PRA presentation

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Safety Enhancement

Particular Risk Analyses

Particular Risks Analyses (PRA)

Particular Risks definition (AMC 1309)

Particular Risk Analyses are defined in the CS25 Book 2 Appendix1 (AMC 1309)

“Particular risks are defined as those events or influences, which are outside the systems concerned.

Examples are fire, leaking fluids, bird strike, tire burst, high intensity radiated fields exposure, lightning, uncontained failure of high energy rotating machines, etc. Each risk should be the subject of a specific study to examine and document the simultaneous or cascading effects or influences, which may violate independence.”

Particular Risks Analyses (PRA)
Method for Particular Risk Analyses

Particular Risks AIRBUS position

Particular Risk Analyses are safety assessments, to be managed from a *global aircraft perspective*, to address particular *physical hazards*, within or external to the aircraft, which could *affect the airframe globally or in one or more sections*, and impact *one or more aircraft systems* and their installation.

PRA are related to intrinsic hazards (i.e. hazards intrinsic to equipment design, technology, etc.), installation hazards and external hazards (i.e. hazards from the environment).

They affect several engineering disciplines and some of them are drivers for the Aircraft Architecture.

Each PRA is "particular" in nature and should be the subject of a dedicated analysis.

In consideration of intrinsic and external hazards, each PRA should examine a wide range of requirements associated with aircraft design & implementation, ranging from structural integrity requirements to independence requirements (for which both simultaneous and cascading effects should be considered).

PRAs aim at analyzing the aircraft level consequences of the above intrinsic and external hazards having occurred and make sure that they are acceptable from a safety point of view.

Particular Risks Analyses (PRA)
Selection of the list of PRAs applicable for an aircraft development

The list of PRA to be analysed on an aircraft development is defined on the basis of the aircraft definition and certification basis.

Two categories are distinguished (from A380 and on):

- GROUP A: gathers all PRAs that shall be provided as means of compliance for certification, and reviewed with corresponding AA panels (e.g. Uncontained Engine Rotor Failure, Bleed Air Duct Rupture, Wheel & Tire Failure)
- GROUP B: gathers PRAs that are performed by Airbus on a voluntary basis to minimize the risks of critical aircraft level consequences following a single PRA event. The complete analysis remains an internal Airbus document, but technical answers may be provided to AA upon request.

Particular Risks Analyses (PRA) - internal

Severity classification Criterion

For PRA deriving their requirements from FHA classifications, the CS/FAR 25.1309 requirements generally apply.

- However, for some PRA, these requirements may be superseded, restricted or completed by particular requirements or associated acceptable means of compliance. As examples:
  - Bird Strike follows the specific requirements of CS.25.631.
  - UERF follows the recommendations of AMC/AC 20-128A, introducing the concept of an acceptable residual risk of 1/20 once all practicable design precautions have been implemented, thus allowing CAT repercussions.
  - For WTF, the CS25.734 applies. It is completed by the AMC 25.734, which in turn refers to CS25.1309 and introduces particular means of compliance for WTF.

This approach applies to new developments and does not supersede the way of working previously used on Legacy Programs.

Particular Risks Analyses (PRA)

PRA are started from the earliest stages in the aircraft design process and are carried-on up to the Type Certificate.

The process for each PRA includes:

- The definition of a risk model / risk policy (reflecting the applicable regulation when it is defined)
- The definition of detailed design requirements to the airframe / structure design and to the systems design & system installation
- The continuous safety assessment of the aircraft level PRA consequences
- An active support to design teams for defining the most appropriate design solutions, including necessary change requests
- The support to the first flight and flight test campaign clearances
- The final demonstration of compliance (internal and for supporting type certification)

Particular Risks Analyses (PRA)

Complying to Certification Requirements is absolute minimum.

- ✓A limited flexibility does exist regarding means of compliance
- ✓The Safety scope exceeds the Certification scope. Safety continues after TC.

Legacy constraints.

- ✓Necessity to show non regression compared to previous programmes
- ✓Duty to consider in service lessons-learnt (accidents, major events ...)

Particular Risks Analyses (PRA)

Combinations between PRA and other events

PRA events not considered in combination with independent failures or missing items:

- it is assumed that no failure (independent of the PRA event) has occurred before the PRA event occurrence and that none will occur during the remaining flight time after the PRA event occurrence
- it is assumed that the A/C was dispatched fully operative (no MMEL or CDL dispatch allowance).

