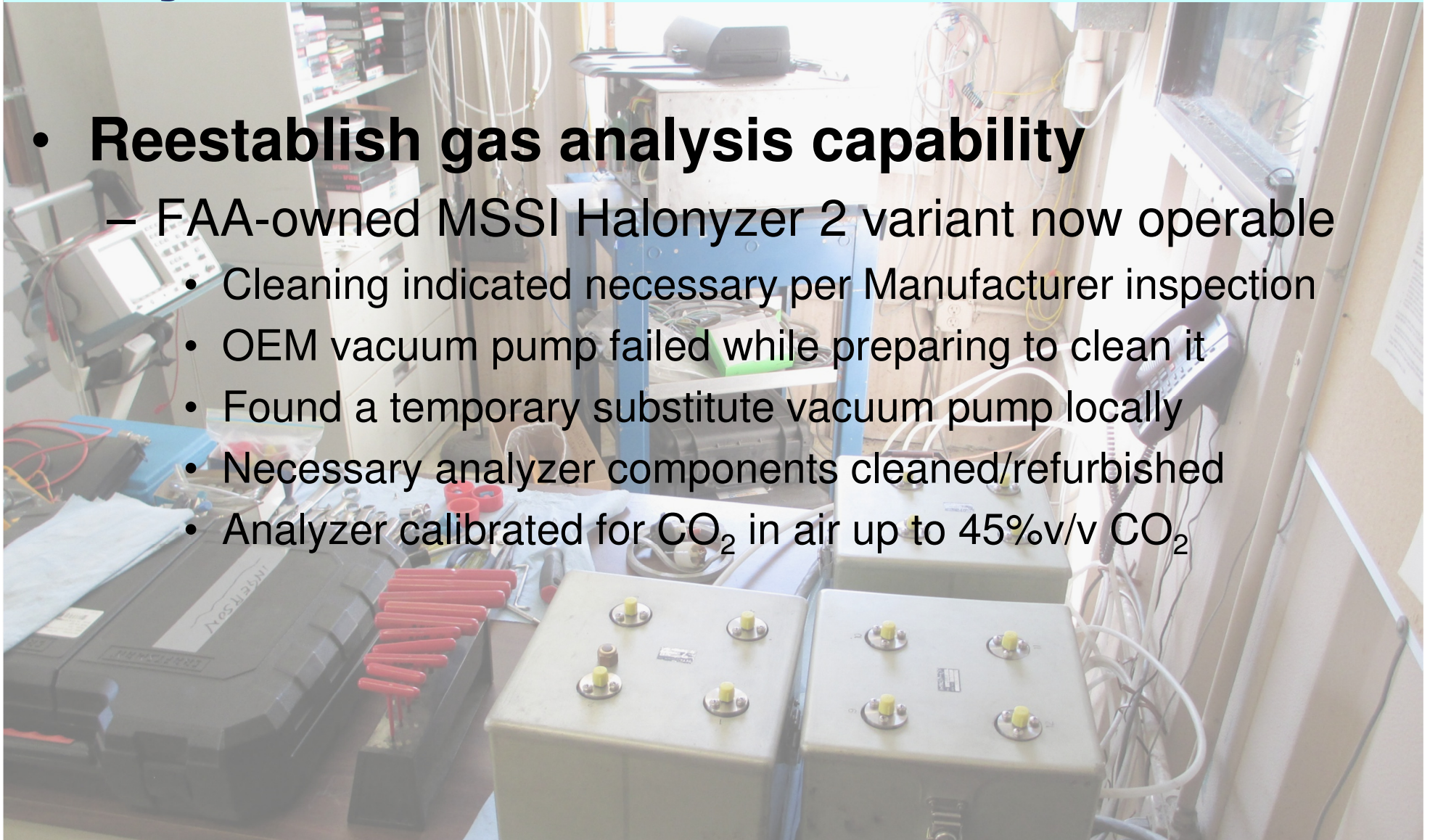
Test Condition	Recent Check Tests		MPSHRe Threshold	
	Average RTD (sec)	Standard Deviation (sec)	Average RTD (sec)	Standard Deviation (sec)
“High”-vent, pool fire	3.67	0.241	3.16	0.265
“High”-vent, spray fire	2.10	0.035	1.74	0.242

