EASA
European Aviation Safety Agency

# Elastomeric parts

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**Rotorcraft Structures Workshop**
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# Elastomers are widely used in Industry

Bridges

Airplanes

Helicopters

**1920s**

- Hugh Lord forms LORD Manufacturing Company.

**1930s**

- Jean-Félix Paulsen forms Paulstra to designing & developing anti-vibration mountings & systems on Aircraft

**1940s**

- LORD first elastomeric parts – transmission and engine isolators for the Bell Model 47 helicopter

**1950s**

- LORD create SPE and BTR elastomers

**1970s**

- Hutchinson buy Paulstra/ Total is Hutchison major staholder
- LORD Elastomeric bearings acceptance in the helicopter industry

**1990s**

- Paulstra's acquires Vibrachoc(specialized business on metallic suspension)
- LORD equip Russian helicopters and fixed wing aircraft
-

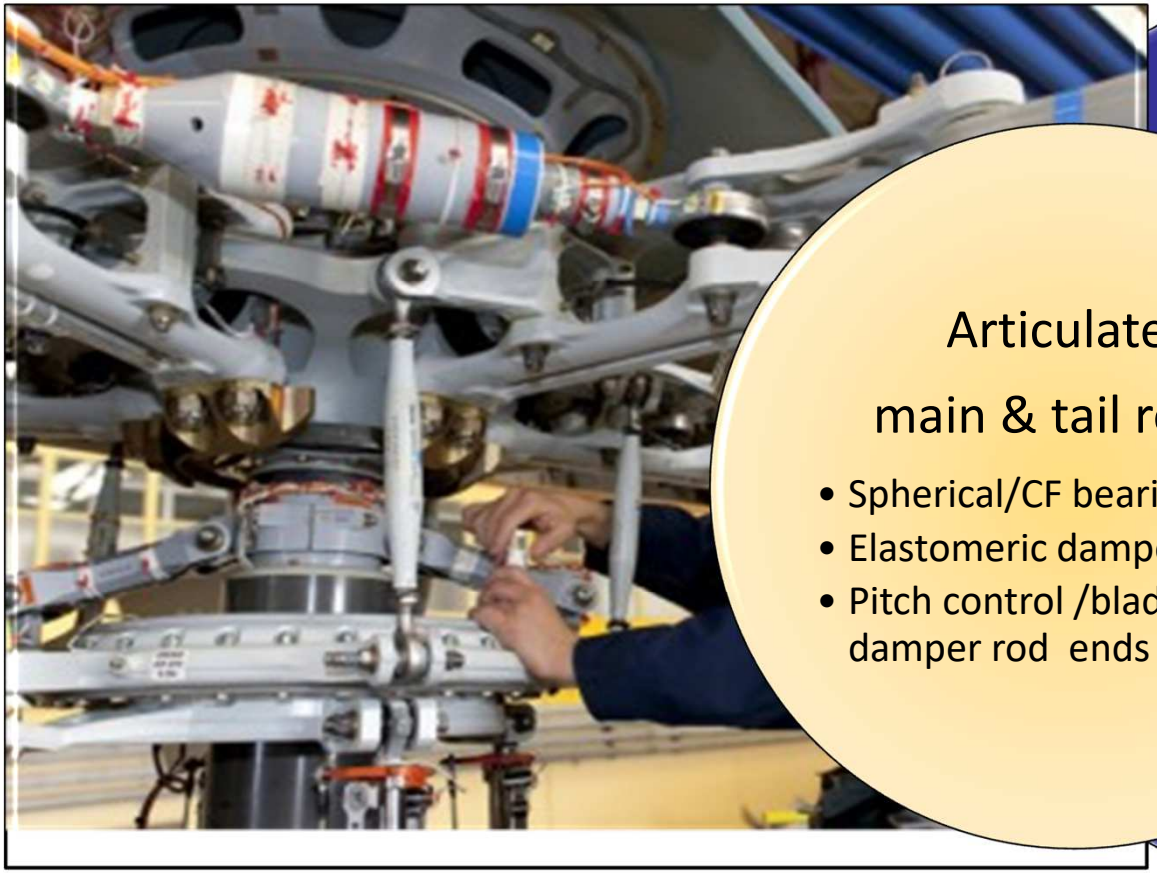
HUTCHINSON PAULSTRA

LORD AskUsHow™

# Presentation objectives:

- Design principle
- Certification approach
- Adverse service experience

# Elastomers on helicopters increased since 2010



Articulated

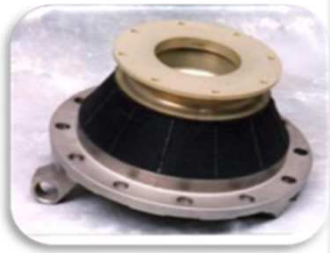
main & tail rotors

- Spherical/CF bearing
- Elastomeric damper
- Pitch control /blade damper rod ends

