

Ingestion of rain and hail

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EU-CHINA
中欧民航合作项目 **APP**

➤ CS -E 790 Ingestion rain and hail: Large hailstones

- Hail ingestion threat is very specific on helicopter engines due to particular engine air inlet systems (engine more integrated in the airframe)
- Almost all SafranHE helicopter engines are protected against hail by the airframer's air inlet grid
- ➔ Classic means of compliance at SafranHE for large hailstones (25 and 50 mm diameter, CS-E 790 (a)(1)): specification of H/C protection in the engine installation manual and engine TCDS, using CS-E 790 (d) provision :

For an Engine that incorporates or requires the use of a protection device, demonstration of the rain and hail ingestion capabilities of the Engine, as required in CS-E 790 (a), (b) and (c), may be waived wholly or in part by the Agency if...(several conditions translated in the installation manual)



➤ CS -E 790 Ingestion rain and hail: Standard rain and hail

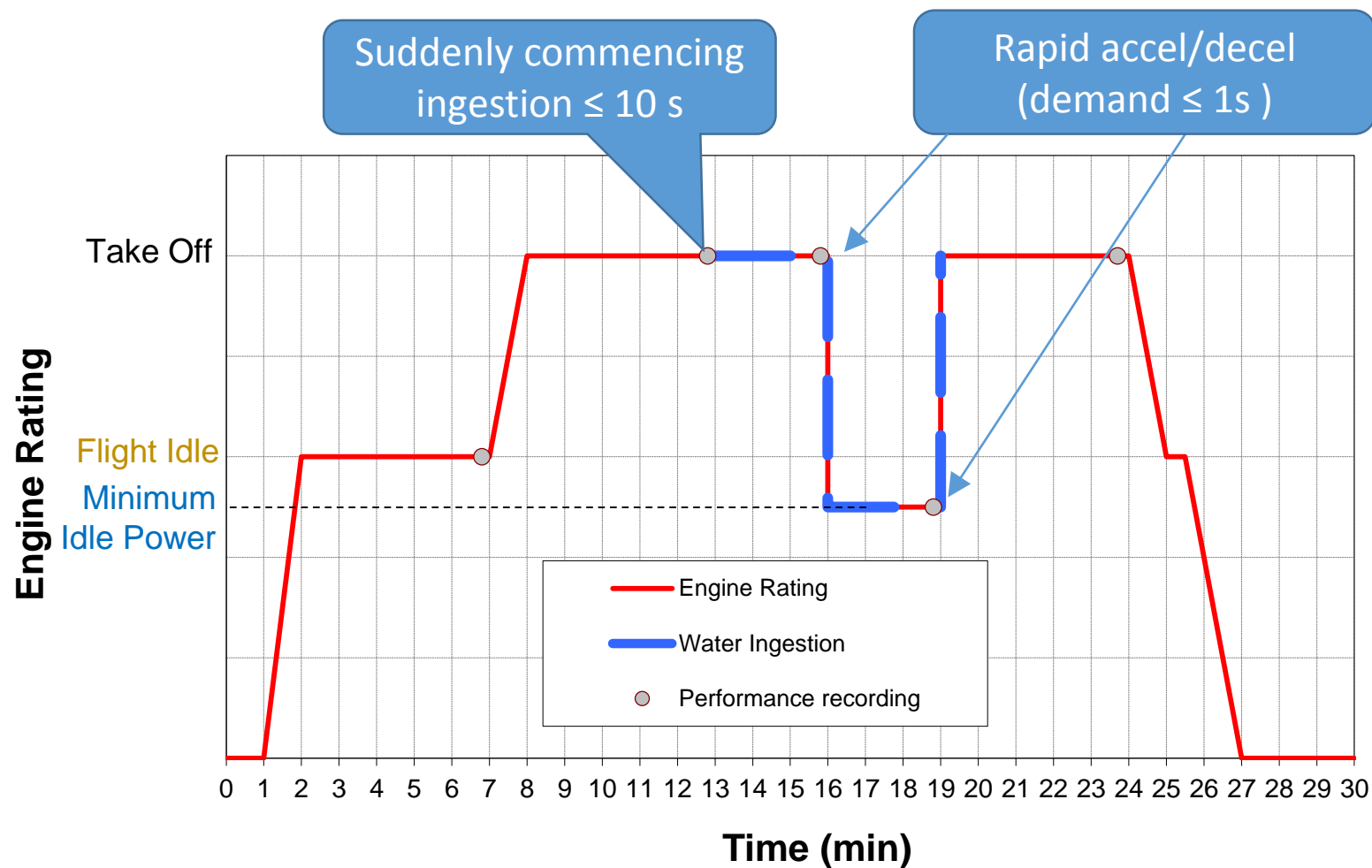
➤ Compliance with CS-E 790 (a) (2) is not demonstrated for rotorcraft engines (rain and hail ingestion tests at standard concentrations given in Appendix A to CS-E)

➤ As an alternative, compliance with CS-E 790 (b) is used
...for rotorcraft turbine Engines only, it must be shown that each Engine is capable of acceptable operation during and after the ingestion of rain with an overall ratio of water droplet flow to airflow, by weight, with a uniform distribution at the inlet plane, of at least 4-percent...



