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AIRCRAFT GENERAL KNOWLEDGE

CHAPTER 12 – FIRE PROTECTION SYSTEM

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FIRE PROTECTION SYSTEM

12.1 Introduction

Probably one of the worst situations a pilot could experience is an engine fire over rough terrain in a single engine aircraft. Unfortunately in this situation options are limited to shutting the engine down followed by a forced landing. If after carrying out all the recommended steps the fire is not extinguished an increased glide angle may be required to find a speed at which combustion cannot occur. Fortunately engine fires are extremely rare.

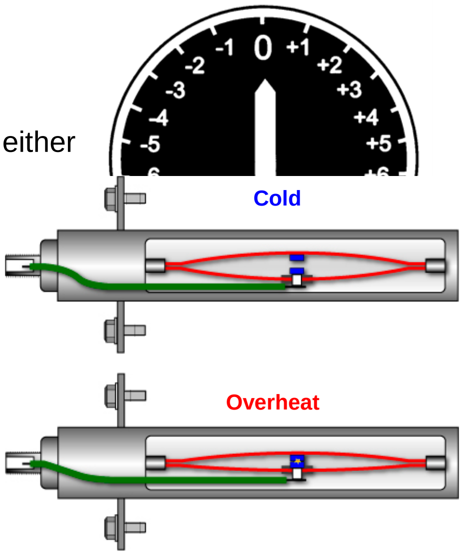
All commercial aircraft incorporate fire detection, warning and extinguishing systems. The system must be capable of quickly detecting overheat or fire conditions, alerting the crew and then rapidly and effectively putting out the fire.

12.2 Fire Detection

Engine fire detectors are usually divided into two categories:

- Unit detectors
- Continuous loop detectors.

12.2.1 Unit Type Detectors



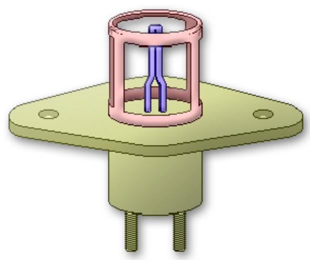
Unit (or Spot) Detectors are normally either temperature sensitive or thermal switches which operate on the principal of the different expansion rates of metal. Thermal switch type detectors are used in areas where specific temperatures are likely to be experienced and thermocouple detectors work on the rate of temperature rise to sense a fire.

12.1.1.1 Thermal Switch

Spot type detectors are usually wired in parallel with each other but in series with an indicator light. This means that any one of the detectors can put the light "on". The switches are heat sensitive and complete a circuit to the light when a preset temperature is reached.

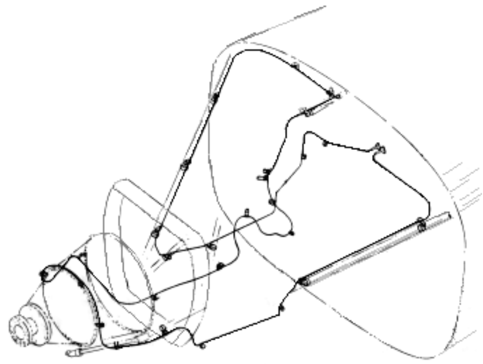
12.1.1.2 Thermocouple Systems

Also referred to as a rate-of-rise detection system. Each thermocouple consists of two dissimilar metals, which, when exposed to heat produce a current.



This Sensing Thermocouple is fitted in specific areas where fires are likely, e.g. adjacent to a turbocharger. The Reference Thermocouple is located remotely behind insulation where fire is unlikely. The current from both is monitored and compared. If the rate of rise in temperature is slow enough so that the Sensing and Reference Thermocouple temperatures both increase together, no differential current is produced. If the rate of rise in temperature is fast enough in the Sensing Thermocouple to produce a sufficient current differential then the alarm will activate.

12.3 Continuous Loop Detectors



Continuous loop detectors monitor the the engine compartment as a Whole, They consist of a central metal core or cores, which act as a conductor, and an outer metal tube which acts as an earth. The two metals are separated by a dielectric compound and will detect an overheat condition anywhere along its length. These types of detectors take the appearance of extruded wire approximately 2-3mm in diameter, and are not "rate-of-rise" sensitive like thermocouple type detectors.

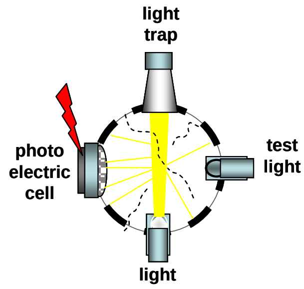
12.4 Smoke Detection Systems

Smoke detection systems are installed in the Avionic Equipment Bays, Baggage and Cargo Compartments, Toilets, Galleys and Crew Rest Areas where considerable smoke may be generated prior to ignition and combustion of flammable substances. Due to the circulation of airflow through the various sections of the fuselage careful consideration is given to placing the detector (sensors) in locations which will give the earliest possible warning.

