



**EASA**  
European Aviation Safety Agency

# STCs: Internal and External Installations

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# Internal and External Installations

- Typical STC Installations
- Classification of Change Criteria
- Applicable Structural Requirements:
  - All STC Applications
  - Internal Installations
  - External Installations
- Additional Considerations
- Conclusions



# Typical STC Installations



**Internal  
Installations**

**External  
Installations**



Flotation





# Change Classification

## SIGNIFICANT

- **EMS** (only if primary structural changes sufficient to invalidate the cert assumptions)
- **Human External Cargo** Must comply with the latest HEC certification specifications (*for the affected areas*)

**Latest  
Amdt.**

## MINOR

### No appreciable effect on:

- Mass, balance, structural strength
- Reliability, operational characteristics, noise, fuel venting, exhaust emission
- Other characteristics affecting the airworthiness of the product

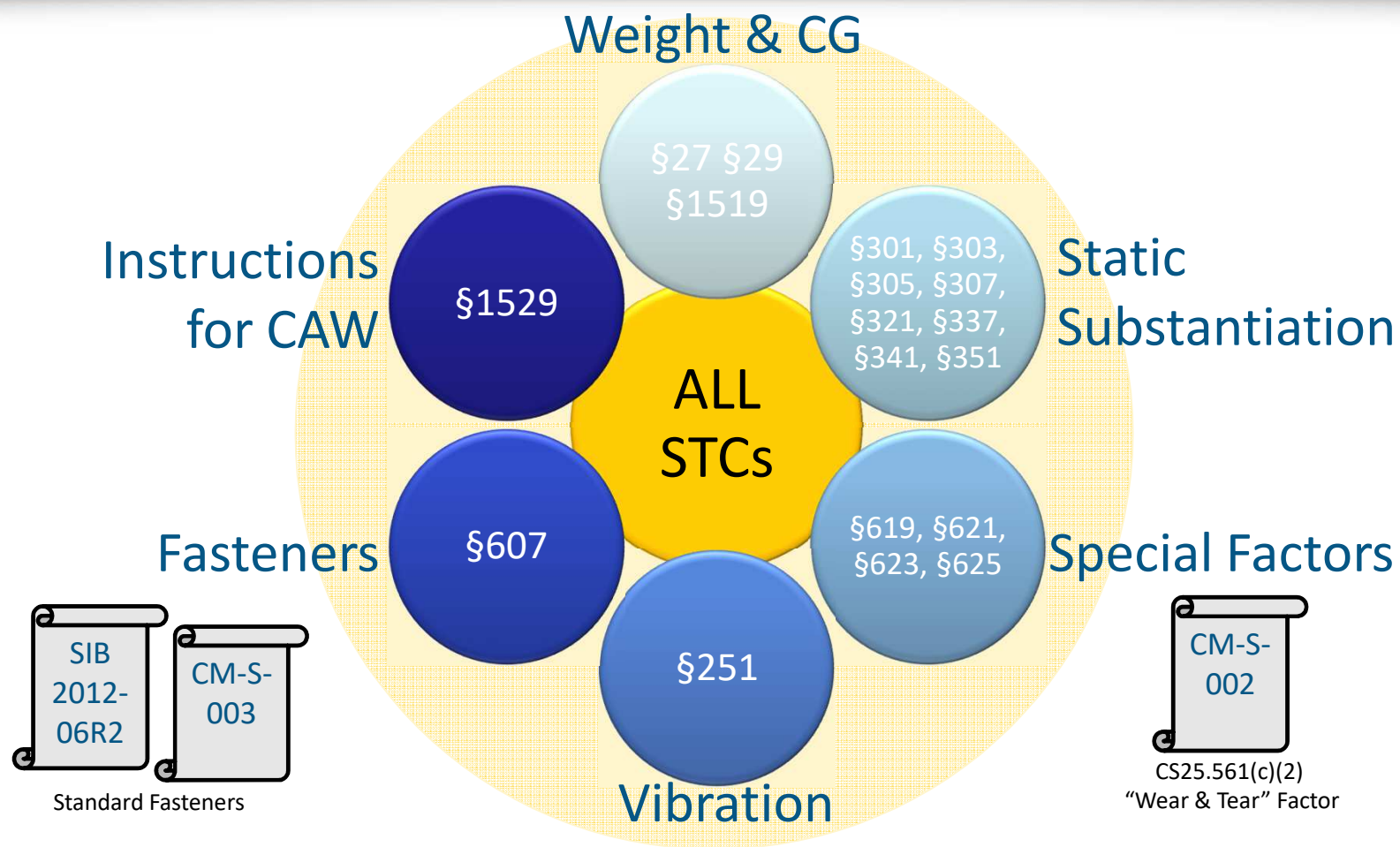
**As  
TCDS**

## MAJOR

- Everything else!



