

# Engine Nacelle Halon Replacement



Federal Aviation  
Administration

Presented to: International Aircraft Systems Fire  
Protection Working Group

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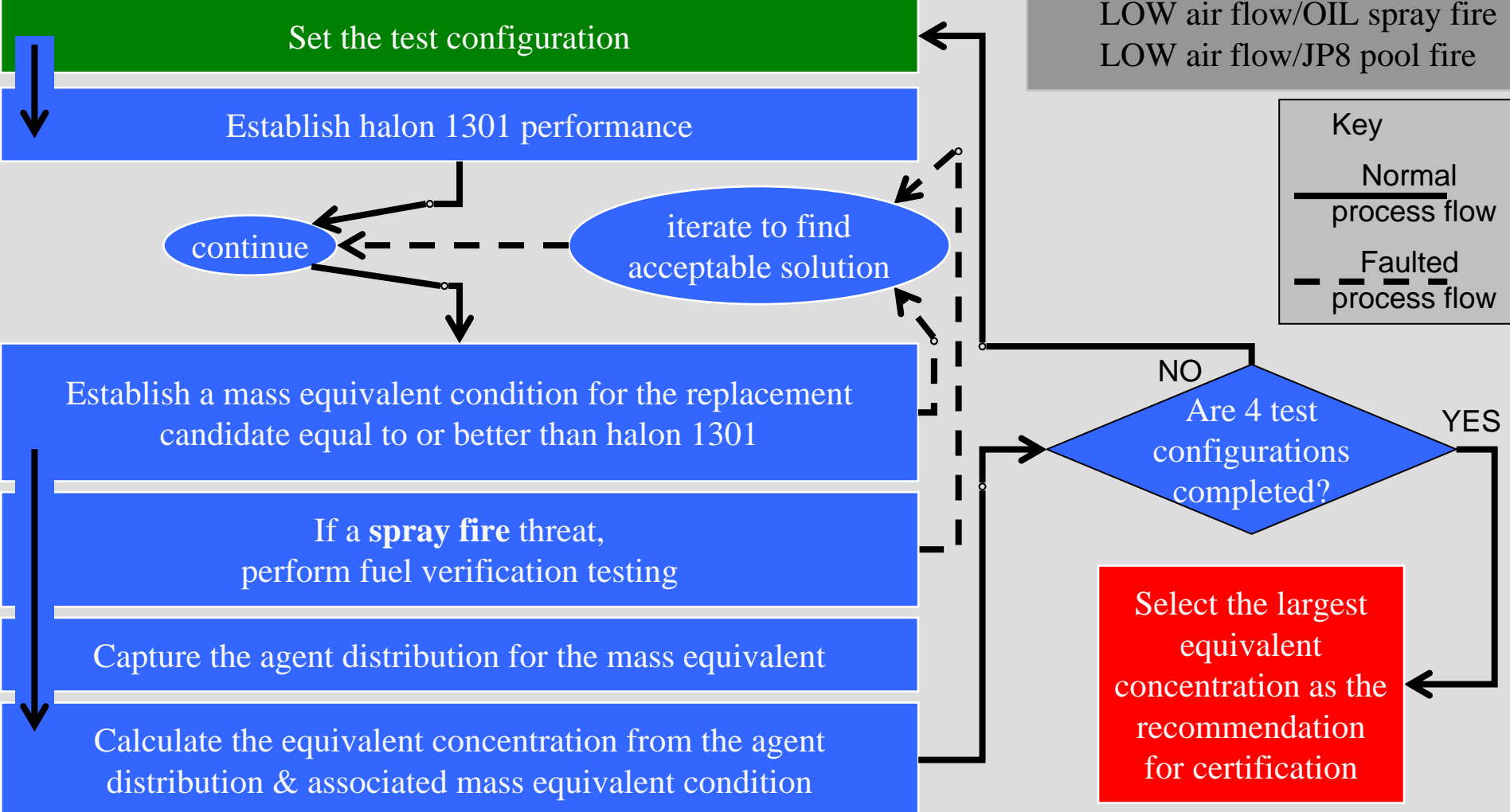
# Presentation Overview

- **Overview**
  - the Minimum Performance Standard for Aircraft Engine Nacelle & Auxiliary Power Unit Compartments, revision 03 (MPSe rev03)
  - Recent task group activity
  - Recent test activity
- **Discuss transitioning from MPSe rev03 to rev04**
- **Conclusion**

