



# EASA

European Aviation Safety Agency

## **Fuel tank crash resistance Certification Memorandum on Compliance to CS27/29.952 a(4) for changes affecting surrounding structure (including external equipments).**

*Herdrice HERESON*

*Structure Expert-Rotorcraft Department  
Rotorcraft Symposium-2nd December 2015*

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# Statement of issue

- There are currently numerous rotorcrafts Post-Type Certificate applications (major changes/STCs) for installation of equipment at the direct proximity of fuel tanks





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# Historical background

## ➤ Requirement

## ➤ FAR and JAR requirements were amended with Fuel Tank Crashworthiness requirement

- FAR 27.952- Amdt. 27-30, Eff. 11/2/94 (CFR NPRM. [90-24](#); Issued on 09/27/90)
- FAR 29.952- Amdt. 27-30, Eff. 11/2/94 (CFR NPRM. [90-24](#); Issued on 09/27/90)
- JAR 27/29.952 issue 1 amended in 1999

Section 27/29.952 provides safety standards that minimize postcrash fire (PCF) in a survivable impact



Comprehensive crash resistant fuel system (CRFS) design

+

Test criteria that significantly minimize fuel leaks, creation of potential ignition sources, and the occurrence of PCF



# Historical background

- (i) Providing comprehensive criteria to minimize fuel leaks and potential ignition sources;
- (ii) Requiring increased crash load factors for fuel cells in and behind occupied areas to ensure the static, ultimate strength necessary for impact energy absorption, structural integrity, fuel containment, and occupant safety;
- (iii) Maintaining the load factors of § 27/29.561 for fuel cells in other areas (particularly underfloor cells) to ensure leak-tight fuel cell deformation in energy absorbing underfloor structure without unduly crushing or penetrating the occupiable volume; and
- (iv) Requiring a 50 ft. dynamic vertical impact (drop) test to measure fuel tank structural and fuel containment integrity.

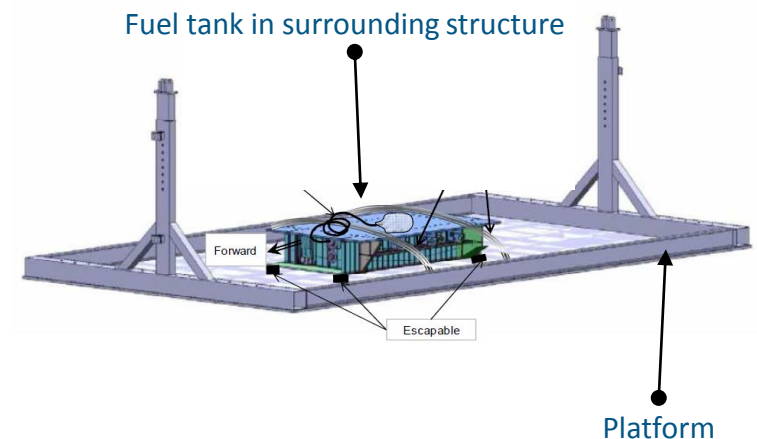
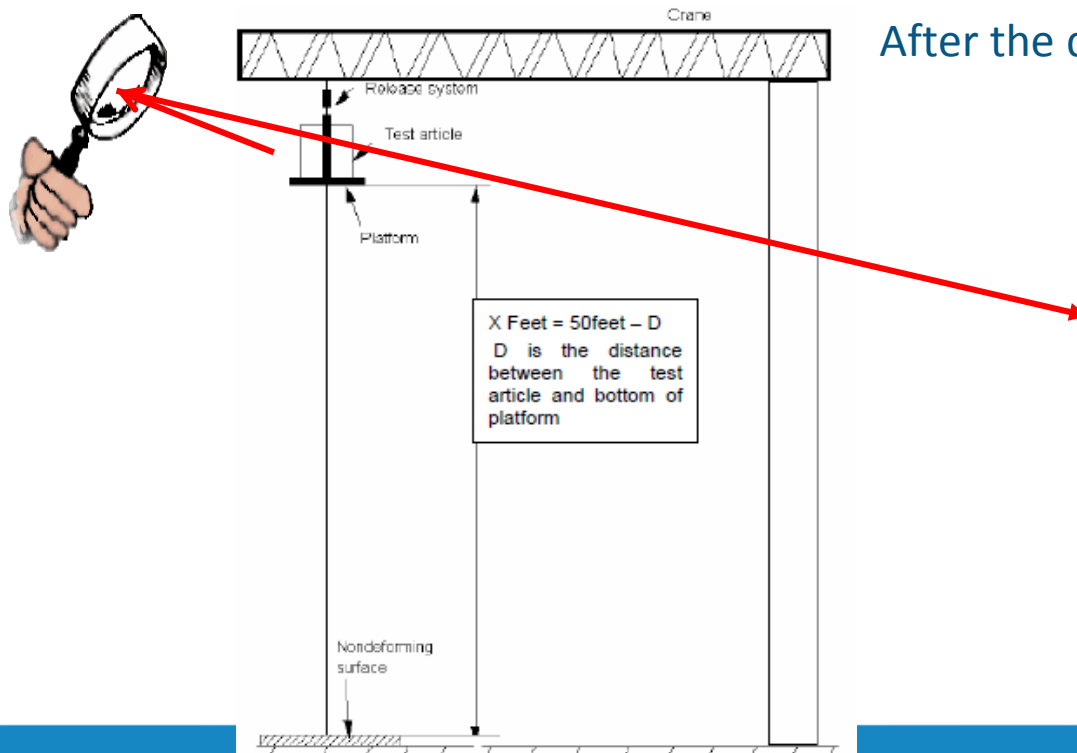


