Engine Nacelle Halon Replacement

Federal Aviation Administration

Presented to:	International Aircraft Systems Fire Protection Working Group
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Presentation Overview

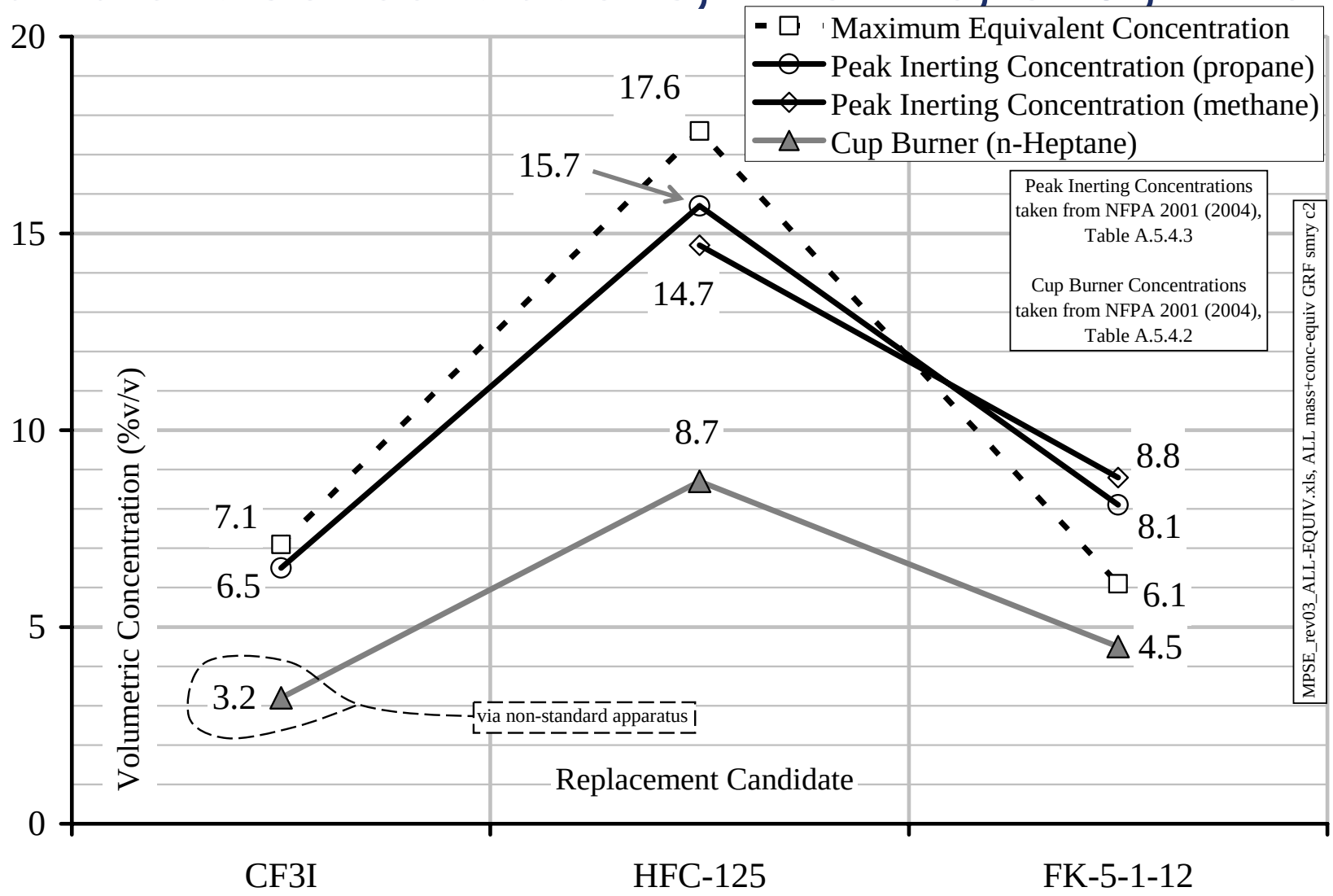
- **Review Equivalent Concentrations for HFC-125, CF3I, and FK-5-1-12**

- **Alterations/Embellishments to the Minimum Performance Standard for Engine Nacelles and APU Compartments (MPSe)**
  - Move away from a Halon 1301 Benchmark
  - Considerations for atypical fire extinguishing agents

Equivalent Concentrations, HFC-125, CF3I, FK-5-1-12

- **Based on work completed in the FAA Technical Center's nacelle fire simulator in accordance with the MPSe**
- **Calculated values exceed cup burner data and intermingle with inerting data**

Equivalent Concentrations, HFC-125, CF3I, FK-5-1-12



Alterations to the MPSe

Move the MPSe off a Halon 1301 Benchmark

- **Why ?**
  - Halon 1301 supplies diminishing
  - continued discharge to atmosphere SPECIFIED for testing purposes
  - need to move forward

- **How ?**
  - specify another fire extinguishing agent as the benchmark
  - specify the combustion threats
  - other ?