# Circle of Requirements: all STCs

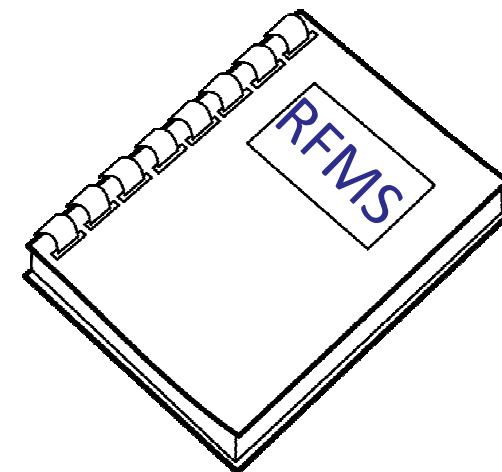
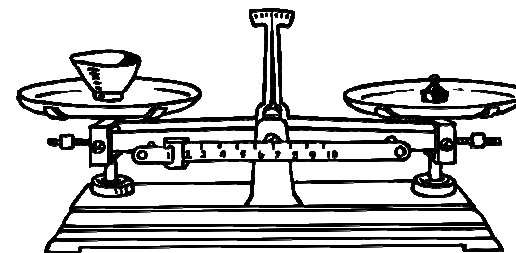




# Weight and CG

§27 §29  
§1519

- Weight and CG should be assessed
- If appropriate, separate into removable parts and fixed parts
- Ensure rotorcraft inside certified weight/CG envelope
- Publish in the Flight Manual Supplement to allow operators to manage the rotorcraft mass/cg.







# Static Substantiation

§301, §303,  
§305, §307,  
§321, §337,  
§341, §351

## EXTERNAL INSTALLATIONS

## INTERNAL INSTALLATIONS

§301 LOADS

§303 FACTOR OF SAFETY

§321 FLIGHT LOADS (General)

§337: -1.0g to +3.5g

TC Holder: Local Accelerations

Aerodynamic Loads (Drag)

§341: Gust Loading

§351: Yaw Manoeuvre

*§561: Occupied, Above  
and/or Behind, Below  
(ULTIMATE)*

§305 STRENGTH AND DEFORMATION

§307 PROOF OF STRUCTURE

Test

Hand Calculations

Finite Element Analysis



Validate



# Static Substantiation

§301, §303,  
§305, §307,  
§321, §337,  
§341, §351

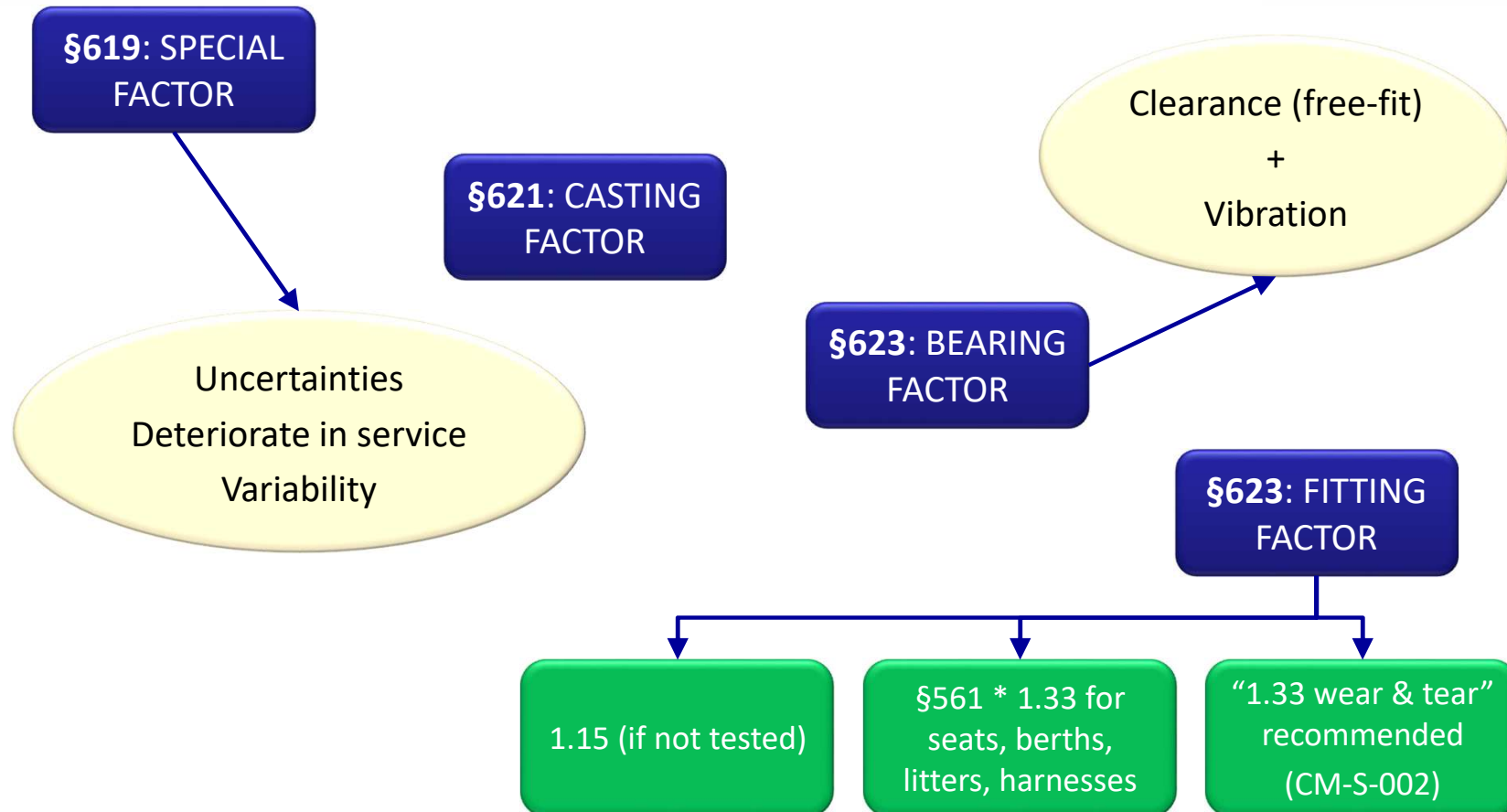
- Rotorcraft Structure Analysis (attachment point and local structure):
  - Strength of attachment points from TC holder (or TC holder NTO)
  - Reverse engineering
  - Analysis with conservative assumptions
  - Multiple variants: careful to cover “weakest” variant
  