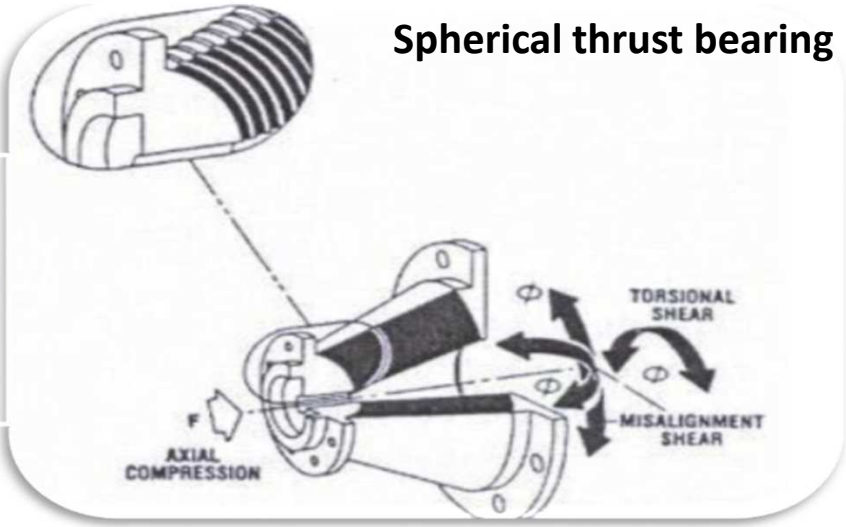
Airframe

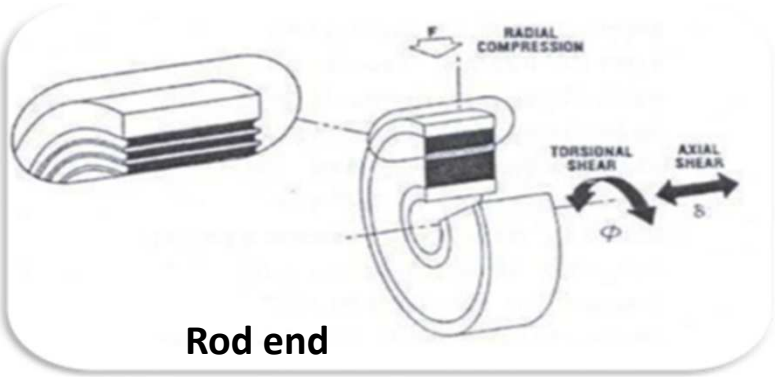
- MGB suspension bearings
- Engine mount
- AVCS

# Type of Elastomer used on Rotorcraft: Laminates



**Spherical thrust bearing**




**Rod end**

**Elastomeric compound (LORD SPE, Paulstra confidential)**

- High Elastic Solid
- Incompressible ( Poisson ration is about 0,5)

**Metal Shim ( Al, steel, Ti..)**

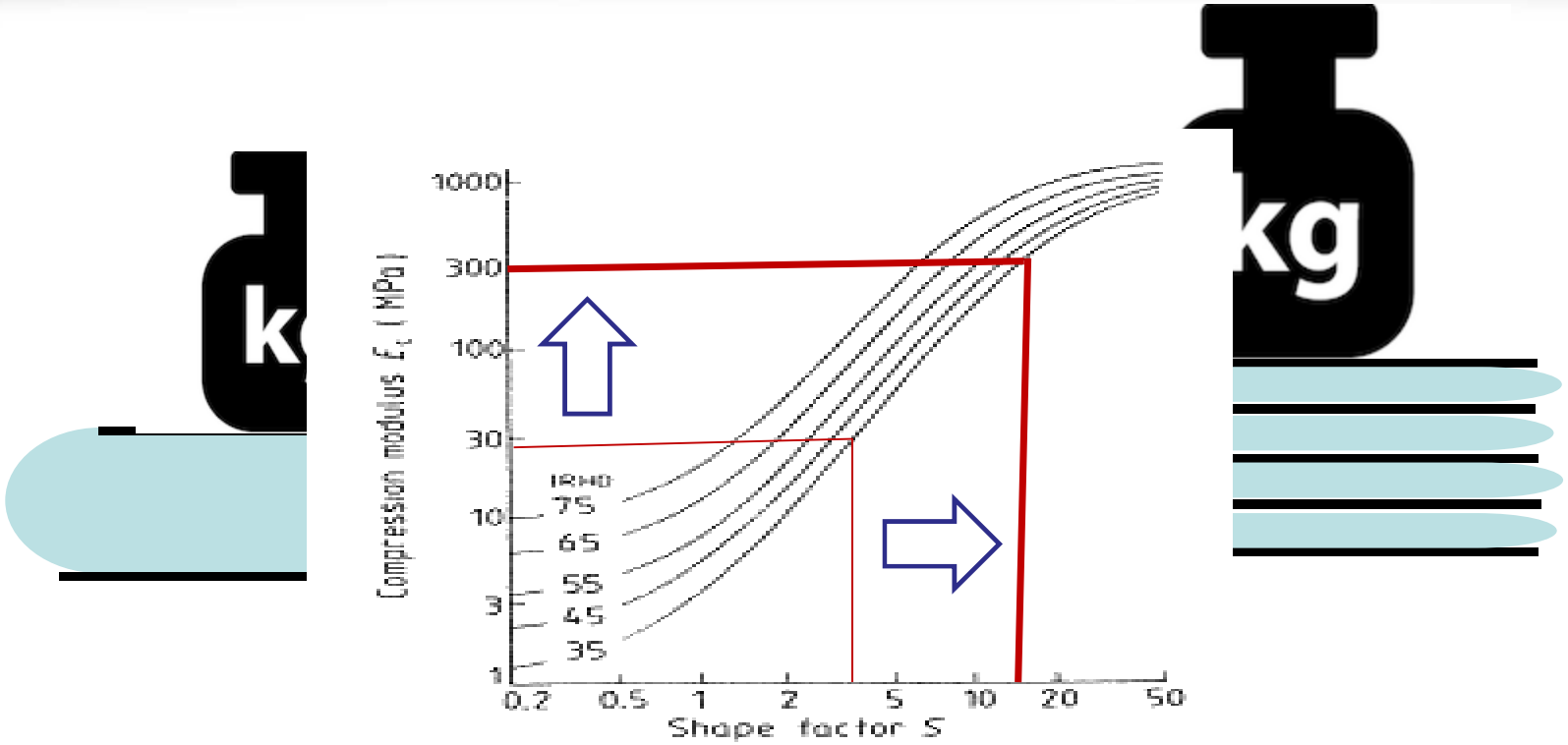
- Act as « races » of conventional bearings
- Mechanism to apply and react loads and motion

- No abrasive wear.
- No lubrication required
- Fail-safe design/capability
- Simple maintenance.
- Capacity of tuning system to natural frequency

# Illustration of laminate performance

Same load surface

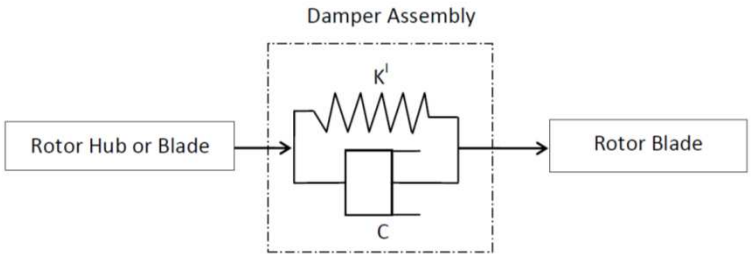
# Illustration of laminate performance




- S=f( compression surface/ rubber  thickness per layer).

