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Bureau d'Enquêtes et d'Analyses
pour la sécurité de l'aviation civile

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REPORT
INCIDENT

Explosion of an oxygen pressure transducer

Aircraft	Bombardier CRJ700 registered F-GRZF
Date and time	1 July 2010 at around 7 h 25[1]
Operator	BritAir
Place	Paris Charles de Gaulle Airport (95)
Type of flight	Scheduled public transport of passengers
Persons on board	Captain (PF), co-pilot (PNF)
Consequences and damage	Oxygen pressure transducer destroyed

[1]Except where otherwise stated, the times shown in this report are expressed in Universal Time Coordinated (UTC).

This is a courtesy translation by the BEA of the Final Report on the Safety Investigation. As accurate as the translation may be, the original text in French is the work of reference.

HISTORY OF FLIGHT

During the landing roll, the crew heard a loud bang and smelled smoke. They noted the loss on the EICAS of the indication of the oxygen pressure on the crew system.

After exiting the runway, the crew requested assistance from the fire service for an external examination of the aeroplane. On arrival at the parking zone, maintenance technicians found that the oxygen pressure transducer on the flight crew oxygen system was damaged and showed traces of burning.

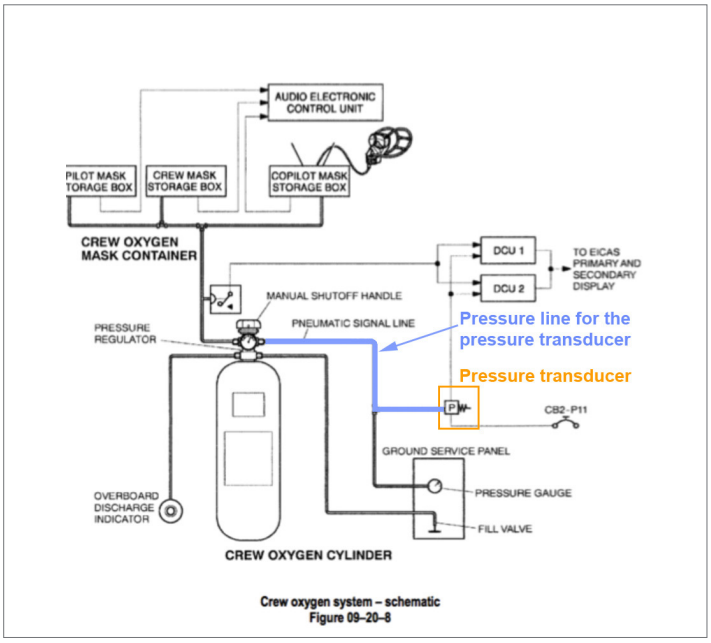
ADDITIONAL INFORMATION

Operating principle of the flight crew oxygen system

The aeroplane oxygen system consists of two independent systems:

- A system that provides the flight crew with oxygen stored in a gas cylinder;
- A system that provides passengers and cabin crew with chemically-generated oxygen.

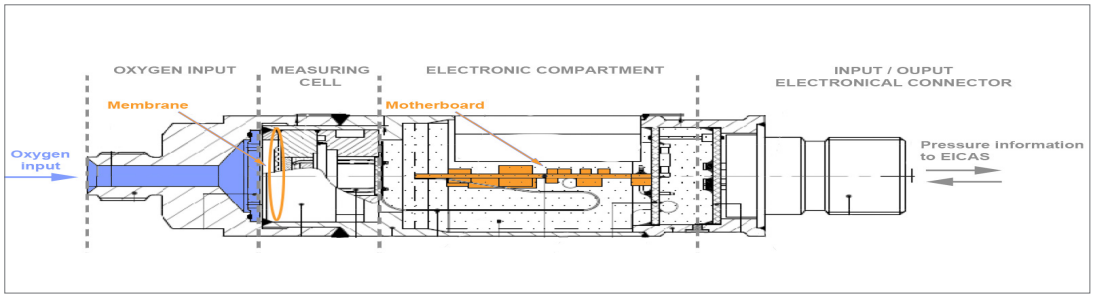
The cylinder contains about 1,415 l of oxygen at a pressure of 1,850 psi. Oxygen is relieved before being distributed to each mask. A capillary tube mounted on the cylinder head is connected to a transducer that measures the cylinder oxygen pressure (see Figure 1 below). This information is then transmitted to the pilots on the STATUS page on the EICAS.



Crew Oxygen system

Description of the air pressure transducer.