- Influence on Global Rotorcraft loading
  - Large masses far from the CG
  - Drag (total and lateral)





# Special Factors

§619, §621,  
§623, §625



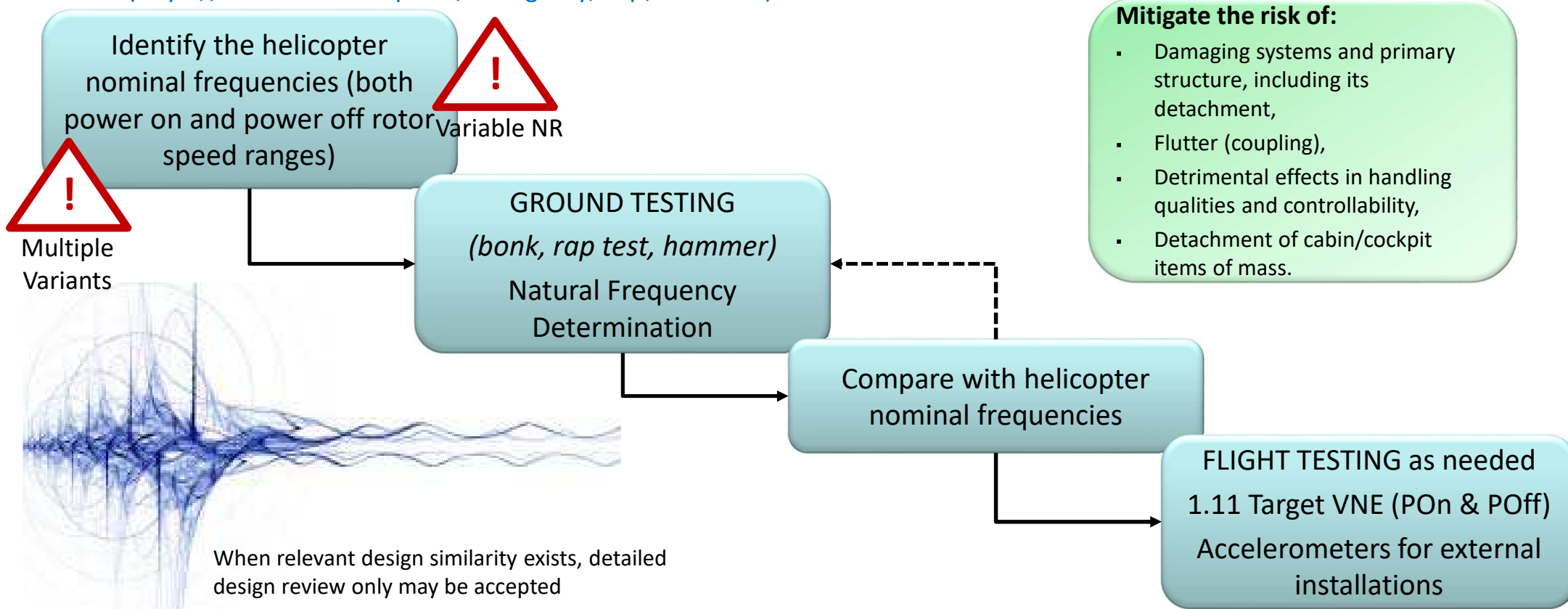


# Vibration

§251

## ► Objective: Prevent the risk of excessive vibration

(<https://www.easa.europa.eu/the-agency/faqs/rotorcraft>)