# Overview, MPSe rev03

Complete these test configurations :

- HIGH air flow/JP8 spray fire
- HIGH air flow/JP8 pool fire
- LOW air flow/OIL spray fire
- LOW air flow/JP8 pool fire



# Overview, Recent Task Group Activity

- **Task group met, 2Nov2007 & 18Nov2008**
- **Principle Outcomes, 2007**
  - Remove halon 1301 use from MPSe
  - Replace halon 1301 with a surrogate gas, HFC-125
  - Consider other means to quantify fire extinguishing agents
- **Principle Outcomes, 2008**
  - updated verbally (information not available at press time)

# Overview, Recent Test Activity

- **A Boeing/Kidde initiative was supported during 2006-2008 with sporadic FAATC testing**
- **Worked with a solid-aerosol, fire extinguishing agent**
- **Support stopped prior to completing MPSe rev03**



# Transitioning from rev03 to rev04

## Overview

- **Identify what will be retained from MPSe rev03**
- **Terminate halon 1301 usage**
  - Use a surrogate
  - Specifying the fire threats
- **Address agent injection dependence**
  - Background
  - Change from determining the agent quantity to proof-testing some agent quantity
  - Review how/where to quantify fire extinguishing agent

# Transitioning from rev03 to rev04 (continued)

- **What will be retained from MPSe rev03 ?**
  - Test fixture geometry
  - Ventilation constraints
  - Fire threat constraints
    - Spray & pool combustion behaviors
    - Hot surface & electrical ignition sources
    - Varied fuel types
    - Fuel flow rate and pool geometry
  - Fire extinguishing agent constraints
    - Storage temperature
    - Continued requirements to mitigate agent injection phenomena

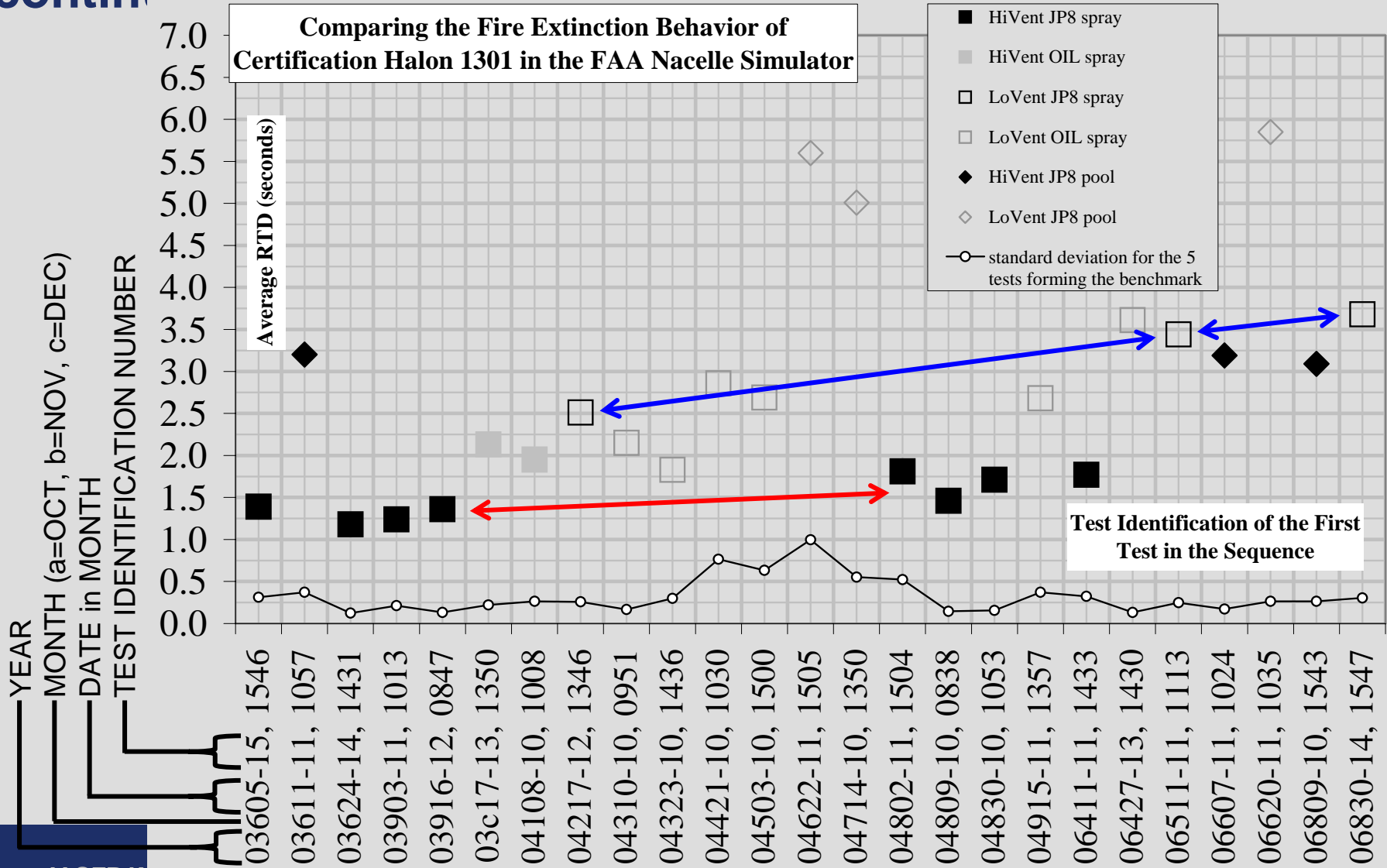
# Transitioning from rev03 to rev04 (continued)

