**FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL HARDWARE**
**NUMBER:M8-1SS-E058 -X**

**SUBSYSTEM NAME:** ECLSS - ISS OXYGEN TRANSFER SYSTEM
**REVISION:** 0 04/08/97

**PART DATA**

| | PART NAME<br>VENDOR NAME | PART NUMBER<br>VENDOR NUMBER |
|---|---|---|
| LRU | :VALVE, O2 MANUAL SHUTOFF<br>CARLETON TECHNOLOGIES | MC250-0004-0006<br>1-4-00-51-27 |

**EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:**
ISS OXYGEN TRANSFER EVA MANUAL SHUTOFF VALVE

**QUANTITY OF LIKE ITEMS:** 1
ONE

**FUNCTION:**
PROVIDES A QUICK MEANS OF SHUTTING OFF OXYGEN FLOW TO THE SPACE STATION PRIOR TO PHYSICALLY CUTTING THE EXTERNAL RIGID O2 LINE DURING AN EMERGENCY SEPARATION EVA. DURING THIS EVA THE CREW HAS TO REMOVE THE 96 BOLTS AND CUT THE O2/N2 LINES AND ELECTRICAL CABLES TO ENABLE ORBITER/ISS SEPARATION. VALVE IS MOUNTED TO THE OUTSIDE OF THE EXTERNAL AIRLOCK UPPER CYCLINDER AND IS MANUALLY OPERATED. VALVE IS NORMALLY OPEN DURING THE ENTIRE MISSION AND ONLY CLOSED DURING AN EMERGENCY SEPARATION.

**REFERENCE DOCUMENTS:** V828-643051

PRINT DATE: 07/15/97

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SUBSYSTEM NAME: ECLSS - ISS OXYGEN TRANSFER SYSTEM
LRU: ISS O2 TRANSFER EVA MANUAL SHUTOFF VALVE
ITEM NAME: VALVE, ISS EVA MANUAL O2 SHUTOFF

CRITICALITY OF THIS FAILURE MODE: 1R2

FAILURE MODE:
EXTERNAL LEAKAGE (GROSS)

MISSION PHASE:
LO LIFT-OFF
OO ON-ORBIT
DO DE-ORBIT

VEHICLE/PAYLOAD/KIT EFFECTIVITY:
103 DISCOVERY
104 ATLANTIS
105 ENDEAVOUR

CAUSE:
CORROSION, MECHANICAL SHOCK, EXCESSIVE VIBRATION, MATERIAL DEFECT, SEAL MATERIAL DEGRADATION

CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO

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REDUNDANCY SCREEN
A) PASS
B) N/A
C) PASS

PASS/FAIL RATIONALE:
A)

B)
N/A - REDUNDANCY IS IN STANDBY UNTIL REQUIRED.

C)

METHOD OF FAULT DETECTION:
NONE UNTIL THE UPSTREAM OXYGEN SHUTOFF VALVE IS OPEN. THEN EXTERNAL LEAKAGE OF OXYGEN CAN BE DETECTED THROUGH INSTRUMENTATION - REDUCED OR LOSS OF EMU OXYGEN PRESSURE INDICATION ON THE AW82D PANEL PRESSURE GAUGE OR THE ORBITER CRT OR BY A DROP IN ORBITER OXYGEN PRESSURE.

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**REMARKS/RECOMMENDATIONS:**
A SINGLE PATH PROVIDES OXYGEN TO THE ISS FROM THE ORBITER GO2 SYSTEM. OXYGEN LINES DOWNSTREAM OF OXYGEN SHUTOFF VALVE ARE NOT PRESSURIZED UNTIL OXYGEN TRANSFER TO ISS TAKES PLACE. GO2 TRANSFER CAN OCCUR DURING SLEEP CYCLES, DURING CREW OR CARGO TRANSFERS BETWEEN ORBITER AND ISS, OR DURING EVA ACTIVITY. CLOSING ORBITER EMERGENCY OXYGEN VALVING TO TERMINATE LEAKAGE IS A CRITICALITY 1/1 CONDITION.

