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-E047-03

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:
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

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:
INSTRUMENTATION - REDUCED OR LOSS OF EMU OXYGEN PRESSURE INDICATION ON THE AW82D PANEL PRESSURE GAUGE. LEAKAGE COULD BE DETECTED BY A DROP IS ORBITER OXYGEN PRESSURE.

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REMARKS/RECOMMENDATIONS:
VALVE PROVIDES A NON-REDUNDANT CONTROL OF OXYGEN SUPPLY TO THE ECLSS PANEL TO SERVICE BOTH EMU PORTS. EACH EMU CONTAINS TWO PRIMARY AND TWO SECONDARY TANKS ALL OF WHICH ARE FILLED PRIOR TO LAUNCH. CLOSING ORBITER EMERGENCY OXYGEN VALVING TO TERMINATE LEAKAGE IS A CRITICALITY 1/1 CONDITION.

- FAILURE EFFECTS -

(A) SUBSYSTEM:
UNCONTROLLED OXYGEN FLOW INTO CABIN.

(B) INTERFACING SUBSYSTEM(S):
INCREASED USE OF OXYGEN. HIGH OXYGEN CONCENTRATION IN CREW CABIN UNTIL LEAK IS ISOLATED. POSSIBLE FLAMMABILITY VIOLATION. POTENTIAL LOSS OF EMERGENCY O2 SYSTEM DUE TO EXCESSIVE OXYGEN LEAKAGE.

(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):
INCREASE USE OF ORBITER CONSUMABLES. POTENTIAL BUILDUP OF OXYGEN IN CREW CABIN. GROSS EXTERNAL LEAKAGE COULD RESULT IN INADEQUATE O2 SUPPLY TO LES STATIONS AND SPACE STATION 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.

(E) FUNCTIONAL CRITICALITY EFFECTS:
LOSS OF EMERGENCY OXYGEN SYSTEM
(1A) FIRST FAILURE (EXTERNAL LEAKAGE OF OXYGEN SHUTOFF VALVE) - OXYGEN IS DIVERTED OUT LEAKY VALVE RESULTING IN AN INADEQUATE O2 SUPPLY TO LES STATIONS. INCREASE USE OF CONSUMABLES. POTENTIAL FOR BUILDUP OF OXYGEN IN CREW CABIN.
(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 (EXTERNAL LEAKAGE OF OXYGEN SHUTOFF VALVE) - OXYGEN IS DIVERTED AWAY FROM EMU PANEL. LOSS OF O2 TO EMU'S COULD RESULT IN LOSS OF EVA CAPABILTIES IF EMU O2 TANKS ARE EMPTY. CREW DECISION TO ABORT MISSION WOULD RESULT IN LOSS OF MISSION OBJECTIVES - CRITICALITY 2/2 CONDITION.

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(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 ISOLATE EXTERNAL LEAKAGE) - 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.

- 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:
THERE IS NO CORRECTIVE ACTION IF CREW DECIDES TO ABORT THE MISSION AS THE RESULT OF THIS FAILURE.

HAZARD REPORT NUMBER(S): FF-09, ORBI 270, ORBI 299

HAZARD(S) DESCRIPTION:
INABILITY TO SAFELY PERFORM EVA (FF-09). INABILITY TO SUPPLY O2 TO CABIN/CREW (ORBI 270), FLAMMABILITY THREAT IN CABIN DUE TO O2 LEAKAGE FROM ARS OR OTHER SYSTEMS (ORBI 299)

-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.

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

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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/CTP/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 PERFORM ORBITER LEAK ISOLATION AND HIGH O2 CONCENTRATION TROUBLE SHOOTING. IF NECESSARY 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	:		: 2-17-98
NASA SUBSYSTEM MANAGER	:		: 2-19-98
JSC MOD	:		: