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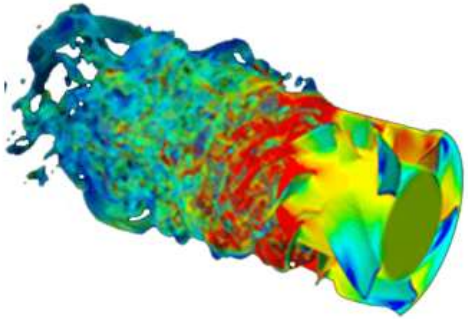

Acoustics & Vibrations

Smart Structures

Fluid Dynamics

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Research

Innovation

faurecia clarion ELECTRONICS

Tonal Noise in Gripen

Cockpit Noise and Vibration

Autumn Meeting SEES 2021-11-19

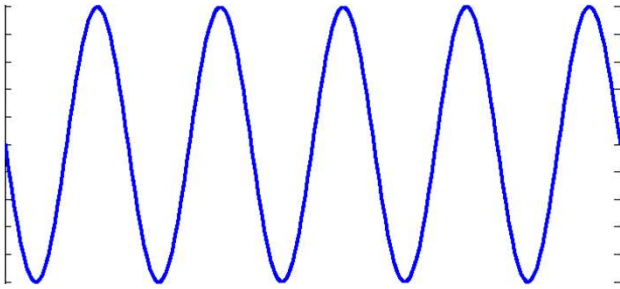
Fredrik Samuelsson

Saab Aeronautics (Faurecia Creo)

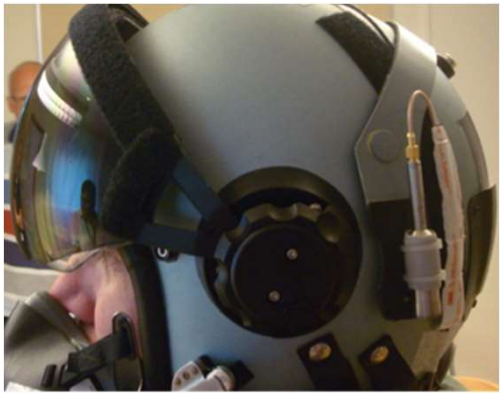
Fredrik Samuelsson Saab Aeronautics (Consultant from Faurecia Creo)

Background

- Tonal noise phenomena have been observed in some Gripen C aircraft.
- A similar phenomena was also observed in one Gripen E test aircraft.
- It was found out that an incorrectly installed seal was the cause in the Gripen E test aircraft.
- The findings in the Gripen E test aircraft led to the question if it is the same phenomena in Gripen C.
- A study of this was performed in Gripen C aircraft 39.266.



Test Installation
- cockpit noise



- Two microphones
  - Pilot chest
  - Pilot helmet
- Siemens LMS SCADAS-XS recording unit
  - Placed in thigh pocket (see picture)
  - Weight ~500 g

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Test Installation
- Vibration

- Accelerometers at equipment attachment
- Data recorded with an ACRA system from Curtiss-Wright

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Test cases

- Level flight at **1000 m** (3 300 ft)
  - M0.8, M0.9, M0.95, Supersonic
  - ~30 s at each speed