Combinations of independent PRA events during a given flight are not considered as such combinations would be Extremely Improbable.

Particular Risks Analyses (PRA)

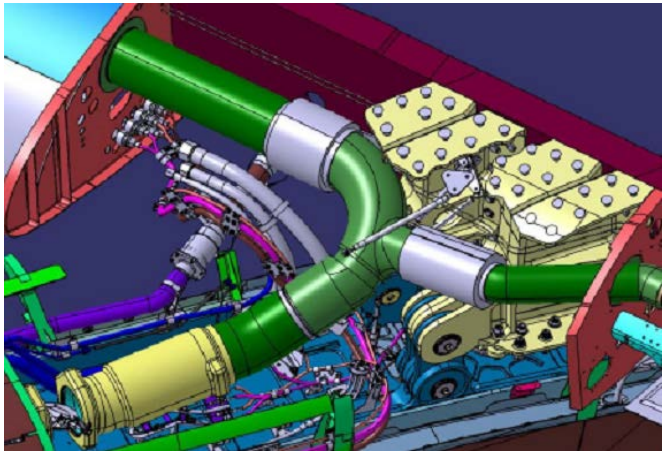
Particular Risks technical overview (examples - not exhaustive)

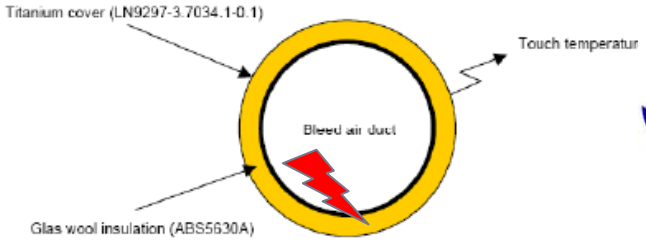
PRA – Bleed Air Duct Rupture (BADR)

The BADR PRA intents to analyse the effects of **hot air leakage** resulting from a damaged **bleed air duct**. **Thermal and overpressure effects** are both analysed.

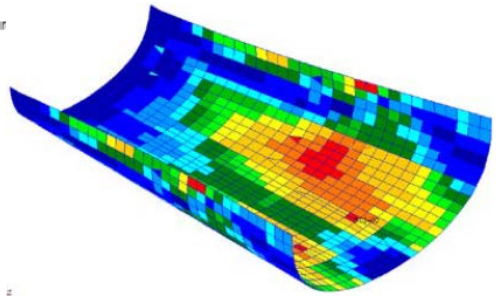
Impacts on structure and systems are assessed, for several models:

- Negligible leakage (not detected), long duration (half of design service goal)
- Small leakage (detected by Overheat Detection System, isolated after typically 10 seconds)
- Duct rupture, large leakage (detected by Overheat Detection System, isolated after typ. 10 seconds)





High temperature leakage (due to excessive overpressure, ageing of material , etc…)



S19 skin, structure stress assessment

PRA – Sustained Engine Imbalance / Fan Blade Out (SEI, FBO)

The intent of the SEI/FBO PRA is to demonstrate that the severe engine vibrations resulting from a contained engine rotor failure will not:

- cause damage either to the primary structure or to systems that would jeopardise continued safe flight and landing
- result in cockpit vibration environment that could prevent the flight crew from operating the aeroplane in a safe manner.

The Fan Blade Out (**FBO**) event corresponds to an instantaneous shock at the time of the Engine Failure.
The Sustained Engine Imbalance (**SEI**) PRA includes the two following vibration conditions:

- The **HPC** (High Power Conditions) phase, before failed engine spool down
- The **wind milling** phase, from failed engine stop to landing (3 hours duration is considered)

PRA – Tail Strike (TS)

A tail strike event occurs when **the tail of the aircraft hits the runway** during **take-off** or landing.

The PRA activity will be performed in order to minimize the effects of a Tail Strike event. It aims to assess:

- the remaining capabilities of the structure to sustain the loads,
- the potential consequences losing or damaging critical systems (fire risk, functional).

The target of the PRA is to show that the A/C will fly and land safely after the impact (to the destination airport if not detected, to the diversion airport if detected).