- **Terminate halon 1301 usage**
  - Preliminary comments
    - Benchmarking with a halon 1301 surrogate is an interim solution
      - Eliminates halon 1301 usage
      - Permits observing the global drift in the test environment
    - HFCs will likely become regulated
      - No other surrogate can readily be utilized
        - » limited experience; HFC-125, CF3I, & FK-5-1-12
        - » none as gas-like as halon 1301, except HFC-125
      - Fire threat specification will occur



# Transitioning from rev03 to rev04

(continued)



MPSErev03\_OI\_benchmarks.xls, all H1301 benchmarks c



# Transitioning from rev03 to rev04 (continued)

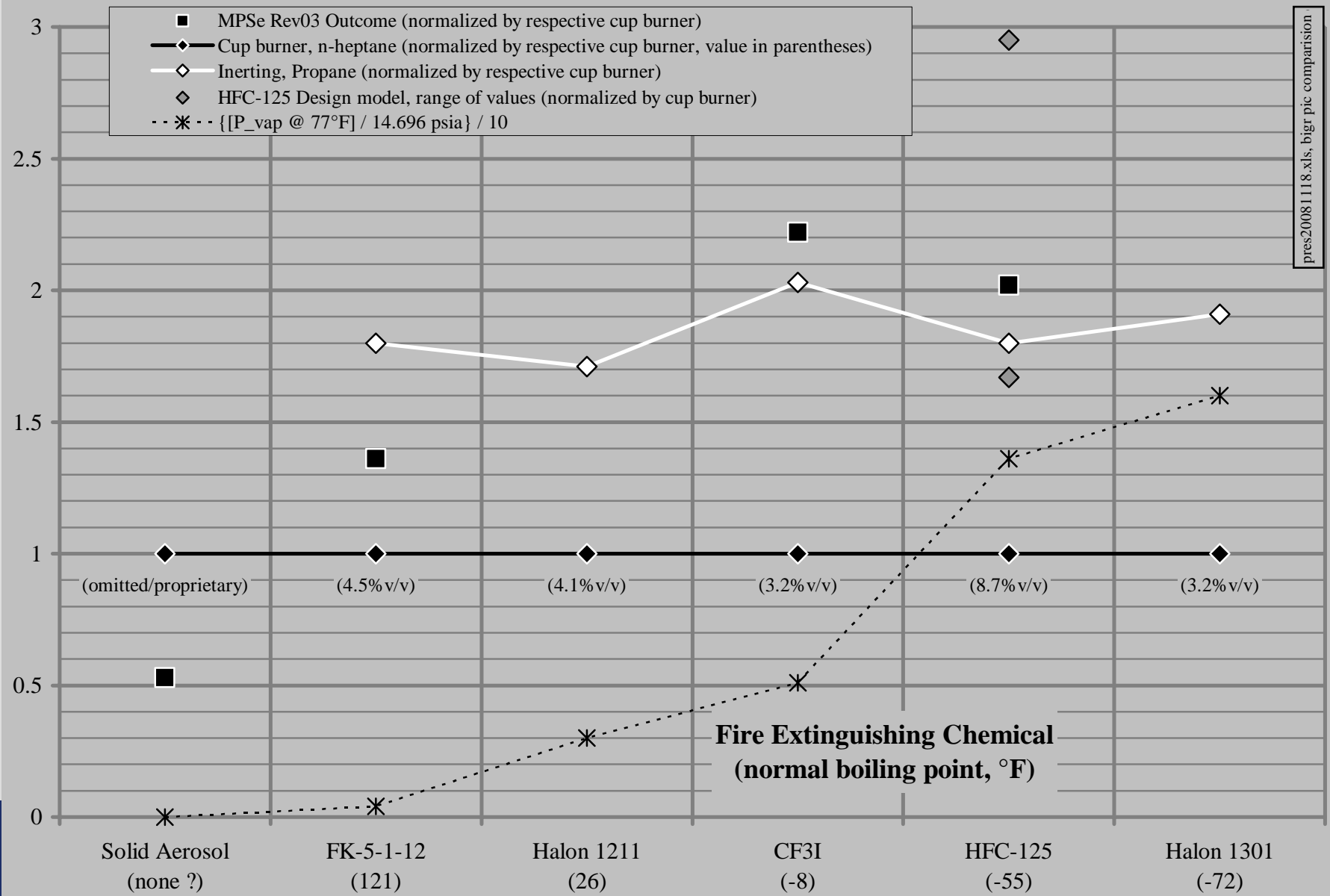
- **Terminate halon 1301 usage (continued)**
  - Halon 1301 surrogate pathway
    - Surrogate is HFC-125
    - Use surrogate as a benchmark for 1 of 4 test configurations
    - Compare remaining configurations to historical halon 1301 performance
  - Fire threat characterization pathway
    - Work in parallel
    - Will transition seamlessly from surrogate benchmark method
    - Describe salient details within test process