- Remaining thresholds will be checked when needed



Project Review, Status

- **Reestablish gas analysis capability**
 - FAA-owned MSSSI Halonyzer 2 variant now operable
 - Cleaning indicated necessary per Manufacturer inspection
 - OEM vacuum pump failed while preparing to clean it
 - Found a temporary substitute vacuum pump locally
 - Necessary analyzer components cleaned/refurbished
 - Analyzer calibrated for CO₂ in air up to 45%v/v CO₂



Project Review, Status

- **Create CO₂ firex capability for FAATC NFS**

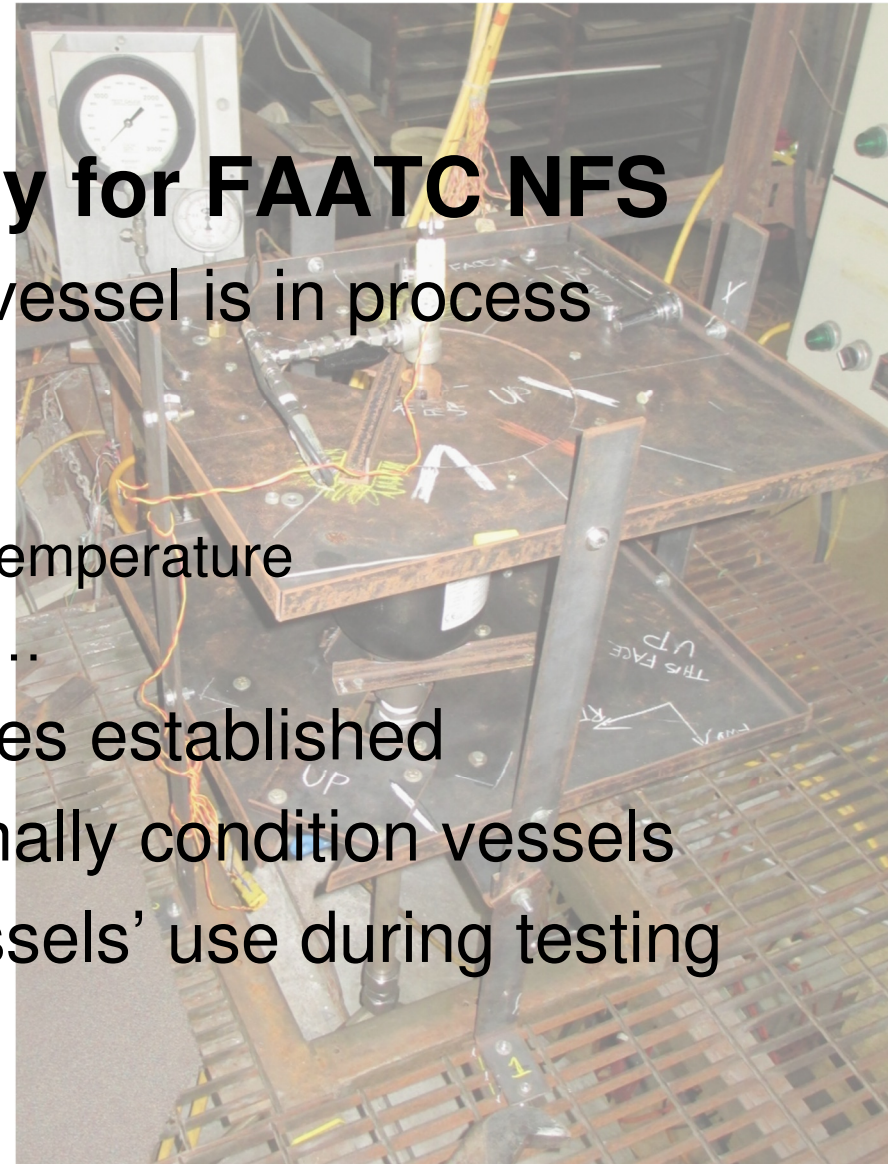
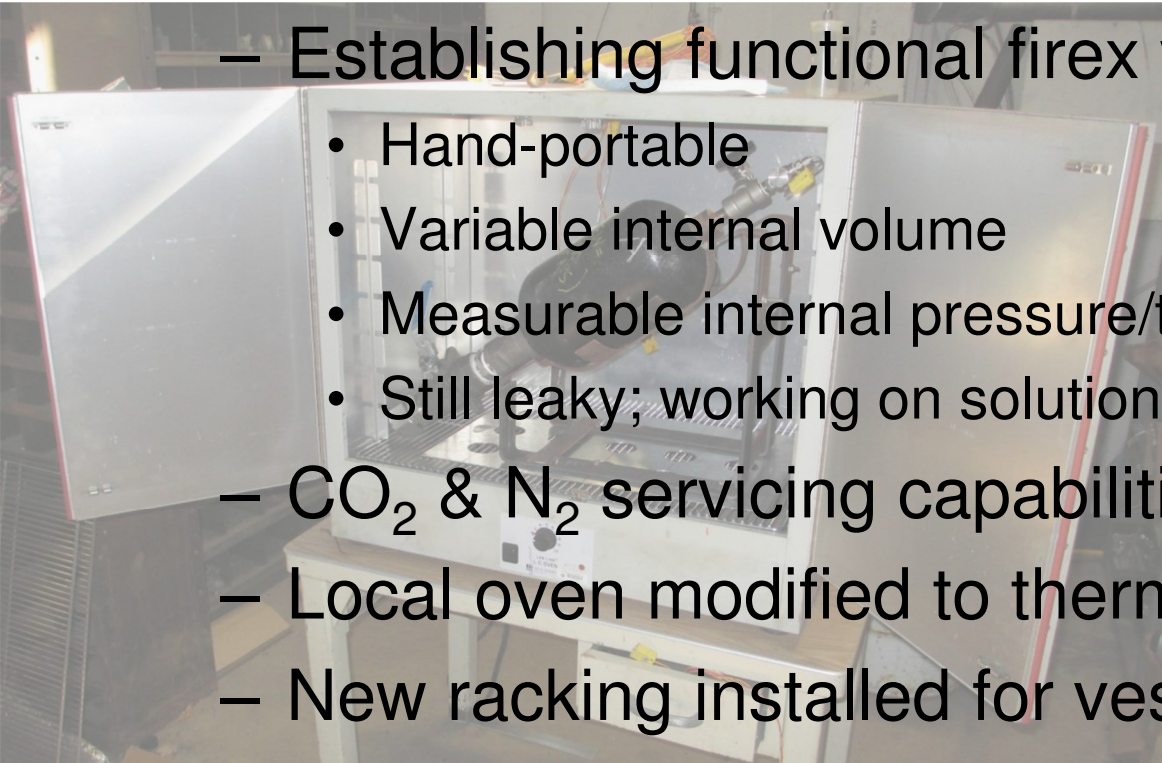
- Establishing functional firex vessel is in process