# Type of Elastomer used on Rotorcraft: ***Rubber (silicone)***

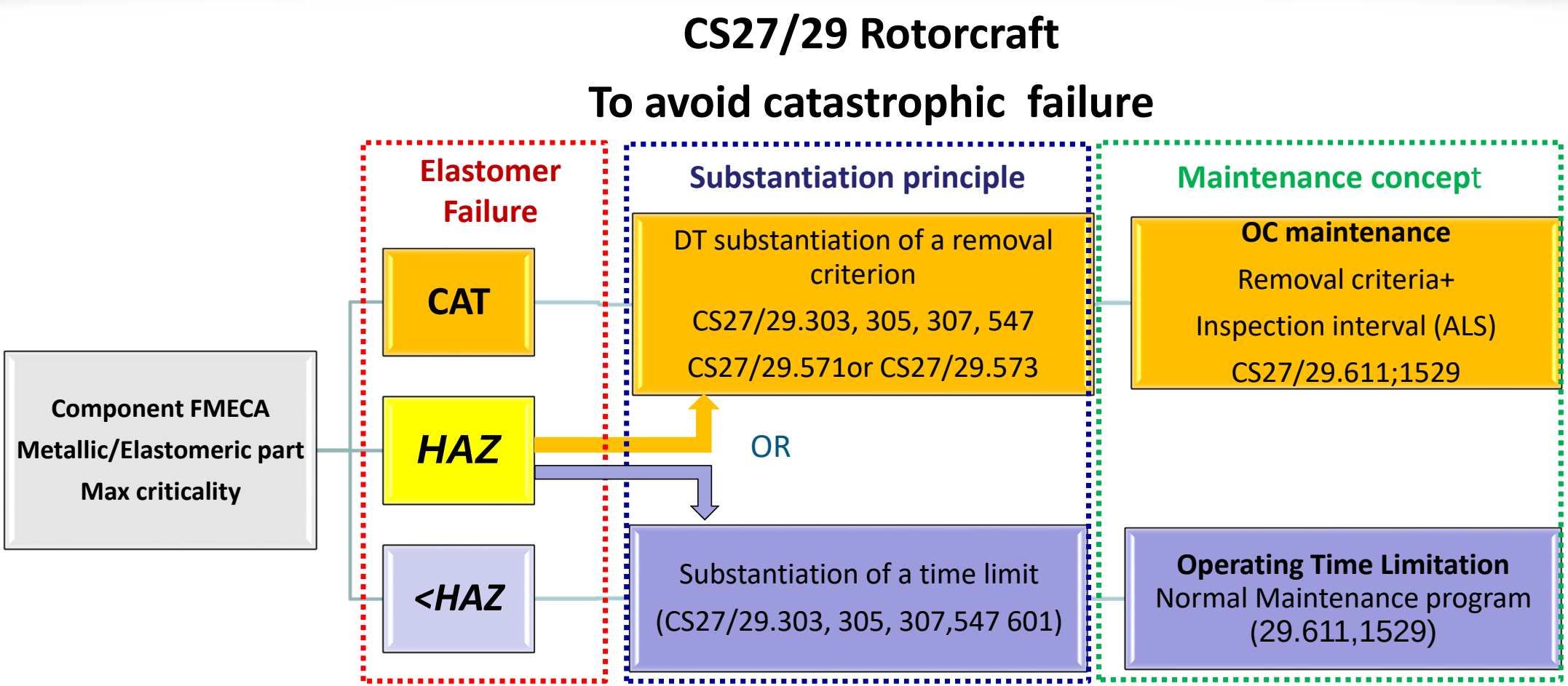
## Elastomeric damper


- **Example: LORD BPR II**
- **BPR®II :**Broad Temperature Range- Silicone elastomer developed to have high Damping and a wide span of operational temperatures (-40°C to +149°C). The loss factor for typical BTR II compounds is in the range of 0.18. This elastomer has better returnability, less drift and better stability with temperature, down to-40°F (-40°C)..

# Presentation objectives:

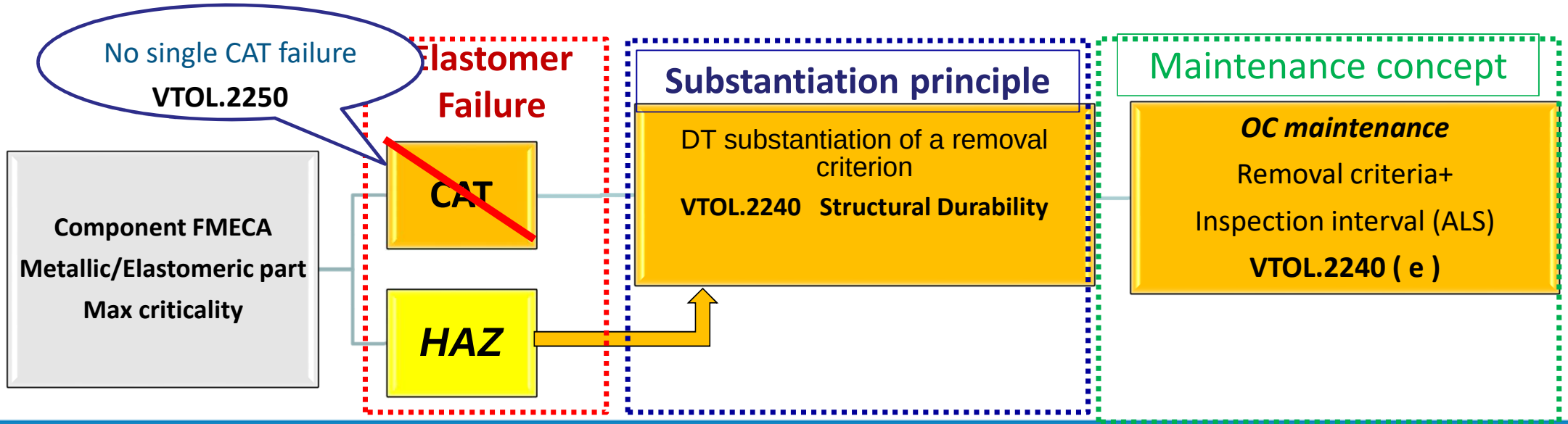
# Elastomeric parts have different criticalities



# Elastomeric parts have different criticalities

**SC-VTOL Enhanced**

VTOL.2240-The applicant must develop and implement inspections or other procedures to prevent structural failures due to foreseeable causes of strength degradation, which could result in serious or fatal injuries, or extended periods of operation with reduced safety margins



# Supplier/OEM-Roles and responsabilities

Qualification test (DT test)

Industrial property make OEM control difficult

Elastomer Manufacturing process &Critical characteristics control (CS27/29.602, 609..)

