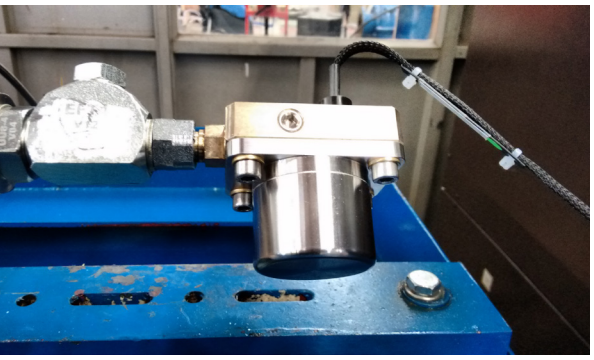
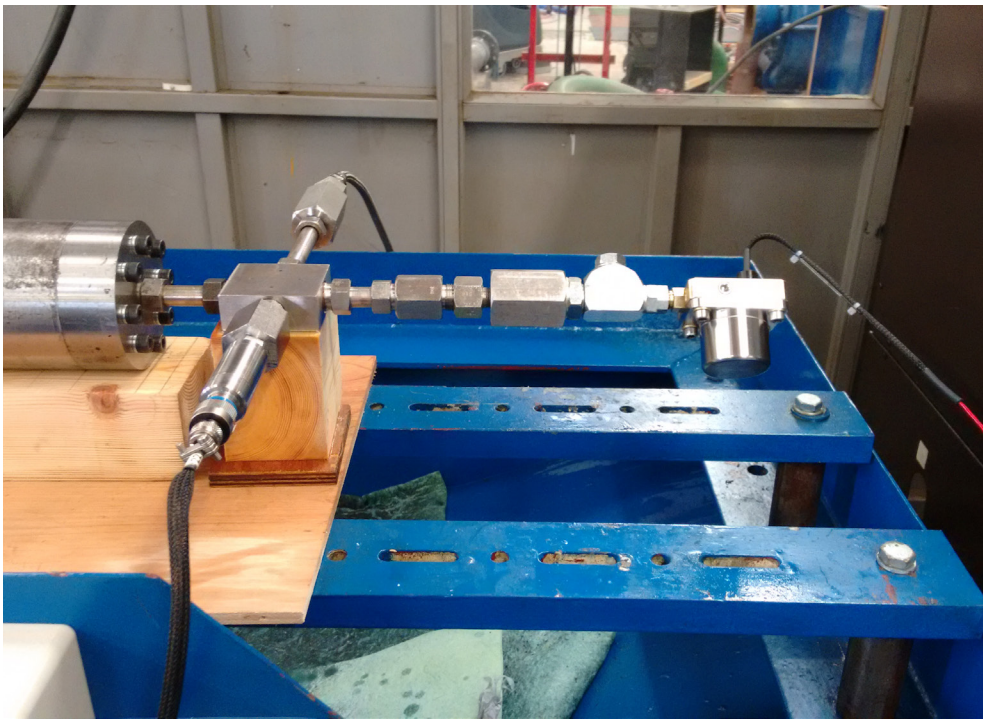
Pressure Sensors for Aircraft Flight Control

BHR Group
EXPERTS IN FLUID ENGINEERING

Pressure Cycle Testing

DRUCK LTD, UK





Druck Ltd has been supplying pressure sensors to the Aerospace Industry for more than 20 years.

A range of high pressure sensors (typically) operating at 3,000 to 4,000 psi, are being supplied to measure the line pressure to safely operate both the primary and secondary flight controls. These sensors are being used to operate Rudders, Flaperons, Flaps, Slats and the landing gear.

Druck Ltd contracted BHR Group to conduct a series of pressure cycle tests as part of a qualification programme on these pressure transducers.

An important consideration in aerospace components is that they can withstand the changes between extremes of pressure and temperature under operational conditions. Pressure Cycle Testing is carried out with the objective of determining the relationship between the stress range and the number of times it can be applied before causing failure.

