PhostrEx™

FIRE SUPPRESSION SYSTEM
FOR THE NEXT GENERATION

PhostrEx™

FAA Certified Halon Replacement for the Eclipse 500 VLJ

David Snowdon

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Eclipse Aviation Corporation

Certification of PhostrEx for the Eclipse 500 Very Light Jet

PhostrEx™
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- **PhostrEx™ agent has no Ozone Depletion Potential (ODP) nor Global Warming Potential (GWP) and so is the first FAA certified, commercially-viable agent to meet the requirements of the Montreal Protocol and Clean Air Act**
- **Technology and applications discussed here are protected by pending and issued patents**

Key Features of PhostrEx

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- **Safer than current Halon systems - no high energy bottles; no filling required in the field**
- **Chemistry is much more effective than Halon**
- **Environmentally friendly – non-ozone-depleting agent**
- **No global warming potential - it will never require regulation under the Kyoto or other greenhouse gas limiting protocols**
- **Easy to ship, handle, and discard when necessary**
- **Drastically reduced maintenance requirements**

Key Features of PhostrEx

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- Order of magnitude life cycle cost savings
  - Initial installation
  - Maintenance schedule, complexity, cost
  - Reduced dead-weight and fuel savings over alternatives
- Order of magnitude reduction in fire suppression system weight
  - Engineering constraints reduced on new platforms
  - Expanded retrofit options
- Low toxicological risk to humans by design
- Certified by the FAA for the Eclipse 500 aircraft
- Methods, devices, and materials are intrinsically scalable to new fire challenges

The Eclipse 500

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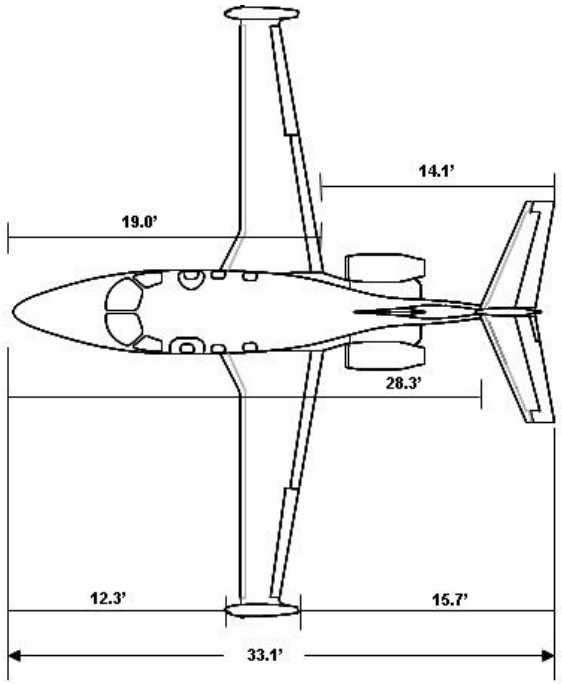
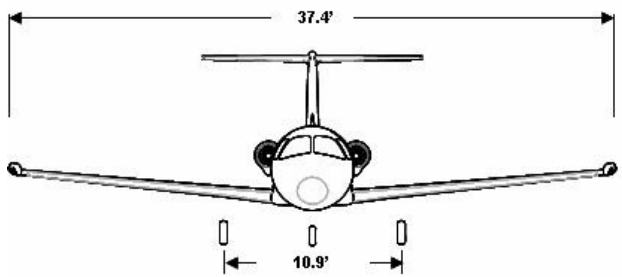
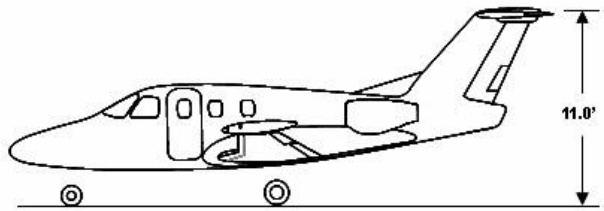
- T-tail monoplane, twin turbofan
- Length – 33 ft
- Wingspan 37 ft
- Standing height 11 ft
- Engines – Pratt & Whitney Canada PW610F-A







