Following a number of in-service events of roll-back (uncommanded power reduction) on one or more engines WEC engineers undertook a complex root cause investigation. The rollback events occurred during operation at over 27,000ft in particular icing conditions found under the anvil of cumulonimbus cloud formations, which was outside of the natural icing certification envelope.

The root cause was initially thought to be a problem with engine fuel control on maximum thrust limits, but following substantial analysis of data from flight recorders, the root cause was found to be ice accretion on the engine compressor supercharger stage vanes causing the engine core flow to be restricted. The transient nature of icing meant that the evidence was lost when the aircraft was on the ground, so that after the occurrences all maintenance checks showed that engine operation was normal.

The problem was cured by providing additional heating of the supercharging vanes.
**Case Study 2**

**Fuel System Level Sensors**

Level sensors were frequently being removed from aircraft because of incorrect indication of fuel levels. The sensors indicated FUEL/WET when the sensor was not covered with fuel, and indicated AIR/DRY when the sensor was covered with fuel.

Subsequent examination and analysis of sensors returned to the equipment supplier identified that the electronics potting material had suffered expansion resulting in micro cracks. These micro cracks allowed ingress of water droplets and contamination of the internal circuitry of the sensors. This altered the response of the circuitry, resulting in false indication of the fuel levels. Expansion of potting material could also result in damage to the internal electrical connections and components.

The potting material was found to have a glass transition temperature and coefficient of thermal expansion that was significantly different to the potting material used in other similar components. Testing by the supplier confirmed that the potting material exhibited expansion and cracking at elevated temperatures.

The supplier replaced the potting material with an improved compound.

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**Case Study 3**

**Fuel Tank Inlet Ball Valve Failures**

After 10 years successful in-service operation the customer was experiencing premature failure of fuel tank inlet valves on a significant number of in-service aircraft. The fuel tank inlet valve would not open during tank refuel, leading to delays and cancellations.

Examination of failed in-service valves showed that the ‘O’ ring seal in the valve ball/seat interface was found to have extruded thus jamming the valve. Investigations concluded that the seal extrusion was caused by the expansion of fuel trapped within the valve housing following fuel transfer. The very cold fuel trapped inside the closed valve following transfers at altitude expanded significantly as it was warmed during descent and on the ground. The consequent increase in pressure extruded the seal.

The equipment supplier replaced the failed valve type with a similar valve type but with provision for pressure relief.