# Fasteners

\$607

Loss can jeopardise the safe operation of the rotorcraft



Independent double locking

[Adhesive is not considered to be a locking device]

## STANDARD FASTENERS

SIN 2012-06R2  
28 Oct 2013  
Defective  
Standard  
Hardware

Cert Memo  
15 Feb 2015  
CM-S-003  
Issue 1



- Is the **expected reliability sufficient** for intended use:
  - criticality (HAZ or CAT),
  - location,
  - level of redundancy,
  - margins of safety,
  - environment,
  - (adverse) service experience?
  - appropriate ICA



# Instructions for Continued Airworthiness

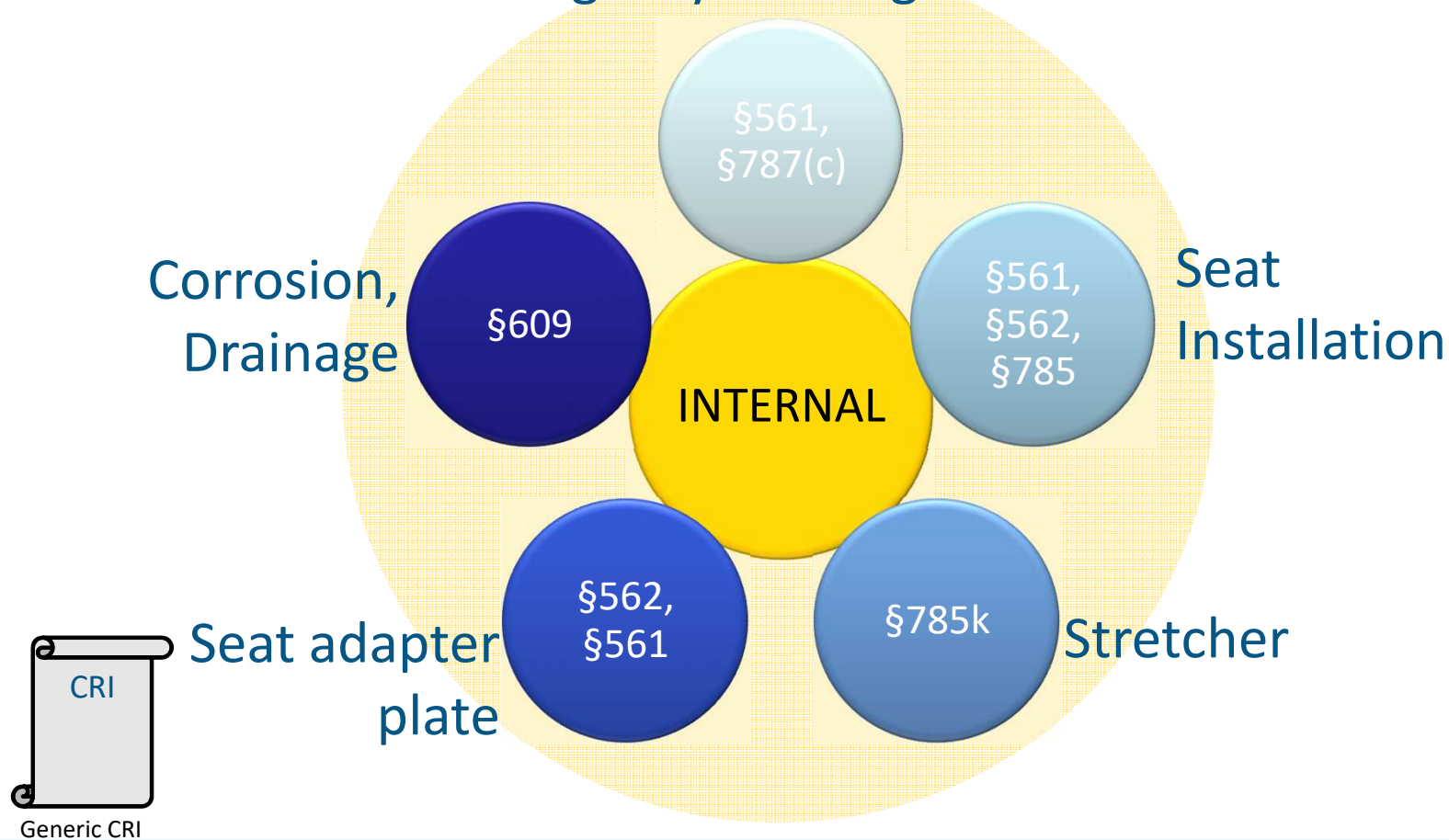
§1529

- Appropriate inspection instructions should be included in the maintenance manual.
- This should cover the STC and the region of the rotorcraft where the external device is attached.