Powerplant Installation

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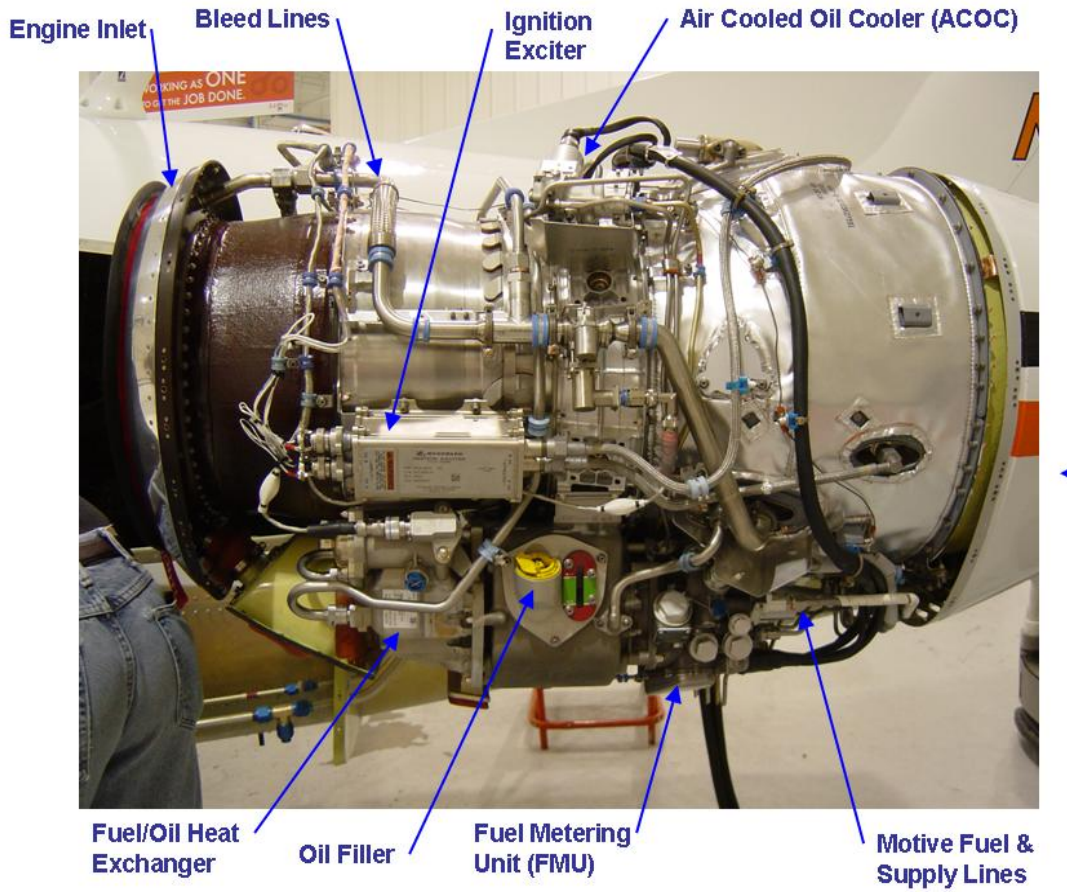

Certification Basis

PhostrEx™
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- 14 CFR Part 23 – Amendment 55
- Special Condition 23-128-SC
  - 23.1195 – Fire Extinguishing Systems
  - 23.1197 – Fire Extinguishing Agents
  - 23.1199 – Extinguishing Agent Containers
  - 23.1201 – Fire Extinguishing Systems Materials

