

Fireproof / Fire-resistance / Fire Condition Compliance Demonstration

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Rotorcraft Structures Workshop
18-19 February 2025

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Rotorcraft Structures Workshop 18-19 February 2025

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Fire condition

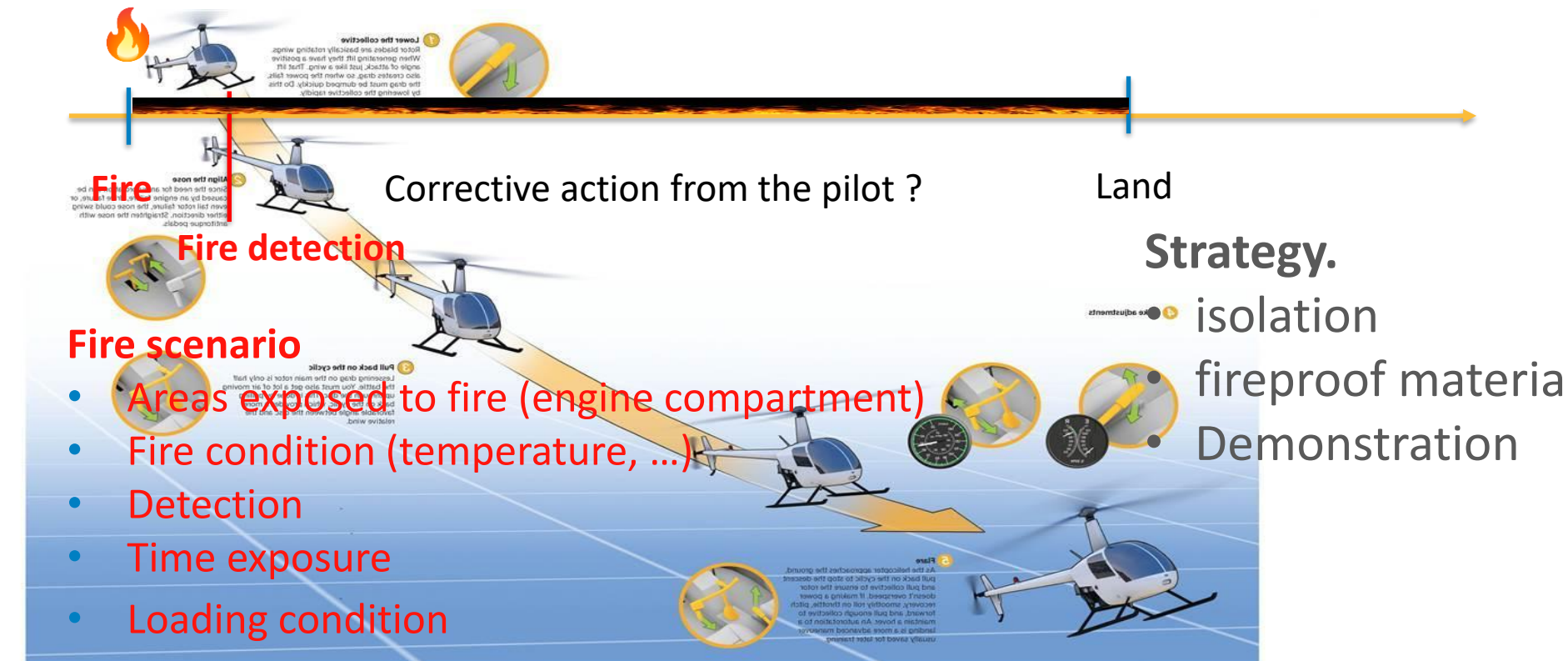
Contents

- History
- Fire scenario
- Requirement
- Acceptable approach. Certification Memorandum
- Conclusion

Fire condition – History

- Loads under fire not uniformly and consistently considered for certification
- Managed by numerous CRIs, IPs

Fire condition



Fire condition – Requirement

CS 29.861 Fire protection of structure, controls, and other parts

Each part of the structure, controls, and the rotor mechanism, and other parts essential to controlled landing and (for Category A) flight that would be affected by powerplant fires must be isolated under CS 29. 1191, or must be:

- (a) For **Category A** rotorcraft, **fire-proof (15')**; and
- (b) For **Category B** rotorcraft, fire-proof or protected so that they can perform their essential functions **for at least 5 minutes** under any foreseeable powerplant fire conditions.

