

Podcast 34, Talk, Fire Protection

Hello and welcome to another Talk where today Ian and I will discuss the 737NG Fire Protection systems. We have fire detection and extinguishing systems for the engines, APU and lavatories. The engines also have overheat detection, the main gear wheel well fire detection but not extinguishing and our cargo compartment has smoke detection along with fire suppression.

Let's start with a look at the engines. Our engine overheat and fire detection is powered by the battery bus with power for the extinguishing coming from the hot battery bus. You may remember from the electrical podcast that if it needs extinguishing it's hot!

Each engine contains 2 overheat/fire detector loops which contain gas that will expand with increasing temperature. They monitor 4 sections of each engine which are the upper and lower fan case and the left and right core section. In the Fan case, overheat and Fire warnings will occur at 174°C/345°F and 304°C/580°F respectively with the core triggers rising to 343°C/650°F and 454°C/850°F. These temperatures relate to the gas pressure sensed by the loops through calculations that as a mere pilot I'm unable to make! Both loops must sense the condition before a warning will occur.

You will get a fault where a loss of gas pressure is sensed. Failure of both loops in one engine will illuminate the fault light automatically but you can diagnose a single loop failure by selecting A or B on the fire protection panel OVHT DET switches. A single faulty loop is automatically disabled and a warning can be given by the one remaining loop when the OVHT DET switch is in normal. Positioning that switch to A or B would manually put the system into single loop detection with the non-selected loop now unmonitored.

An overheat would be indicated by both master caution lights, the OVHT/DET annunciator and the related ENG OVERHEAT light. Just a heads up on a TRE favourite here. If you have had an engine fire warning and fired the first bottle it's not been unknown for your friendly TRE to get rid of the red fire warnings but leave behind the ENG OVERHEAT light that is relatively easy to miss. Just give that Fire protection panel a good look before considering the fire to be out.

As we've just mentioned those red fire warnings let's just clarify what we get in the event of an engine fire. The fire warning bell will sound, both master FIRE WARN lights illuminate, the related engine fire switch illuminates and all related engine overheat alert indications illuminate.

Our fire switch will unlock when an overheat is detected, a fire is detected, during the OVHT/FIRE test or when pressing the manual override button hidden underneath them.

Pulling the fire switch will do the following:

- Close both the engine fuel shut off valve and the spar fuel shutoff valve
- Closes the engine bleed air valve which results in the loss of wing-anti ice to the affected wing and closure of the bleed air operated pack valve.

- Trips the generator control relay and breaker.
- Closes the hydraulic fluid shutoff valve while deactivating EDP LOW PRESSURE light.
- Disables the related engine thrust reverser
- Allows the fire switch to be rotated for bottle discharge
- Arms one bottle discharge squib on each engine fire extinguisher bottle.

Extinguishing wise we have two bottles containing halon and two BOTTLE DISCHARGE lights. The bottles are located in the top left corner of the wheel well and can be discharged into either engine.

Rotating the fire switch electrically fires the squib, which incidentally is a small explosive device, which breaks the seal on the related fire bottle and releases the halon gas to the engine through nitrogen pressure within the bottle. The L or R BOTTLE DISCHARGE light then illuminates a few seconds after the switch is rotated, indicating the discharge. Warnings or cautions remain illuminated until the temperature drops below the onset temperature.

For our APU we only have the one bottle in a system powered in the same way as the engines in that detection is through the battery bus and extinguishing through the hot battery bus. Our fire switch for the APU may be turned in either direction but you'll still only get one bottle to work with! This bottle is filled with Freon with Nitrogen again being used as the propelling agent. The same process happens on turning of the fire switch with a squib breaking the seal to release the Freon into the APU thus suffocating the fire. The APU BOTTLE DISCHARGE light will then illuminate a few seconds after indicating bottle discharge.

Our APU detectors, through a single loop, monitor 3 different compartment sections; The upper and lower as well as the tailpipe section. Once the predetermined limits are reached the APU fire switch illuminates until temperature drops back below limits.

The indications of an APU fire are:

- Fire warning bell
- Both master FIRE WARN lights illuminate
- The APU fire switch illuminates
- The APU automatically shuts down
- The wheel well APU fire warning horn sounds on the ground and the fire warning light flashes.

Loop failure is indicated to us by the APU DET INOP light on the fire protection panel.

The APU fire switch is normally locked down preventing inadvertent shutdown with illumination of the switch unlocking it and also we have the ability for manually unlocking it as with the engine fire switches. Pulling the APU fire switch up will:

- Provide backup for the automatic shutdown feature
- Deactivate the fuel solenoid and close the APU fuel shutoff valve
- Close the APU bleed air valve
- Close the APU air inlet door

- Trips the APU generator control relay and breaker
- Allows the rotation of the fire switch and
- Arms the APU bottle squib

We also have a second set of APU fire controls on the aft wall of the main wheel well. Mark mentioned the fire warning horn and light and we also have the APU BOTTLE DISCHARGE switch, the APU Fire control handle and the Horn Cutout switch. Instructions on it's use are printed on it and it would usually be handled by ground crew but there is always the possibility we may have to use it ourselves.

Talking about that main wheel well, we mentioned at the start it had detection only which is powered by AC Transfer bus 2. It uses a single fire detector loop and warns us through activating the fire warning bell, illuminating both master FIRE WARN lights and also the WHEEL WELL fire warning light on the fire protection panel. With no extinguishing available here some thought needs to be given as to how you would handle this one with one option to be to extend that gear, slowing to limit speed first perhaps and then thinking about a landing at the nearest suitable.

Our cargo holds have a dual loop detection configuration in the forward and aft hold powered by DC bus 1 and DC bus 2. Normally both loops must sense smoke to cause an alert. If a detector fails we can manually convert the system to single loop operation through the DET SELECT switch on the cargo fire panel. In the event of a power failure in one loop this switching happens automatically. The system consists of 4 detectors in the FWD compartment and 6 in the AFT with the FWD compartment containing 2 fire extinguishing ports and the AFT 3.

Our cargo compartments are class C which means we have an approved smoke detector system, an approved fire suppression system controllable from the flight deck and means to exclude hazardous quantities of smoke, flames or suppression agent from the cabin and flight deck. To aid in this when the CARGO FIRE warning is active the CPCs will set cabin rate of descent to -750fpm to help prevent smoke penetration. This feature is only active inflight. We have a passive heat resistant cargo compartment lining that must be able to withstand heat of 927°C or 1700F for at least 5 minutes.

The extinguishing bottle, or bottles for ETOPS models, are located on the forward wing spar in the air-conditioning mixing bay. A single bottle provides suppression for a total time of 75mins broken down into 60mins flight time to land plus an additional 15mins for a missed approach then landing and passenger unloading. The dual bottle system gives 195mins broken down into 180mins and 15mins as for the single bottle.

The indications of smoke sensed in the cargo compartment will be a fire warning bell, both master FIRE WARN lights and either the FWD/AFT cargo fire warning lights illuminate on the cargo fire panel. After initial indication the FWD/AFT cargo fire warning lights can extinguish, remain illuminated, or re-illuminate over the remainder of the flight. This indication alone does not indicate the fire is uncontrolled.

We arm the extinguisher by pushing the appropriate illuminated cargo fire armed switch. Once armed we then push the DISCH switch which will result in total discharge of the bottle

into the relevant compartment. The cargo fire DISCH light illuminates once the bottle is discharged indicating the fire suppression system has been fully activated. It may take up to 30 seconds for the light to illuminate.]

For systems with the 2nd bottle, this will automatically slowly discharge after 60 mins if we are still in flight, but it will be inhibited upon landing or if the system is disarmed. Remember that important point that the cargo doors are not to be opened when passengers remain on board. This is due to the fact we would be potentially aggravating the situation by adding more Oxygen to the mix.

Something we'll quickly mention here as we haven't really talked about them is those round green lights we have on both our Fire protection and Cargo fire panels. We test these on our pre-flight checks but what do they mean. Well, they are simply a circuit continuity check to verify continuity to the squib ensuring that when we turn that fire switch, or push discharge in the cargo compartment case, we can fire that squib and release our agent.

Finally for this one we'll take a look at the toilet, thankfully not literally. We have smoke detection and heat activated fire extinguishing in the lavs. There are a few different fits but all have an aural warning as well as indicator lights on the lavatory smoke detector panel. Some aircraft have a flight deck light although if someone is smoking in that front toilet we will likely smell it first!

Beneath the sink we have our heat operated extinguisher. We have no means of indication on the flight deck if one has discharged. There is a temperature indicator placard that will show the highest reached temperature and if any of the white dot has turned black you should suspect fire and check the extinguisher.

Well that just about wraps it up for this week but we can't leave you without testing those brain cells again first so it's time for... Talks Tech Ten

Q1: How many fire extinguishing bottles are there for the engines and APU combined?

Q2: How many smoke detectors do we have in the FWD and AFT cargo compartments?

Q3: What are the limit speeds for gear extension?

Q4: What is the power source for our extinguishers?

Q5: What powers the smoke detection in the cargo compartments?

Q6: What is tested when you push the cargo fire TEST switch

Q7: What does holding the TEST switch to the FAULT/INOP position check?

Q8: Define final reserve fuel for jets?

Q9: Where will a swept wing stall first and why is this a disadvantage?

Q10: What is the required climb gradient in the second segment for two engine aircraft?

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