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Baseline configuration

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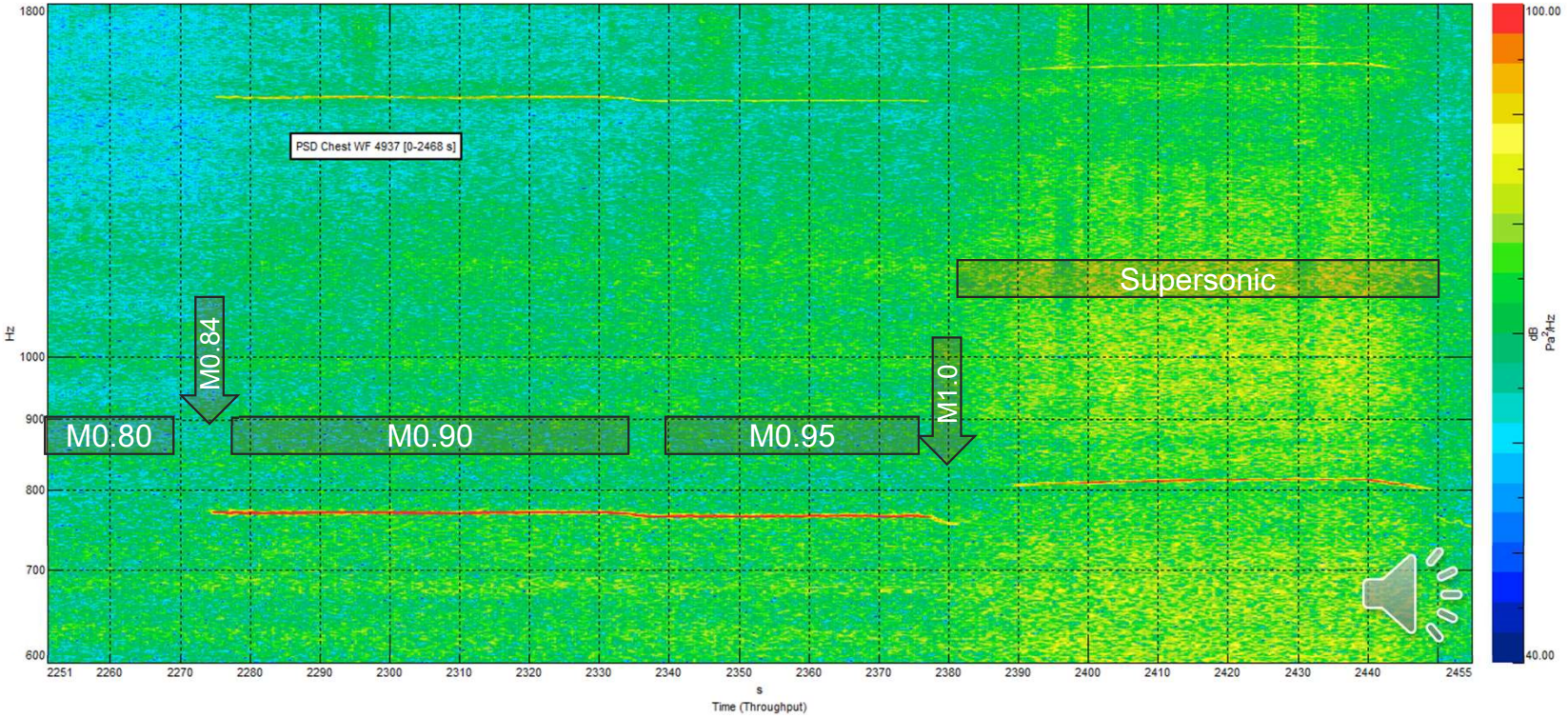
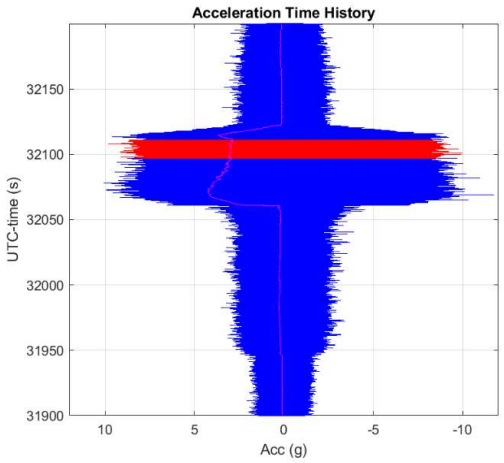
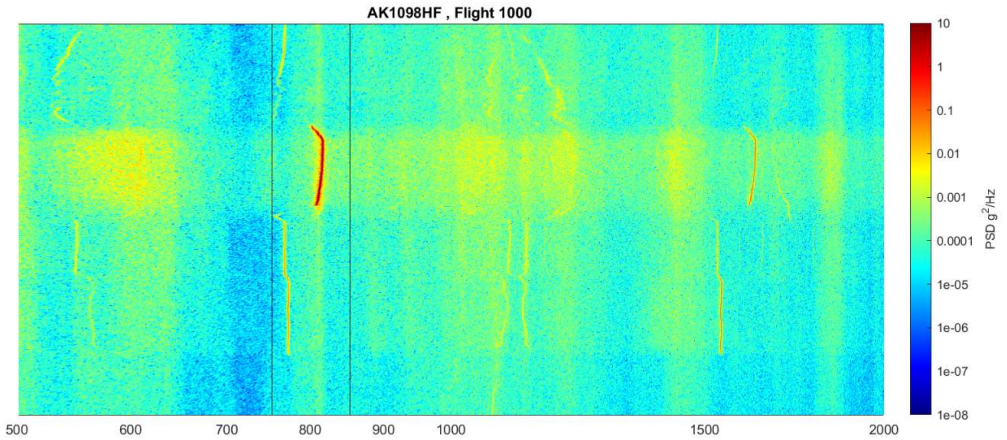
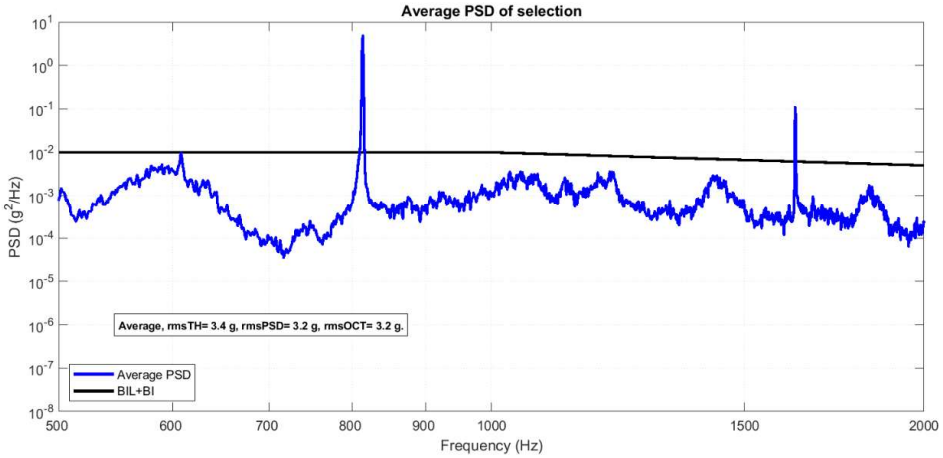
Chest sound Baseline configuration