CS 27.861 Fire protection of structure, controls, and other parts

Each part of the structure, controls, rotor mechanism, and other parts essential to a controlled landing that would be affected by powerplant fires must be

- fireproof (15') **or**
- protected so they can perform their essential functions **for at least 5 minutes** under any foreseeable powerplant fire conditions (AC 27.861 (b). Procedures. time necessary...)

Fire condition – Requirement & Guidance

AC 27/29.861 Fire protection of structure

(b)(3)(i) / (b)(4) (i) time necessary to complete an emergency descent and to land (total time interval to be **not less than 5 minutes**).

AC 20-135 Powerplant Installation and Propulsion System Component Fire Protection Test Methods, Standards, and Criteria

AC33.17-1A Engine Fire Protection

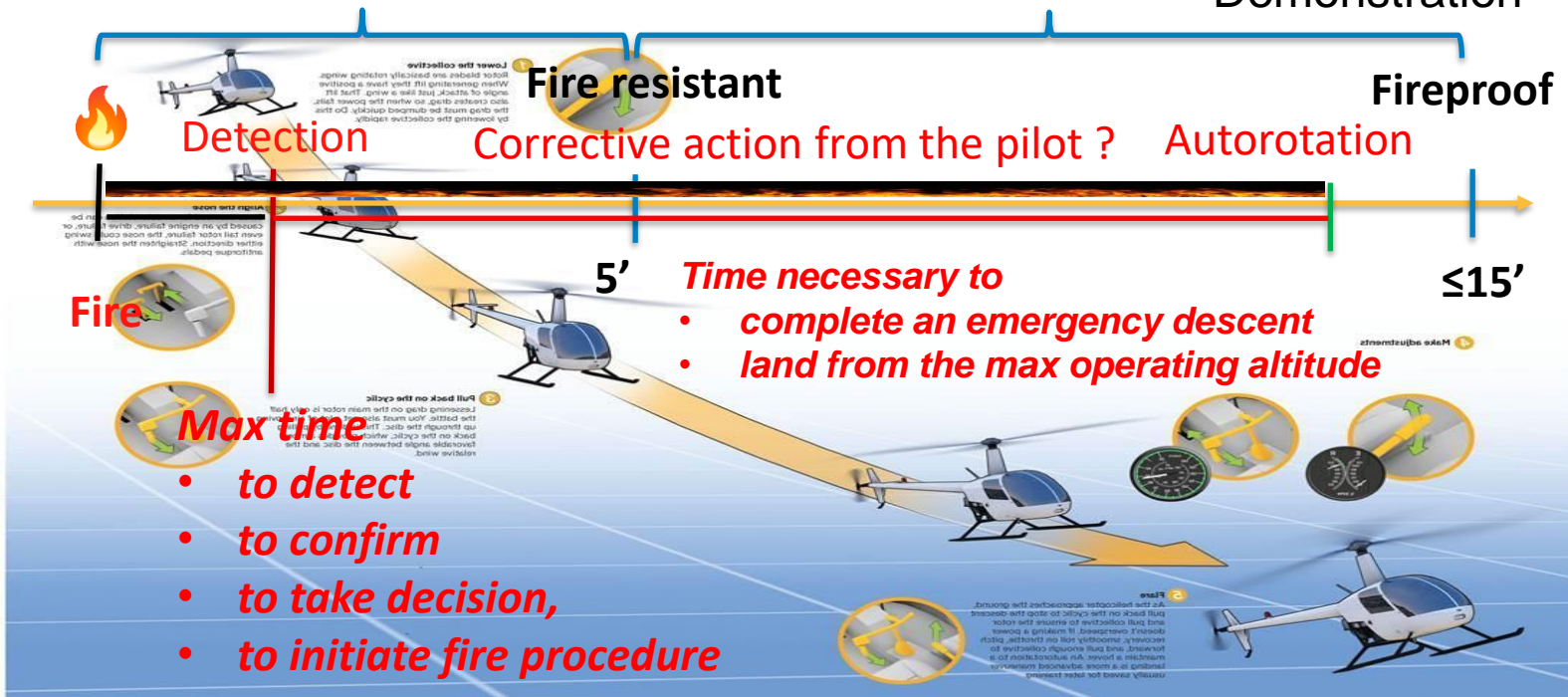
CS-Definition

- Fireproof 15'
- Fire Resistance 5'