**- FAILURE EFFECTS -**

**(A) SUBSYSTEM:**
OXYGEN SUPPLY IS DIVERTED BEFORE IT REACHES THE EMU ECLSS PANEL OR SPACE STATION.

**(B) INTERFACING SUBSYSTEM(S):**
INCREASED USE OF OXYGEN. POTENTIAL LOSS OF EMERGENCY O2 SYSTEM DUE TO EXCESSIVE OXYGEN LEAKAGE. CLOSING UPSTREAM O2 SHUTOFF VALVE TO ISOLATE LEAKAGE WILL LOSE OXYGEN SUPPLY FOR RECHARGING EMU'S RESULTING IN LOSS OF EVA CAPABILITIES.

**(C) MISSION:**
CREW DECISION TO ABORT MISSION WOULD RESULT IN LOSS OF MISSION OBJECTIVES. LES/AIRLOCK O2 SUPPORT HAS BEEN LOST IF LEAKAGE IS SIGNIFICANT. CABIN O2 MAKEUP CAPABILITY IS STILL AVAILABLE.

**(D) CREW, VEHICLE, AND ELEMENT(S):**
AN UNCONTROLLED GROSS EXTERNAL LEAKAGE COULD RESULT IN INADEQUATE O2 SUPPLY TO LES STATIONS. LOSS OF LES SUPPORT CAPABILITY MAY RESULT IN LOSS OF CREW IF UNCONTROLLED LEAK RATE PROHIBITS LES SYSTEM PRESSURIZATION AND LES IS REQUIRED. LOSS OF O2 TO EMU'S COULD RESULT IN LOSS OF CAPABILITY TO PERFORM CONTINGENCY EVA. LOSS OF O2 SUPPLY TO ISS COULD IMPACT SPACE STATION OPERATIONS.

**(E) FUNCTIONAL CRITICALITY EFFECTS:**
**LOSS OF EMERGENCY OXYGEN SYSTEM**
(1A) FIRST FAILURE (EVA O2 SHUTOFF VALVE EXTERNALLY LEAKS) - OXYGEN IS DIVERTED OUT LEAKY VALVE RESULTING IN AN INADEQUATE O2 SUPPLY TO LES STATIONS.
(2A) SECOND FAILURE (FAILURE THAT REQUIRED THE LES TO BE USED) - LOSS OF ORBITER OXYGEN SUPPLY RESULTING IN POTENTIAL LOSS OF CREW AND VEHICLE. - CRITICALITY 1R2 CONDITION.

**INABILITY TO PERFORM CONTINGENCY EVA**
(1B) FIRST FAILURE (EVA O2 SHUTOFF VALVE EXTERNALLY LEAKS) - CORRECTIVE ACTION TO CLOSE UPSTREAM MID DECK O2 SHUTOFF VALVE WILL RESULT IN LOSS OF O2 TO EMU'S. LOSS OF O2 TO EMU'S COULD RESULT IN LOSS OF EVA CAPABILTIES IF

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EMU O2 TANKS ARE EMPTY. CREW DECISION TO ABORT MISSION WOULD RESULT IN LOSS OF MISSION OBJECTIVES - CRITICALITY 2/2 CONDITION.
(2B) SECOND FAILURE (FAILURE NECESSITATING AN EVA TO PREVENT A POTENTIAL CATASTROPHIC SITUATION) - INABILITY TO PERFORM A CONTINGENCY EVA TO CORRECT A CRIT 1 CONDITION COULD RESULT IN LOSS OF CREW AND VEHICLE - CRITICALITY 1R2 CONDITION.

**DESIGN CRITICALITY (PRIOR TO DOWNGRADE, DESCRIBED IN (F)):** 1R2

**(F) RATIONALE FOR CRITICALITY DOWNGRADE:**
**LOSS OF EMERGENCY OXYGEN SYSTEM**
(3A) THIRD FAILURE (INABILITY TO CLOSE O2 SHUTOFF VALVE) - CONTINUOUS DEPLETION OF ORBITER OXYGEN. GROSS EXTERNAL LEAKAGE RESULTS IN INADEQUATE O2 SUPPLY TO LES STATIONS. LOSS OF LES SUPPORT CAPABILITY MAY RESULT IN LOSS OF CREW IF LEAK RATE PROHIBITS LES SYSTEM PRESSURIZATION AND LES IS REQUIRED. NOTE - IN AN 8.0 PSIA HOLE IN CABIN CONTINGENCY MODE, AN EXTERNAL LEAK ALLOWING FLOW INTO THE CABIN MAY NOT BE CATASTROPHIC SINCE THERE IS A POSSIBILITY OF SAFELY BREATHING CABIN AIR, INTO WHICH THE O2 IS LEAKING, BY RAISING LES VISOR. WORST CASE FAILURE WOULD BE IN CASE OF CONTAMINATED CABIN ATMOSPHERE, WHEN LEAKAGE PREVENTS ADEQUATE FLOW TO LES STATIONS AND CABIN AIR MAY NOT BE SAFE FOR BREATHING. - CRITICALITY 1R3 CONDITION.