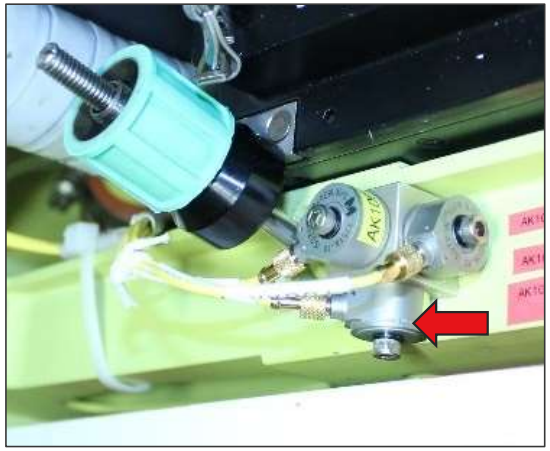


Vibration Baseline









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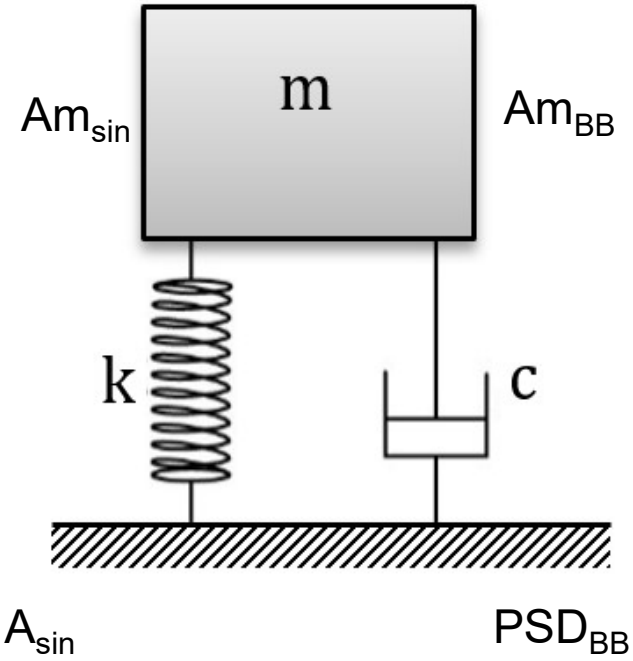
Comparing ”Sine” with ”Random” excitation

- Random data converted to equivalent Sine level
- SDOF resp. used
- Broadband random data assumed
- $A_{sinpeak} = 2.5\, A_{BBrms}$