Smoke, flame and gas detectors operate according to a number of basic principles, they include

Carbon Monoxide Detectors normally consist of a tube filled with a yellow coloured silica gel that changes to a green colour when exposed to the effects of carbon monoxide. The darker the green, the greater the concentrations of carbon monoxide present. Another type is in the form of a placard which is positioned on the instrument panel or flight deck wall. This type of detector changes to a grey or black colour when exposed to specific levels of carbon monoxide. These units are particularly good for use in aircraft using exhaust manifold heaters.

Photo-electric Cell Detectors consist of a box with a diffuser in the middle. On one side of the diffuser is a light source and on the other is a light trap. A photo-electric cell is located adjacent to the light source. The system uses the principle of light refraction. During normal conditions there is nothing to refract the light and therefore the photo-electric cell will not detect. However, when smoke enters the box, the light is refracted off the smoke particles and the photo-electric cell detects the change. Smoke density in the air needs to be **10%** to activate the warning system.

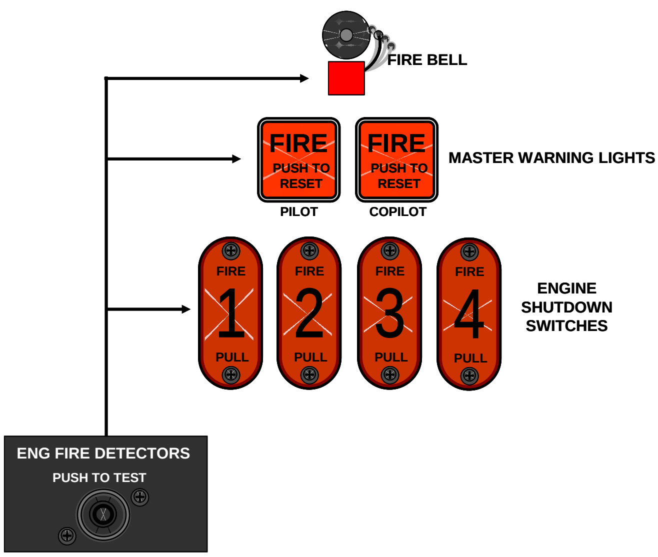


12.5 Overheat Warning systems

Overheat warning systems are used on some aircraft to indicate high area temperatures that may lead to a fire. On these aircraft they are used in engine nacelle and wheel well areas as well as around pneumatic manifolds. Whilst a fire may not be present, an overheated brake unit in a wheel well, or a bleed air leak in an engine nacelle or near an air manifold, could cause a fire to develop. When an overheat condition occurs in one of these areas, the system causes a light on the fire control panel to illuminate.

12.6 Indications and Warnings

Components of an engine fire indicating system will normally consist of a fire control handle, a fire warning light to clearly identify which engine fire detector has actuated, a master warning light normally located on the glare-shield in front of both pilots, an audible warning horn and cancel switch and a test system for both the fire and overheat detection systems.



Both the master warning light and the horn can be individually cancelled, but the light for the fire control handle *will only extinguish once the sensing element temperature has reduced to below its detection range*.

12.7 Detection Test System

It is imperative that the aircraft fire detection/overheat circuits are serviceable prior to engine start. *All systems are fitted with a detector test circuit, which simulates a fire or overheat condition.* When the detector test is carried out, the Fire Warning bell should sound, and the Fire Warning light come on. The fire bell has a cancel button which when pushed, should cancel the horn, but not the light.

Each of the continuous loop systems use a separate control amplifier to which the loop is connected. If the loop is broken, the system will not test, however, the wire on either side of the break is still capable of detecting a fire. On some of the larger systems, a dual loop circuit is fitted for extra reliability. On this type of system, both loops are tested prior to flight.

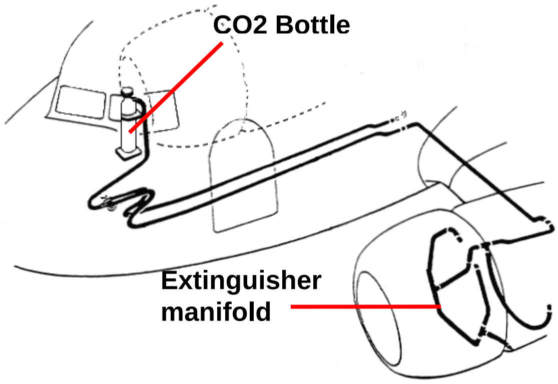
The Detection System Test when carried out will test the continuity of the Continuous Loops, the Detectors themselves, the Warning lights and the Audible alarms (Bells)

12.8 Fire Extinguishing Systems

Fire extinguisher systems can be divided into two categories, they are:

- **CO2** or conventional type used on most light commercial twin engine aircraft, and
- **High Rate Discharge** (**HRD**) types found on most modern commercial aircraft.