# Circle of Requirements: Internal

## Emergency Landing Conditions



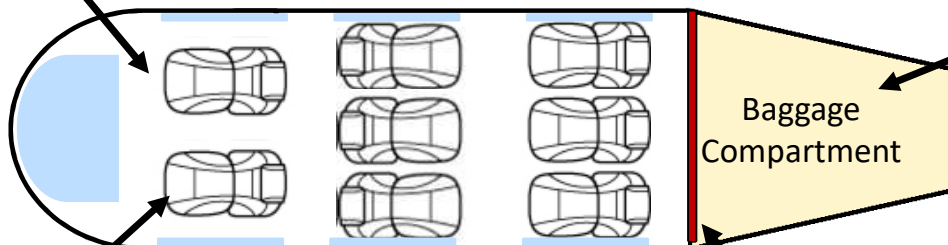


# Emergency Landing Conditions

§561,  
§787(c)

## Occupied Space:

- CS27/29.787
- CS27/29.561(b)  
[16g forward]



## Seats:

- CS27/29.561(b)
- CS27/29.562(b)  
[18.4g forward]  
[30.0g vertical]

## Structural Partition:

- CS27/29.561(c)  
[12g forward]

## Baggage Compartment

### No Structural Partition:

- CS27/29.787
- CS27/29.561(b)  
[16g forward]

### With Structural Partition:

- CS27/29.787
- CS27/29.561(c)  
[12g forward]

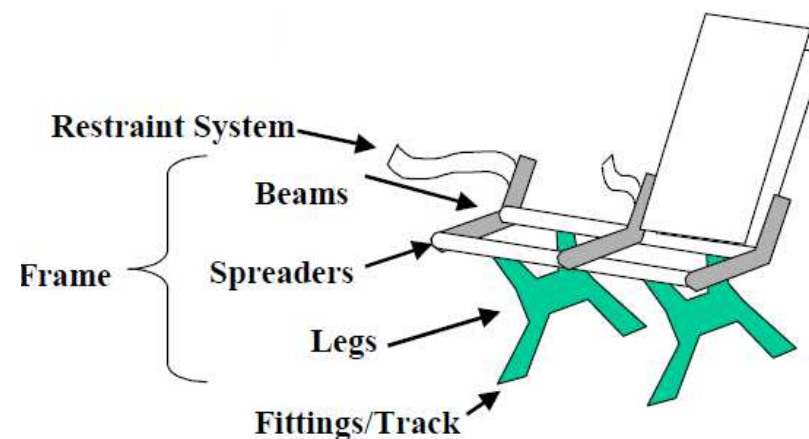
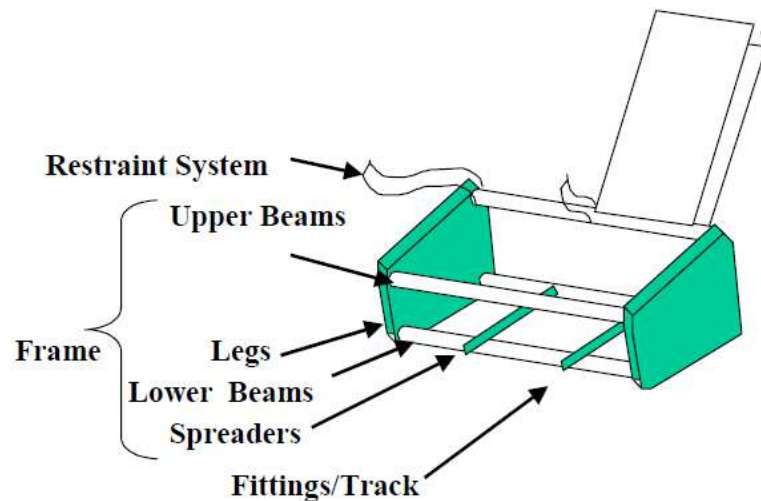
NOTE: For simplicity only forward g factors are quoted. All directions must be considered.



