

# ***FIRE DETECTION AND SUPPRESSION SYSTEM TEXAQS 2006***

***For Aircraft Instrument Wing Pods***

***By  
Jorge E. Delgado  
Electronics Engineer  
Science and Engineering Division  
NOAA / Aircraft Operations Center***

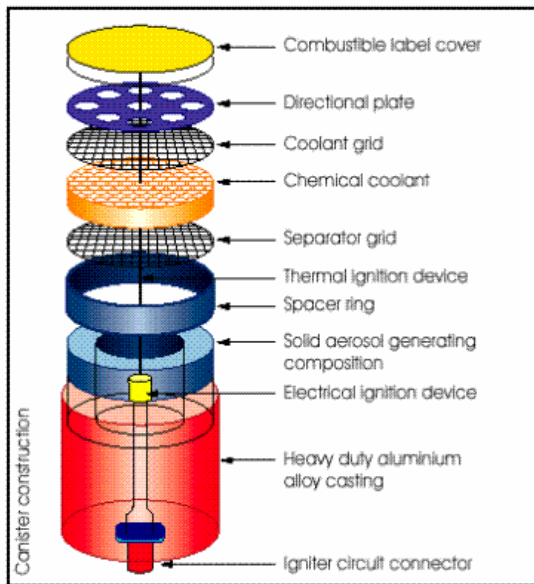




## Pyrogen Overview

Pyrogen aerosol extinguishes the fire chemically by reacting with the flame chain carriers and thereby interfering with the process of combustion. As **Pyrogen** does not rely on halogen compounds to react with the flame, it **does not produce corrosive halogen-acid by-products when in contact with flame**. In order to minimize damage due to the fire, however, the system should be designed to attain its design concentration within the shortest time possible upon actuation of the aerosol generators. An important factor to achieving a rapid and even distribution of the extinguishing depends upon the placement/distribution of the Pyrogen generators within the protected enclosure.

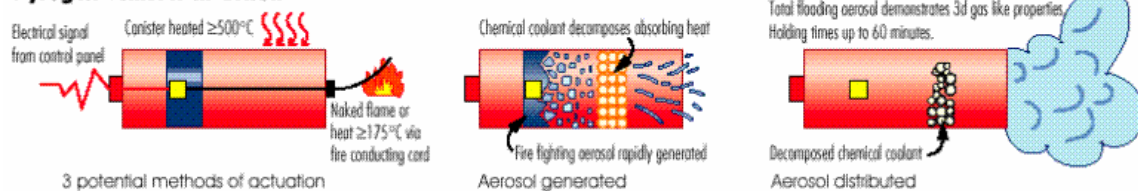
*Total Flooding Applications should be used where the hazard is within an enclosure that will permit the establishment of the required concentration of the Pyrogen aerosol and the maintenance of that concentration for the required period, of 3 minutes as a minimum.*



The principle of extinguishing action employed by Pyrogen is unique - a special solid chemical, when electrically or thermally ignited, produces combustion products - micron size dry chemical particles and gases. Dry chemical particles, (mainly potassium carbonates), and gaseous mixture, (mainly carbon dioxide, nitrogen and water vapour), mix together into a uniform fire extinguishing aerosol. Before being released into a protected area, the hot aerosol propels itself through a unique solid chemical coolant, which decomposes absorbing huge amounts of heat, thus ensuring flameless discharge and uniform distribution of the cool aerosol within the area.

The high rate of aerosol discharge ensures a tremendous knock-down effect. Micron size aerosol particles exhibit gas-like three-dimensional qualities that allow the agent to rapidly distribute throughout enclosure and reach even the most concealed and shielded locations. Homogeneous distribution is achieved in a matter of seconds, while long holding times all help to prevent fire re-ignition.

### Pyrogen canister in action



## **System Design**

### **Design Factor**

Pyrogen design calculations refer not to the design concentration of the actual extinguishing agent - aerosol, but to the design factor, which is the mass of solid aerosol-generating element per unit of enclosure volume required to extinguish a specific type of fire, including a safety factor.

