V-22 AIRCRAFT PROTECTION SUCCESS STORY

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The V-22 midwing area is the section of the aircraft over the cabin that houses the midwing gearbox, auxiliary power unit (APU), oil cooler, oil and hydraulic pumps, and other equipment. Prior to the implementation of the midwing inert gas generator fire extinguishing system aboard V-22 EMD aircraft, only the hot section of the APU was seen as a "fire zone." Consequently, that small volume was shrouded and protected by a very small halon bottle aboard V-22 FSD aircraft. Only after a much more detailed analysis was conducted on the overall midwing volume to assess potential hot surfaces, fuel sources, ignition sources, and airflow predictions was the decision made to protect the entire midwing volume (rather than just the minuscule APU volume) from fire.

An aggressive design, development, and test program ensued to qualify a non-halon fire protection system for the large, high airflow midwing. The inert gas generator fire extinguishing system selected is derived from the airbag technology of the automobile industry. In the V-22 application, optical fire detectors automatically sense an ignition anywhere in the high-clutter midwing and signal the system controller. An extensive arrangement of gas generators positioned throughout the midwing is then activated according to predetermined sequences (based on which detector saw the fire first). Inside each gas generator, self-contained solid propellant materials bum, liberating large volumes of carbon dioxide, nitrogen, and water vapor. These gases act to extinguish any fires present and preclude reignition by maintaining an inert atmosphere within the midwing.

On Sunday, November 30,1997, V-22 EMD aircraft No. 10 experienced an on-board fire in the midwing area, which was then successfully extinguished by the midwing gas generator fire extinguishing system. This activation of the V-22 midwing fire protection system is the first time a halon-replacement system has been employed on an actual in-service fire aboard naval aircraft. This paper will describe the performance of the system during this real-life event.

V-22 FIRE PROTECTION
Background

- Initial Configuration
  - APU protection only
  - Wing ballistic protection
- Concerns
  - Communication among volumes
  - Uncontrolled fuel & air sources
  - No fire containment provisions

V-22 FIRE PROTECTION
Background

- Revised Configuration
  - Single protected volume
  - Cohesive system design
    - One **system protects all**
  - Dual modality protection
    - **Ballistic and safety fire events**

V-22 FIRE PROTECTION
System Description

- Optical Detectors
  - **2** millisecond response
- Inert Gas Generators
  - 150 millisecond unit discharge
  - 1.1 second system discharge
- System Control Unit
  - Prescribed discharge sequences
  - System BIT
- Cockpit Discharge Indications

V-22 FIRE PROTECTION System Testing

- Test Objectives
  - Optimize system sizing
    - Baselined to prior ballistic tests
  - Optimize detector placement
  - Assess generator sequencing
  - Prove system effectiveness
    - Fire extinguished (w/ no reignition)
    - No bay overpressures
  - Evaluate agent dispersion

V-22 FIRE PROTECTION System Testing

- Test Results
  - Tailored generator loading
    - 189 - 420 grams
  - 16 optical detectors
  - 17 inert gas generators
  - Confirmed controller sequencing
    - "Corral" fire theory debunked
  - Quantified a sustained inert atmosphere

V-22 FIRE PROTECTION Incident Details

- Midwing Fire
  - 30 Nov. 97 at contractor facility
  - During ground operations
  - **RPU** failure
    - Hydraulic line rupture
    - Hot surface ignition
  - 3D fuel fed fire

V-22 FIRE PROTECTION
System Performance

- FIRE OUT!!
- **System worked as advertised**
  - **Detectors detected**
  - **Extinguishers extinguished**
- **Minimal local fire damage**
- **$40M Naval asset "saved"**

V-22 FIRE PROTECTION
Outstanding Issues

- **Detector Excitation**
  - **Several signals lingered**
  - No **impact on system performance**
- **Impingement Issues**
  - **Local to gas generators**
  - **Bum-through** of **protective tape**
  - **Added tape**

V-22 FIRE PROTECTION
Conclusion

- **Gas Generator Technology Proven**
  - **Acceptable halon alternative methodology**
  - **Viable** for **many applications**
    - **Offers speed for ballistic threat**
    - **Proven performance on "classic" safety fires**
  - **Extensive growth potential**
    - V-22 **"optimized to its schedule**
      - 2 years concept to installation
    - **Propellant enhancement opportunities**
      - **Higher efficiencies**
      - **Chemically active**