The Eclipse 500 must have a powerplant fire extinguishing system

Fire Extinguisher Installation

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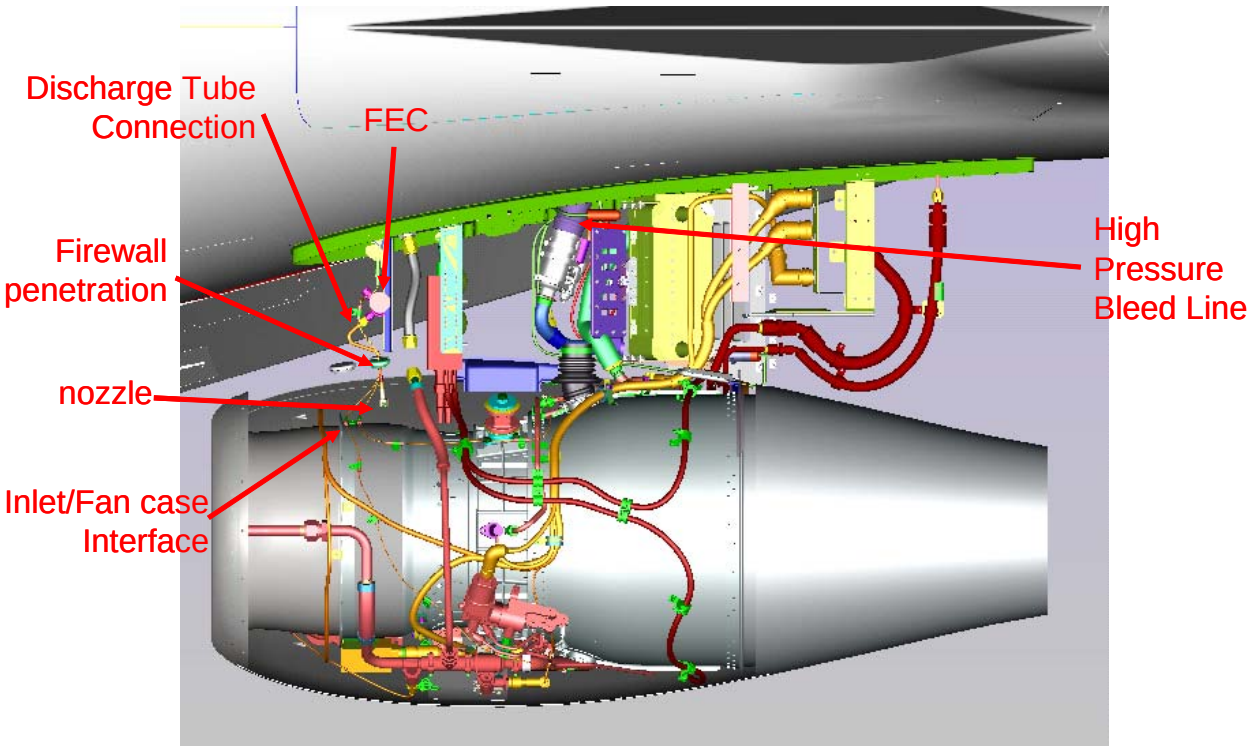

Compliance Summary

PhostrEx™
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- **Fire Extinguishing Performance**
  - **No established concentration factors for PhostrEx™**
    - Halon 6% for 0.5 second
    - No known requirement for PhostrEx™. Certified “by test”
    - Development of a concentration measurement device (CMD) is underway for future use by any aircraft installation.

Eclipse elected to carry out a full scale rig test to demonstrate fire extinguishing capabilities

Fire Extinguishing Rig Test

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- **Methodology and Logistics**
  - **Analysis to establish airflow in the nacelle**
  - **Build a fire test rig**
  - **Replicate the powerplant installation**
  - **Provide airflow (measured inlet airflow)**
  - **Cover all flight regimes (speed, altitude, attitude)**
  - **Cover all likely fire initiation points**
  - **Cover high and low temperature for fire extinguisher bottle**
  - **Cover minimum pressure bottle**
  - **Verify nacelle airflow values with flight test**