$$A_{sin} = 2.5\sqrt{\frac{\pi}{2} \cdot PSD_{BB} \cdot f_n \cdot \frac{1}{Q}}$$



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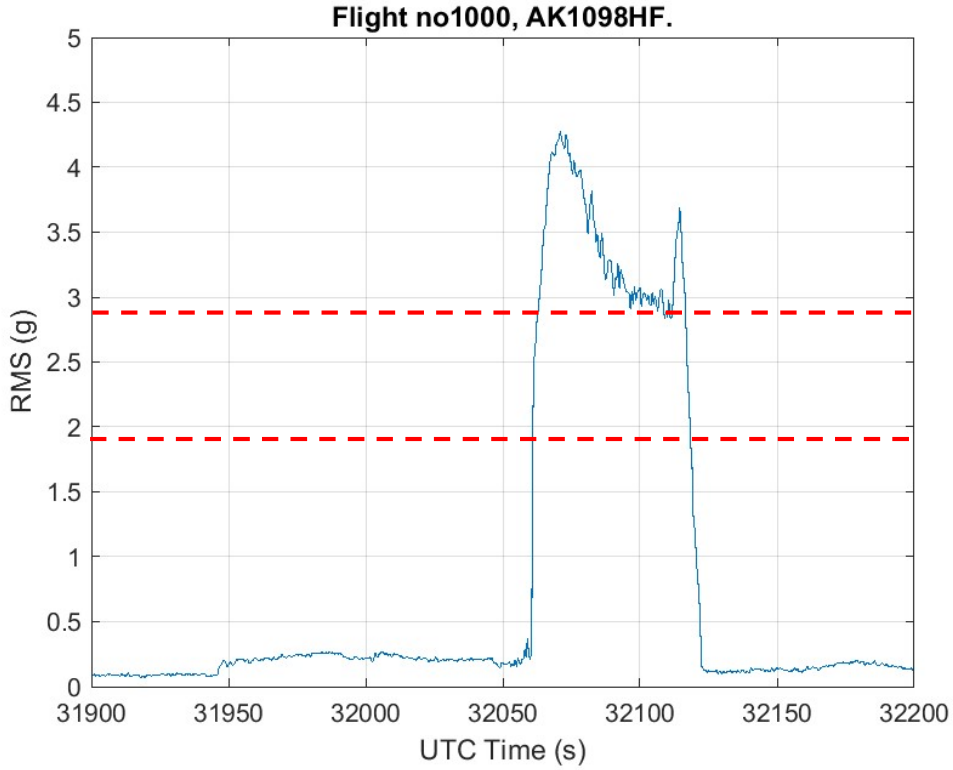
Tonal level : Baseline

MI Gunfire qual.



BBI Endurance qual.

BI Functional qual.

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Conclusion ”Baseline old seal”

- Vibration levels in 39.266 are higher than ”normal”
  - levels are above qualification curve BI
  - Supersonic speeds at low altitudes
- At high altitudes the levels are below qualifications.
- Levels are still below qualification levels for Gunfire.
- Life is consumed at a higher rate than assumed when flying supersonic at low altitudes.

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Taped intake

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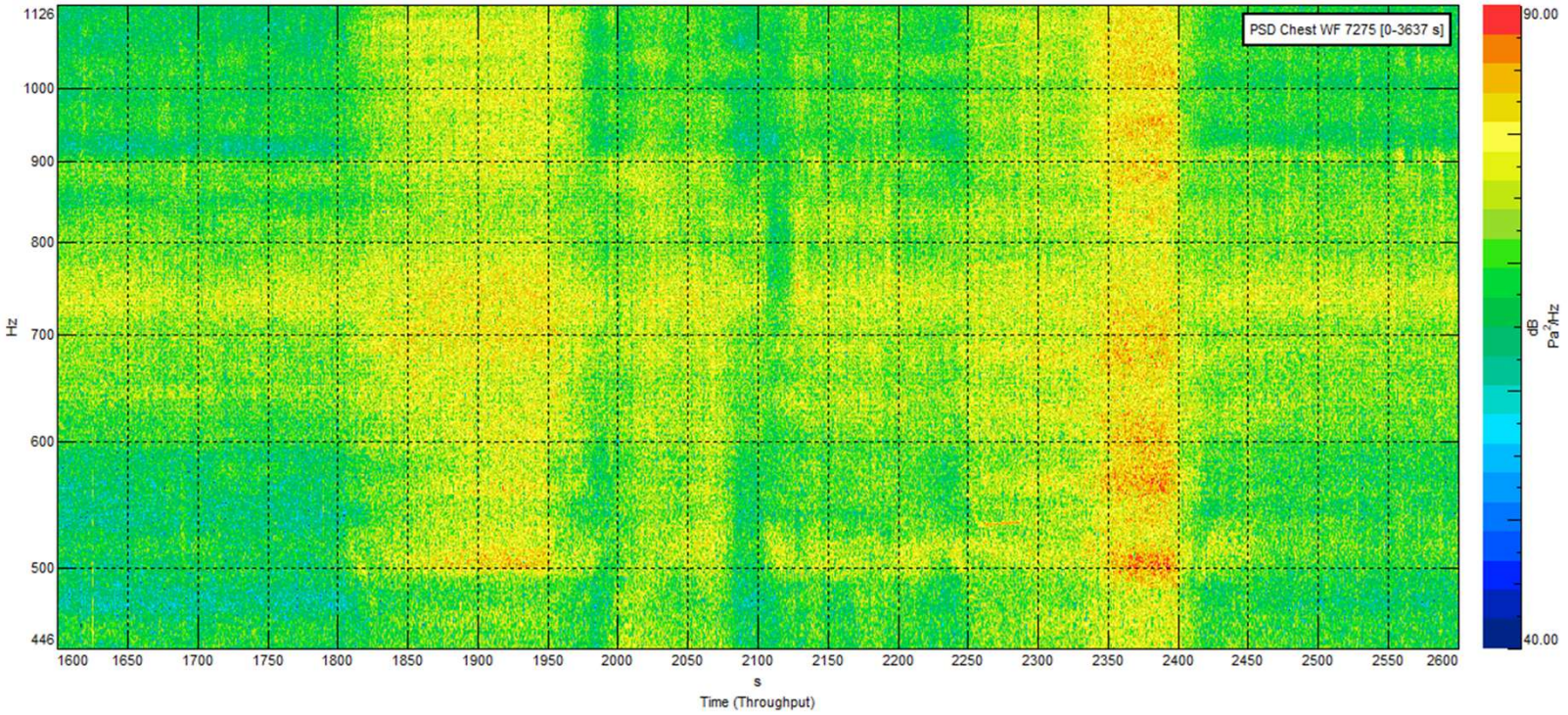
Chest sound taped intake



