

AIRCRAFT ENGINES



SAFRAN : COMPLIANCE STRATEGY TO CS-E 510 (APPLICATION TO AM PARTS)



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PURPOSE OF PRESENTATION

Description of SAFRAN Compliance strategy to CS-E 510 requirement (Engine Fault and Safety Analysis), application to Additive Manufacturing Parts.

COMPLIANCE STRATEGY TO ENGINE SAFETY AND FAULT ANALYSIS CS-E 510

SAFRAN engine products are classified in term of criticality towards Safety and Fault analysis required by CS-E 510 regulation (1/3)

- ◆ For certification of the engine, a FMEA (Failures Modes and Effects Analysis) is performed at engine level and reported in a certification report: Engine Fault and Safety analysis, approved by the Regulation Authority.
- ◆ This report documents the likely engine-level consequences of all failures that can reasonably be expected to occur, to show by analysis and consideration of comparable service experience that the probability of Hazardous effects as defined in CS-E 510 is Extremely Remote, and that the probability of Major effects is Remote.
- ◆ At component level, the FMEA consists in analyzing the consequences of the primary failure of the part (in each location). Depending on the gravity of their effects : Hazardous, Major or Minor effects, parts are classified following Safran procedure; this procedure is referenced in the Design Organization Manual of the applicant.
- ◆ The article classification and its associated characteristics lead to technical definition requirements which have themselves consequences in the organization of both the production and quality assurance systems. Main technical requirements relative to materials down selection, manufacturing validation, serialization, marking are introduced by technical documents referenced in the Article Technical Definition (DTA) (drawings, definitions document)

COMPLIANCE STRATEGY TO ENGINE SAFETY AND FAULT ANALYSIS CS-E 510

SAFRAN products are classified in term of criticality towards Safety and Fault analysis required by CS-E 510 regulation (2/3)

4 Parts classification levels exist: L1 to L4 , L1 corresponding to the most critical level

A classification is affected to each Component of the Engine included in the Engine part list.

- ◆ L1 Parts: Engine Critical Part: parts whose primary failure induced by a non conforming material characteristic or an not-controllable process, may lead to a Hazardous Engine Effect, as defined by CS-E 510.
- ◆ L2 Parts: Parts (not L1) whose primary failure induced by a non conforming material characteristic or an not-controllable process, may lead to a Major Effect, as defined by CS-E 510.
- ◆ L3 Parts: Parts (not L1 nor L2) whose primary failure induced by a non conforming material characteristic or an not-controllable process, may lead to a Minor Effect (can affect at worse a customer requirement)
- ◆ L4 Parts: All others parts not classified as L1, L2, L3, for which the standard material and process requirements for manufacturing and maintenance in service, ensure the reliability requirement for the part.

COMPLIANCE STRATEGY TO ENGINE SAFETY AND FAULT ANALYSIS CS-E 510

SAFRAN products are classified in term of criticality towards Safety and Fault analysis required by CS-E 510 regulation (3/3)

- ◆ Depending on the classification level of the part, specific requirements are introduced in the Technical Definition as per Safran procedure, for example but not limited to:
 - ◆ Specific material specifications
 - ◆ Manufacturing and operating traceability of each individual part
 - ◆ Individual production serialization
 - ◆ Marking rules for each manufacturing operation from billet to finished part
 - ◆ Substantiation of manufacturing processes approved both by Engineering and Manufacturing Quality
 - ◆ Enhanced production quality assurance, including the monitoring of specified characteristics.
 - ◆ Control of manufacturing processes for functionality assurance
 - ◆ Processing and approval of non-conforming parts performed by both Engineering and Manufacturing Quality
 - ◆ Requirements for control and substantiation of changes (configuration, process)
- ◆ Classification of influencing characteristics of the parts
 - The most influencing characteristics of the part to attain its technical requirements (durability, strength) are classified as Major / Key and are reported in the Technical Definition (drawings) per the same Safran procedure.

COMPLIANCE TO CS-E 510 FOR A PART CHANGE

- ◆ When a change is introduced on a part, the compliance of the change to all regulation requirements needs to be substantiated by Safran “Change Process”,
- ◆ If a new part is introduced by a change, FMEA analysis and subsequent classification will be assessed, accounting for characteristics of the new part.
- ◆ If the FMEA needs to be updated (for example new failure mode identified, or criticality increased etc...), then a substantiation plan (equivalent to the EASA Certification Programme) is proposed to Agency through Change Process.
- ◆ In this Substantiation plan, an update of the FMEA and implications on the Engine Fault and Safety analysis and implications on the aircraft reliability is requested.
- ◆ The compliance with the Regulation Requirements (CS-E 510) will be introduced in the Change itself
- ◆ Usually the Major changes do not change the classification of the new part.

COMPLIANCE TO CS-E 510 FOR AM PARTS

AM parts will follow the same “classification process” regarding the consequences of their primary failure as any other part of the engine following the existing processes (Parts Classification process, and Change Process).

Would the introduction of an AM part change the classification of the part, the consequences on the Engine Fault and Reliability analysis would be analyzed, justified during the certification process of the Change and thus taken into account as for any other part of the engine.