Fire Extinguishing Rig Test

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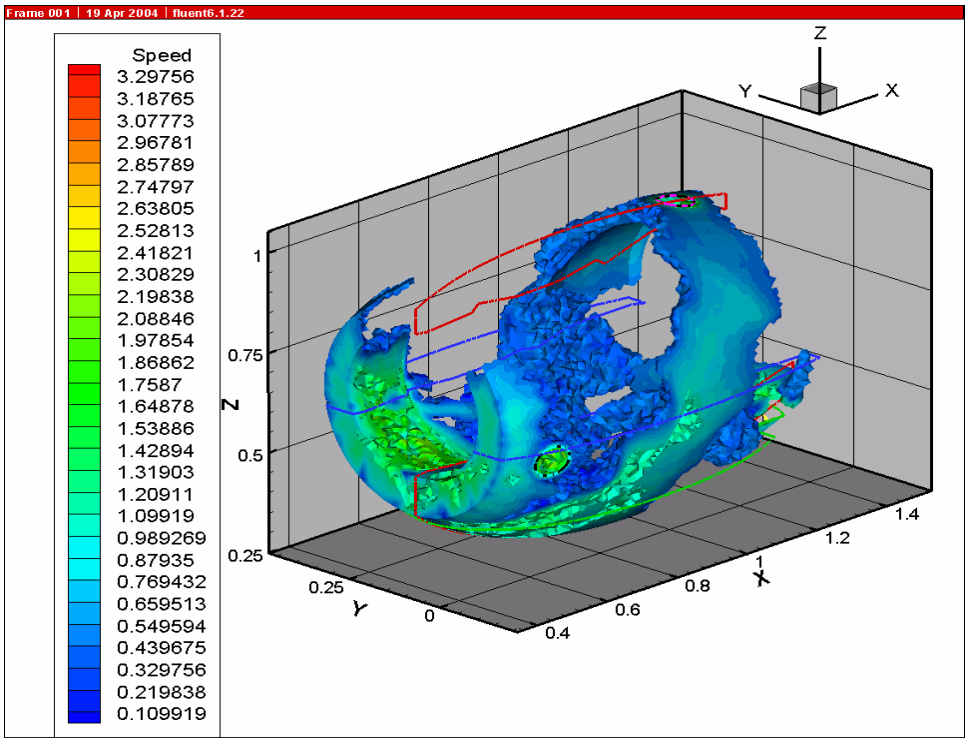
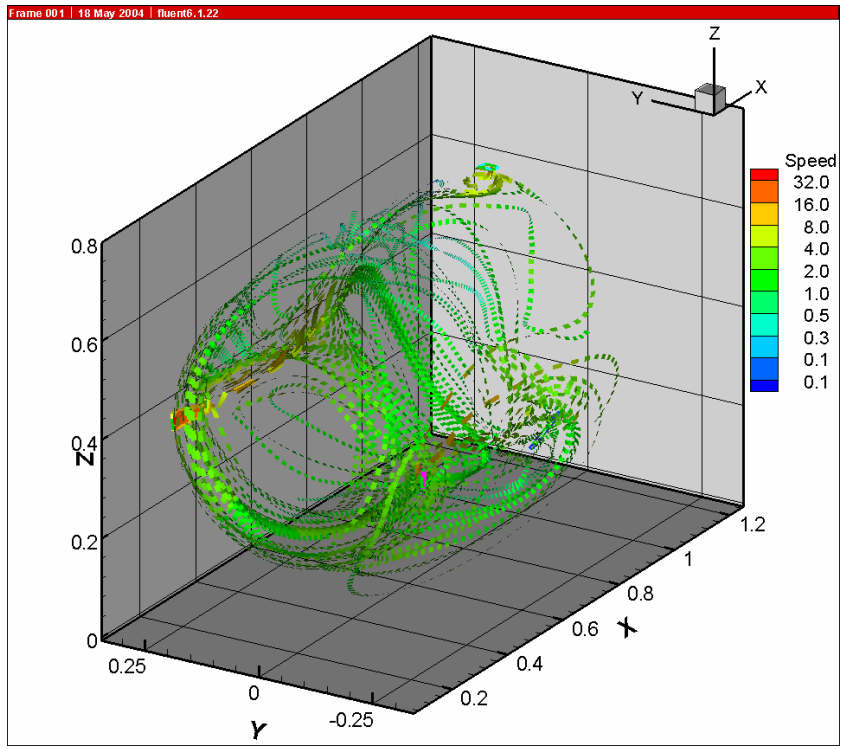
- **CFD Analysis**





