

**FAILURE MODES EFFECTS ANALYSIS (FMEA) - CIL HARDWARE**  
**NUMBER: M8-1SS-E003 -X**

SUBSYSTEM NAME: ECLSS - ARPCS

REVISION: 1 04/08/97

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**PART DATA**


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	<b>PART NAME</b>	<b>PART NUMBER</b>
	<b>VENDOR NAME</b>	<b>VENDOR NUMBER</b>
LRU	:VALVE, VESTIBULE DEPRESSURIZATION CARLETON TECHNOLOGIES	MC250-0002-0290 2765-0001-01

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**EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:**  
**VESTIBULE DEPRESSURIZATION VALVE**

**QUANTITY OF LIKE ITEMS: 2**  
**TWO**

**FUNCTION:**  
 PROVIDES REDUNDANT CAPABILITY FOR DEPRESSURIZATION OF THE VESTIBULE BY VENTING AIR OVERBOARD. EACH VALVE CONTAINS TWO BUTTERFLY VALVES (VENT AND VENT ISOLATION) WHICH WORK IN SERIES TO ALLOW 16-20 LB/MIN OF AIR TO FLOW OUT OF THE DOCKING BASE. EACH OF THESE TWO VALVE ASSEMBLIES ARE MOUNTED ON THE OUTSIDE OF THE DOCKING BASE, ON TOP OF EACH OTHER, USING A SINGLE O-RING SEAL TO PREVENT POSSIBLE MOVEMENT OF THE ORBITER/ISS, A NON-PROPULSIVE DIFFUSER CAP ON THE OUTLET OF EACH VALVE PROVIDES AN EVEN DISBURSEMENT OF PRESSURE DURING VESTIBULE VENTING.

**REFERENCE DOCUMENTS:** V076-643028  
 V076-643051

## FAILURE MODES EFFECTS ANALYSIS FMEA - CIL FAILURE MODE

NUMBER: M8-155-E003-02

REVISION#: 0 04/08/97

SUBSYSTEM NAME: ECLSS - ARPCS

LRU: ASSY. VESTIBULE DEPRESSURIZATION VALVE

CRITICALITY OF THIS

ITEM NAME: VALVE, VESTIBULE DEPRESSURIZATION

FAILURE MODE: 2R3

FAILURE MODE:  
FAILS TO CLOSE, INTERNAL LEAKAGE

MISSION PHASE: OO ON-ORBIT

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

## CAUSE:

MECHANICAL SHOCK, EXCESSIVE VIBRATION, CONTAMINATION, CORROSION, PHYSICAL BINDING/JAMMING, SEAL MATERIAL DEGRADATION, PIECE PART STRUCTURAL FAILURE

CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO

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

## PASS/FAIL RATIONALE:

A)

B)

N/A - SINCE BOTH ISO AND VENT VALVES INTERNAL TO DEPRESS VALVE ASSEMBLY ARE IN STANDBY REDUNDANCY TO EACH OTHER. (INTERNAL LEAKAGE FAILURE MODE ONLY.)

C)

SCREEN C FAILS BECAUSE A SOURCE OF CONTAMINATION COULD AFFECT BOTH INTERNAL VALVES WITHIN A SINGLE DEPRESS VALVE ASSEMBLY. (FAILS TO CLOSE FAILURE MODE ONLY.)

## METHOD OF FAULT DETECTION:

INSTRUMENTATION - INDIVIDUAL INTERNAL BUTTERFLY VALVE (ISO AND VENT) STATUS INDICATION WOULD DETECT A FAILURE OF A VESTIBULE DEPRESS VALVE TO CLOSE.  
PHYSICAL OBSERVATION - AN OPEN OR INTERNAL LEAKAGE CONDITION OF A VESTIBULE DEPRESS VALVE, DURING PRESSURIZATION OF VESTIBULE, WOULD BE DETECTED BY A LOSS OF PRESSURE.

**FAILURE MODES EFFECTS ANALYSIS (FMEA) - CIL FAILURE MODE  
NUMBER: M8-1SS-E003-02****REMARKS/RECOMMENDATIONS:**

DUE TO CONTAMINATION CONCERNS, THE VESTIBULE MAY BE PURGED PRIOR TO OPENING EXTERNAL AIRLOCK UPPER HATCH. VESTIBULE TUNNEL IS DEPRESSURIZED PRIOR TO ORBITER/SPACE STATION SEPARATION. CLOSING VALVE FOLLOWING DEPRESSURIZATION AND SPACE STATION SEPARATION IS NOT CRITICAL. SERIES INTERNAL VALVES (VENT AND ISO) PROVIDES REDUNDANT PROTECTION AGAINST INTERNAL LEAKAGE. LEAKAGE THROUGH A SINGLE DEPRESSURIZATION VALVE WOULD NOT EXCEED CONSUMABLE MAKEUP CAPABILITY OF THE ORBITER ARPCS.