## Characterization tests

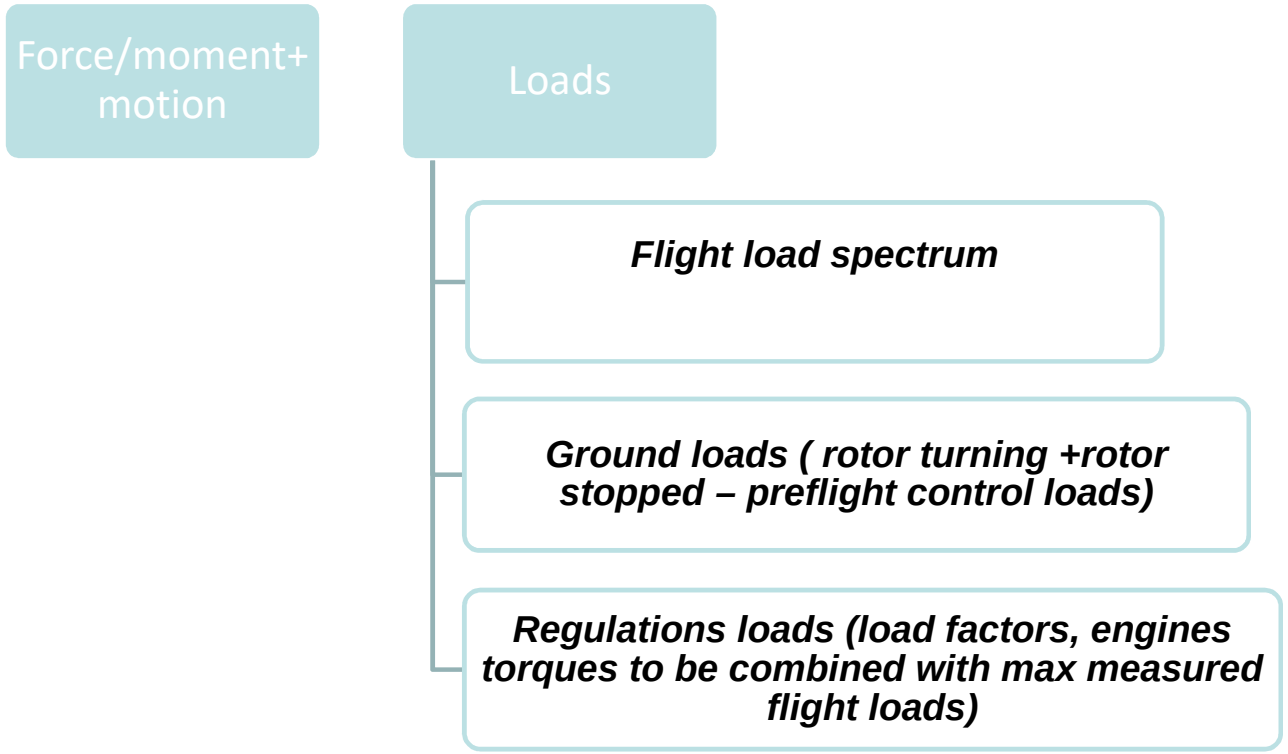
- Temperature
- Heat aged (ASTM573)
- Tensile strength and Elongation (ASTMD412)
- Compression (ASTMD395)
- Static modulus Dynamic modulus
- Ozone (ASTM1149)
- Fluids (oils, fuels, coolants, etc.) & the level of fluid exposure (immersion vs. splash)
- (…)