Fire Extinguishing Rig Test

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- **The Test Rig**

Fire Extinguishing Rig Test

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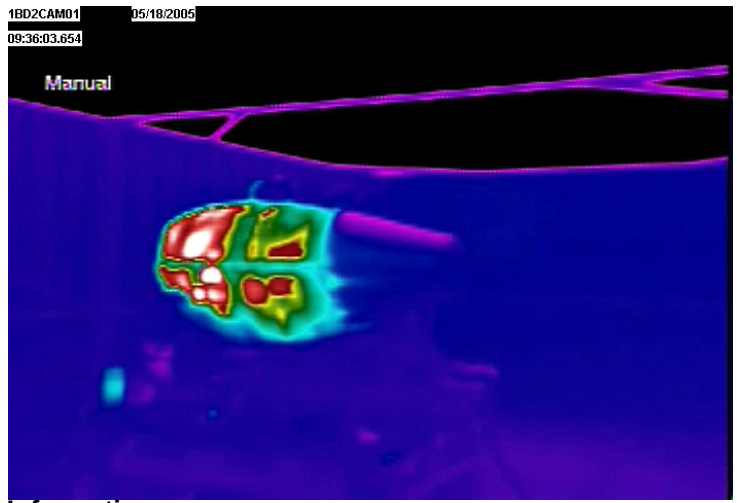
- We used Forward Looking Infra-Red (FLIR) technology to overcome the lack of windows in the conformed installation

- Allows for both qualitative and quantitative analysis of a fire's behavior and the associated extinguishment via PhostrEx™