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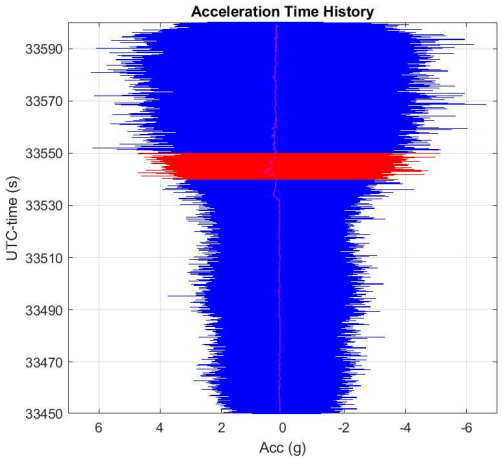
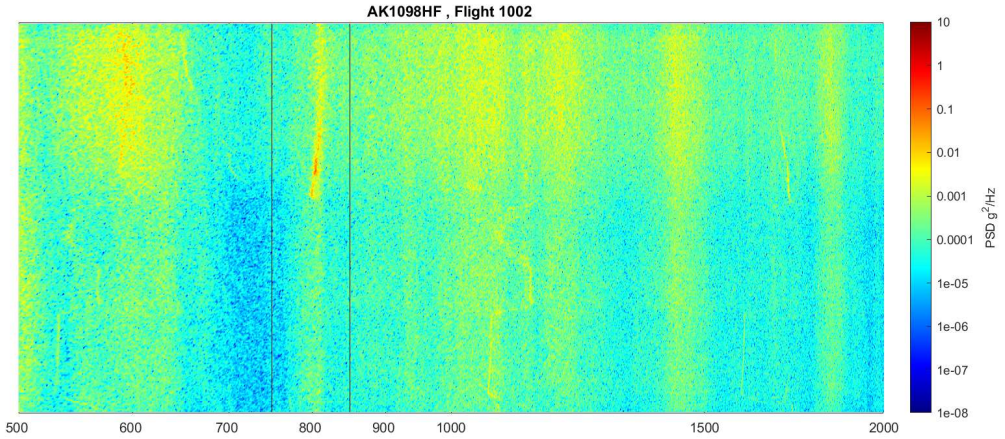
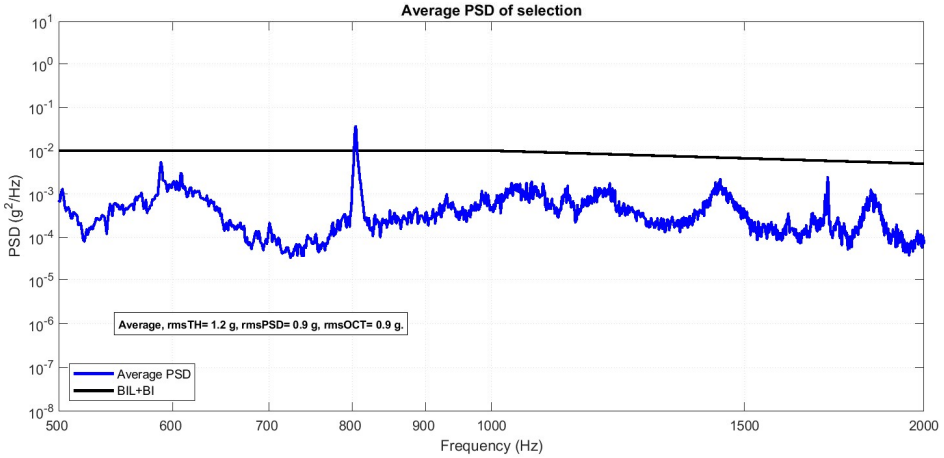
Vibration taped intake





Taped



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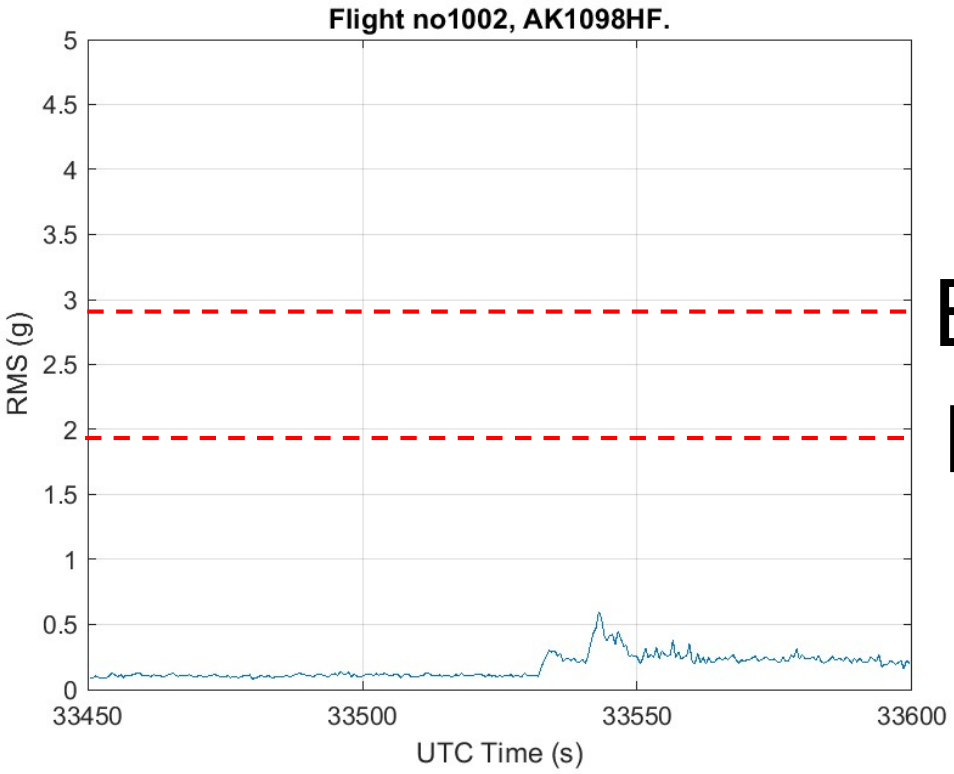
Tonal level : Taped inlet

MI Gunfire qual.



BBI General qual.

BI General qual.

Fredrik Samuelsson Saab Aeronautics (Consultant from Faurecia Creo)

Conclusion ”Taped” inlet

- No tonal sound in cockpit observed.
- Weak tonal vibration observed.
- Vibration levels are however below qualification for all speeds.

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Changed seal

New seal

Old seal

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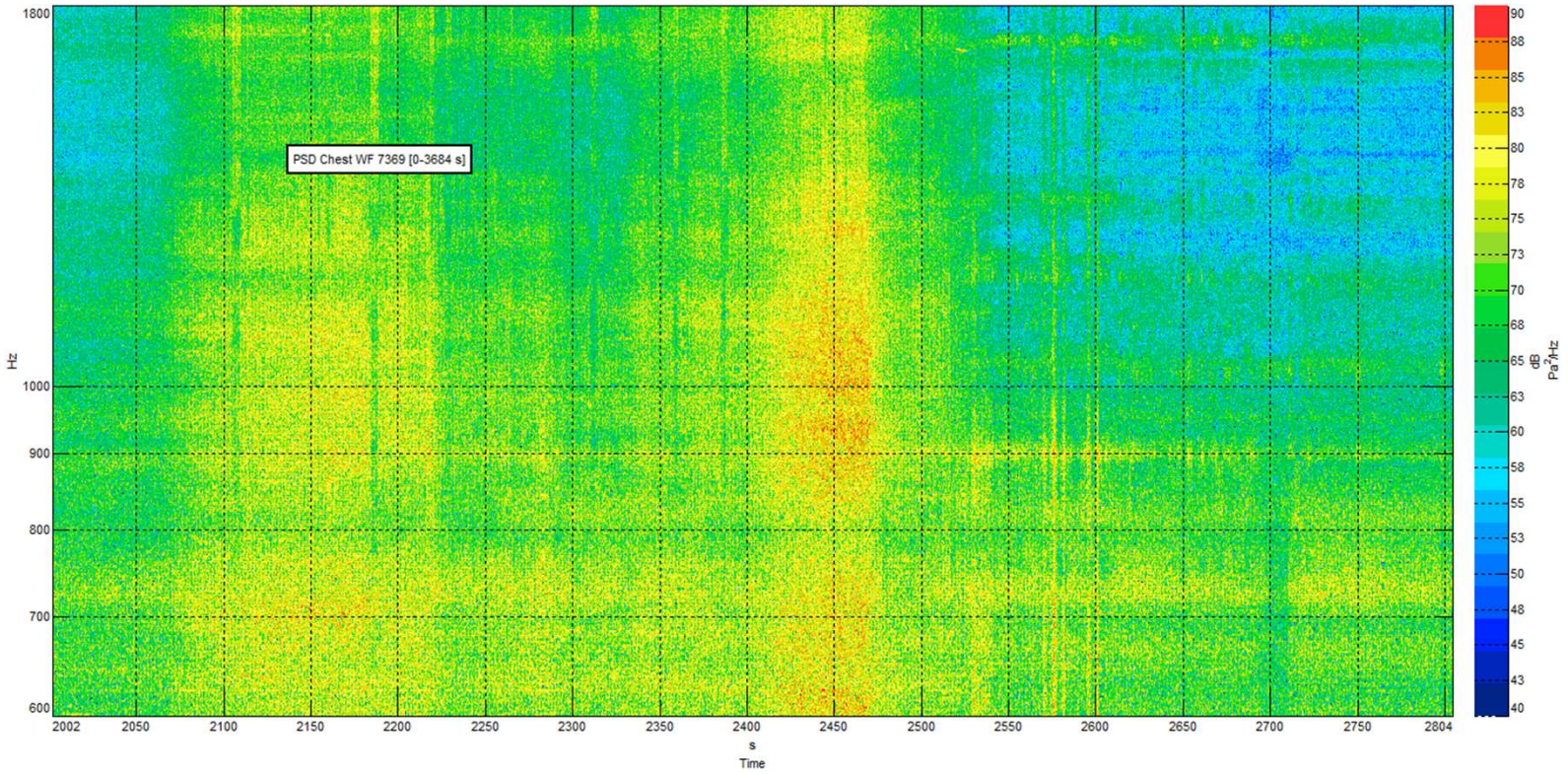
Chest sound new seal with support



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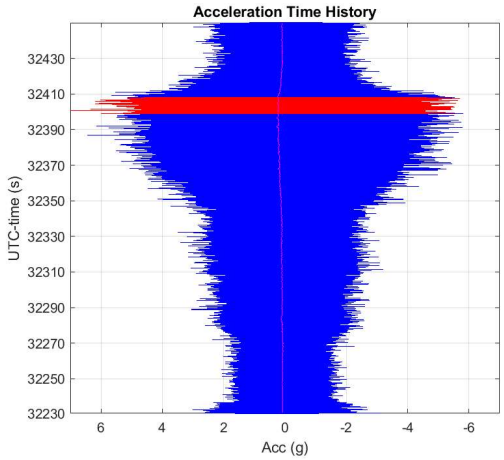
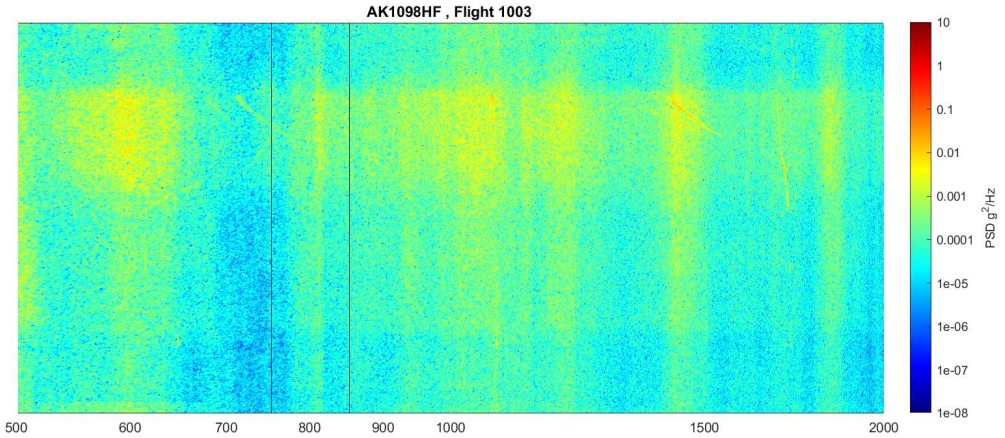
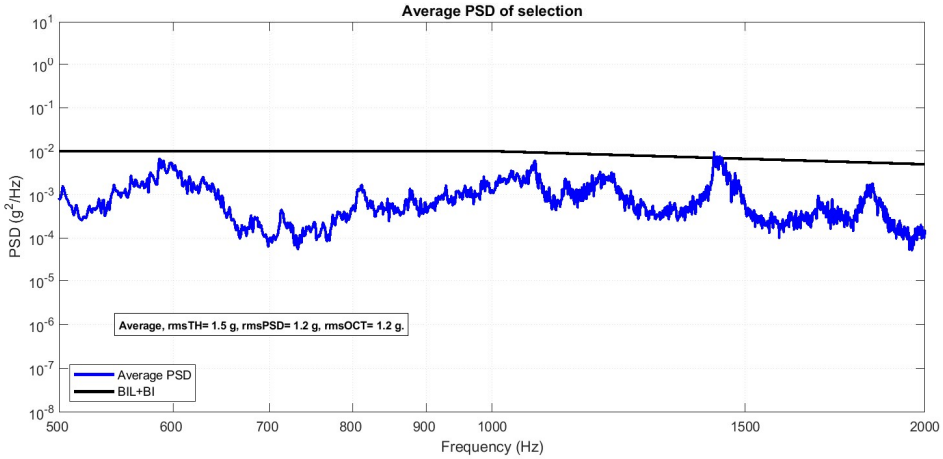
New seal with support