Pyrogen design factor is expressed in  $\text{g/m}^3$ .

Pyrogen minimum design factor for Class B fires, involving flammable liquids such as petrol, diesel, hydraulic oil and automotive distillate is  $100 \text{ g/m}^3$ .

Pyrogen minimum design factor for Class A surface fires, involving non-smouldering combustible solids such as wood, textile and ordinary plastics is  $100 \text{ g/m}^3$ .

### **Enclosure Volume**

Assuming that each pod volume consists of a cylinder of maximum length measured from the front end to the back end and using the largest diameter of each instrument pod, then:

#### **CO Pod**

Length (L) = 130 in

Diameter (D) = 18 in

Volume (V) =  $3.14 * L * (D/2)^2$

V =  $33080.97 \text{ in}^3$

V =  $0.54 \text{ m}^3$

#### **ALQ-170 Pod**

Length (L) = 200 in

Diameter (D) = 28 in

V =  $123150.4 \text{ in}^3$

V =  $2.00 \text{ m}^3$

#### **AMPS Pod**

Length (L) = 200 in

Diameter (D) = 42 in

V =  $277088.5 \text{ in}^3$

V =  $4.54 \text{ m}^3$

Considering the cone shaped at the ends at each pod and the space used by instruments, the actual enclosure volume is approximately 2/3 of the total volume of each cylinder. Therefore:

- CO Pod Volume = 0.36 m<sup>3</sup>
- ALQ-170 Pod Volume = 1.30 m<sup>3</sup>
- AMPS Pod Volume = 3.00 m<sup>3</sup>

**Number of MAG generators**

Pyrogen comes in a form of small non-pressurized canisters with one or two end-plate delivery nozzles. The canisters are called MAG generators and vary in size depending on the mass of solid aerosol-generating element contained in the generator. Technical parameters of some of the current range of MAG generators based on Design Factor of 100g/m<sup>3</sup> are as follows:

Parameter	MAG	1	2	3	4	5
1. Mass of generator, g		650	750	1,000	4,000	2,200
2. Mass of aerosol-forming element, g		60	100	200	1,000	500
3. Efficiency Coefficient of unit		1	1	1	1	1
4. Max protected volume m <sup>3</sup> , class B fires		0.6	1	2	10	5
5. Nozzle outlet		mono	mono	mono	bi	mono
6. Length of generator, B (mm)		75	90	135	375	200
7. Diameter of generator, A (mm)		75	75	75	95	95
8. Discharge time, s		<3.5	<6.0	<7.5	<10.0	<7.5

Base on the design elements and the above table, the following selection of MAG generator satisfies effective fire suppression for the corresponding instrument pods.

- One MAG-1 for the CO Pod**
- One MAG-3 for the ALQ-170 Pod**
- One MAG-5 for the AMPS Pod**

## ***System Installation***

Due to a potential hazard of high temperatures (250-600°C) of Pyrogen aerosol at the end-plate nozzle, the minimum clearances from the discharge nozzle for each type of MAG generator should be observed during installation:

*MAG-1 300 mm*

*MAG-3 700 mm*

*MAG-5 700 mm*

Operation of Pyrogen MAG generator is either electrical automatic, electrical manual or thermal automatic.

### ***Electrical automatic operation***

Electrical automatic operation is performed upon activation of the detection circuit initiating a voltage source from the Fire Control / Alarm Panel to the generator(s) electrical activation device.

### ***Electrical manual operation***

Electrical manual operation is performed electrically by manual release point located outside the protected enclosure.

### ***Thermal automatic operation***

Thermal automatic operation is provided by action of an in-built thermal activation device - a linear fire conducting cord, which automatically activates at 175 °C or when exposed to a naked flame and propagates activation to the solid aerosol-forming composition. (The linear fire conducting cord is no longer available. The T-Start Initiating Device has been selected by Pyrogen LTD as the preferred automatic activation alternative).