This consists mainly of a high pressure fitting, a measuring cell, an electronics compartment and an electrical connector.



The oxygen puts pressure on a metal diaphragm that transmits the force to an incompressible fluid. The hydrostatic pressure of the fluid is then exerted on a piezo-resistive device that converts the pressure information into an electrical signal. This signal is then processed by the motherboard and then used to display the oxygen pressure on the EICAS.

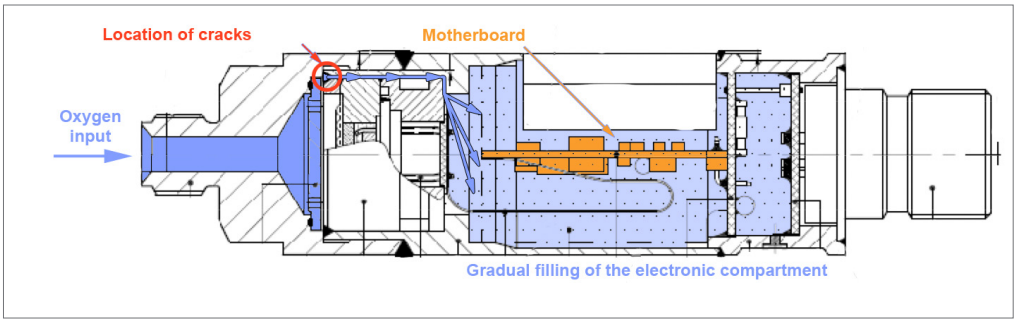
The electronic part consists of a motherboard and two protective cards. The card is electrically powered by 28V DC and its consumption is less than 5 mA.

This pressure transducer (P/N CMC 1904) was installed as a replacement for the original transducer (P/N CMC 1901-1) following application of Service Bulletin 670BA-35-010. This replacement followed detection of electronic malfunctions on several transducers (motherboard memory degraded) installed on the CRJ700 fleet.

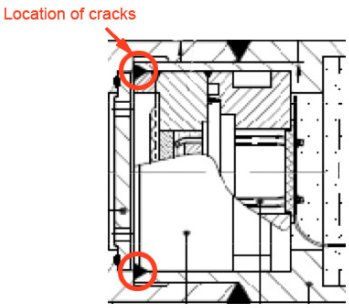
Examination of the pressure transducer

The examination revealed signs of an explosion and showed that the body of the pressure transducer failed at the electrical connector input/output.

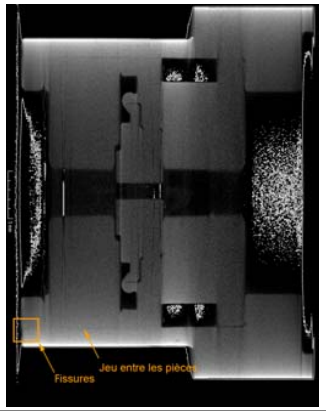
During tests on the damaged transducer, a pressure of 870 psi of oxygen (which corresponds to about half of the nominal pressure in the cylinder) was applied to the metal membrane. A micro leakage of about 2 millilitres per hour was demonstrated between the oxygen input and the electronics compartment.



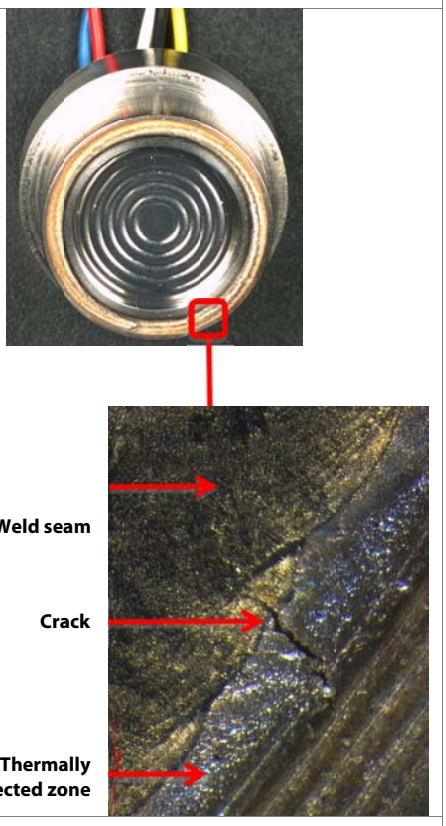
The measuring cell was then extracted and examined. The upper weld connecting the membrane to the body of the measuring cell, as well as the metal in the measuring cell itself, had cracks.



