

NAME P/N QTY	CRIT	FAILURE MODE & CAUSES	FAILURE EFFECT	RATIONALE FOR ACCEPTANCE
PRIMARY OXYGEN PRESSURE SENSOR, ITEM 112 ----- SV778528-1/-2 (1)	1/1	112FM05 Rupture of Bourdon tube. Material or weld defect in Bourdon tube.	END ITEM: Rapid release of high pressure oxygen (up to 1000 psi) and resulting shock wave into the sensor reference cavity. Loss of signal voltage (zero). Possible ignition. GFE INTERFACE: Ignition. MISSION: Terminate EVA. Loss of use of one EMU. CREW/VEHICLE: Potential safety hazard and case rupture if ignition occurs. Possible loss of crewmember. TIME TO EFFECT /ACTIONS: Seconds. If detected during the EMU checkout sequence, do not use EMU. TIME AVAILABLE: N/A TIME REQUIRED: N/A	A. Design - -1 Conrac and -2 Gulton: Conrac: The likelihood of rupture of the Bourdon tube is minimized by the following: 1. Use of 0.009 thick seamless Inconel X-750 tubing that is heat treated after forming, provides a high strength, corrosion resistant pressure barrier that has been burst tested to 5000 psi before leaking. 2. The Bourdon Tube sensing element is surrounded by an all metal/glass welded case which has been burst tested to 5000 psi before leaking. Maximum operating pressure is 1100 psi. This case is designed to withstand the pressure of 6000 psi. 3. The outer case is 80% filled with series AO Halocarbon Oil, which has demonstrated oxygen compatibilities of 3000 psi at 70 degrees F. 4. A fracture mechanics analysis predicts that the bourdon tube will leak before it bursts at operating pressure. The fracture mechanics also predicts that, for a 15 year cycle life, the unit will tolerate an initial defect of 0.50 inch in length and 97% through the 0.009 inch thick wall of the tube. 5. The factor of safety at the braze joint at the tube base is 66 at proof pressure. 6. The weld factor of safety is 26 at proof pressure. Gulton: The likelihood of rupture of the Bourdon tube is minimized by the following: 1. Use of .008" thick seamless Inconel X-718 tubing with a yield strength of 175,000 psi maximum, the calculated stress at 4400 psi is 37,000 psi. 2. The sensing element is surrounded by an all metal/glass welded case which has been burst tested to 5500 psi before leaking. Maximum operating pressure is 1100 psi. This case is not designed to withstand the pressure generated if ignition occurs. 3. The outer case is filled with Fomblin type V06 Oil, which has demonstrated oxygen compatibility at 9000 psi at 150 degrees F, to prevent ignition should the Bourdon Tube burst. 4. A fracture mechanics analysis predicts that the Bourdon Tube will leak before it bursts at operating pressure. The fracture mechanics also predicts that for 15 years cycle life, it will tolerate an initial defect of 0.5 inch in length and 65% through the 0.008 inch thick wall of the tube. 5. The factor of safety on the braze joint at the tube base is 11 at proof pressure of 1650 psi. 6. The weld safety factor is greater than 100 at proof pressure. B. Test - Component Acceptance Test - Conrac: The primary oxygen pressure sensor is subjected to acceptance testing prior to shipment by the assembly vendor. This includes the following tests which ensure that the sensing element is sound. 1. Proof pressure testing to a pressure of 1650 psi for one minute. This ensures the element can withstand a pressure of 150% of rated pressure without damage. 2. Calibration check of sensor after pressure testing ensures the proof testing has not caused the sensing element to leak. Gulton: The primary oxygen pressure sensor is subjected to acceptance testing prior to shipment by the assembly vendor. This includes the following tests which ensure that the sensing element is sound. 1. Proof pressure testing to a pressure of 1650 psi for one minute. This ensures

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		112FM05	REDUNDANCY SCREENS: A-N/A B-N/A C-N/A	<p>the element can withstand a pressure of 150% of rated pressure without damage.</p> <p>2. Calibration check of sensor after pressure testing ensures the proof testing has not caused the sensing element to leak.</p> <p>3. Pressure cycled between 0-1210 psi for 10 cycles using gaseous O2. This test ensures sensor compatibility with high pressure O2.</p> <p>4. Random vibration for one minute per axis. A level of 6.1 grms in 3 mutually orthogonal axes is applied.</p> <p>5. Calibration check of sensor after pressure testing ensures the proof and cycle testing have not caused the sensing element to leak.</p> <p>PDA Test - The primary oxygen sensor undergoes proof leakage and performance testing per SEMU-60-010 after installation in the shear plate assembly. The item is proof tested at 1155-1180 psi for at least 5 minutes followed by a leakage test. The leakage test pressurizes the sensor and installation with a 2% helium 98% nitrogen gas mixture to 850-950 psi and a helium mass spectrometer is used to check for evidence of leakage. A subsequent calibration check verifies the Bourdon tube integrity by comparing sensor accuracy with spec requirements over the range of 30-1070 psi. The accuracy requirement for this unit is +/-2%.</p> <p>Certification Test - Certified for a useful life of 25 years (Ref. EMUM-1434).</p> <p>C. Inspection - Conrac: To ensure structural integrity of the Bourdon Tube, the tube weld and the tube to pressure fitting braze joint, the following inspections are performed: Visual inspection of the tube braze joint. Visual inspection of base/tube weld joint. Helium leak inspection of braze joint, weld joint, tube, and base. X-ray inspection of assembled tube and base assembly (two views). Gulton: To ensure structural integrity of the Bourdon tube, the tube weld and the tube to pressure fitting braze joint, the following inspections are performed: Microscope inspection of a sample from each length of tubing to ensure tubing workmanship. X-ray of the tube and weld. Visual inspection of the tube weld joint for complete braze material penetration. Helium leak inspection of the braze joint, weld joint, tube, and braze. Pressure cycled at 250 degrees F to stabilize tube.</p> <p>D. Failure History - None.</p> <p>E. Ground Turnaround - Tested for non-EET processing per FEMU-R-001, Transducer and DCM Gage Calibration Check. This test checks the accuracy of the sensor and assures that there has not been any leakage through the Bourdon tube into the case cavity. High Pressure O2 Leakage. If a rupture has occurred, this test will detect leakage from the sensor.</p>

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112FM05

FEMU-R-001 Para 8.2 EMU Preflight KSC Checkout for EET processing.

F. Operational Use -
Crew Response -
PreEVA/PostEVA/EVA: No response possible.
Training - No training specifically covers this failure mode.
Operational Considerations - Not applicable.

EXTRAVEHICULAR MOBILITY UNIT
SYSTEMS SAFETY REVIEW PANEL REVIEW
FOR THE
I-112 PRIMARY OXYGEN PRESSURE SENSOR
CRITICAL ITEM LIST (CIL)

EMU CONTRACT NO. NAS 9-97150

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