# Seat Installation

§561,  
§562,  
§785

- Emergency landing loads §561 with 1.33 fitting factor
- New Dynamic Seat test:
  - Primary load path modification  
Restraint system, Seat frames, Fittings and tracks, Seat back, Bottom cushions, Seat pan
  - Seat Family Definition, see (AC25.562-1B)



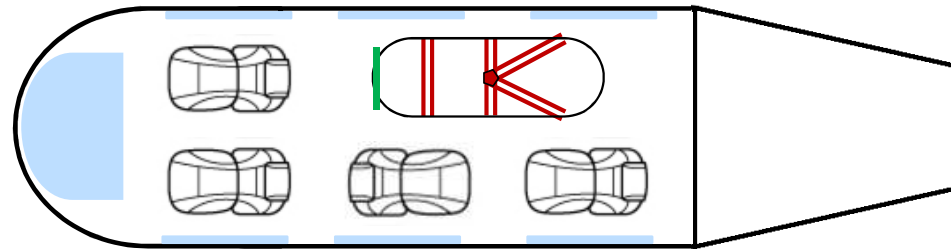




# Stretcher

§785k

- §562 not applicable
- §561 stretcher attachments
- §785 harnesses
- 1.33 fitting factor
- Longitudinal orientation → padded end-board, cloth diaphragm or equivalent





# Seat Adapter Plate

§562,  
§561

- Objective: Level of safety equal to original seat to floor attachment

**Option 1:**

adapter = plinth

- Plinth must be tested as part of the seat to §562b

**Option 2:**

adapter = pallet

- Seat and its attachment to pallet tested to §562b
- Pallet justified to §561 only

**Option 3:**

adapter ≠ plinth,  
adapter ≠ pallet

- Adapter proposed to be classified as part of floor based on (detailed) design review
- Seat and its attachment tested to §562b



# Corrosion, Drainage

\$609

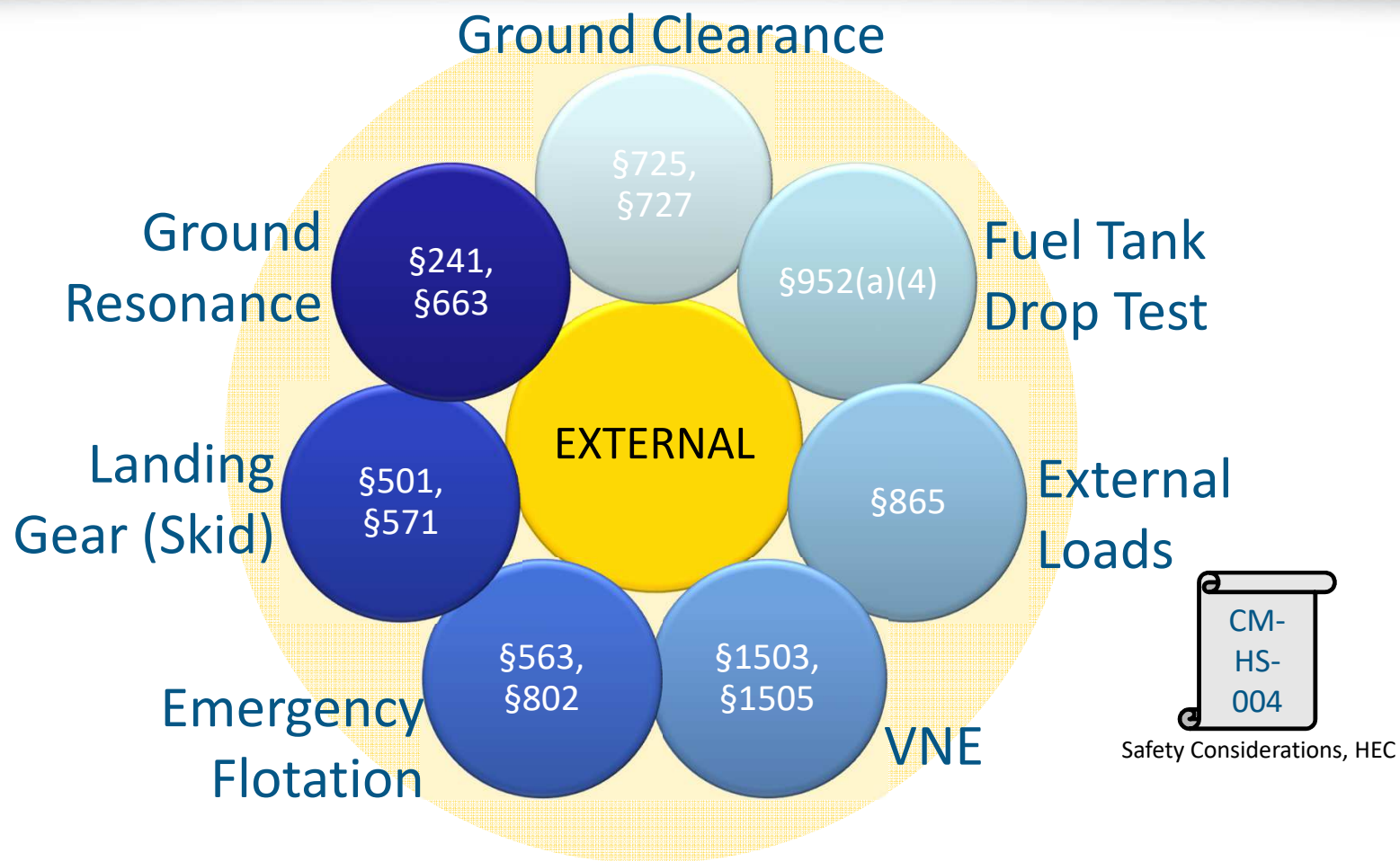
## ➤ Protection of Structure:

### ➤ Floor protection:

- Corrosion
- Drainage



# Circle of Requirements: External





# Ground Clearance

§725,  
§727

## Ground Clearance

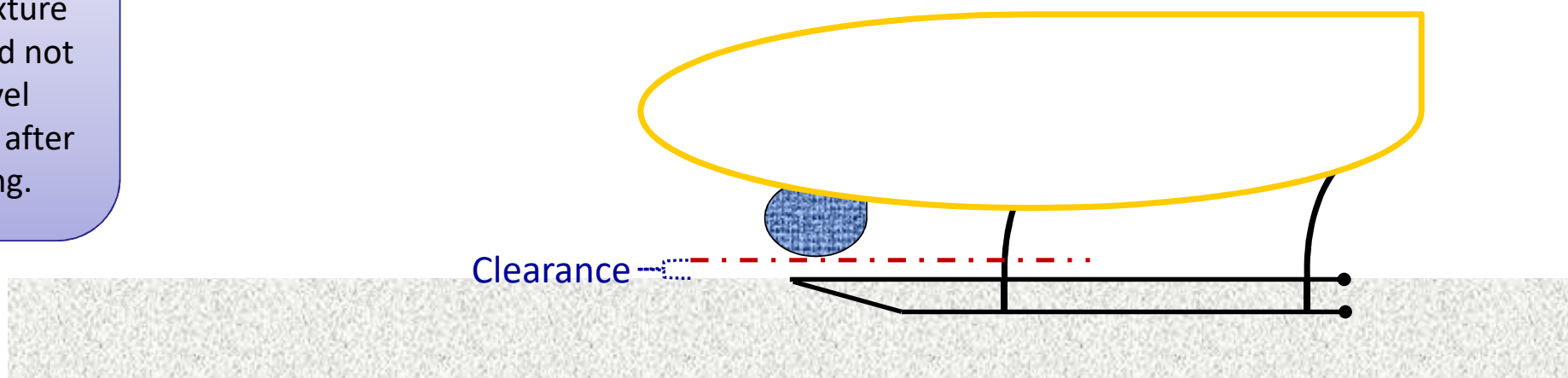
§725 Limit Drop Test

§727 Reserve energy absorption drop test

AC §.727(b)(2), AC§ MG6b.(8) External Devices

### Limit landing load deflection:

The external fixture or device should not contact a level landing surface after a limit landing.





# Ground Clearance

§725,  
§727

Reserve energy absorption drop test deflection:

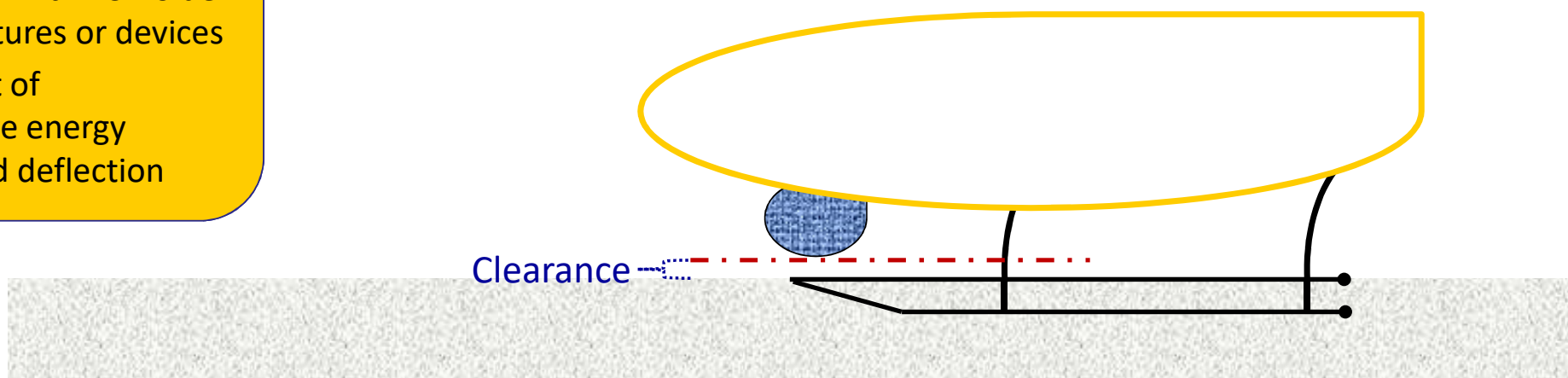
- Devices likely to cause post-landing fires → No Impact
- Electrical connections protection to prevent electrical fires
- Design and/or location to avoid penetration into a critical area