Plan of the measuring cell



Longitudinal section view



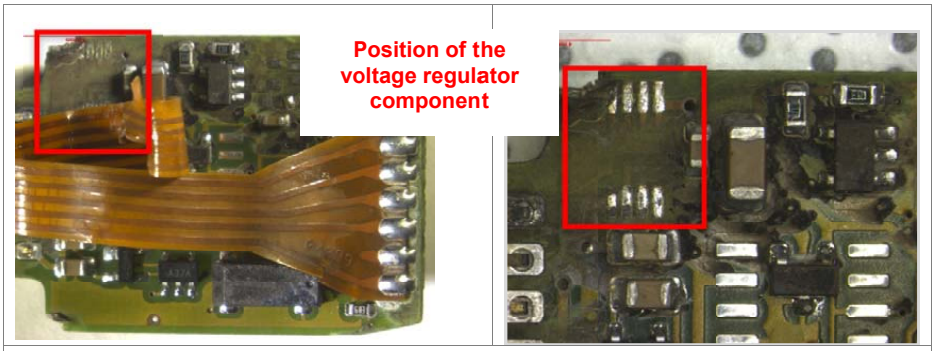
Side section view

The welding operations during the production of the transducer, on metal that likely had a minor defect, was one of the contributing factors to the appearance of these cracks. They may have appeared either at the time of the welding operations or during tranducer use under the associated effect of the oxygen pressure.

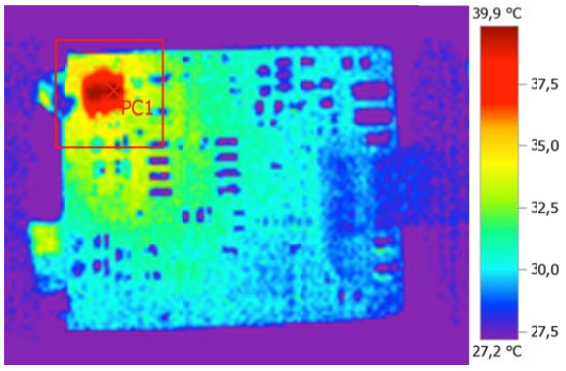
Note: Tests at the manufacturer's showed that the failure pressure on the sensor body was greater than the internal cylinder pressure.

Examination of the motherboard in the electronics compartment

The motherboard had a lot of damage: the voltage regulator component was missing and there was some black residue present, especially around the missing component. This was a powered component, which induced a local increase in temperature on the electronic board at this point (see photos below).



Electronic Card



Example of temperature distribution on an operating electronic card

Note: It is possible that the temperature of the card installed on the aeroplane reached higher values.

Maintenance actions

The cylinder was installed on the aeroplane on 21 April 2010. On April 27, the company conducted further filling of the oxygen cylinder. Since its installation on the aeroplane the transducer had accumulated a total of 4,369 flying hours.

CONCLUSION AND LESSONS LEARNED

Conclusion

The explosion of the oxygen pressure transducer very likely resulted from ignition of a voltage regulator component on the motherboard in an oxygen rich environment under pressure. The micro-leakage of oxygen from the high pressure sealed container generated, over time, the oxygen concentration.

Safety lessons

- ❒ The pressure transducer was installed although it likely had production defects that were not detected.
- ❒ The design of the pressure transducer allows a high concentration of oxygen under pressure in an area not designed for this purpose.

Following this incident, the manufacturer decided to check the sealing of all measuring cells in production.

SAFETY RECOMMENDATION

Note: In accordance with Article 17.3 of European Regulation (EU) 996/2010 of the European Parliament and Council of 20 October 2010 on the investigation and prevention of accidents and incidents in civil aviation, a safety recommendation shall in no case create a presumption of blame or liability for an accident, a serious incident or an incident. The addressee of a safety recommendation shall inform the safety investigation authority which issued the recommendation of the actions taken or under consideration, under the conditions described in Article 18 of the aforementioned Regulation.

The investigation showed micro-cracks in the pressure transducer. These micro-cracks caused an oxygen leak that allowed a high concentration of oxygen under pressure in an area of the oxygen system not designed for this. This abnormal concentration of oxygen then led to ignition of the component.

Consequently, the BEA recommends that:

- ❍ **EASA ensure that oxygen system design does not allow a high concentration of oxygen under pressure in areas not designed for this purpose. [Recommendation FRAN-2012-030]**