**Because of the instrument pods physical location in the aircraft, the Fire Suppression System should use Thermal (electrical) automatic operation using the T-Start thermal activation and detection device.**

### ***System Isolate Device***

The discharge of the thermal-electrical automatic Pyrogen generators shall be capable of being prevented by means of a system isolate switch or by securing the T-Start system activation devices avoiding accidental discharge in the protected area or the adjacent area which could be rendered hazardous by the

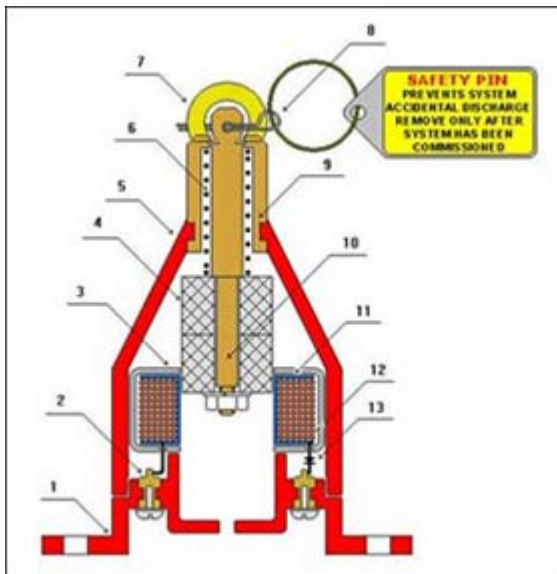
discharge of extinguishant. The T-Start devices can be secured by means of a safety pin. Pin removal, enables the T-Start to its operational mode.

### ***Description of Automatic Activation Device (T-Start)***

The T-start is a unique autonomous thermal activation and detection device that allows detecting a fire and activating a powder, aerosol or gaseous fire suppression system. Also the device has features such as provision of a signal to a fire panel and incorporation of an additional output designed to shut down the electrical equipment or activate an alarm (depends on a specific modification).

T-start can also be used as a thermal detector with a fixed temperature reading and can be connected to an existing fire detection circuit or a fire-indicating panel.

No external power supply is required for operation of the T-start device.



1. Base
2. Electric terminals
3. RF & EMI shielded protective cover
4. Magnet
5. Housing made from high-temperature plastic
6. Compression spring
7. Thermal sensitive lock made from shape memory alloy
8. Safety pin
9. Bronze nose piece
10. Bronze rod
11. Frame of reel
12. Electromagnetic coil
13. Diode

The main feature of the automatically operated T-start is a special heat-sensitive element (7) with a rated temperature reading. When subjected to a fire or a heat the element expands at the rated temperature reading and releases a spring-loaded rod (10) mounted inside a nosepiece (9).

The spring moves a cylindrical shape magnet (4), which is mounted on the rod (10), through an induction coil (12). The induction coil generates an electric impulse. The impulse is transmitted to the electrical terminals (2) and further to the aerosol or powder fire extinguishers.

### ***T Start Technical Characteristics***

- Length, mm – not more than 85mm;
- Diameter, mm – not more than 65mm;
- Total mass, kg – not more than 0.2;
- Operation Temperature Ranges - from –60 to +95°C;
- Rated Activation Temperature - +110°C±5°C

### ***Electric Wiring***

If the integrity of the MAG generators is in doubt, the integrity and resistance of the electric activation circuit for each MAG generator should be checked with the use of a **digital multi-meter**. **The maximum test current shall not exceed 50 milliamps for a period of 5 minutes.** The monitoring current shall not exceed 5 milliamps.

Resistance of the electric activation circuit shall be within 2.5-4.5 Ohms. It is also important to check earth fault of every MAG generator. Earth fault resistance must not be less than 10 MOhm.

- Up to ten Pyrogen MAG generators may be connected on a single discharge circuit with one power source.
- Wiring between generators shall be by parallel configuration only.
- Cables should be fire-resistant.
- Conductors should be of copper, each having a cross-sectional area of not less than 1 mm<sup>2</sup>, or if stranded, not less than 0.5 mm<sup>2</sup> should be used. (20 AWG).

The cable shall be screened and the care taken when the cable runs through high frequency energy zone, such as a two-way radio, sonar, etc. Should the cabling run alongside electric magnetic fields of high intensity, such as high voltage transformers, the cables shall be enclosed into a steel conduit.