## How to determine clearance:

- ✓ TC Holder Data
- ✓ Comparison with TC Holder external fixtures or devices
- ✓ Assessment of limit/reserve energy landing load deflection

## Flight Test:

Slope landing envelope: Check no problem exists within the TCH certified envelope





# Fuel System Crash Resistance: Drop Test

§952(a)(4)

- Installation of equipment in the vicinity of the fuel tanks may invalidate the §952(a)(4) fuel tank drop test compliance

## Option 1

Demonstrate added structure is not a contributing hazard to fuel tank

- **Dynamic Drop Test**

- Direct Compliance
- High Cost

## Option 2

Demonstrate added structure is not a contributing hazard to fuel tank

- **Dynamic Analysis**

- Correlation of model with a fully instrumented drop test
- Only valid with close similarity to the reference drop test

## Option 3

Remove interaction between installation and fuel tank

- **By Design**

- Locate installation away from the fuel tank





# External Loads / PCDS

§865

§865 is not applicable to External Fixtures:

- NO true jettison capability
- NO true payload capability

*Cameras*

*Searchlights*

*Equipment box with fixed mass/cg*

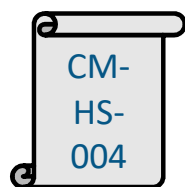
FUTURE  
CM

## HUMAN EXTERNAL CARGO (HEC)

- 3.5g load factor, 30° angle to vertical
- Safety Factor  $\geq 3$  (if no static test)
- Fatigue evaluation §571 §573

## NON HUMAN EXTERNAL CARGO (NHEC)

- 2.5g load factor, 30° angle to vertical
- Safety Factor  $\geq 1.5$
- Fatigue evaluation §571 §573 (hazard to rotorcraft)



Simple PCDS

AMC §865 Simplified method

Complex PCDS

§571 §573 Fatigue evaluation



**Reverse Engineering:**

HEC STC on a NHEC rotorcraft  
can be challenging

Safety Considerations, HEC



# Never-exceed speed (VNE)

§1503,  
§1505

- The operational never-exceed speed VNE should be not more than:
  - 0.9 times the VD speed analysed for structural strength
  - 0.9 times the speed flown for the vibration flight test
- Any restrictions should be clearly defined in the RFMS



# Emergency Flotation

§563,  
§802

## §802 Emergency Flotation and AMC§802

Introduced at CS27/29 Amendment 5, Replaces AC 29 MG 10

Compliance to **§563 Structural Ditching and emergency flotation provisions** is necessary for emergency flotation

**CS27 and CS29  $\leq 9$  passenger capacity:**

Flotation units and attachments only

**CS29  $\geq 10$  passenger capacity:**

Rotorcraft

Resist capsize in sea conditions selected by applicant:

- Scale Model Testing with irregular waves
- Sea conditions defined by significant wave height and mean wave period

CS29: Rotorcraft will not sink following functional loss of any single complete flotation unit



## Landing Gear (Skid)

§501,  
§571

- Attachment of the device to landing gear cross-tube:
  - Static and fatigue consideration of flight loads introduced on the skid landing gear
  - Behaviour of the landing gear may be modified in the landing phase
  - Ground resonance mode may be modified (§241, §663)
  - Protection of cross-tube against degradation at attachment point (§609)



## Additional Considerations – All STCs

- Influence on Global Rotorcraft:
  - Evacuation (Internal Installations)
  - Flammability (Internal Installations)
  - Interference
  - Compatibility with optional kits
  - Global loading on aircraft:
    - Impact on global fatigue
    - Aerodynamic influence on horizontal stabiliser, TR, fin from external installations
- Check current ADs on variant



# Conclusions

- Classification of change:
  - External Installations typically major
  - Internal Installations major if evacuation affected
- Requirement checklist → should be reviewed for each project
- External installation → location is important  
(fuel tank drop test, loading, ground clearance, skid landing gear...)
- Impact on rotorcraft should not be forgotten



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**Thank you for your attention!**

Any questions....?

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