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**- FAILURE EFFECTS -**

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**(A) SUBSYSTEM:**

NO EFFECT FIRST FAILURE. SECOND ASSOCIATED VALVE FAILURE - LOSS OF CAPABILITY TO REPRESSURIZE VESTIBULE TUNNEL FOLLOWING DEPRESSURIZATION. VESTIBULE TUNNEL PRESSURE WILL REMAIN AT ATMOSPHERIC PRESSURE.

**(B) INTERFACING SUBSYSTEM(S):**

NO EFFECT FIRST FAILURE. EXTERNAL LEAKAGE OF PRESSURE WOULD RESULT IN AN INCREASE USE OF CONSUMABLES FOLLOWING AN INTERNAL LEAKAGE CONDITION OF THE INTERNALLY REDUNDANT VALVE.

**(C) MISSION:**

NO EFFECT UNTIL DEPRESSURIZATION VALVES ARE OPEN. THEN INABILITY TO CLOSE A DEPRESSURIZATION VALVE WILL PRECLUDE VESTIBULE TUNNEL PRESSURIZATION RESULTING IN LOSS OF MISSION OBJECTIVES. POSSIBLE EARLY MISSION TERMINATION IF AN INTERNAL LEAKAGE CONDITION OF THE INTERNALLY REDUNDANT VALVE OCCURS CAUSING EXTERNAL LEAKAGE OF HABITABLE PRESSURE.

**(D) CREW, VEHICLE, AND ELEMENT(S):**

NO EFFECT ON CREW/VEHICLE.

**(E) FUNCTIONAL CRITICALITY EFFECTS:**

FIRST FAILURE (VENT VALVE WITHIN ONE VESTIBULE DEPRESS VALVE FAILS TO CLOSE OR INTERNALLY LEAKS) - NO EFFECT.

(2A) SECOND FAILURE (ISO VALVE WITHIN SAME VESTIBULE DEPRESS VALVE FAILS TO CLOSE) OCCURS DURING PURGING - INABILITY TO PRESSURIZE VESTIBULE TUNNEL FOR OPENING OF EXTERNAL AIRLOCK UPPER HATCH RESULTING IN LOSS OF PRIMARY MISSION OBJECTIVES (CREW ENTRY INTO SPACE STATION).

(2B) SECOND FAILURE (ISO VALVE WITHIN SAME VESTIBULE DEPRESS VALVE INTERNALLY LEAKS - LOSS OF PRESSURE WITHIN EXTERNAL AIRLOCK RESULTING IN AN INCREASED USE OF CONSUMABLES. POSSIBLE EARLY MISSION TERMINATION.

DESIGN CRITICALITY (PRIOR TO DOWNGRADE, DESCRIBED IN (F)): 2R3

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**(F) RATIONALE FOR CRITICALITY DOWNGRADE:  
PERFORMING WORKAROUND TO RECYCLE VALVES OR CLOSE UPPER HATCH TO  
ISOLATE LEAKAGE DOES NOT AFFECT CRITICALITY OF THIS FAILURE MODE.  
CRITICALITY REMAINS A 2R3.**

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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: MINUTES**

**IS TIME REQUIRED TO IMPLEMENT CORRECTING ACTION LESS THAN TIME TO EFFECT?  
YES**

**RATIONALE FOR TIME TO CORRECTING ACTION VS TIME TO EFFECT:  
CREW WOULD HAVE ENOUGH TIME TO RECYCLE VESTIBULE DEPRESS VALVE OPENED  
AND CLOSED OR CLOSE EXTERNAL AIRLOCK UPPER HATCH BEFORE THE PROBLEM  
BECAME CRITICAL TO MISSION SUCCESS.**

**HAZARD REPORT NUMBER(S): NONE**

**HAZARD(S) DESCRIPTION:  
N/A**

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**-DISPOSITION RATIONALE-**

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**(A) DESIGN:**

SILASTIC 675 SILICONE RUBBER IS MOLDED IN PLACE ON THE METAL FLAPPER, ASSURING A CONTINUOUS GAS SEAL ACROSS THE EDGE OF THE FLAPPER. 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. ECCENTRIC ACTUATED VALVE POSITION INDICATOR PROVIDES POSITIVE VALVE POSITION INDICATION. THE BORE AREA IS TEFLON IMPREGNATED HARD ANODIZED TO MINIMIZE FRICTION AND PROVIDE CORROSION RESISTANCE. VALVE STEM THRUST BEARINGS ELIMINATE LONGITUDINAL RUNOUT INSURING THAT THE CENTERLINE OF THE VALVE STEM RUNS THROUGH THE CENTERLINE OF THE BORE. TWO VALVES (VENT AND VENT ISOLATION) PROVIDE REDUNDANCY AGAINST INTERNAL LEAKAGE FAILURE MODE. INLET SCREEN PROVIDES FOR DEBRIS SCREENING. THE VALVE BODY IS MADE OF A356.0-T61 ALUMINUM ALLOY, TEFLON PENETRATED HARD ANODIZED (NITUFF COATING).

**(B) TEST:**

ACCEPTANCE TEST (VALVE ASSEMBLY) - PROOF PRESSURE TESTED AT 24 PSIG, LEAKAGE (INTERNAL AND EXTERNAL) 1 SCCM MAX AT 16.7 PSIG.

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QUALIFICATION TEST (VALVE ASSEMBLY) - LIFE CYCLE AND THERMAL VACUUM WERE CERTIFIED BY SIMILARITY TO THE CABIN POSITIVE PRESSURE RELIEF VALVE (PPRV). THE PPRV HAS BEEN SUBJECTED TO AN OPERATIONAL LIFE CYCLE TEST OF 200 HOURS OF CONTINUOUS VALVE CYCLES. SUBJECT TO RANDOM VIBRATION FROM 20 TO 150 HZ INCREASING AT 6 DB/OCTAVE TO 0.09 G\*\*2/HZ. CONSTANT AT 0.09 G\*\*2/HZ FROM 150 TO 900 HZ, DECREASING AT 9 DB/OCTAVE FROM 900 TO 2000 HZ FOR 48 MINUTES PER AXIS. BURST PRESSURE IS 33.4 +/- 0.15 PSIG FOR 3 MINUTES MINIMUM; LEAKAGE NOT TO EXCEED 100 SCCM. FACTOR OF SAFETY = 2. DESIGN SHOCK - THREE 20 G TERMINAL PEAK, 11 MS DURATION SHOCK PULSES IN THREE ORTHOGONAL AXIS. INTERNAL LEAK TEST IS PERFORMED AFTER SHOCK AND VIBRATION TESTING TO VERIFY VALVE IS WITHIN SPEC LEAK RATE.

INTEGRATED SYSTEM CHECKOUT (EXTERNAL AIRLOCK) - LEAK TEST CONDUCTED AS PART OF INTEGRATED TEST. HIGH PRESSURE LEAK TEST PERFORMED AT 14.9 +/- 0.2 PSIG USING AIR OR GN2 FOR 4.0 HOURS MINIMUM. MAXIMUM ALLOWABLE LEAK RATE OF 6 SCIM.

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 OF 200A PER MA0110-301 AND 100 ML RINSE TESTS VERIFIED BY  
INSPECTION.

ASSEMBLY/INSTALLATION  
TORQUES VERIFIED BY INSPECTION. DIMENSIONAL CHECKS PERFORMED BY  
INSPECTION. 10X VISUAL INSPECTION ON O-RING SEAL.

NONDESTRUCTIVE EVALUATION  
LEAK TEST IS VERIFIED BY INSPECTION.

CRITICAL PROCESSES  
APPLICATION OF BRAYCOTE LUBRICANT ON SEAL RING VERIFIED BY TECHNICIAN.  
SOLDER CONNECTIONS VERIFIED BY INSPECTION IN ACCORDANCE WITH  
NH85300.4(3A). HEAT TREATMENT, PARTS PASSIVATION, AND ANODIZING VERIFIED BY  
INSPECTION.

TESTING  
ATP/QTP/OMRSD/INTEGRATED TESTING VERIFIED BY INSPECTION.

HANDLING/PACKAGING  
HANDLING, PACKAGING, STORAGE, AND SHIPPING PROCEDURES ARE 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:**

CREW COULD ATTEMPT TO RECYCLE BLEED VALVE CLOSED OR ISOLATE LEAK BY CLOSING EXTERNAL AIRLOCK UPPER HATCH.

**- APPROVALS -**

SS & PAE  
SS & PAE MANAGER  
DESIGN ENGINEER  
NASA SS/MA  
NASA SUBSYSTEM MANAGER  
JSC MOD

M. W. GUENTHER  
C. A. ALLISON  
K. J. KELLY

*[Handwritten signatures and dates]*  
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D. M. Kelly 2-17-98  
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