**•Elastomer Supplier tests**

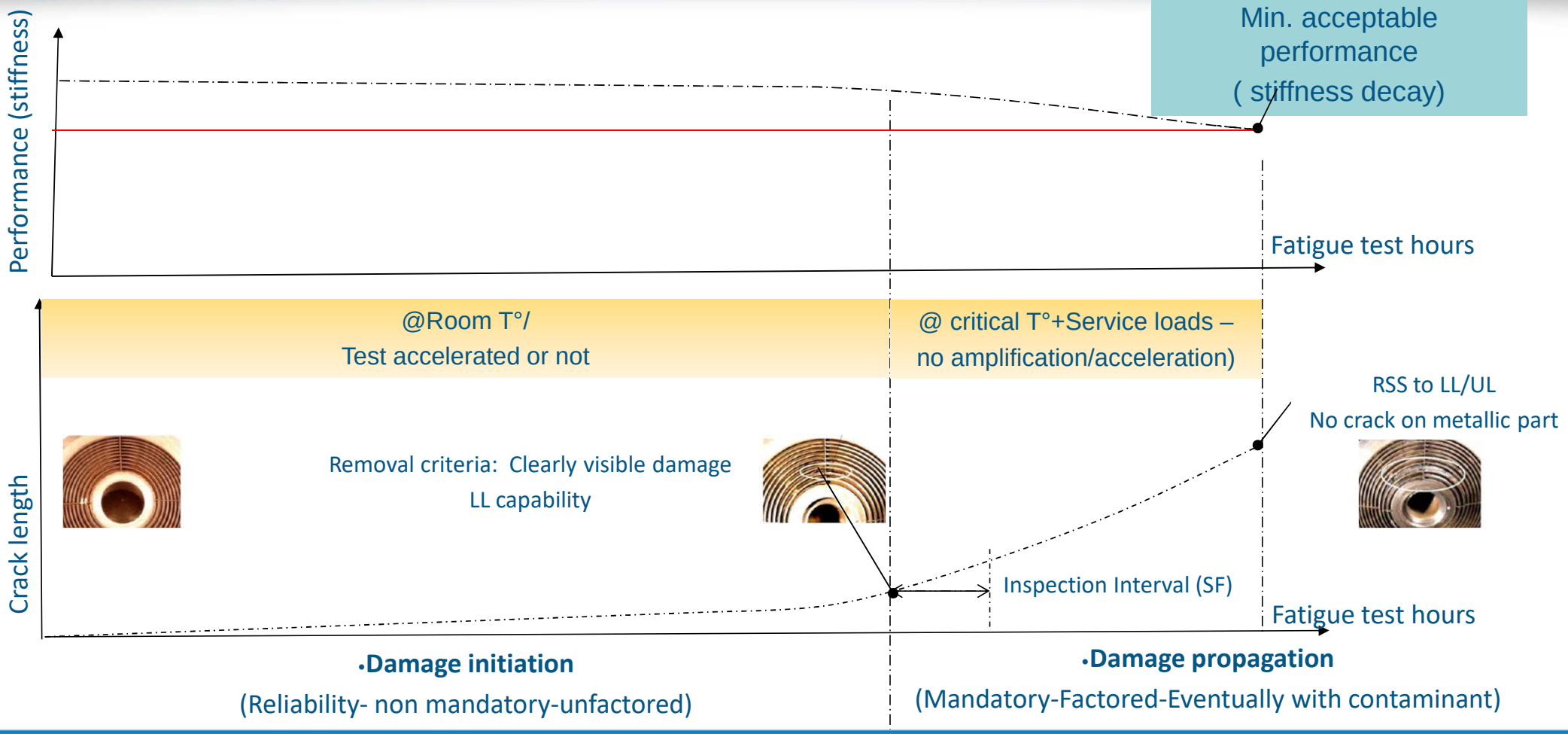
**•OEM Tests/Evaluation**

- Instrumented flight tests
- Continued safe flight and landing test/ analysis after bird impact/lightning strike)
- Vibration/Ground resonance/Aeroelastic stability evaluation (nominal and with reduced stiffness)
- Any other applicable requirements

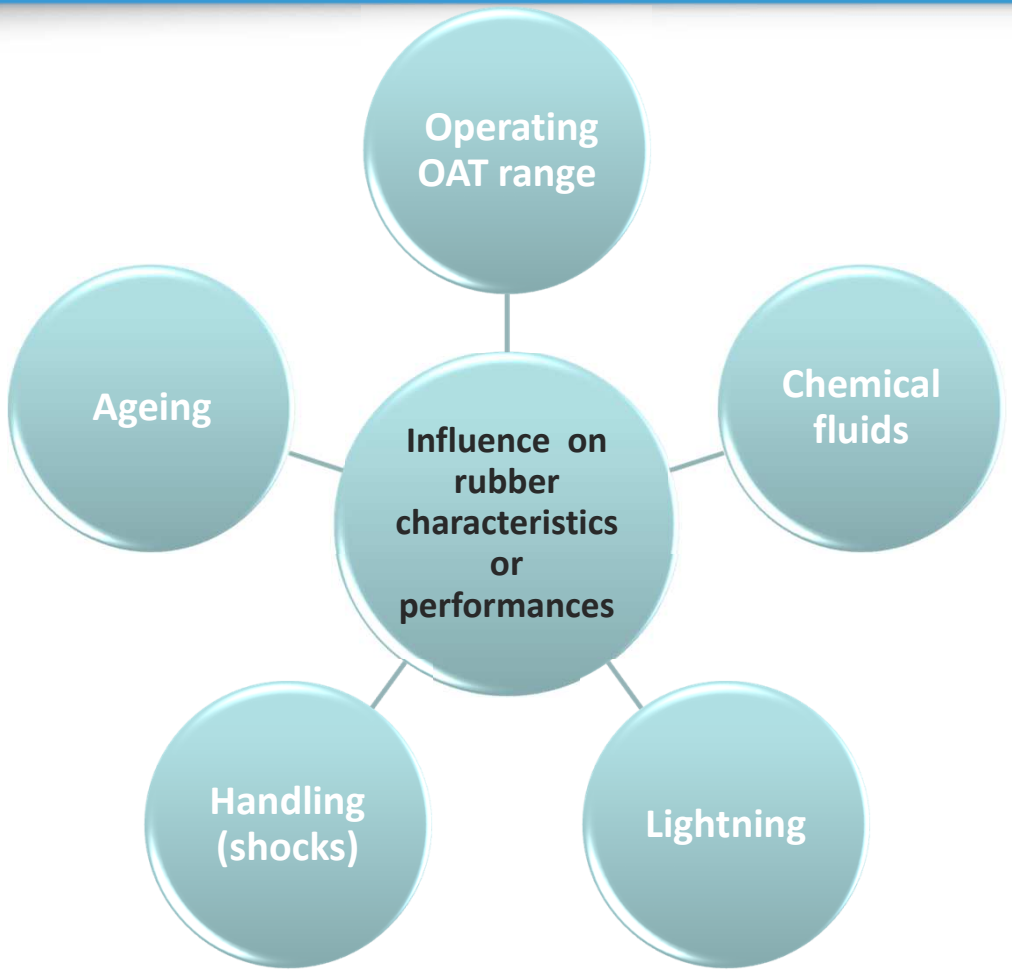
# Major input-Qualification Test  Spectrum