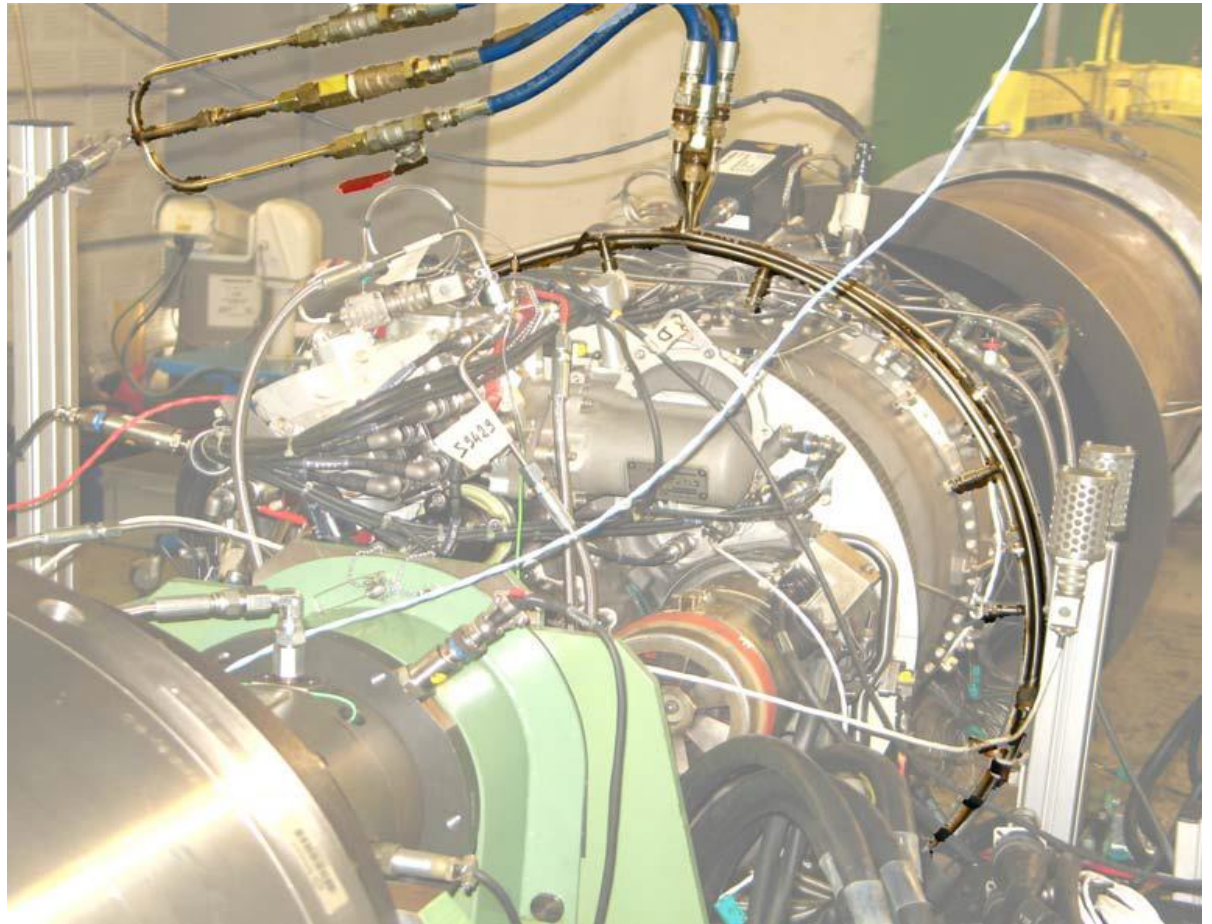
► Rain ingestion test at SafranHE

► Rain ingestion test cycle according to CS-E 790 (b)



► Rain ingestion test at SafranHE

Example of
water injection
device



➤ Rain ingestion test at SafranHE

- No Critical Point Analysis in the flight envelope (static ground-level conditions) ➔ 4% rain concentration compensates flight/installation effects
- The water injection system can be tuned to maintain the 4% mass ratio even during deceleration and acceleration
- Success criteria given by CS-E790 (d), typical issues :
 - Surge during acceleration
 - Flame out during deceleration
 - Power loss due to compressor rotor/stator rubbing





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LAST SLIDE

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