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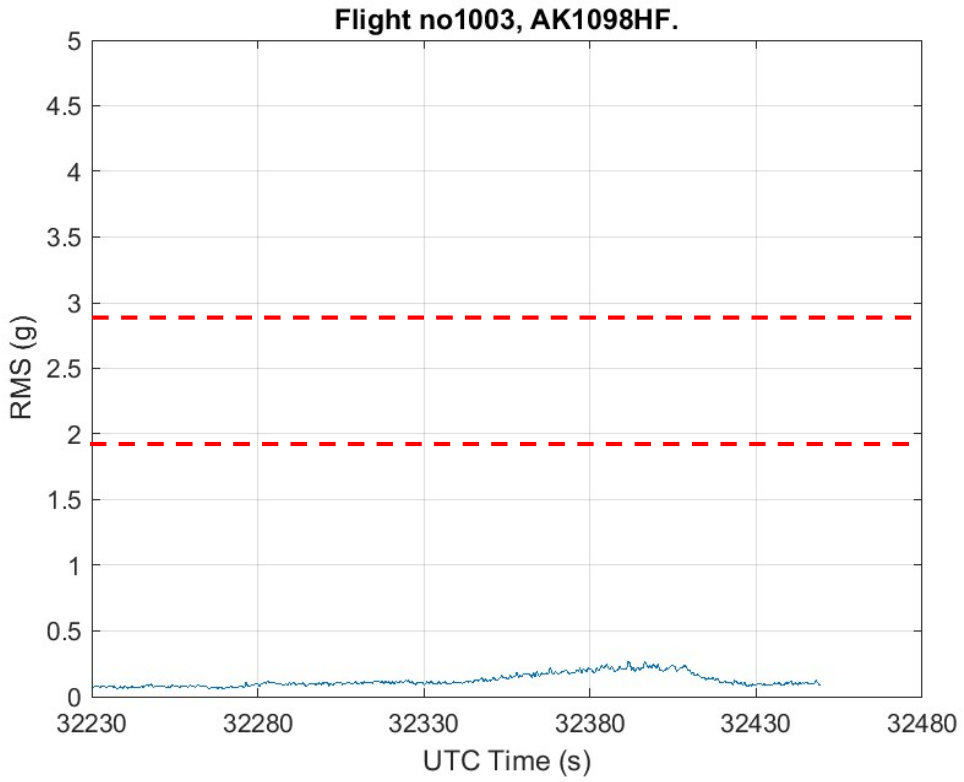
Tonal level : New Seal with support brackets

MI Gunfire qual.



BBI Endurance qual.

BI Functional qual.

Fredrik Samuelsson Saab Aeronautics (Consultant from Faurecia Creo)

Conclusion ”New seal+support bracket”

- No tonal sound in cockpit observed.
- No tonal vibration observed at equipment.
- Vibration levels are below qualification for all speeds.

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Summary

- Tonal noise phenomena in 39.266 origin from bad seals in ECS air intakes
- Generates high vibration levels at high speeds
- The data show that there is no immediate risk
- It is recommended to avoid flying with tonal noise at these conditions for long periods.
- Aircraft with tonal noise shall be fitted with new seals

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