12.8.1 CO2 Extinguisher System



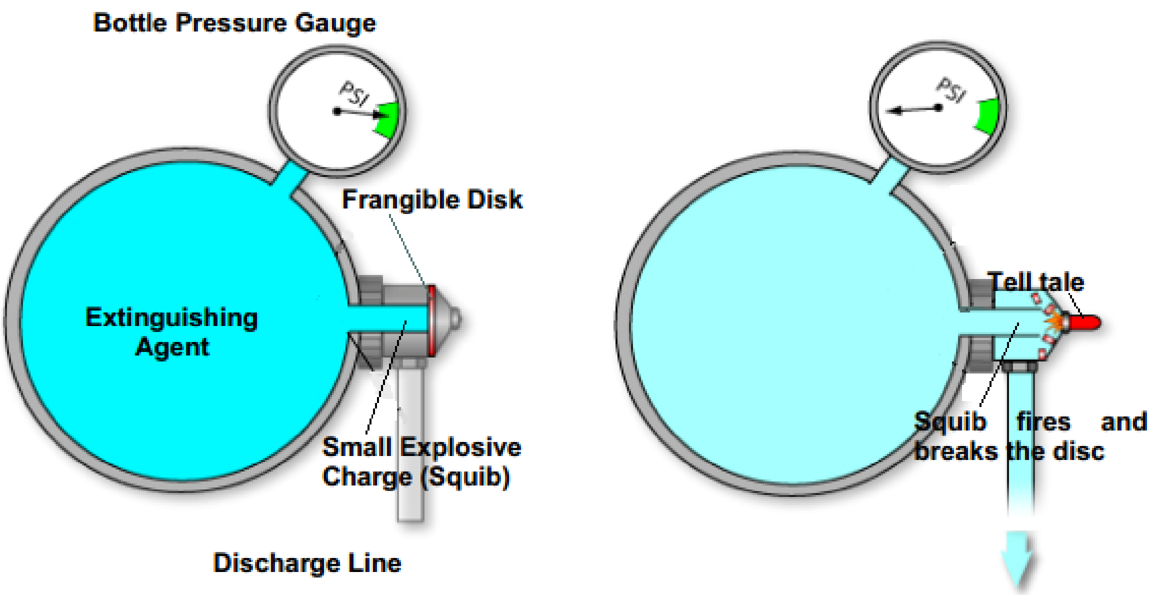
The system normally consists of high pressure CO2 bottles located in the nose wheel well or in the flight deck. The bottles are fitted with Directional operating valves on top, which control the discharge of the agent to the appropriate engine. The bottles are connected to the engine nacelle by pressure tested stainless steel tubing. This tubing extends into the nacelle where it is blanked off at the end, and has an array of pre-drilled holes to distribute the agent into the nacelle cavity.

The bottles are fired from the flight deck by firstly selecting the appropriate engine and then actuating the control lever to release the agent. Some systems allow for the discharge of more than one bottle to an engine.

12.8.2 HRD Extinguisher Systems

High Rate Discharge (HRD) extinguishers are fitted to most modern commercial aircraft. They operate, as the name implies, by rapidly discharging an extinguishing agent into the nacelle area. The agent is normally one of the Halon group of gases. These agents work by either depriving the fire of oxygen or by cooling the fuel down to a temperature that will no longer support combustion.

Extinguishing systems vary slightly between different aircraft, but will always consist of a fire extinguisher container, a frangible disk, a detonator device, a discharged indicator, a pressure gauge and associated plumbing.



A standard type A Fire Bottle would consist of a pressure container of appropriate size for the type of installation to which it is fitted. The container will normally have an indicator on the side which will show the pressure under which the extinguishing agent is held. This pressure is required to propel the extinguishing agent to the engine nacelle. Often the pressure gauge will have a temperature correction plate, to allow for deviations from standard. It is very important that the system be charged with the correct pressure to work effectively.

12.9 Fire Classifications

The types of fires likely to be encountered in or around an aircraft have been defined as:

- **Class A** – solid combustibles such as cloth, upholstery materials, wood, paper etc,
- **Class B** – flammable petroleum products such as Fuels Greases, Solvents, Paints etc,
- **Class C** – fires involve combustible gases either escaping or having the potential to escape,
- **Class D** – flammable metal such as magnesium, or magnesium alloy, and
- **Class E** - Electrical fires.

  Note: Ensure the source of electrical power is isolated before fighting an Electrical Fire.

12.10 Portable Fire Extinguishers

Portable or hand held extinguishers must be available and approved for the aircraft type. They must be appropriate for the kinds of fires most likely to occur in the specified area. For a fire to exist there must be three factors present, Fuel, Oxygen and Heat. The removal of any one of these factors will extinguish the fire. Portable fire extinguishers suitable for aircraft interiors are:

- ***Water*** extinguishers are primarily used for non electrical fires such as smouldering fabric, paper, cigarette butts etc. They must not be used on electrical fires due to risk of electric shock,
- ***Carbon Dioxide*** extinguishers are ideal for electrical fires, they are also suitable for liquid and material fires,
- ***Dry Chemical*** extinguishers can be used on all types of fires, however caution should be exercised when discharged in confined spaces, as they deposit fine powder particles and reduce visibility, the deposits from Dry Chemical extinguishers are also corrosive.
- ***Halon*** extinguishers are suitable for all classes of fire with the benefit of no residue or deposits remaining after use.

WARNING If a BCF (Halon) extinguisher is to be discharged in the flight deck,it should be ventilated as much as possible due to the fact that Halon displaces Oxygen. If Oxygen masks are available they should be donned and selected to use 100% Oxygen .