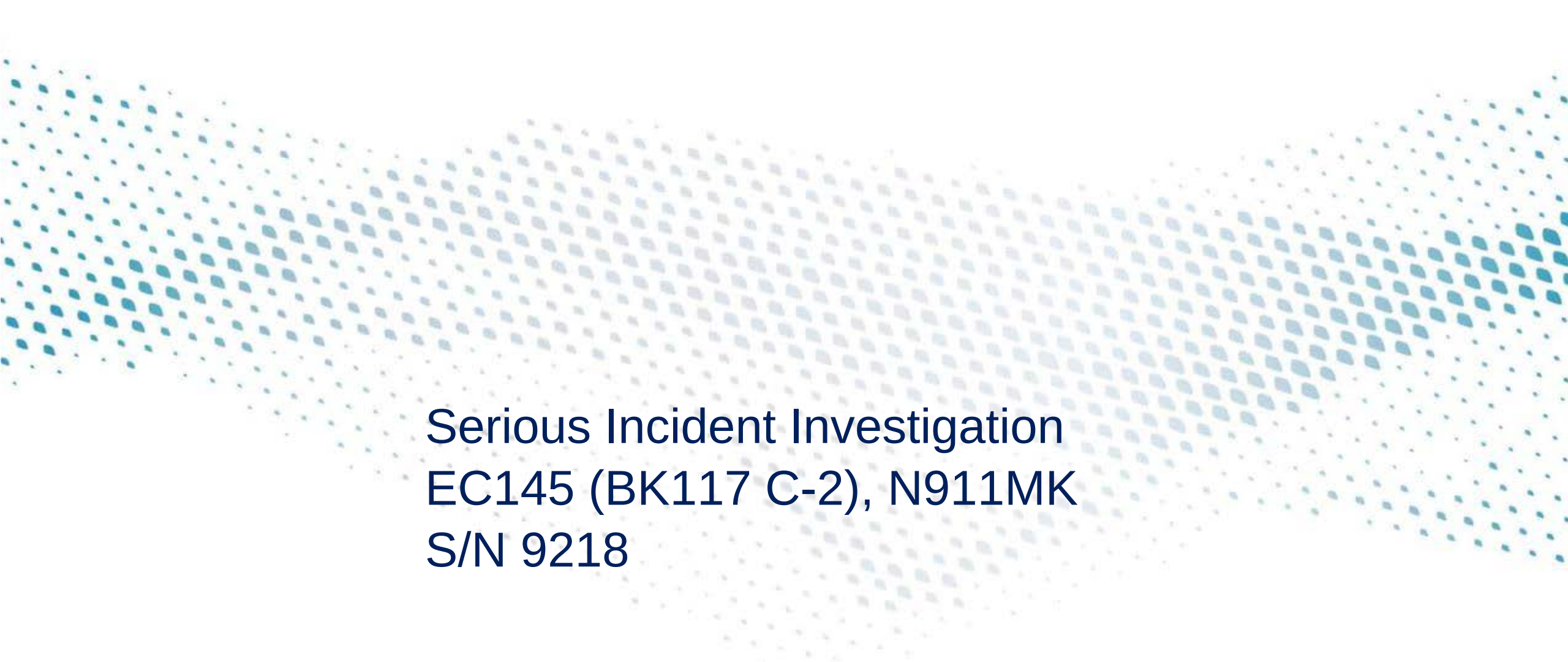




Serious Incident Investigation EC145 (BK117 C-2), N911MK S/N 9218

HELICOPTERS

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AIRBUS

Overview

Part 1 – Considerations - Inflight Fire

- Requirements on helicopter level (part 29 helicopter) concerning engine fire
 - Fire detection
 - Fire containment
 - Fire extinguishing system
- Flight Manual Emergency Procedure Engine Fire
- Conclusion

Part 2 – Considerations - Coking and Scavenge Line Clogging

- Scavenge Line clogging with influence on engine operation
 - Occurrence rate comparison
- Conclusion

Part 3 – Maintenance

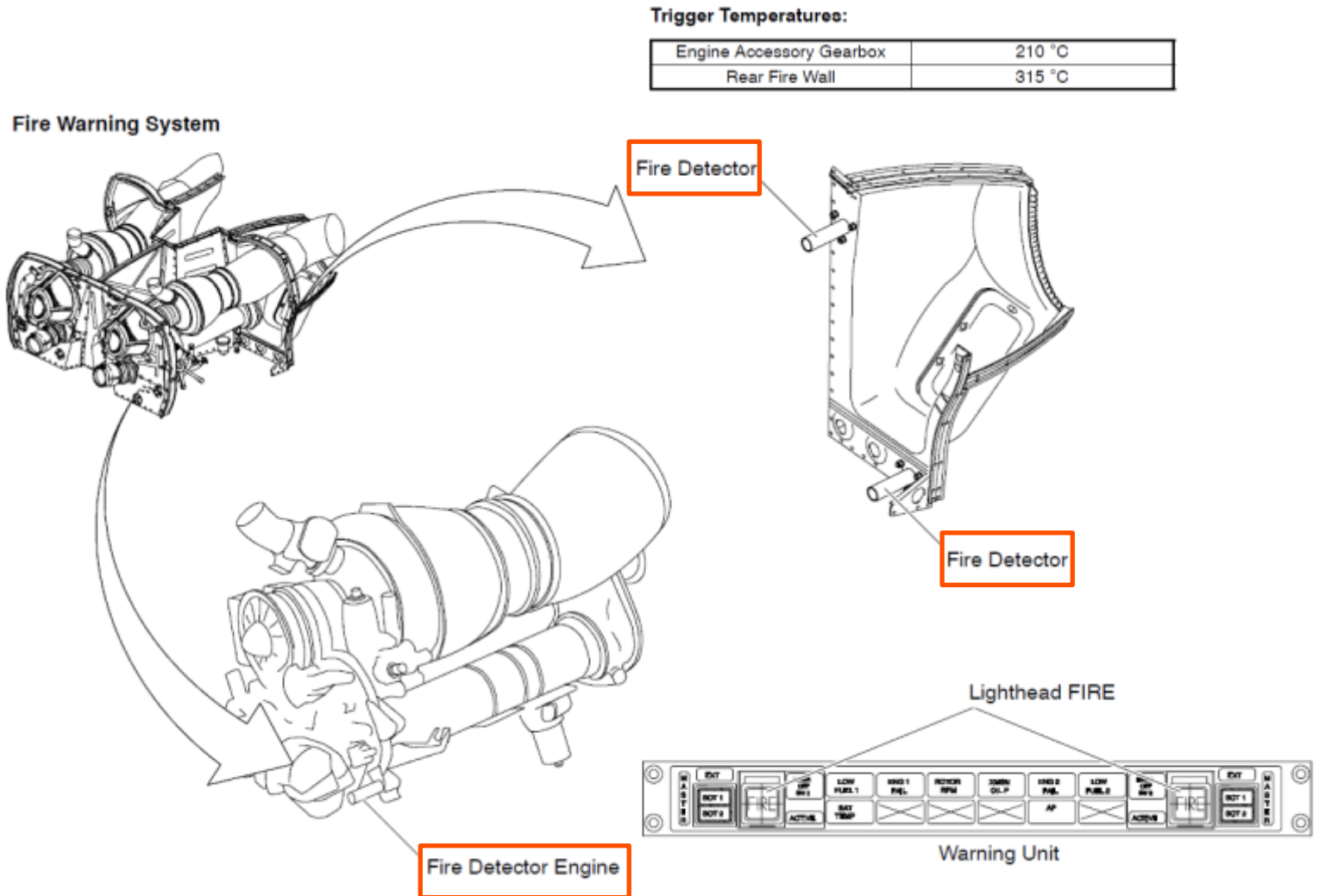
- Maintenance improvements
- Conclusion

Part 1

Considerations Inflight Fire

Fire Detection System AC 29-2C

- The EC145 has 3 fire detectors for each engine.
- They are bi-metal type detectors that close an electrical circuit when they are exposed to heat.
- AC 29-2C: (4) The detector system should:
 - (i) Indicate fire within 15 seconds after ignition, and show which engine compartment in which the fire is located.

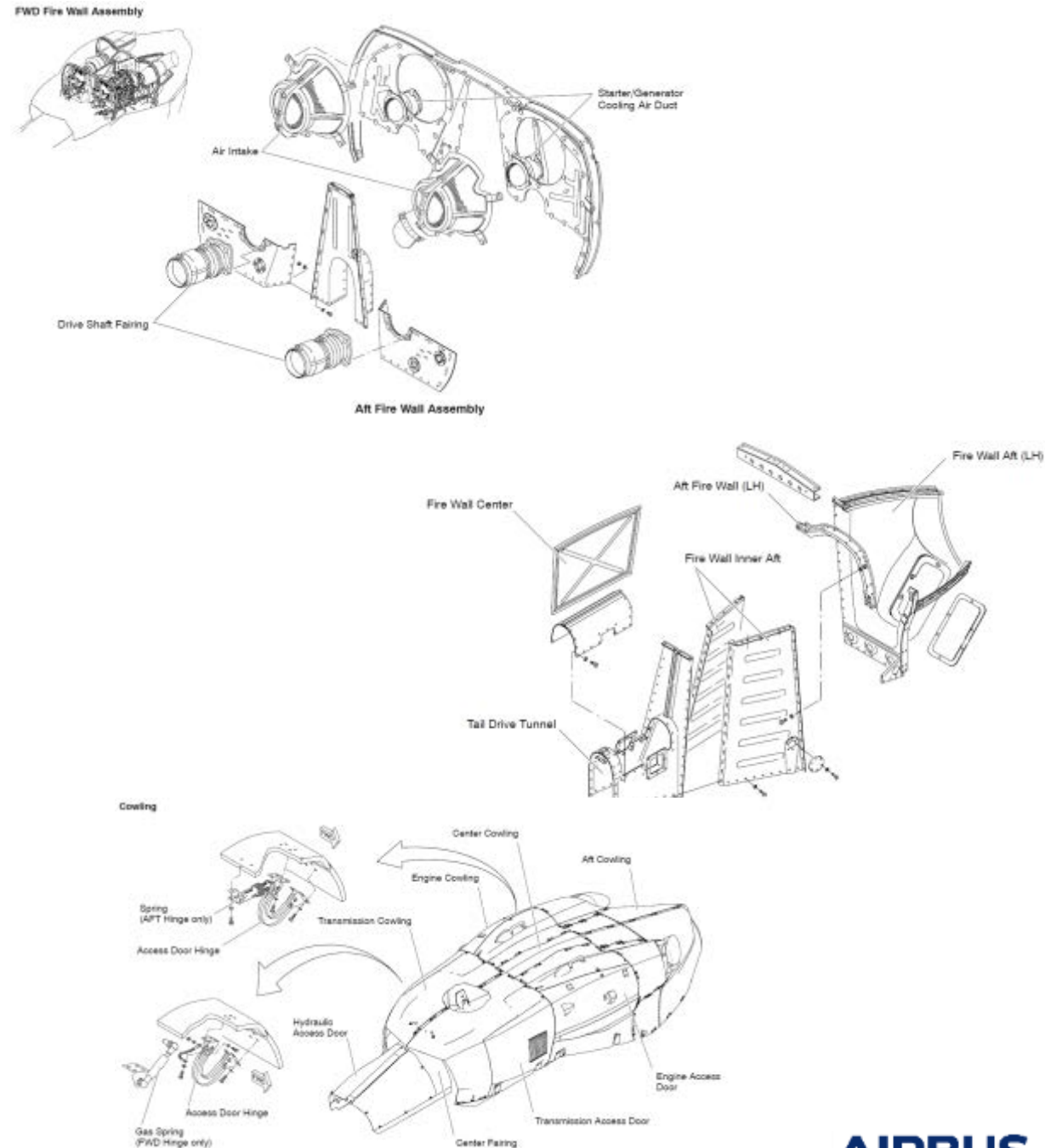


Fire Containment AC 20-135

- Fire should be contained for 15 min
- The engine deck carries both engines. The deck is built from aluminium frames and stringers, the sheeting is made of titanium.
- Fire Walls are made of Titanium
- Required thickness for Titanium sheet as given in AC 20-135:

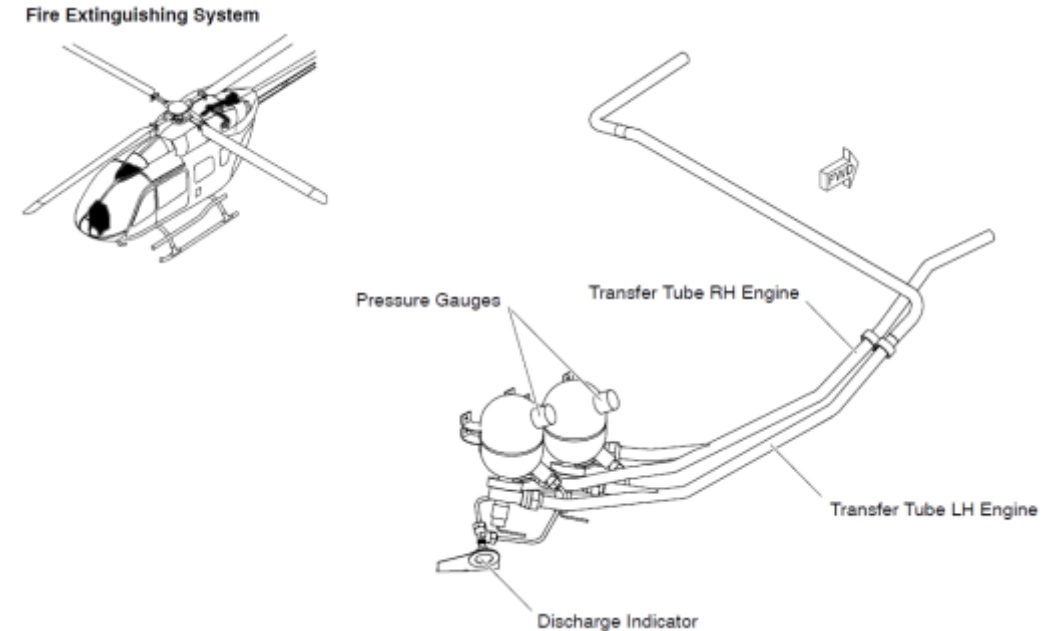
(6) The following minimum thickness materials are considered acceptable for use in firewalls or shrouds for non structural/non load carrying
 (iii) Titanium sheet, .016 inch thick.

- The cowlings are made of Kevlar. The hot section of the cowlings interior is protected with fire retarding paint.
- Engine Cowling fire resistance was demonstrated by testing.



Fire Extinguishing System AC 20-100

- The fire extinguishing system is a semi automatic system with a extinguishing logic, integrated into the warning unit. Two extinguishing bottles are installed to the right hand side of the aft deck. The bottles have two outlet ports each, guarded by explosive cartridges. From these outlet ports tubes are routed to the engine compartments.
- AC 20-100 gives a value of 6% volumetric concentration for Halon for 0,5 sec at all sampling points to extinguish a fire.



Emergency Procedure FLM

WARNING LIGHT INDICATIONS

FIRE

or

FIRE

(ENGINE 1)

(ENGINE 2)

Conditions/Indications

Overtemperature in engine compartment

- Warning bell will be activated

Procedure

● ON GROUND

- | | |
|------------------------------|----------------------|
| 1. FIRE sw (affected engine) | – Raise guard, press |
|------------------------------|----------------------|

NOTE Affected engine will shut down automatically, ACTIVE indicator light, BOT 1 legend (both EMER OFF SW pnl), and F VALVE CL caution indication (CAD) come on. FIRE legend remains on as long as overheat condition exists.

- | | |
|--------------------------|-------------|
| 2. Both FUEL PRIME PUMPS | – Check OFF |
|--------------------------|-------------|

- | | |
|-------------------|--|
| 3. BOT 1/BOT 2 pb | – Press; bottle 1 activated;
– EXT indicator light comes on (EMER OFF SW pnl) |
|-------------------|--|

NOTE Extinguisher bottle will begin discharging when $N_1 < 50\%$. After discharge of bottle contents, BOT 1 legend and EXT indicator light go off; BOT 2pb legend comes on.

- | | |
|---------------------|---|
| 4. Clock stop watch | – Start (after BOT 1 legend and EXT indicator light go off (EMER OFF SW pnl)) |
|---------------------|---|

- | | |
|-------------------------------------|-----------|
| 5. Double engine emergency shutdown | – Perform |
|-------------------------------------|-----------|

- | | |
|---------------|------------------|
| 6. Passengers | – Alert/Evacuate |
|---------------|------------------|

(continued):

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If situation permits and FIRE warning is still on after 1 minute:

- | | |
|-------------------|--|
| 7. BOT 1/BOT 2 pb | – Press; bottle 2 activated;
– EXT indicator light comes on (EMER OFF SW pnl) |
| 8. BAT MSTR sw | – OFF |

● IN FLIGHT

- | | |
|------------------------------|--------------------------------------|
| 1. OEI flight condition | – Establish |
| 2. Airspeed | – Reduce if IAS is exceeding 100 kts |
| 3. FIRE sw (affected engine) | – Raise guard, press |

NOTE Affected engine will shut down automatically, ACTIVE indicator light, BOT 1 legend (both EMER OFF SW pnl), and F VALVE CL caution indication (CAD) come on. FIRE legend remains on as long as overheat condition exists.

- | | |
|-------------------|--|
| 4. BOT 1/BOT 2 pb | – Press; bottle 1 activated;
– EXT indicator light comes on (EMER OFF SW pnl) |
|-------------------|--|

NOTE Extinguisher bottle will begin discharging when $N_1 < 50\%$. After discharge of bottle contents, BOT 1 legend and EXT indicator light go off; BOT 2pb legend comes on.

- | | |
|-------------------------------------|---|
| 5. Clock stop watch | – Start (after BOT 1 legend and EXT indicator light go off (EMER OFF SW pnl)) |
| 6. Affected engine | – Identify |
| 7. Single engine emergency shutdown | – Perform |
| 8. Passengers | – Alert |
| 9. LAND AS SOON AS POSSIBLE | |

If FIRE warning is still on after 1 minute:

- | | |
|--------------------|--|
| 10. BOT 1/BOT 2 pb | – Press; bottle 2 activated;
– EXT indicator light comes on (EMER OFF SW pnl) |
|--------------------|--|

If FIRE warning remains on:

- | |
|----------------------|
| 11. LAND IMMEDIATELY |
|----------------------|

Conclusions Inflight Fire

1. The inflight fire was a consequence of the clogged gas generator rear bearing scavenge line as the initial trigger
2. The oil that is therefore ejected from the engine can lead to a fire whatever the condition of the vent line and 3-way union is at this stage.
3. It cannot be determined if the 3-way was clogged before or after the clogging of the scavenge line
4. The clogged 3-way union which prevents the oil from being purged through the vent line would force the oil into the engine compartment.
5. The fire was a “controlled fire” as it was detected, contained and extinguished as required by certification
6. This is the only known occurrence on the BK117 family equipped with an Arriel 1 engine
7. The capability of the gas generator rear bearing air vent line to cope with the oil and oil-coke material seems insufficient in such an event. The direct implication from this fact is that the event preceding the ejection of oil and oil-coke through the vent line must be prevented. This condition is the coking and subsequent clogging of the scavenge line of the gas generator rear bearing. This will be looked at in the second part of the presentation.

Part 2

Considerations - Coking and Scavenge Line Clogging

Scavenge Line clogging with influence on engine operation

Occurrence rate comparison

(for Ecureuil and EC145 versions equipped with Arriel 1 engines between 2000-2017)

The comparison is done to determine how often the condition of a blogged scavenge line was encountered on the 2 different fleets as the phenomenon is present on both helicopter types with different vent system designs.

- Ecureuil vent line ends in the exhaust.
- BK117 vent line goes through the engine compartment into the airframe engine deck.

Flight Hours

- Ecureuil (with Arriel 1)
 - Approx. **12.000.000 FLH**
- BK117 (with Arriel 1)
 - Approx. **4.360.000 FLH**

Cases with partially or completely blocked scavenge line

- Ecureuil: **13**
- BK117 (including N911MK): **2**

Occurrence Rate per 100.000 FLH

Ecureuil: **0,11**

BK117: **0,05**

Ratio: **2,2**

Conclusion occurrence rate comparison (coking and scavenge line clogging)

1. The comparison is intentionally done at a high level just looking at the complete system (helicopter). This allows to make a comparison regardless of the differences in the design and integration (vent line) of engine on the helicopter.
2. The rate on the Ecureuil fleet is approximately 2 times higher than on the BK117 fleet.
3. This simplification requires to look at the operational differences between single engine and twin engine helicopters. The fact that the usage of the engine is different can be seen in the different maintenance plans in terms of periodicity.
4. The ratio strongly suggests that the engine integration (specifically of the gas generator rear bearing vent line) on the helicopter is not an important contributing factor as initially suspected.
5. It has been demonstrated that under stabilized rating conditions, there is no noticeable impact on the environment of the rear bearing when the vent line is clogged and the scavenge line is open.

Part 3 Maintenance

Maintenance improvements

The 2 most clear cases which can be used to elaborate on what an effective approach to improve the situation of the clogged 3-way union (which is part of the gas generator rear bearing vent system) are:

- The engine found on the Air Methods EC145 in Des Moines showed no increased level of coking. The 3-way union was found clogged. The permeability check was passed.
- The first reported case of a constricted vent line (in this case caused by a shrink tube) also showed that despite the fact that the engine was most probably operated in this condition for 2500 flight hours. The engine underwent 4 successful permeability checks.

These cases show that the necessity to perform additional maintenance on the engine cannot be drawn from the condition of the 3-way union. The 3-way union cannot be used as an indicator or sensor for the coking inside the gas generator rear bearing.

Conclusion

It appears most reasonable and effective to link the cleaning of the 3-way union (a task which doesn't exist today, because the phenomenon was unknown) to maintenance tasks on the engine like the permeability check, strainer cleaning or a removal of the engine.

The new maintenance task to clean the 3-way union will be created by Airbus Helicopters and then shall be referred to by the SafranHE EMM.