# Transitioning from rev03 to rev04 (continued)

- **Address agent injection dependence**
  - Background
    - The internal energy of the fire extinguishing agent is playing a role in MPSe outcome
    - The more recently evaluated chemicals have internal energies similar to the early halons, which are known to be more dependent upon their respective injection systems than is halon 1301
    - The role of this dependence must be minimized in the MPSe process

# Transitioning from rev03 to rev04

(continued)



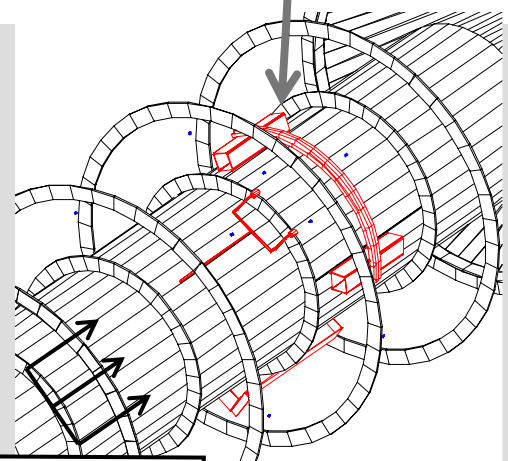
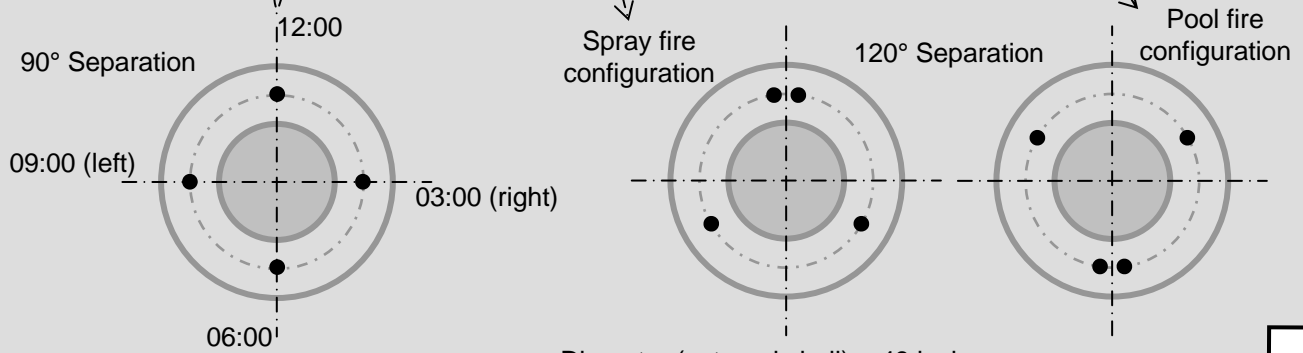
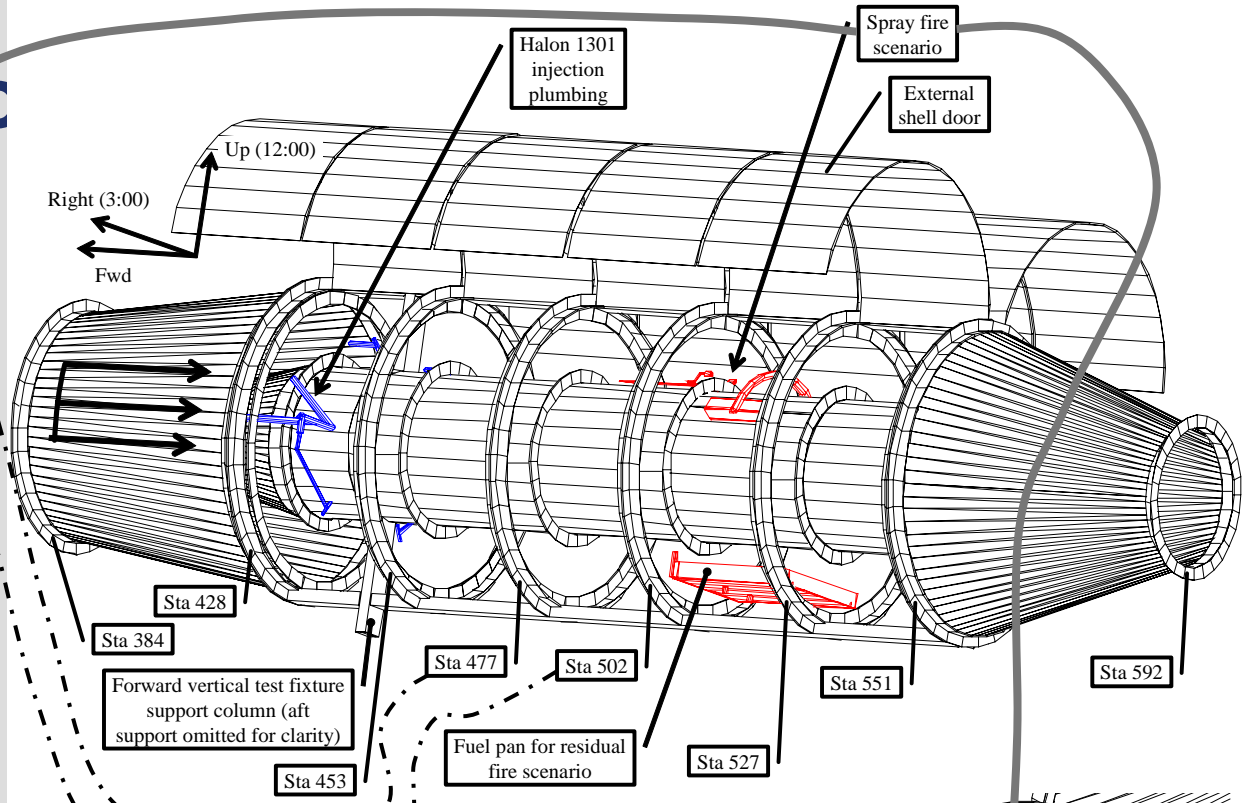
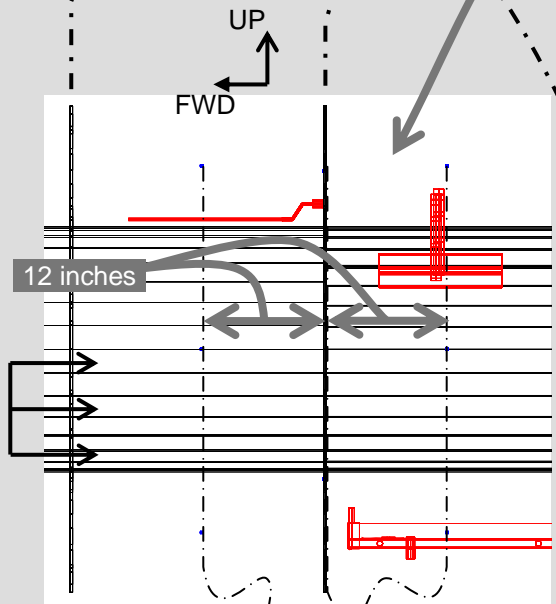
# Transitioning from rev03 to rev04 (continued)

- **Address agent injection dependence (continued)**
  - Change from determining the agent quantity to proof-testing some agent quantity
    - The MPSe will become a proof-test
    - Any entity moving forward some replacement candidate will identify the agent dosage (amount & residence time) prior to MPSe testing
    - The lowest quantity of agent considered for MPSe testing will be a 30% increase above experimental cup-burner values, as described in NFPA 2001
      - The bench-scale test procedure is based on liquid-fueled, diffusion flame combustion, thus similar to nacelle fires
      - Flow field & agent concentration gradients are minimized, thus minimizing agent injection phenomena

# Transitioning from rev03 to rev04 (continued)

- **Address agent injection dependence (continued)**
  - Review how/where to quantify fire extinguishing agent
    - Regarding ALL MPSe testing to date
      - Based on free-stream agent concentration measurements
      - Halon 1301 performance was defined on a 12-point sampling volume
      - Reported replacement outcomes are based on 2 points at the flame front
    - Indications point to measuring in recirculation zones, not free-stream
      - Recent literature indicates (NIST Special Pub 1069) :
        - » Values from a cup-burner assay are adequate predictors of agent quantity needed for flame extinction in aircraft engine nacelles
        - » These quantities must reside in the recirculation zones for some indeterminate duration
      - However, HFC-125 Design Model (AFRL-VA-WP-TR-1999-3068) outcomes conflict with NIST Special Pub 1069

# Transitioning from (continued)



Diameter (external shell) = 48 inches  
 Diameter (core) = 24 inches

Rib height, core = rib height, shell = 2 inches

Sample points placed mid-distance between shell & core surfaces

**AIRFLOW**

# MPSe rev04 (h1301 surrogate)

Establish the concentration profile (dosage) of the halon replacement candidate to be proof-tested for HIGH & LOW air flow conditions

Set the test configuration

If the test configuration requires establishing the singular surrogate performance, do so

continue

iterate to find acceptable solution

Demonstrate halon replacement dosage is equal to or better than (1) the surrogate or (2) historical halon 1301 performance

If a **spray fire** threat, perform fuel verification testing

Complete these test configurations :

HIGH air flow/JP8 spray fire  
HIGH air flow/JP8 pool fire  
LOW air flow/OIL spray fire  
LOW air flow/JP8 pool fire

Key

Normal process flow

Faulted process flow

NO

Are 4 test configurations completed?

YES

The agent dosage successfully completing the challenges is recommended for certification



# MPSe rev04 (no h1301 surrogate)

Establish the concentration profile (dosage) of the halon replacement candidate to be proof-tested for HIGH & LOW air flow conditions

Set the test configuration

continue

iterate to find acceptable solution

Demonstrate halon replacement dosage is equal to or better than the historical halon 1301 performance

If a **spray fire** threat, perform fuel verification testing

Complete these test configurations :

- HIGH air flow/JP8 spray fire
- HIGH air flow/JP8 pool fire
- LOW air flow/OIL spray fire
- LOW air flow/JP8 pool fire

Key

Normal process flow

Faulted process flow

NO

Are 4 test configurations completed?

YES

The agent dosage successfully completing the challenges is recommended for certification

# Conclusions

- **Agent distribution is interfering with MPSe rev03**
- **MPSe rev04 will :**
  - not require halon 1301 use
  - remain a salient, 4-condition, evaluation process
  - require known fire extinction performance for a replacement candidate prior to full-scale testing
  - be a proof-test
  - start as a surrogate benchmark concept, then transition to a non-surrogate, fire-specified challenge
- **Must review agent measurement to address agent injection dependence & relate historical work**

# End

