Dedicated to innovation in aerospace

# Acoustic fatigue analysis of aircraft structures

PRODUCTS & SERVICES

## Methods for the prediction of the acoustic fatigue life

**Is your aircraft structure subjected to acoustic loading? Do you need help to evaluate or improve the design of your aircraft structure in terms of acoustic fatigue? Acoustic loads from an aircraft jet or propeller engine can excite the resonant frequencies of an aircraft structure like a panel near the engine. These vibrations can lead to acoustic fatigue damage and ultimately failure of the panel. NLR can deliver analytical, numerical and experimental methods to evaluate the aircraft structure response due to acoustic loading and predict the acoustic fatigue life.**



## WHAT YOU NEED

- Resonant frequencies of your aircraft structure
- Sound Pressure Level & Power Spectral Density of the acoustic load
- Viscous damping ratio of the aircraft structure material
- Acoustic fatigue allowables of the aircraft structure material
- Root Mean Square strain/stress in your aircraft structure
- Acoustic fatigue life of your aircraft structure

## WHAT WE DELIVER

- Analytical & numerical methods to predict the resonant frequencies of the structure
- Methods to determine the Sound Pressure Level & Power Spectral Density
- Experimental method to determine the viscous damping ratio of the material
- Experimental method to determine the acoustic fatigue allowables of the material
- Analytical & numerical methods to predict the Root Mean Square strain/stress
- Method to estimate the acoustic fatigue life

## OUR CAPABILITIES

In the Vibration and Shock Test laboratory at NLR, structural elements of your aircraft structure can be tested on a shaker at room or other temperature to determine the resonant frequencies, viscous damping ratio and acoustic fatigue allowables of the aircraft structure material. The resonant frequencies can be measured with available accelerometers or massless with laser-based vibrometers.

At NLR structural elements can be instrumented with strain gauges to measure the strain for the acoustic fatigue allowables. Before and after the shaker test the structural elements can be inspected with Non Destructive Inspection like ultrasonic C-scan for manufacturing defects and fatigue damage respectively. Also aircraft structures like panels can be instrumented with accelerometers, strain gauges, temperature sensors or pressure sensors for a full scale acoustic fatigue test.

The Sound Pressure Level of e.g. propeller noise over your aircraft structure can be predictive with software available at NLR. Analytical and numerical methods are also available at NLR to size the structural elements and predict their resonant frequencies.

We can also assist you in predicting the resonant frequencies of your aircraft structure and optimizing your aircraft structure design with respect to acoustic fatigue life.

## RELEVANT EXPERIENCE:

For the Clean Sky Smart Fixed Wing Aircraft project NLR contributed to an innovative noise shielding empennage for a business jet. To investigate the impact of engine jet flow thermal and acoustic fatigue loads on the empennage, a demonstrator empennage was developed under the lead of Dassault Aviation in collaboration with INCAS, GKN Aerospace and NLR.
NLR instrumented the composite and metal panels, which were installed on the horizontal tail plane of the empennage in the full scale tests. NLR also predicted the resonant frequencies and acoustic fatigue life of the composite structural panel and determined the acoustic fatigue allowables of the composite material.

## PRODUCTS & FEATURES

- Experimental solution to determine the acoustic fatigue allowables
- Fast analytical & accurate numerical prediction of the acoustic fatigue life
- Safe-life design of aircraft structure subjected to acoustic loading



**AEROSPACE VEHICLES DIVISION**
**Collaborative Engineering Systems**
p ) **+31 88 511 43 08**
e ) **info@nlr.nl**

**NLR AMSTERDAM**
Anthony Fokkerweg 2
1059 CM Amsterdam • The Netherlands
PO box 90502 • 1006 BM Amsterdam • The Netherlands
e ) info@nlr.nl i ) **www.nlr.org**

**NLR MARKNESSE**
Voorsterweg 31
8316 PR Marknesse • The Netherlands
PO box 153 • 8300 AD Emmeloord • The Netherlands
e ) info@nlr.nl i ) **www.nlr.org**

F506-01