- Hand-portable
- Variable internal volume
- Measurable internal pressure/temperature
- Still leaky; working on solution...

- CO₂ & N₂ servicing capabilities established

- Local oven modified to thermally condition vessels

- New racking installed for vessels' use during testing



firex = fire extinguisher or extinguishing



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Recognizing those supporting...

FAA :

Ms. Louise Speitel, Mr. Rick Whedbee, Mr. Tom Carmen, Mr. Sean Crowley

Technology and Management International, LLC :

Mr. Mark Materio, Mr. Mike Donio



References...

References/Internet Links

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<http://www.osti.gov/scitech/servlets/purl/7328370>

- ❑ FAA Advisory Circular 20-100, "General Guidelines for Measuring Fire-Extinguishing Agent Concentrations in Powerplant Compartments", FAA, September 21, 1977.
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- ❑ FAA-DS-70-3, Chamberlain, G., 1970, "Criteria for Aircraft Installation and Utilization of an Extinguishing Agent Recorder," Report No. FAA-DS-70-3, U.S. Department of Transportation, Federal Aviation Administration, National Aviation Facilities Experimental Center, Atlantic City, NJ
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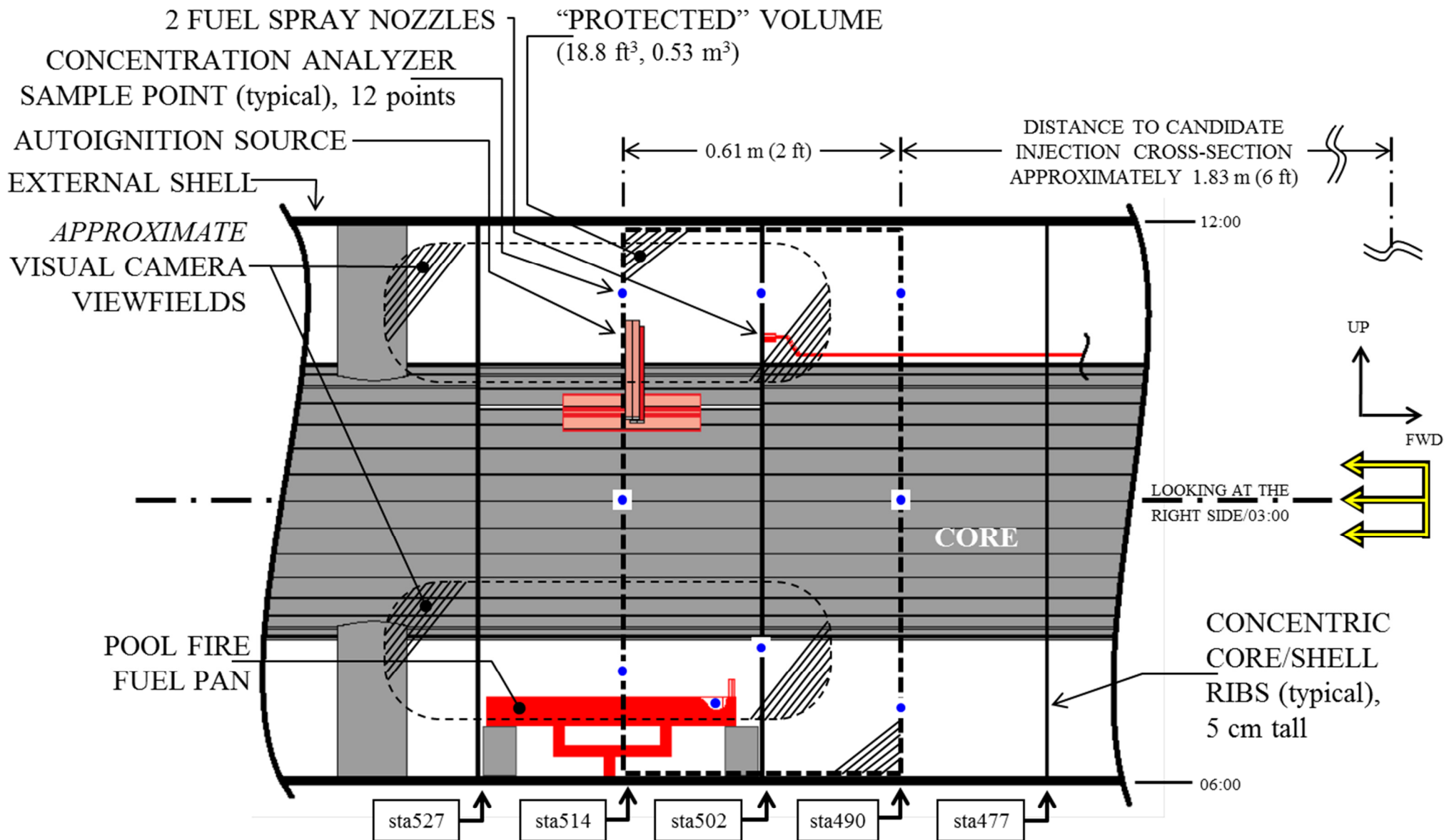
- ❑ MPShRe rev04
http://www.fire.tc.faa.gov/pdf/systems/MPSErev04_MPSeRev04doc-02submtd.pdf



Appendix Slide(s)



Protected Volume & View-field



NOTES : Station (sta) numbers are incremented as inches.
Some details omitted for clarity.
This is a schematic view. Not drawn to scale.



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