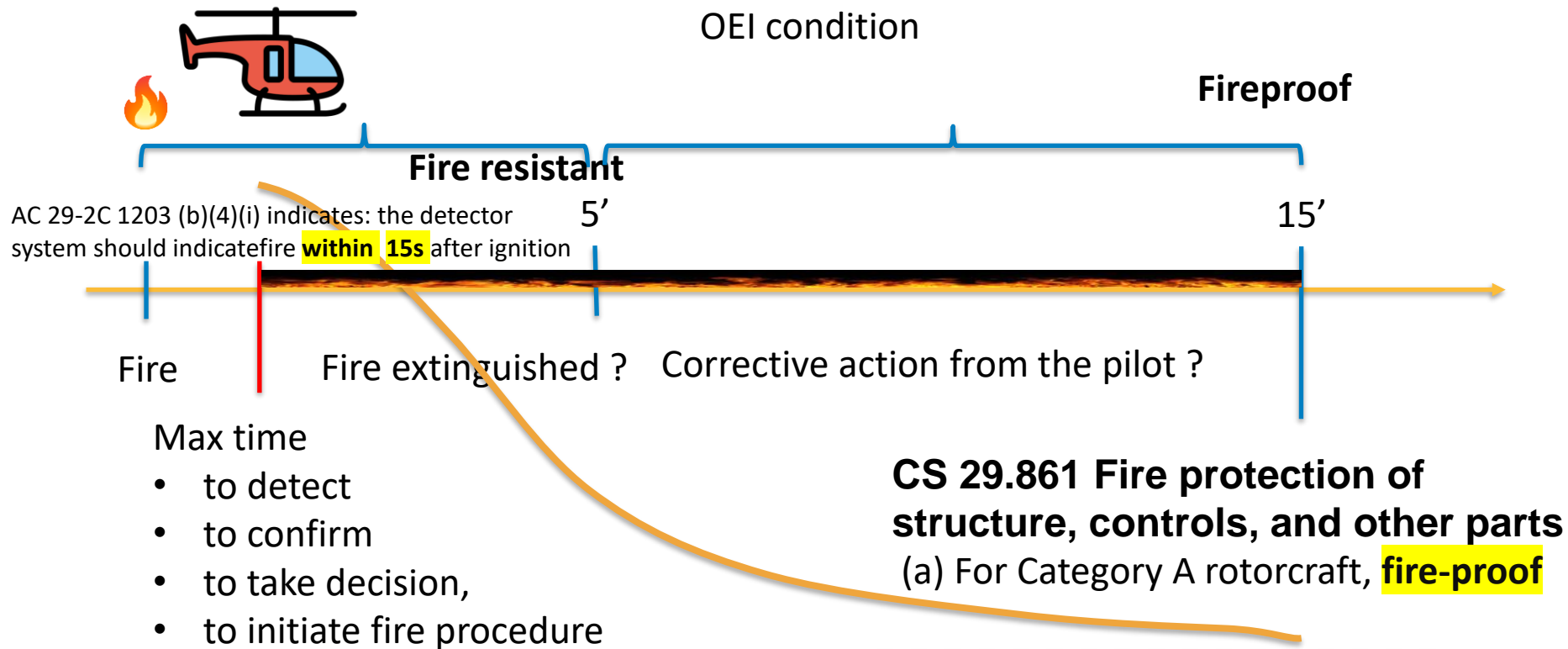
Fire condition (CS 27 & cat B)

Strategy (AC 27.571).