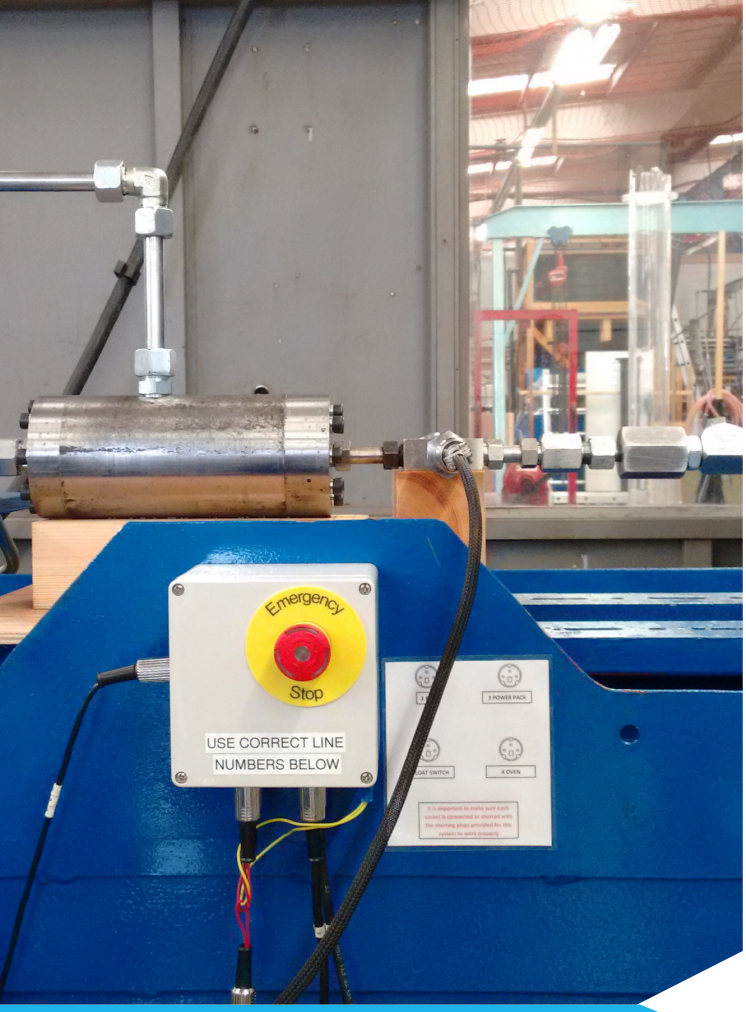
A range of high pressure sensors (typically) operating at 3,000 to 4,000 psi, are being supplied by Druck Ltd to measure the line pressure to safely operate both the primary and secondary flight controls. These sensors are being used to operate rudders, flaperons, flaps, slats and the landing gear in the Boeing 777X.

"Our customised rig enabled us to test the pressure sensors at high pressures and fast pressure rise rate for Druck Ltd."

Craig Knight
OPERATIONS MANAGER, BHR GROUP

BHR used a customised Pressure Cycle Test Rig comprising a servo-hydraulic system with pressure feedback to generate the required pressure waveform.

A 6,000 psi GE Druck reference pressure sensor (Druck PTX3000) was also mounted to the manifold, and its output provided feedback for the servo-hydraulic pressure control. For the second and third phases of the cyclic testing regime a pressure intensifier was used to generate the required PMAX.



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Test 1: Pressure cycle test with a large number of pressure cycles at increasing maximum pressures

- Cycle frequency: <3 Hz
- Number of cycles:
  - Stage 1: 1,600,000
  - Stage 2: 40,000
  - Stage 3: 80
- Nominal Pressure maximum:
  - Stage 1: 3,600 psi
  - Stage 2: 4,800 psi
  - Stage 3: 6,000 psi
- Environmental temperature: Ambient
- Test Fluid: Shell Tellus S2 M Industrial Hydraulic Fluid 46

The key challenge in this test regime was the high pressures required (6,000 psi). BHR engineers integrated a pressure intensifier into the hydraulic system to achieve the required pressure and waveform shape in a controlled manner.

The test transducer completed the full regime of testing at 0-3600psi, 0-4800psi and finally 0-6000 psi for the required number of pressure cycles, giving no visual indication of structural failure or leakage of hydraulic fluid throughout the pressure cycle test.

"We were delighted to be able to give Druck Ltd confidence in their sensors and then enable them to move forward to the next stage of their project in line with key deadlines."

Craig Knight
OPERATIONS MANAGER, BHR GROUP

BHR's test rig addressed key challenges:

- High pressures (up to 6,000 psi)
- Fast pressure rise rate (1.8m psi/s)
- Large number of cycles

Test 2: Pressure cycle test with very fast pressure rise rate (1.8 million psi/second) for a total of 130,000 cycles

- Cycle frequency: 1 Hz
- Number of cycles: 130,000
- Pressure maximum: 3,000 psi
- Pressure rise rate: 1.8 Mpsi/second
- Environmental temperature: Ambient

The key challenge in test 2 was delivery of multiple cycles at high pressure rise rate. BHR engineers modified the rig control system to respond very fast in order to achieve the required pressure waveform, reaching full pressure in less than 2 milliseconds. The pressure cycle test was conducted with a pressure rise rate of 1,800,000 psi/second to 3,000 psi for a total of 130,000 cycles

The test transducer completed 130,000 pressure cycles to 3,000 psi with a pressure rise rate of 1.8 Mpsi/s, again, with no visual indication of structural failure or leakage of hydraulic fluid throughout the pressure cycle test.

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