# Historical background

## ➤ Reminder of Test conditions CS27/29.952(a)

- A 50 ft. dynamic vertical impact (drop) test to measure fuel tank structural and fuel containment integrity (1). The drop impact surface must be non deforming (2). The fuel tank is filled at 80% with water (3) and embedded in a surrounding structure representative of the installation unless it can be established that the surrounding structure is free of projections or other design features likely to contribute to rupture of the tank(4). The tank must drop freely and impact in a horizontal position  $\pm 10^\circ$ (5).

After the drop test, there must be no leakage (6).





# Historical background

## ➤ CS 27/29.952 (a) Drop test requirements.

(a) Drop test requirements. Each tank, or the most critical tank, must be drop-tested;

(a)(4) The tank must be enclosed in a surrounding structure representative of the installation unless it can be established that the surrounding structure is free of projections or other design features likely to contribute to rupture of the tank.





# Historical background

## ► Workshare at EASA

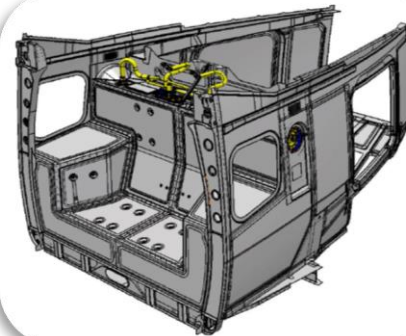
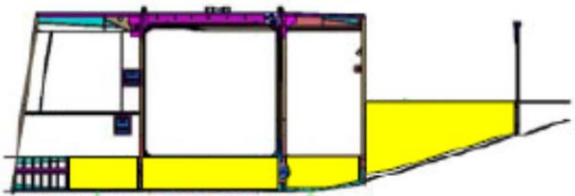
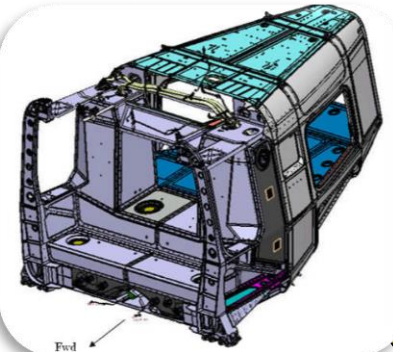
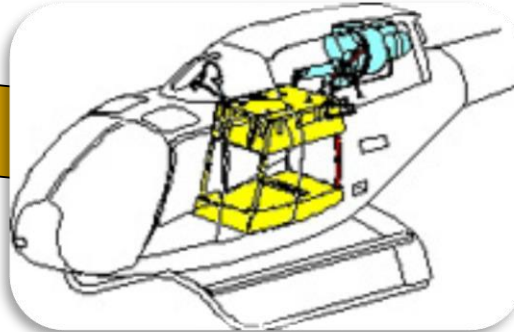
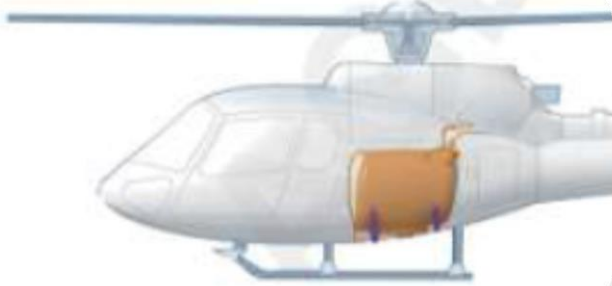
Powerplant expert (P7) has the primary responsibility for fuel tank certification. Structure Experts (P3) assists Powerplant Experts as a secondary panel to identify the amount of surrounding structure to be tested with the fuel tank, in the validation of structural similarity demonstration, simulation tool validation, etc.

Today, this activity represents an important part of fuel tank certification.