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**- TIME FRAME -**

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**TIME FROM FAILURE TO CRITICAL EFFECT:** DAYS

**TIME FROM FAILURE OCCURRENCE TO DETECTION:** SECONDS

**TIME FROM DETECTION TO COMPLETED CORRECTING ACTION:** N/A

**IS TIME REQUIRED TO IMPLEMENT CORRECTING ACTION LESS THAN TIME TO EFFECT?**
NO

**RATIONALE FOR TIME TO CORRECTING ACTION VS TIME TO EFFECT:**
THERE IS NO WORKAROUND IF THE CREW DECIDES TO ABORT THE MISSION AS THE RESULT OF THIS FAILURE.

**HAZARD REPORT NUMBER(S):** ORBI 270, FF-09

**HAZARD(S) DESCRIPTION:**
INABILITY TO SUPPLY O2 TO CABIN/CREW (ORBI 270). INABILITY TO SAFELY PERFORM EVA (FF-09).

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**-DISPOSITION RATIONALE-**

(A) DESIGN:
VALVE BODY IS MADE OF 6061-T6 ALUMINUM ANODIZED FOR CORROSION RESISTANCE. FITTINGS ARE MADE OF 17-4 PH CONDITION A CRES, WHICH IS PRECIPITATION HARDENED CORROSION RESISTANT STEEL AND HAS A HIGH STRENGTH TO WEIGHT RATIO. THE VALVE SEAT IS MOLDED OF VESPEL SP-1, WHICH EXHIBITS HIGH MECHANICAL STRENGTH, LOW WEAR RATE, AND SEALING COMPLIANCE WITHOUT PERMANENT DISTORTION. STATIC SEALS ARE MADE OF SILASTIC 675 SILICONE RUBBER. POPPET IS PRESSURE COMPENSATED THROUGH THE USE OF DYNAMIC SEALS AT EACH END, WHICH SLIDE ON THE VALVE STEM. VALVE STEM IS HIGHLY POLISHED FOR EASE OF OPERATION (REDUCED FRICTION PROTECTS SEALS). DYNAMIC SEALS ARE ALSO SILASTIC 675 SILICONE AND ARE LUBRICATED WITH BRAYCO LUBE. SILASTIC 675 SILICONE RUBBER HAS GOOD RESISTANCE TO ENVIRONMENTAL EXPOSURE, FLEXING, AND FATIGUE. IT ALSO HAS LOW FLAMMABILITY AND OUTGASSING. THE OZONE RESISTANCE OF SILICONE RUBBER IS EXCELLENT. BRAYCO LUBE IS COMPATIBLE WITH LOW AND HIGH PRESSURE GO2. INLET/OUTLET PORTS ARE FILTER PROTECTED TO 25 MICRONS. CONSTANT SEAT FORCES DUE TO BELLEVILLE CLOSING SPRING ELIMINATE EXCESS SEAL AND SEAT WEAR. OPERATING FORCE IS 4.5 POUNDS MAXIMUM AND IS INDEPENDENT OF PRESSURE LOADS. ALL MATERIALS USED ARE COMPATIBLE WITH OXYGEN.

