

Technical document

Hydro-Mechanical Unit (HMU) and Assembly Valve examination Final report

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 Date of occurrence: 21st February 2017
 Place of occurrence: San Juan Airport (Puerto Rico)
 Aircraft type: AEROSPATIALE - AS350 – B3
 Registration number: **N413LP**
 Equipment examined:

HMU	Assembly valve
Safran Helicopter Engines Ariel 2B P/N: 0292861320 S/N: 701B	Safran Helicopter Engines Ariel 2B P/N: 0292958050 S/N: 407B
	

Circumstances and objectives of the examination:

During a control flight with instructor, while performing an autorotation exercise, the pilot experienced an engine overspeed when recovering the power. The helicopter experienced a hard landing.

The aim of those two examinations was to check the proper functioning of the HMU and the assembly valve.

Examination performed:

The HMU and assembly valve examinations were performed at Safran Helicopter Engines, on the 10th Mai 2017, with representatives from the BEA and Airbus Helicopters.

The HMU is the hydro-mechanical part of the fuel regulation.

The examination of the HMU consisted in a test on a dedicated bench following the protocol previously agreed on by the different participants.

The assembly valve is composed of the following elements:

- start electro-valve,
- pressurizing valve,
- shut-off valve,
- purge valve.

The examination of the assembly did consist of checking the good functioning of the valves and measuring the possible leakages.

It has to be noticed that both examination tests were performed following an Acceptance Test Procedure (ATP) designed for new parts and not for an engine in operation.

Results:

The HMU was found acceptable. A little discrepancy was found during the test: the stall margin protection was out of the limits fixed for new engines. This discrepancy was not significant and had no link with the reported event (engine overspeed).

The assembly valve was found acceptable. Some slight leakages were found on the assembly valve, but without any effect on the functioning of the engine.

None of the discrepancies found on the HMU or the assembly valve could explain either the engine overspeed nor the blade-shedding speed observed during the event.

Therefore, it was decided to perform some simulations to determine what action was needed to reach the engine blade-shedding speed.

Simulations:

Safran HE did realise those simulations taking into account the parameters provided by Airbus Helicopters and recovered from the VEMD.

The principle of the regulation is the following one:

- When the twist grip is in the “flight position” (“flight notch”), the regulation is in automatic mode: the required fuel flow is adjusted by the ECU piloting the metering needle.
- When the twist grip is placed out of the “flight notch”, the regulation switches to “mixed mode”: the position of the twist grip has a direct action on the position of the metering needle, but this action is compensated by the stepper motor to get the power requested by the collective pitch position (thanks to the ECU).
- When the twist grip is turned towards idle position (“reducing power direction”), the stepper motor is able to compensate until the twist grip reaches the “idle position” (at this position, an electro-switch gives the indication to the stepper motor to reduce to “idle mode”).
- When the twist grip is turned towards Emergency + position (“increasing power direction”), the stepper motor compensates to its mechanical stop. If the twist grip angle is increased over this stepper motor limit, the fuel flow will increase and, consequently, the engine rotation speed (NR) will also increase.

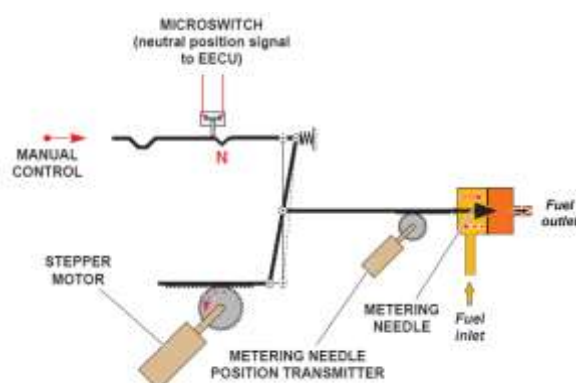


Fig 1 : Regulation functional diagram

For each failure recorded in the VEMD the associated parameters gave torque and rotor speed values. From those values, the required engine power and collective pitch position could be computed.

The simulations done by Safran HE were the following:

- Required engine power 540 kW (from VEMD failure 1 parameters),
- Required engine power 660 kW (from VEMD failure 2 parameters),
- Required engine power to reach blade-shedding speed.

For each simulation, the movement of the twist grip was simulated out of the flight notch and towards “emergency +” to determine the twist grip position for which the required engine power was reached.

The simulations performed confirmed that, the blade-shedding speed was reachable with the twist grip at its mechanical stop (92°, maximum rotation angle).

Conclusion:

The analysis based on failure messages recorded by VEMD and ECU showed that N1 (gas generator rotation speed) and N2 (free turbine rotation speed) reached values that exceeded values encountered during normal operations.

No warning message was recorded in the VEMD or in the ECU that indicated an engine regulation malfunction.

It is highly probable that the NG/N1 failure was triggered following an excessive opening of the fuel metering unit leading to an overspeed of the free turbine (N2).

The subsequent NF/N2 and TRQ failures were probably a consequence of the free turbine overspeed.

The examination of the HMU and the adjusted valve assembly did not show any malfunction that could have contributed to the excessive opening of the fuel metering unit leading to an engine overspeed. Therefore, it is highly probable that the engine overspeed situation encountered during this event resulted from pilot inputs on the twist grip.

In addition, HMU simulations performed by Safran HE allowed:

- to calculate the collective pitch and twist grip inputs necessary to reach the engine power levels corresponding to VEMD recorded data
- showed that an engine overspeed up to the blade shedding level (NR higher than 146%) could be reached with collective pitch input of 38.5% and a twist grip input at its mechanical stop (92° rotation).

The examinations, the simulations and the results are detailed in a dedicated report issued by Safran HE referenced is 2017/033 (file name: *N413LP SafranHE HMU Assy valve tests*) attached to this document.