Fire Extinguishing Rig Test

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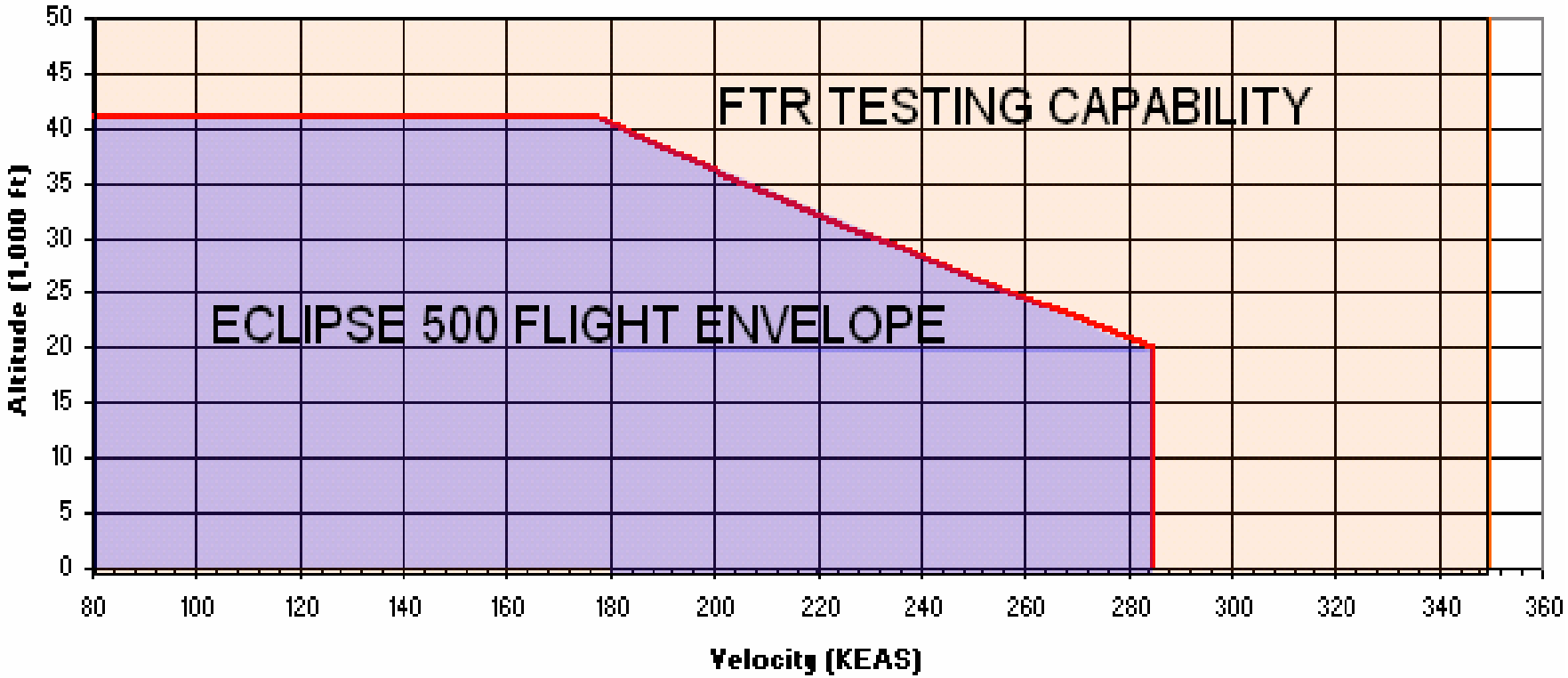
- **Test Rig Capability**



Fire Extinguishing Rig Test

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- **Test Methodology**
  - **Select condition to be tested**
    - Fire initiation point
    - Flight condition
    - FEC status (temperature/pressure)
  - **Energize glow plugs at ignition location and other areas**
  - **Establish airflow in nacelle**
  - **Introduce fuel at ignition location**
  - **Establish fire – allow temperatures to stabilize**
  - **Monitor temperatures**
  - **Initiate PhostrEx™ release**
  - **Leave glow plugs on to simulate hot surfaces**
  - **Leave fuel on for worst case conditions**
  - **Observe temperature fall**

Fire Extinguishing Rig Test Results

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- **Development Tests**
  - **200 + fires successfully tested**
    - Complete flight envelope covered – take off/climb/cruise/approach/landing
    - All fire initiation points covered
    - Extreme high and low temperature for bottle covered
    - Minimum pressure bottle tested
  - **All fires successfully extinguished**
  - **Most significant problem during testing – getting fire started**
    - Lack of oxygen is critical factor
  - **Nacelle changed several times due to repeat exposure to fire**

Based on results of development testing, four conditions chosen for certification test

Fire Extinguishing Rig Test Results

PhostrEx™
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- **Certification Tests**
  - **Four conditions successfully demonstrated in July 2005 – FAA in attendance**
  - **Ultimate critical condition M_{mo} (max airflow in nacelle) with low pressure, cold FEC**
    - First certification test failed to extinguish
    - Partial rupture of containment disk observed
    - Initial pressure increased to ensure complete disk rupture
    - Repeat test successful
  - **As a result of testing, nominal FEC pressures increased to ensure correct function under minimum pressure, cold ambient conditions**

Conclusion

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- Complete program of design, analysis and test carried out
- Material compatibility demonstrated
- Toxicity requirements demonstrated
- Full scale fire tests carried out
- Flight tests carried out to verify nacelle airflow

The certification program has resulted in The PhostrEx™ fire suppression system as a fully qualified fire extinguishing system on the Eclipse 500 aircraft

Fire Extinguishing Canister (FEC)

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Questions?

For More information:

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Phone toll free: (866) 898-1097