Alterations to the MPSe

Move the MPSe off a Halon 1301 Benchmark

- **Specify another fire extinguishing agent as the benchmark**
  - HFC-125
    - Pro's
      - compares physically to Halon 1301 better than common choices
      - established work with this agent already exists within aviation
      - widely used outside aviation as a halon replacement candidate
    - Con's
      - global warmer
      - increased mass required to equate to Halon 1301 performance
  - CF3I : no forecasted use by working group members; currently not considered a possibility for this issue

Alterations to the MPSe

Move the MPSe off a Halon 1301 Benchmark

- **Specify another fire extinguishing agent as the benchmark (continued)**
  - FK-5-1-12
    - Pro's
      - not a global warmer
      - wide use as a halon replacement being established outside aviation
    - Con's
      - physically dissimilar to Halon 1301
      - increased mass required to equate to Halon 1301 performance
      - lesser work established within aviation
  - other suggestion ?

Alterations to the MPSe

Move the MPSe off a Halon 1301 Benchmark

- **Specify the combustion threats**
  - During early developmental history of the MPSe, task group opted NOT to do this
    - complex test environment; i.e. aerodynamically dependent, flame holding, electrical arcs, hot surfaces, ignition behaviors, fuel/air diffusion behavior, etc.
    - observed/measured the fire extinction performance of Halon 1301 and forced a candidate to replicate the established performance
      - fire threat intensity affirmed by delivering “half-certification” Halon 1301 and verifying no fire extinction
      - negated specifying by heat flux, temperature profile, geometries, fuel flows, etc.

Alterations to the MPSe

Move the MPSe off a Halon 1301 Benchmark

- **Specify the combustion threats (continued)**
  - HOWEVER, this offers another path to remove the specification of Halon 1301 from the MPSe
    - need to specify :
      - fuel types, initial fuel temperature, flow rates, fuel spray patterns, etc.
      - energy release of the fire threat; i.e. heat flux, temperature
      - geometries of the fire threat; i.e. flame holders, hot surface(s)
      - ventilated pathway of the structure
    - some of this specification already exists in the MPSe
    - principle focus for additional thought/work/specification are the fire threats themselves

Alterations to the MPSe

Move the MPSe off a Halon 1301 Benchmark

- **Other possibilities to remove the Halon 1301 benchmark ?**

Alterations to the MPSe

Considerations for atypical replacement candidates

- **MPSe is written with sections reserved to allow for atypical replacement candidates**
- **These sections are currently unspecified**
- **Potential examples :**
  - agents delivered as liquid or solid aerosols; i.e. particles
  - active or inert gas generators; i.e. gases and particles
  - hybrids; clean agents sitting atop an inert gas generator

Alterations to the MPSe

Considerations for atypical replacement candidates

- **Current state of the art for civil aviation is clean, gaseous agents**
- **The entire certification process is dependent upon the current state of the art**
- **Atypical candidates will require alternate means of measurement to demonstrate acceptable behavior**

Alterations to the MPSe

Considerations for atypical replacement candidates

- **How should atypical agent quantification be handled in the MPSe ?**
  - Statham-derivative gas analyzers are written into the MPSe due to common availability and historical stature
  - no means to measure aerosols is recognized by the FAA
  - no means to measure products from inert gas generators is recognized by the FAA
    - two major decomposition products are $H_2O(g)$ and N_2
    - Statham-derivative analyzers :
      - can not measure N_2 concentration
      - have no history of measuring water vapor
        - » early reports indicate sensitivity to atmospheric humidity
        - » however, potentially insufficient sensitivity

Alterations to the MPSe

Considerations for atypical replacement candidates

- **How should atypical agent quantification be handled in the MPSe ? (continued)**
  - if an applicant pursues an atypical agent pathway :
    - they will be required, by default, to develop/prove their own measurement method and equipment
    - what is the impact on the MPSe as a result ?
      - incorporate new words in the reserved sections about the atypical agent and measurement procedure; in essence, specify agent and applicant in the MPSe
      - remove details from the MPSe regarding the Statham-derivative analyzers and their applicability to clean agents
        - » by doing so, negates the need to specify atypical agent details
        - » could place ambiguous wording to ensure an adequate measurement process is followed

Alterations to the MPSe

Considerations for atypical replacement candidates

- **Impact on the assessment of the reignition time delay (RTD)**
  - RTD = time (fire reignition) – time (fire extinction)
    - agent pulse moves through ventilated test fixture
    - persistent fuel and ignition sources force reignition after agent pulse degrades sufficiently
  - due to the use of clean agents, the RTD is a reasonably visiual determination from video tape; is specified so in the MPSe
  - atypical agents may obscure visibility
    - change the specification in the MPSe to permit alternate means ?
    - should the specification change be “tight”/exact or ambiguous ?

Alterations to the MPSe

Considerations for atypical replacement candidates

- **Impact on the assessment of the reignition time delay (RTD) (continued)**
  - historical work indicates the use of a fine-bead thermocouple is inexact as compared to visual indication
    - thermal response too slow
    - thermocouple bead location is very important
  - alternate considerations
    - track energy output from the obscured volume surrounding the flame
      - obscured cloud temperature should change obviously based on the lack or presence of energy (flames) internal to the cloud
      - absorption/reflection/transmission characteristics of the cloud are likely unknowns
    - use a Gardon gage style heat flux transducer
    - other ?

Concluding Summary

- **Equivalent concentrations**
  - HFC-125 = 17.6%v/v
  - CF3I = 7.1%v/v
  - FK-5-1-12 = 6.1%v/v
- **Engine task group members please consider impacts to the MPSe due to :**
  - replacing the Halon 1301 benchmark with another reference
  - atypical Halon 1301 replacement agents :
    - whether or not to specify individual analytical measurement methods
    - how to asses the RTD by non-visual means
  - comments to be solicited in the “near” future