Cable screen and steel conduit shall be grounded in accordance with standard requirements. Should there be any possibility of the mechanical damage; the cables shall be enclosed into a metal conduit.

Using the above guidelines, multiple T-Start devices would be used, as shown in the following images. The distribution of the heat detecting devices is selected to offer comprehensive fire detection along the horizontal axis of the pod considering relative easy access for securing the devices from accidental activation when ground work is performed in the area.

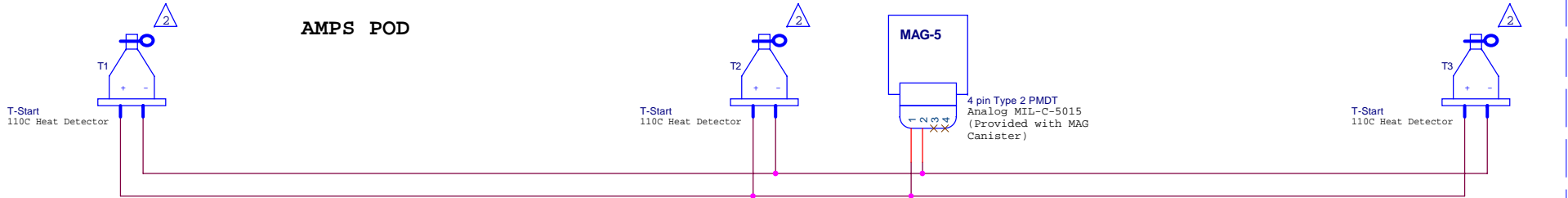
The CO pod offers difficult access for securing the T-Start detectors. Therefore, a system isolate switch strategically installed allows access to unarm the system.

The T-Star devices in the ALQ-170 and AMPS pods shall have red flags attached to the pins used to secure the Fire Detection and Suppression System during ground work at the pods. A similar red flag shall be installed at the CO pod isolation switch.

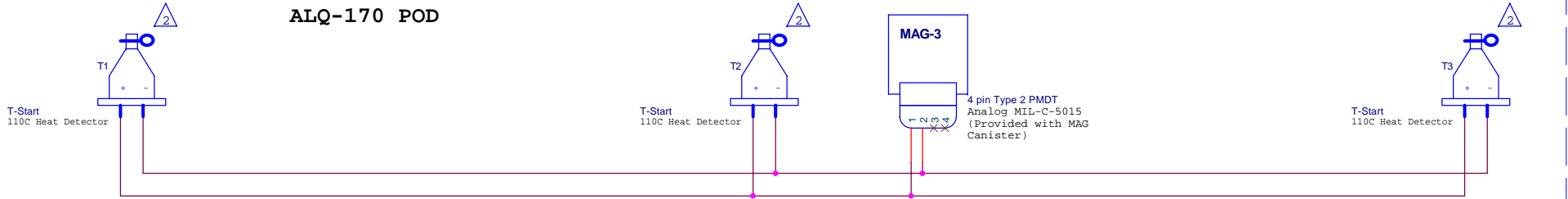
A total of seven flags; three for the ALQ-170 pod, three for the AMPS pod, and one for the CO pod shall be collected before flights. The red flags shall be collected and storage inside the aircraft by an aircrew member. The collecting, counting and storing of the flags shall be part of the preflight operations and logged as such by the SED flight crew.