- Isolation
- Material selection.
- Demonstration



Fire condition (CS 29 & Cat A)



Loads under fire CM-S-015 (History)

Fire scenario defined but loads under fire condition not well addressed



EASA Proposed CM No.: CM-S-015 Issue 01

- 2020 CM applicable to CS 29 & 27 Cat A
- 2021 Public consultation
- 2022 SAE A-22
 - EASA – FAA – TCCA
- 2024 Convergence
- 2025 CM “Reactivated”

**Notification of a Proposal to issue a
Certification Memorandum**

**Required material properties and structural residual
strength for Fireproof / Fire-resistance compliance
demonstration**

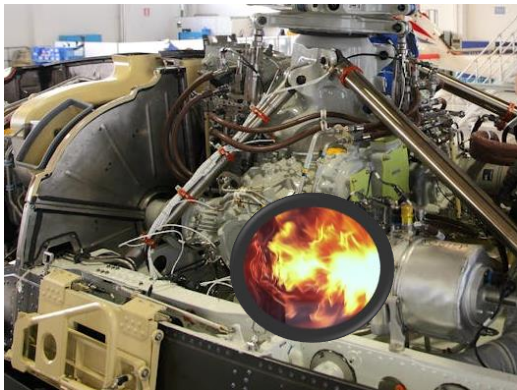
EASA Proposed CM No.: CM-S-015 Issue 01 issued 07 July 2021

Regulatory requirements: CS 29.861, 29.1181, 27/29.1183, 29.1191, 29.1193, 27/29.1194

EASA Certification Memoranda clarify the European Aviation Safety Agency's general course of action on specific certification items. They are intended to provide guidance on a particular subject and, as non-binding material, may provide complementary information and guidance for compliance demonstration with current standards. Certification Memoranda are provided for information purposes only and must not be misconstrued as formally adopted Acceptable Means of Compliance (AMC) or as Guidance Material (GM). Certification Memoranda are not intended to introduce new certification requirements or to modify existing certification requirements and do not constitute any legal obligation.

EASA Certification Memoranda are living documents into which either additional criteria or additional issues can be incorporated as soon as a need is identified by EASA.

Loads under fire CM-S-015

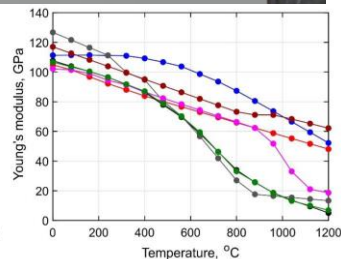
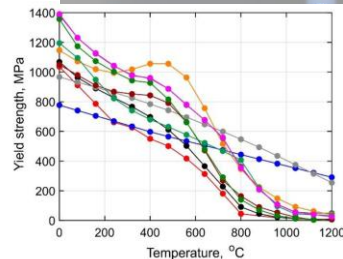


Temperature under fire

Temperature: inside the fire zone & adjacent structure

Strategy:

Thermal protection (shield, insulation),
Material selection & performances



Material Characteristics Vs temperature

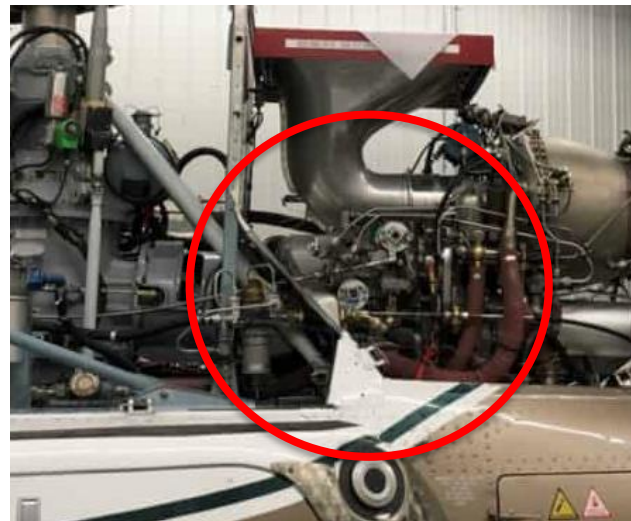


Fire conditions – Certification Memorandum

Material selection

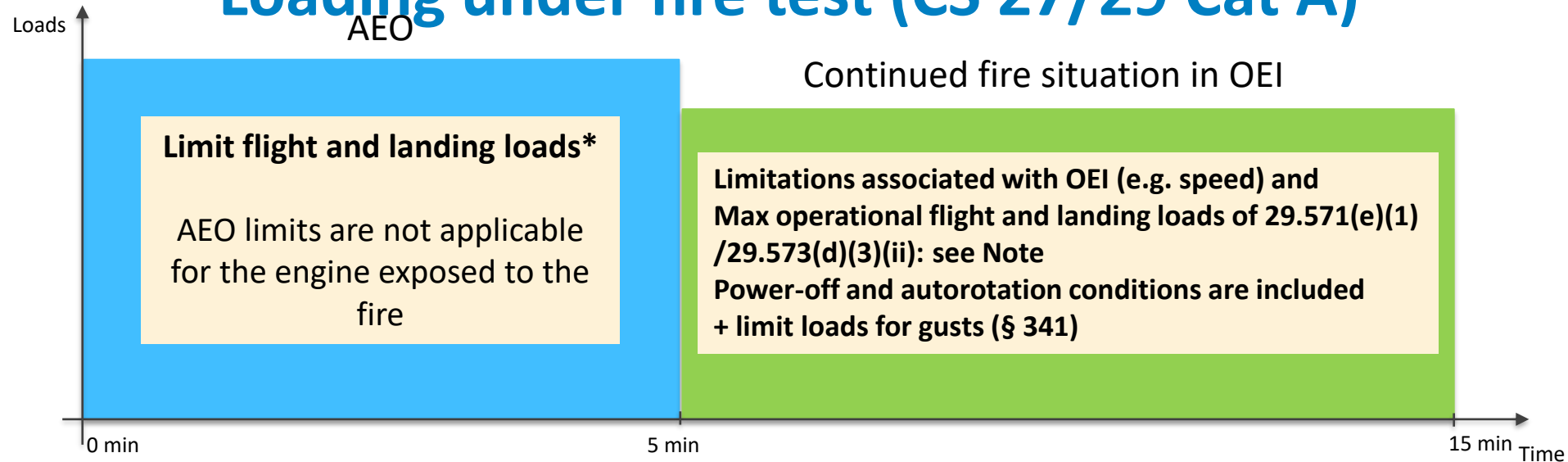
fireproof material

- AISI 4100 series and 15-5PH CRES steels,
- Inconel 718,
- Ti-6Al-4V and Ti-6Al-2Sn-4Zr-2Mo alloys



Demonstration: loading capability under limit and ultimate load condition (no fire condition) are substantiated

Loading under fire test (CS 27/29 Cat A)



Note: Max operational loads expected in service selected according to 29.571(e)(1) / 29.573(d)(3)(ii), including:

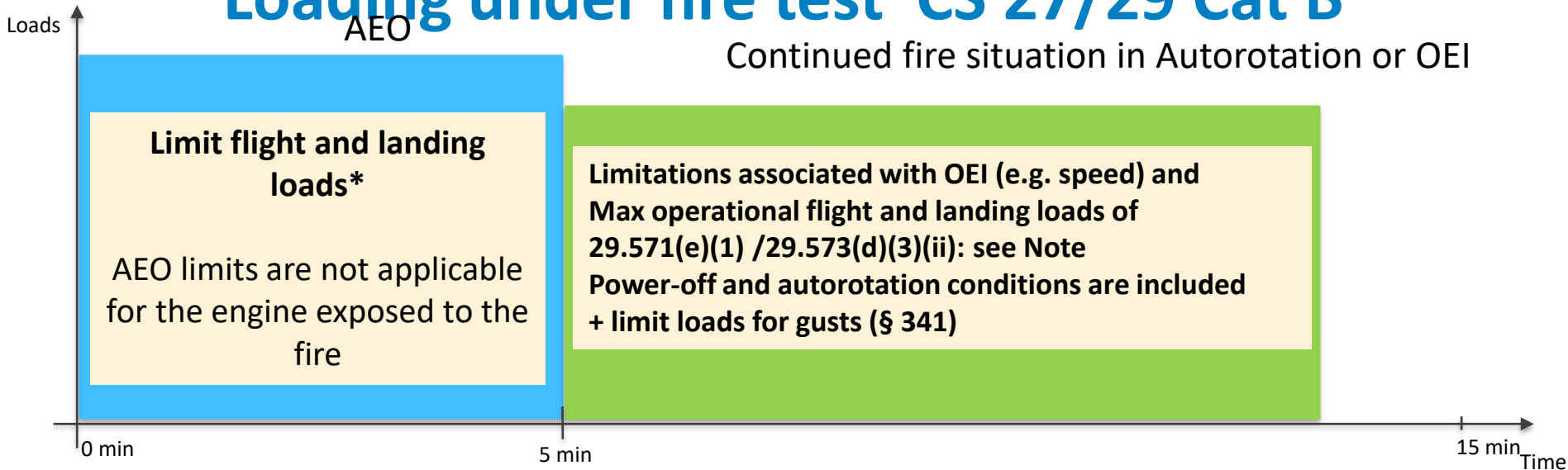
- pull-up manoeuvres to no less than 2.0g,
- full pedal spot turns

Load conditions to be agreed with the Authority

No probability of occurrence to be taken into account (probability of 1)

* Limit load is considered as ultimate, i.e. safety factor = 1.0. No failure permitted and deformation should not prevent continued safe flight and landing. This is also applicable for the continued fire situation.

Loading under fire test CS 27/29 Cat B



Note: Max operational loads expected in service selected according to 29.571(e)(1) / 29.573(d)(3)(ii), including:

- pull-up manoeuvres to no less than 2.0g,
- full pedal spot turns

Load conditions to be agreed with the Authority

No probability of occurrence to be taken into account (probability of 1)

* Limit load is considered as ultimate, i.e. safety factor = 1.0. No failure permitted and deformation should not prevent continued safe flight and landing. This is also applicable for the continued fire situation.

Fire conditions – Certification Memorandum

In the absence of a more rational determination the following criteria are applicable to the structure including elastomeric materials:

The structure should be able to support limit flight and landing loads* (including engine limit torque) in AEO Condition without failure for **at least 5 minutes**. For multi engine rotorcraft, OEI limits are not applicable for engine exposed to the fire.

**Limit load is considered as ultimate, i.e. safety factor = 1.0. No failure permitted and deformation should not prevent continued safe flight and landing. This is also applicable for the continued fire situation.*

After 5 minutes and until the end of the total time duration under consideration, the engine/APU may be assumed to be shut down and the structure should be able to support the following load conditions, consistent with any limitations given in the Flight Manual for autorotation or OEI, as applicable:

1. Max operational flight and landing loads of 27.571(a)(3), 29.571(e)(1) and 27/29.573(d)(3)(ii) including
 - I. pull-up manoeuvres to no less than 2.0g
 - II. full pedal spot turns
2. Power-off and autorotation conditions are included and
3. limit loads for gusts (27/29.341)

Fire conditions – Certification Memorandum

Duration

CS 27/29 Cat A

→ For fireproof structure, the total time interval is **15 minutes**.

CS 27/29 Cat B

→ For structure that is protected so that they can perform their essential functions under any foreseeable powerplant fire conditions, the total time duration may be reduced from 15 minutes to the **time necessary to complete an emergency descent (as described in the flight manual) and landing** from the maximum operating altitude for which certification is required. In no case is the total time interval to be less than 5 minutes.

Loads under fire CM-S-015

CM-S-015 “reactivation”

1. Extend the applicability to CS 27 & CS 29 Cat B

2. Clarify the conditions for “fireproof material”

3.2.1.1 The following materials that are commonly used on engine and APU mounts and have been previously accepted as fireproof by EASA can be considered fireproof provided that dimensions / loading capability under limit and ultimate load condition (no fire condition) are substantiated

3. Include the agreed loading under fire (EASA – FAA agreement)

3.2.1.4. In the absence of a more rational determination the following criteria are applicable to the structure including elastomeric material

Conclusion fire condition

CM-S-015 ready for publication

→ Fire scenario well identified

→ Strategy

→ Selection of the Material (fireproof) or

→ thermal shield

→ Test under fire condition

→ Structure Exposed **directly** and **indirectly** to fire (including airframe)

→ Loading conditions defined



2020-2025

CS27 \leq 15' Vs CS 29 (no credit of the fire extinguisher system)

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Loading under fire condition

How to determine the loading conditions associated to fire Scenario?

- Limit loads
- Discrete source damage as per CS 25.571(e) : The aeroplane must be capable of successfully completing a flight during which likely structural damage occurs
- Cat 4 damage (composite) By definition, Category 4 damage will require residual strength substantiation to levels that complete a flight with limited maneuvers based on the associated regulatory loads.
- Max operational loads used for fatigue covering OEI
- Limit OEI
- Max operational loads used for get home loads (AMC CS25.571 70% LL)