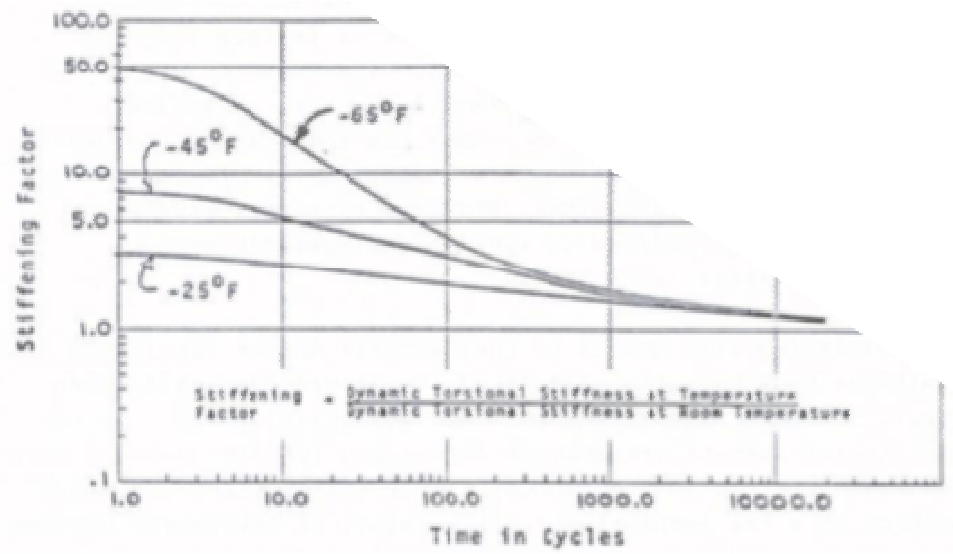


# Qualification test –Damage tolerance fatigue test



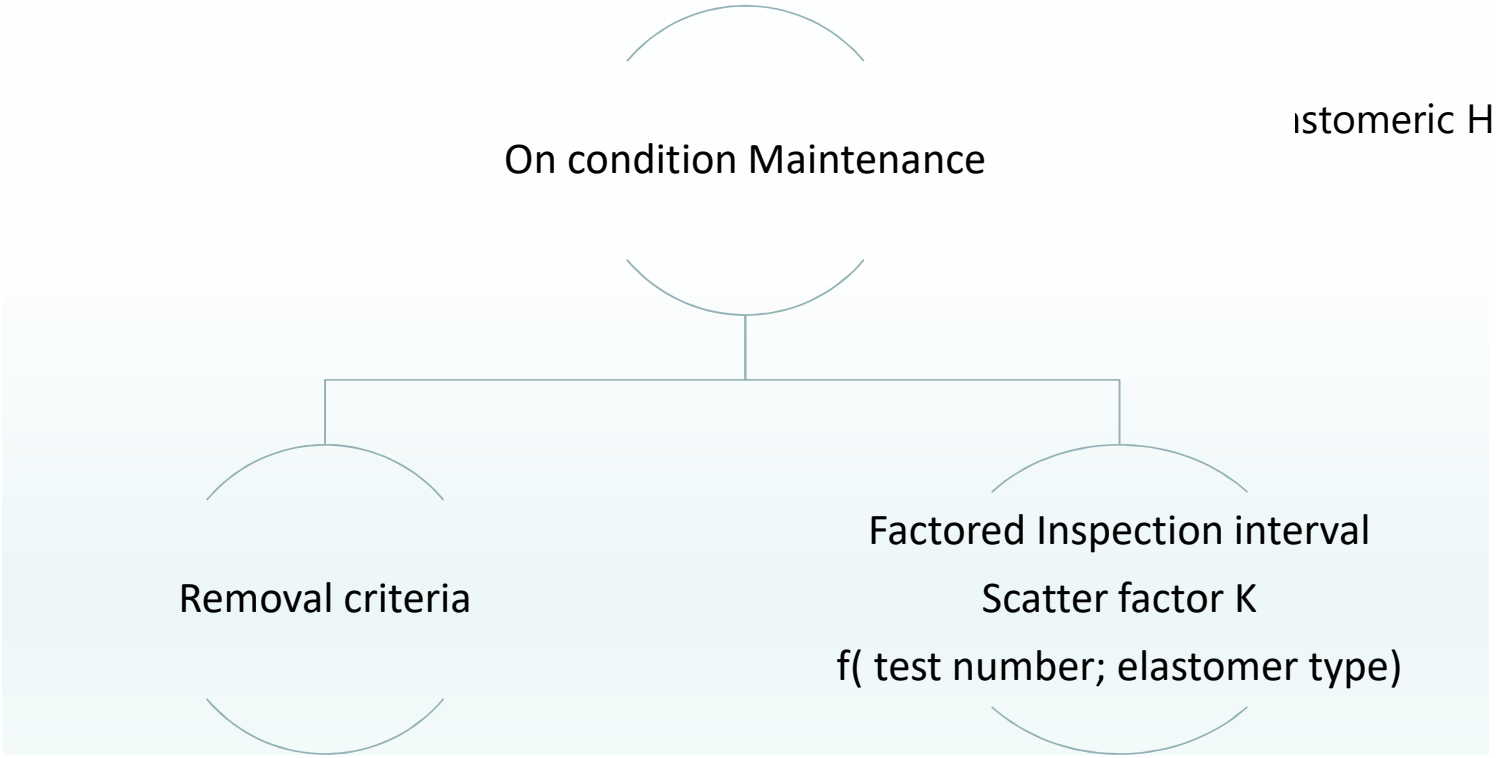
# Main parameters influencing performance



# Inspection criteria/Degradation mode

- https://www.youtube.com/watch?v=3tSHzSLh3Yw

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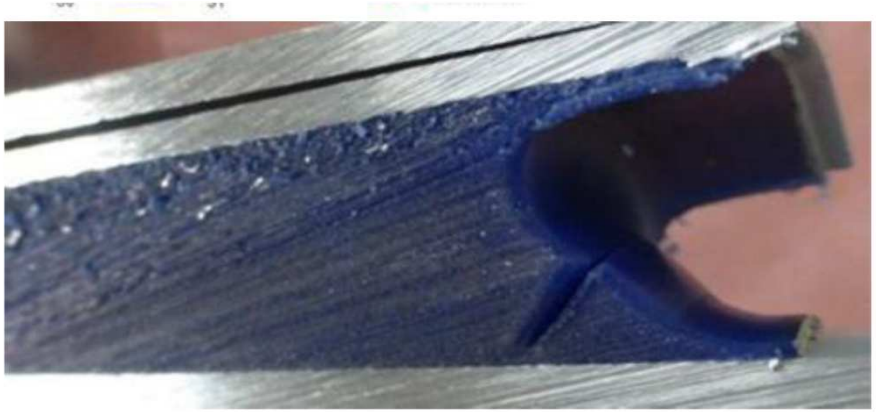
# Presentation objectives:

# Adverse service experience 1

159 Main rotor damper discarded - Removal criteria reached after 12FH min. instead of 55FH inspection (2000 FH initial reliability)



## Root cause

The adjustment of a parameter of the damper production process have "polluted the raw material". Not detected with the supplier control checks

# Adverse service experience2

## Tail rotor Laminated bearing failure- Fatal accident (TSN 101h- post MOD configuration)

### Root cause

Non-conservative spectrum

Addition of Chinese weight (passive control load compensator)/Design issue

# Adverse service experience 3

## Main rotor damper link elastomeric bearing failure (TSN: 75FH)

### Root cause

No test performed at low temperature

(penalty factor instead)

# Presentation objectives:

- Design principle
- Certification approach
- Adverse service experience

# Conclusion on elastomeric components

**Improved compared to normal bearings & easy to maintain.**

**More and more extended!**

**But still more challenges**

- No dedicated elastomeric parts requirement
- Classification difficult (impact @ rotorcraft level)
- OEM highly dependant on the supplier (CS27/29-602-Critical process change &control )
- Spectrum & environmental conditions sensitive
- Scatter factor are not well harmonized
- Detectability ( Room for improvement)

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# Thank you for your attention!

Any questions….?

Your safety is our mission.

An agency of the European Union