CS 29.952	a.(1)	a.(2)	a.(3)	a.(4)	a.(5)	a(6)	b	c	d	e	f	g
Panel	7	7	7	3	7	7	3	7	3	7	7	7
	Drop test	Impact surface	Tank fill with water	Surrounding structure	Tank attitude	No leakage	Load factor	Fuel line attachment breakaway	Frangible and deformable structural	Ignition source	design criteria	Rigid or semi-rigid fuel tanks



# Typical Fuel tank location on Rotorcrafts





# Draft CM – EASA Policy

- This CM intent is to remind that CS27/29.952(a)(4) is applicable when certifying design features, item of mass, structures installed at the vicinity of fuel tanks e.g:
  - equipment
  - external load attachment means
  - massive hooks
  - Steps
  - (...)
- TC assumptions might be invalidated due to the presence of additional equipment and the associated structural reinforcement.
- ➔ **Compliance to CS27/29-952 have to be re-evaluated in the frame of post TC activities (major MOD, STC) involving installation of equipment at the vicinity of fuel tanks as they can be a contributing hazard to the fuel tank.**



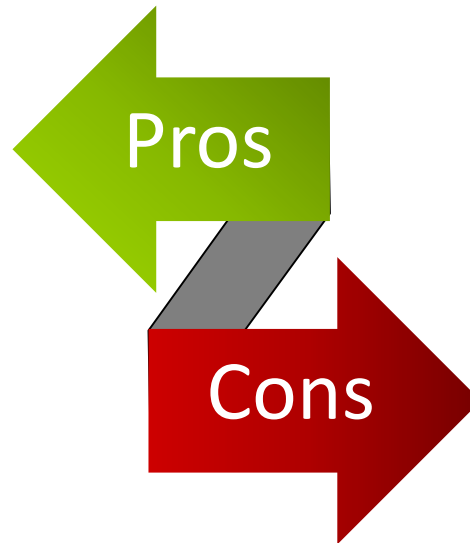
# Draft CM –Guidance for compliance

To demonstrate that the added structure is not a contributing hazard for the fuel tank by:

OEM: Original Equipment  
Manufacturer  
STCH: Supplement type certificate  
holder



- Direct compliance to CS27/29-952



- High costs for OEM or STCH
- Difficulties to define the test article and to install the test article on the platform



# Draft CM –Guidance for compliance

- To demonstrate that the added structure is not a contributing hazard for the fuel tank by:

## Option 2

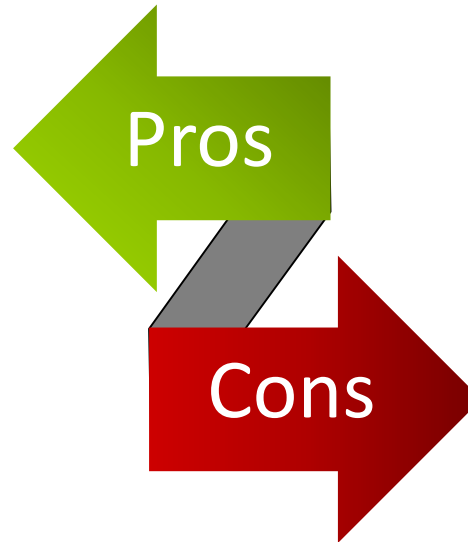
Dynamic analysis correlated by a  
reference dynamic drop test.

Note: AC 27/29.952 offers to use dynamic analysis in order to show that the added structure does not adversely impact the result of the reference drop test.



# Draft CM –Guidance for compliance

- Reduced costs



- Time consuming,
- A fully instrumented reference dynamic drop test is needed for dynamic analysis correlation, including drop speed.
- Only valid when close similarity with the reference drop test surrounding structure can be demonstrated.
- Additional subassembly or component tests can be requested
- Inaccuracy of modelling approach / macro approach:
  - ❖ No capability to detail the fracture of composite structure (1)
  - ❖ Limited capability to simulate fluid dynamics effect
- Pass fail criteria: absence of leakage can be challenged

(1) Needles, fibre rupture pattern, local fibre structural properties to puncture a bladder.



# Guidance for compliance demonstration

- To demonstrate that the added structure is not a contributing hazard for the fuel tank by:

## Option 3

Design provision to minimize interaction with fuel tank with external equipment

•Compliance by design  
description or partial tests

Pros

Cons

- Heavy equipment moved away from the fuel tank area usually close to the rotorcraft center of gravity..
- Additional shield/protection features could cause weight penalty.



# Draft CM –Guidance for compliance

- Options 1&2 would be more feasible for OEMs or STCH supported by OEMs.
- Option 3 should be the best option for STCH when not supported by OEMs





# Conclusion and way forward

- This policy has been applied on Changes to Type certification and Validations since 2013.
- Draft CM to be published by the end of the year on EASA web site:  
<http://easa.europa.eu/document-library/public-consultations/certification-memoranda>
- A public consultation phase is part of the CM process.
- Others initiatives to improve post-crash survivability
  - EASA is also looking at extending the policy for installation of cabin equipment at the direct vicinity of fuel tanks (CS27/29.952(a)4)).
  - The Federal Aviation Administration tasks the *Aviation Rulemaking Advisory Committee (ARAC)* to provide advice and recommendations on occupant protection rulemaking, in particular on the possibility for already certified rotorcrafts, of retroactive standards for emergency landing conditions and fuel system crash resistance.



# Questions?

