

Mean Time Between Failure (MTBF) of JJ-CCR oxygen sensors, model R17JJ-CCR (VST part number: 8010004)

Preamble:

It is not feasible to determine the true MTBF of JJ-CCR oxygen sensors, as we don't have the date of failure occurrence recorded by the diver - or when reported by the diver to JJ-CCR. We can only state from when we at VST are advised of the failure or when we receive the sensor back. In addition we don't know when sensors are put into service, nor do we have the data for how long sensors are lasting in use before being exhausted or replaced as part of a PPM programme. Besides the above, there are too many variables (ppO₂, temperature, humidity, usage...) for true figures - we have to make some assumptions.

So our sensor life data is based on invoice date to the JJ-CCR and when a sensor is reported faulty to us/or when received back by us. VST's ISO system actively updates the records of failures and percentage failure rates.

Rather than MTBF, perhaps MTBUR (mean time before unit replacement) or MTTF (mean time to failure) would be better, as we don't have serial failures on one sensor and the sensor is defined as a consumable item. However, we will use MTBF if that is what's required.

The question is how to equate for the sensors that have not failed? Do we assume that all the other sensors in the field are lasting for the specified nominal sensor life? Sensors are under 12 months warranty, so a nominal % oxygen hours specified life would be a good indicator of: non-failure or reasonable life. However, if we do this and calculate the failure data, then the MTBF figure will always be less than the specified nominal sensor life. This is because we don't have the figures for how long all the sensors last in the field, before they are exhausted or replaced. For a true representation it would involve maintaining detailed and accurate life-time records of a sample set of sensors in actual use - until they are naturally exhausted or exhibit a fault.

Calculation of MTBF figure:

In order to calculate the figure for MTBF - the first 1,000 sensors have been used as the data set. The 1,000th sensor was sold on the 8th January 2012, so all the sensors concerned have been in the field for a minimum of 24 months

From the first 1,000 sensors, only two faulty sensors have been reported and returned, this equates to a failure rate of **0.2 %**.

Details of the faulty sensors:

- 1) Sensor serial number: **JJ100173**

Invoice date 8th March 2011, reported faulty 24th October 2011.

Diagnosed fault: No output.

Equates to 231 days before failure reported.

2) Sensor serial number: **JJ100695**

Invoice date 8th November 2011, reported faulty 17th May 2012.

Diagnosed fault: Unstable output.

Equates to 192 days - before failure reported.

We are assuming that all the other 998 sensors have been in use until exhausted and experienced the specified nominal sensor life of >500,000 % oxygen hours. So based on specified nominal data, the expected sensor life is 994.43 days. Therefore adding this to the days before failure of the faulty sensors equates to a MTBF of 992.87 days = **499,215 % oxygen hours**.