(B) TEST:
CERTIFICATION FOR 100 MISSION LIFE (ORBITER O2 VALVE) - CERTIFIED BY SIMILARITY TO IDENTICAL VALVES (O2 ISOLATION VALVE, LES O2 MANUAL SHUTOFF VALVE, AND NITROGEN CROSSOVER VALVE) AND TO SIMILAR TYPE VALVES USED ON APOLLO PROGRAM THAT WERE FULLY QUALIFIED TO MORE SEVERE REQUIREMENTS. LIFE CYCLE TESTING - VALVES SUBJECTED TO 150 OPEN/CLOSE CYCLES AT A PRESSURE OF 300 PSIG, AND TESTED FOR EXTERNAL LEAKAGE PRE AND POST LIFE CYCLE TESTING. COMPONENT BURST PRESSURE TESTED AT 490 PSIG FOR A MINIMUM OF 5 MINUTES (2 TIMES MAXIMUM OPERATING PRESSURE). ORBITER O2 ISOLATION AND N2 CROSSOVER VALVES SUBJECTED TO THE FOLLOWING AS PART OF THE N2/O2 CONTROL PANEL: RANDOM VIBRATION SPECTRUM - 20 TO 150 HZ INCREASING AT 6 DB/OCTAVE TO 0.03 G**2/HZ AT 150 HZ; CONSTANT AT 0.03 G**2/HZ FROM 150 TO 1000 HZ, DECREASING AT 6 DB/OCTAVE FROM 1000 TO 2000 HZ FOR 48 MINUTES PER AXIS FOR THREE ORTHOGONAL AXES. DESIGN SHOCK - 20 G TERMINAL SAWTOOTH PULSE OF 11 MS DURATION IN EACH DIRECTION OF THREE ORTHOGONAL AXES. ATP TO VERIFY LEAKAGE PERFORMED AFTER SHOCK AND VIBRATION TESTING, NOT TO EXCEED 0.2 SCCM AT PRESSURE OF 110 PSIG.

ACCEPTANCE TEST (ORBITER O2 VALVE) - PROOF PRESSURE 1875 PSIG, INTERNAL LEAK TEST REQUIREMENT 5.0 SCCM MAXIMUM LEAKAGE AT 1250 PSIG, AND EXTERNAL LEAK 0.2 SCCM MAXIMUM AT 1250 PSIG.

IN-VEHICLE TESTING (ORBITER O2 VALVE) - INTERNAL LEAK TEST AT 925-950 PSIG, 10 SCCM MAXIMUM LEAKAGE.

OMRSD - TURNAROUND CHECKOUT TESTING IS ACCOMPLISHED IN ACCORDANCE WITH OMRSD.

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(C) INSPECTION:
RECEIVING INSPECTION
RAW MATERIAL VERIFIED BY INSPECTION FOR MATERIAL AND PROCESS CERTIFICATION.

CONTAMINATION CONTROL
CLEANLINESS LEVEL 200A PER MA0110-301 AND 100 ML RINSE TESTS VERIFIED BY INSPECTION.

ASSEMBLY/INSTALLATION
TORQUES VERIFIED BY INSPECTION. SPRING FORCES VERIFIED BY INSPECTION. DIMENSIONAL CHECKS PERFORMED BY INSPECTION. MIPS FOR CONCENTRICITY AND PERPENDICULARITY VERIFIED BY INSPECTION. 10X VISUAL INSPECTION ON SEAL RING VERIFIED BY INSPECTION

NONDESTRUCTIVE EVALUATION
WELDS ARE VISUALLY EXAMINED BY 20X AND X-RAY AND DYE PENETRANT INSPECTION.

CRITICAL PROCESSES
TIG WELD SCHEDULE, PARTS PASSIVATION, ANODIZING, AND HEAT TREATMENT VERIFIED BY INSPECTION. SOLDER CONNECTIONS VERIFIED BY INSPECTION TO BE PER NHB5300.4(3A). POTTING VISUALLY VERIFIED BY INSPECTION. APPLICATION OF LUBRICANT ON SEAL RING VERIFIED BY TECHNICIAN.

TESTING
ATP/QTP/OMRSD VERIFIED BY INSPECTION.

HANDLING/PACKAGING
PARTS PROTECTION AND HANDLING/SHIPPING REQUIREMENTS VERIFIED BY INSPECTION.

(D) FAILURE HISTORY:
CURRENT DATA ON TEST FAILURES, FLIGHT FAILURES, UNEXPLAINED ANOMALIES, AND OTHER FAILURES EXPERIENCED DURING GROUND PROCESSING ACTIVITY CAN BE FOUND IN PRACA DATA BASE.

(E) OPERATIONAL USE:
CREW COULD CLOSE UPSTREAM O2 SHUTOFF VALVE OR PERFORM ORBITER LEAK ISOLATION TROUBLE SHOOTING TO ISOLATE OXYGEN LEAKAGE. IF REQUIRED, CREW COULD THEN UTILIZE AN EMU THAT CONTAINS A SUFFICIENT AMOUNT OF OXYGEN TO PERFORM AN EVA.

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- APPROVALS -

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