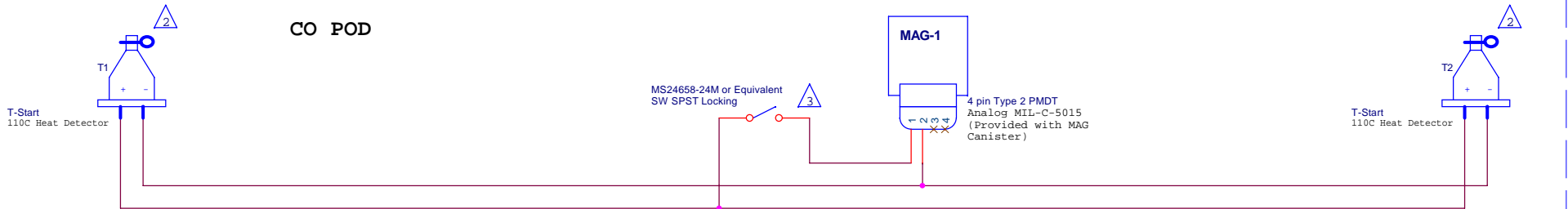
**AMPS POD**



**ALQ-170 POD**



**CO POD**



**NOTES:**

1. ALL SINGLE CONDUCTOR WIRE M22759/34-20 UNLESS NOTED.
2. REMOVE PIN BEFORE FLIGHT TO ARM THE "T START" TRIGGER DEVICES.
3. SWITCH TO "ON" POSITION BEFORE FLIGHT TO ARM THE "T START" TRIGGER DEVICES. TRIGGER PINS REMOVED.
4. IF USING A DIGITAL MULTI-METER. MAXIMUM TEST CURRENT SHALL NOT EXCEED 50 MILLIAMPS FOR A PERIOD OF 5 MINUTES. RECOMMENDED TO DISCONNECT MAG GENERATOR PRIOR TO ELECTRICAL WIRING TESTING.

FIRE DETECTION AND SUPPRESSION SYSTEM			
AIRCRAFT INSTRUMENT POD PROTECTION - TEXAQS 2006			
PROJECT WIRING TO AMPS, ALQ-170, AND CO PODS			
DATE: Thursday, August 03, 2006	REV DATE: Thursday, August 10, 2006	SHEET 1 OF 1	
NOAA / AOC / SED PO Box 6829 MacDill AFB, FL 33608	REV: -	FILE: 990033_1	DRAWING NUMBER
	ENG: JED	APP:	WD-990033-I

## ***System Operation***

### ***Post-fire procedure***

After discharge of Pyrogen allow a minimum holding time of 3 minutes for fire hazards involving flammable liquids (Class B) and non-smouldering combustible solids (Class A surface fires). Allow a 10 minutes holding time for fires involving PVC electrical cables and smouldering solids.

### ***Ensure first aid portable fire extinguishers are at hand.***

Ventilate the area by opening doors. ***Avoid exposure to the fire by-products and extinguishing mixture.*** Wearing a respirator or other available means of protection may be required should it be necessary to work in the area before it is fully ventilated.

Check the area when it is clear of agent and fire by-products, to inspect and ensure that the fire is fully extinguished and there is no danger of re-flash from hot spots or damaged equipment.

Should any residue be left, blow, brush or, if appropriate, wash it away. Be aware, that any residue that is allowed to absorb moisture may become electrically conductive.

## ***System Markings***

### ***Pyrogen Installation and Expiry Date Label***

The following label is “filled in” and affixed to every generator used in the system.

**PYROGEN GENERATOR**

INSTALLED DATE: \_\_\_\_\_

EXPIRY DATE: \_\_\_\_\_

For systems with electrical operation only the installed date is the current date and the expiry date is normally 10 years later, except when installed in an aggressive environment where the service life is likely to be less, in which case please refer to an Approved Representative for an assessment of the expected service life.

After filling out these details the installer places the clear protective self-adhesive film over the front of the label and attaches the label onto the generator adjacent to the body label.

### ***Pyrogen Warning & Instruction Signs***

The following Warning and Instruction Signs shall be firmly attached to specified locations by the installer on completion of Pyrogen installation in normally unoccupied areas, where people may work near the enclosure for brief periods:

*Label to be displayed at entrance to enclosure:*

THIS AREA IS FITTED WITH A PYROGEN FIRE EXTINGUISHING AEROSOL SYSTEM

***DO NOT ENTER***

***UNLESS THE FIRE SUPPRESSION SYSTEM IS ISOLATED***

AFTER AEROSOL DISCHARGE DO NOT ENTER

UNTIL AREA HAS BEEN THOROUGHLY VENTILATED