PRINT DATE: 07/09/97

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL HARDWARE
NUMBER:M8-16S-E047 -X

SUBSYSTEM NAME: ECLSS - EMU OXYGEN RECHARGE SYSTEM
REVISION: 0 04/08/97

PART DATA

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

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:
EMU OXYGEN SHUTOFF VALVE

QUANTITY OF LIKE ITEMS: 1
ONE

FUNCTION:
PROVIDES A QUICK MEANS OF MANUALLY SHUTTING OFF OXYGEN FLOW TO BOTH EMU SERVICE PORTS LOCATED ON THE EXTERNAL AIRLOCK ECLSS PANEL. VALVE IS NORMALLY OPEN DURING EMU SERVICING.

REFERENCE DOCUMENTS: VS28-643001

FAILURE MODES EFFECTS ANALYSIS FMEA – CIL FAILURE MODE
NUMBER: M8-1SS-E047-01

REVISION#: 0 04/08/97

SUBSYSTEM NAME: ECLSS - EMU OXYGEN RECHARGE SYSTEM
LRU: EMU OXYGEN SHUTOFF VALVE
ITEM NAME: VALVE, EMU OXYGEN SHUTOFF
CRITICALITY OF THIS FAILURE MODE: 1R2

FAILURE MODE:
FAILS TO OPEN, RESTRICTED FLOW (CLOGGED)

MISSION PHASE: OO ON-ORBIT

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

CAUSE:
CONTAMINATION, CORROSION, MECHANICAL SHOCK, EXCESSIVE VIBRATION, PHYSICAL BINDING/JAMMING, MATERIAL DEFECT, FATIGUE

CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO

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:
VISUAL OBSERVATION - INCREASED TIME IN FILLING EMU OXYGEN TANKS.
INSTRUMENTATION - EMU OXYGEN PRESSURE ANOMALY ON AW820 PANEL PRESSURE GAUGE OR ON EMU ITSELF.

REMARKS/RECOMMENDATIONS:
A SINGLE PATH PROVIDES OXYGEN TO THE ECLSS PANEL TO SERVICE ALL EMU'S. EACH EMU CONTAINS TWO PRIMARY AND TWO SECONDARY TANKS ALL OF WHICH ARE FILLED PRIOR TO LAUNCH. WORST CASE SCENARIO IS WHEN RESTRICTED OXYGEN FLOW OCCURS PRIOR TO FILLING ALL EMU'S FOLLOWING INITIAL EVA.

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- FAILURE EFFECTS -

(A) SUBSYSTEM:
REDUCED OR LOSS OF OXYGEN TO ALL EMU O2 MECHANICAL FITTINGS AND QUICK DISCONNECTS.

(B) INTERFACING SUBSYSTEM(S):
NO INITIAL EFFECT - LOSS OF OXYGEN SUPPLY COULD RESULT IN LOSS OF EVA CAPABILITIES SUBSEQUENT TO FIRST EVA SINCE OXYGEN IS NOT AVAILABLE FOR BREATHING PURPOSES.

(C) MISSION:
NO INITIAL EFFECT. WORST CASE, LOSS OF CAPABILITY TO PERFORM A SECOND PLANNED EVA DUE TO LOSS OF OXYGEN TO ALL EMU'S. LOSS OF MISSION OBJECTIVES ASSOCIATED WITH PLANNED EVA'S SUBSEQUENT TO INITIAL EVA.

(D) CREW, VEHICLE, AND ELEMENT(S):
NO EFFECT UNTIL FAILURE OCCURS AFTER INITIAL EVA. THEN INABILITY TO PERFORM A CONTINGENCY EVA TO CORRECT A POTENTIAL CRIT 1 EVENT COULD RESULT IN LOSS OF CREW AND VEHICLE. OXYGEN TRANSFER TO SPACE STATION IS ALSO LOST WITH THIS FAILURE.

(E) FUNCTIONAL CRITICALITY EFFECTS:
FIRST FAILURE (RESTRICTED FLOW OF OXYGEN) - WORST CASE IF FAILURE OCCURS FOLLOWING AN INITIAL EVA. THEN LOSS OF OXYGEN FOR BREATHING PURPOSES WOULD PRECLUDE SUBSEQUENT EVA CAPABILITIES. OXYGEN TRANSFER TO THE SPACE STATION IS ALSO LOST WITH THIS FAILURE. CREW DECISION TO ABORT A SECOND PLANNED EVA WOULD RESULT IN LOSS OF MISSION OBJECTIVES ASSOCIATED WITH THE PLANNED EVA. - CRITICALITY 2/2 CONDITION.
SECOND FAILURE (FAILURE NECESSITATING AN EVA TO PREVENT A POTENTIAL CATASTROPHIC SITUATION) - INABILITY TO PERFORM 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:
THERE ARE NO WORKAROUNDS TO CIRCUMVENT A LOSS OF O2 SUPPLY TO EMU SERVICE PANEL AND ISS IF FAILURE OCCURS FOLLOWING INITIAL EVA WHEN EMU O2 TANKS ARE EMPTY.

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- TIME FRAME -

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:
FOLLOWING INITIAL EVA'S WHEN EMU OXYGEN SUPPLY IS DEPLETED, THERE IS NO WORKAROUND IF CREW CANNOT OPEN VALVE TO REFILL EMU'S.

HAZARD REPORT NUMBER(S): FF-09

HAZARD(S) DESCRIPTION:
INABILITY TO SAFELY PERFORM EVA.

-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 O2. 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

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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) - FLOW LIMITER (RESTRICTOR) TEST VERIFIES THE REQUIRED FLOWRATE FROM THE PRSD O2 SYSTEM. FLOW TEST AT EACH OF THE EIGHT QD'S VERIFIES FULLY OPEN FLOW PATH.

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

(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.

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(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:
SINCE EMU OXYGEN TANKS ARE FILLED PRIOR TO LAUNCH, CREW COULD UTILIZE AN EMU THAT CONTAINS A SUFFICIENT AMOUNT OF OXYGEN TO PERFORM AN EVA.

- APPROVALS -

SS & PAE	:	M. W. GUENTHER	:
PAE MANAGER	:	C. A. ALLISON	:
DESIGN ENGINEER	:	K. J. KELLY	:
NASA SS/MA	:		: 12-17-97
NASA SUBSYSTEM MANAGER	:		: 12-17-98
JSC MOD	:		: