FAILURE MODES EFFECTS ANALYSIS (FMEA) – NON-CIL HARDWARE
NUMBER:M8-1MR-E040 -X

SUBSYSTEM NAME: ECLSS - EMU POTABLE & WASTE WATER SYSTEM
REVISION: 1 10/22/97

PART DATA

	PART NAME VENDOR NAME	PART NUMBER VENDOR NUMBER
LRU	:LINES & FITTINGS	M072-643401
LRU	:LINES & FITTINGS	M072-643403
LRU	:LINES & FITTINGS	V828-643050
LRU	:LINES & FITTINGS	V828-643051
SRU	:LINES & FITTINGS MULTIPLE SOURCES	MULTIPLE P/N'S

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:
EMU WASTE WATER RETURN LINES AND FITTINGS

QUANTITY OF LIKE ITEMS: 1
ONE SET PER SUBSYSTEM

FUNCTION:
PROVIDES A DUAL CONTROLLED RETURN PATH OF WASTE WATER, WITHIN THE ECLSS PANEL. THIS DUAL PATH CONVERGES INTO A SINGLE RIGID LINE, INTERNAL TO THE AIRLOCK, THAT EXTENDS TO THE MID DECK FLUID CONNECTIONS.

REFERENCE DOCUMENTS: VS28-643001
V828-643050
V828-643051
M072-643403

FAILURE MODES EFFECTS ANALYSIS FMEA – NON-CIL FAILURE MODE
NUMBER: M8-1SS-E040-01

REVISION#: 1 04/17/98

SUBSYSTEM NAME: ECLSS - EMU POTABLE & WASTE WATER SYSTEM
LRU: EMU WASTE WATER RETURN LINES **CRITICALITY OF THIS**
ITEM NAME: LINES & FITTINGS **FAILURE MODE: 1R3**

FAILURE MODE:
EXTERNAL LEAKAGE

MISSION PHASE: OO ON-ORBIT

VEHICLE/PAYLOAD/KIT EFFECTIVITY:

103	DISCOVERY
104	ATLANTIS
105	ENDEAVOUR

CAUSE:
CORROSION, MECHANICAL SHOCK, EXCESSIVE VIBRATION

CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO

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

PASS/FAIL RATIONALE:
A)

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

C)

METHOD OF FAULT DETECTION:
DECREASE IN PRESSURE WITHIN CREW CABIN. FAILURE CAN ALSO BE DETECTED WHEN EMU'S ARE CONNECTED TO ECLSS PANEL THROUGH VISUAL OBSERVATION (WASTE WATER BUILDUP IN HABITABLE AREAS).

CORRECTING ACTION: MANUAL

CORRECTING ACTION DESCRIPTION:
CREW COULD CONTINUE TO UTILIZE WASTE WATER REMOVAL SYSTEM DEPENDING ON MAGNITUDE OF LEAKAGE OR STOP LEAKAGE IN RETURN PATH BY DISCONNECTING EMU(S) OR BY CUTTING OUT THE AFFECTED LINE AND SPLICING IN A SECTION OF

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FLEXIBLE HOSE (FLEXIBLE HOSE & CLAMPS ARE PART OF A CONTINGENCY KIT). IF LEAKAGE IS DOWNSTREAM OF THE ECLSS PANEL CONTROL VALVE CREW COULD CLOSE VALVE AND UTILIZED REDUNDANT WASTE WATER RETURN LINE TO SERVICE ALL EMU'S. IF LEAKAGE IS UPSTREAM OF THE CONTROL VALVE CREW COULD UTILIZE AN EMU WHOSE WASTE WATER TANK(S) ARE EMPTY TO PERFORM AN EVA. ORBITER/ISS CAN ALSO BE MANEUVERED SUCH THAT THE EVA CREWMEMBERS ARE NOT EXPOSED TO THE SUN.

IN THE EVENT BOTH NOMINAL UNLATCHING AND PYRO SYSTEMS FAIL TO SEPARATE ORBITER FROM STATION, AS A RESULT OF WATER IN THE KEEL AREA, CREW COULD: (1) PERFORM IFM TO DRIVE HOOKS OPEN; OR (2) PERFORM EVA TO REMOVE 96 BOLTS HOLDING DOCKING BASE TO EXTERNAL AIRLOCK.

IN THE EVENT A PRESSURE LEAK OCCURS WITHIN THE CREW CABIN, AS A RESULT OF THIS FAILURE, CREW COULD: (1) DEMATE THE EMU DRAIN QD; OR (2) REMOVE THE TOP PLATE OF THE URINE DIVERTER VALVE, PLUG UP THE FEEDTHROUGH FROM THE WASTE WATER LINE, AND REINSTALL THE TOP PLATE TO PREVENT AN EXTERNAL LEAKAGE OF HABITABLE PRESSURE THROUGH THE EMU WASTE WATER LINE.

REMARKS/RECOMMENDATIONS:
WITHIN THE ECLSS PANEL DUAL WASTE WATER RETURN PATHS ARE PROVIDED TO SERVICE THE EMU'S. THESE TWO PATHS CONVERGE INTO A SINGLE LINE INSIDE THE ECLSS PANEL TO THE ORBITER WASTE WATER REMOVAL SYSTEM. A FAILURE WOULD NOT BE DETECTED UNTIL AN EMU IS ATTACHED TO THE WASTE WATER TRANSFER PORT. WORST CASE SCENARIO IS WHEN WASTE WATER LEAKAGE OCCURS UPSTREAM OF THE ECLSS CONTROL VALVE, IN THE SINGLE LINE, FOLLOWING INITIAL EVA. THERE ARE FOUR EMU'S AVAILABLE TO PERFORM AN EVA. A PLANNED EVA REQUIRES THE USE OF A MINIMUM OF THREE EMU'S (FOR THREE EVA CREWMEMBERS) WHILE A CONTINGENCY EVA REQUIRES A MINIMUM OF TWO EMU'S (FOR TWO EVA CREWMEMBERS).

THE WASTE WATER RETURN LINE BETWEEN THE EXTERNAL AIRLOCK ECLSS PANEL AND URINE DIVERTER VALVE IS ONLY 0.25 INCHES IN DIAMETER. AN EXTERNAL LEAKAGE OF CABIN PRESSURE THROUGH A 0.25 INCH DIAMETER LINE WOULD NOT EXCEED THE AIR MAKEUP CAPABILITIES OF THE ORBITER ARPCS.

- FAILURE EFFECTS -

(A) SUBSYSTEM:
PRESSURE DROP WITHIN CREW CABIN. ALSO WHEN AFFECTED EMU IS CONNECTED, FOLLOWING AN EVA, WASTE WATER IS DIVERTED BEFORE IT REACHES THE ORBITER WASTE WATER SYSTEM.

(B) INTERFACING SUBSYSTEM(S):
POTENTIAL FOR WASTE WATER BUILDUP IN EXTERNAL AIRLOCK, PAYLOAD BAY, OR MID DECK DEPENDING ON LOCATION OF LEAKAGE WHEN AN EMU IS CONNECTED FOLLOWING AN EVA. NO INITIAL EFFECT - INABILITY TO REMOVE WASTE WATER,

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FOLLOWING AN EVA, COULD RESULT IN LOSS OF CAPABILITY TO UTILIZE AFFECTED EMU'S FOR SUBSEQUENT EVA'S.

CREW CABIN PRESSURE LOSS - CREW CABIN PRESSURE WOULD LEAK THROUGH THE WASTE WATER RETURN LINE, VIA THE URINE DIVERTER VALVE, RESULTING IN AN INCREASE USE OF CONSUMABLES.

(C) MISSION:
LOSS OF CREW CABIN PRESSURE THROUGH THE WASTE WATER RETURN LINE COULD RESULT IN LOSS OF MISSION DUE TO INCREASED USE OF CONSUMABLES. INABILITY TO REMOVE WASTE WATER FROM EMU'S, WHEN REQUIRED, COULD LIMIT USE OF AFFECTED EMU'S IN PERFORMING A SECOND PLANNED EVA.

(D) CREW, VEHICLE, AND ELEMENT(S):
NO INITIAL EFFECT. INABILITY TO REMOVE WASTE WATER FROM EMU'S, WHEN REQUIRED, COULD LIMIT USE OF AFFECTED EMU'S IN PERFORMING A CONTINGENCY EVA TO CORRECT A POTENTIAL CRIT 1 CONDITION. WATER BUILDUP IN EXTERNAL AIRLOCK WHEN WASTE WATER WITHIN EMU'S IS DRAINED COULD RENDER RUSSIAN AVIONICS INOPERATIVE RESULTING IN THE INABILITY TO NOMINALLY SEPARATE ORBITER AND ISS.

(E) FUNCTIONAL CRITICALITY EFFECTS:
LOSS OF CREW CABIN PRESSURE:
FIRST FAILURE (EMU WASTE WATER LINE, OUTSIDE EXTERNAL AIRLOCK, CRACKED OR BROKEN) - LOSS OF CREW CABIN PRESSURE THROUGH 0.25 INCH WASTE WATER RETURN LINE VIA URINE DIVERTER VALVE ASSEMBLY. INCREASE USE OF CONSUMABLES COULD RESULT IN EARLY MISSION TERMINATION. - CRITICALITY 2/2 CONDITION

LOSS OF CONTINGENCY EVA CAPABILITIES:
FIRST FAILURE (EXTERNAL LEAKAGE OF EMU WASTE WATER) - INABILITY TO REMOVE WASTE WATER FROM ALL EMU'S. WORST CASE IF FAILURE OCCURS FOLLOWING AN INITIAL EVA. THEN LOSS OF CAPABILITY TO REMOVE WASTE WATER WOULD PRECLUDE SUBSEQUENT EVA CAPABILITIES. POTENTIAL LOSS OF CONTINGENCY EVA OPERATIONS. - CRITICALITY 1R2 CONDITION.

LOSS OF ORBITER/ISS UNDOCKING CAPABILITIES:
FIRST FAILURE (EXTERNAL LEAKAGE OF EMU WASTE WATER) - POTENTIAL BUILDUP OF WATER WITHIN EXTERNAL AIRLOCK. WATER MOLECULES COULD MIGRATE TO THE RUSSIAN AVIONICS BOXES LOCATED IN THE KEEL AREA RENDERING THEM INOPERATIVE. (RUSSIAN BOXES ARE NOT HERMETICALLY SEALED.) LOSS OF RUSSIAN AVIONICS WOULD TAKE OUT BOTH NOMINAL UNLATCHING AND BACKUP PYRO CAPABILITIES RESULTING IN LOSS OF NOMINAL UNDOCKING. - CRITICALITY 1/1 CONDITION

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

(F) RATIONALE FOR CRITICALITY DOWNGRADE:
LOSS OF CREW CABIN PRESSURE:
SECOND FAILURE (INABILITY TO DEMATE EMU DRAIN QD) - INABILITY TO STOP EXTERNAL LEAKAGE OF CREW CABIN PRESSURE USING THIS WORKAROUND. CONTINUOUS DEPLETION OF ORBITER CONSUMABLES.
THIRD FAILURE (INABILITY TO CLOG WASTE WATER FEEDTHROUGH WITHIN URINE DIVERTER VALVE) - INABILITY TO TERMINATE EXTERNAL LEAKAGE OF PRESSURE WITHIN CREW CABIN. INCREASED USE OF CONSUMABLES COULD RESLULT IN EARLY MISSION TERMINATION. - CRITICALITY 2R3 CONDITION

LOSS OF CONTINGENCY EVA CAPABILITIES:
SECOND FAILURE (INABILITY TO BYPASS LEAK USING FLEX LINE) - UNABLE TO STOP EXTERNAL LEAKAGE OF POTABLE WATER.
THIRD FAILURE (UNABLE TO PERFORM WORKAROUND TO MANEUVER ORBITER/ISS) - EVA CREWMEMBERS WOULD BE EXPOSED TO THE SUN DURING AN EVA REQUIRING EMU SUBLIMATORS TO BE ON RESULTING IN AN INCREASED USE OF EMU POTABLE WATER. LOSS OF POTABLE WATER SUPPLY TO EMU'S WOULD PRECLUDE SUBSEQUENT EVA'S.
FOURTH 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 1R3 CONDITION.

LOSS OF ORBITER/ISS UNDOCKING CAPABILITIES:
SECOND FAILURE (INABILITY TO PERFORM IFM TO DRIVE HOOKS OPEN) - INABILITY TO SEPARATE ORBITER ACTIVE DOCKING MECHANISM FROM ISS PASSIVE DOCKING MECHANISM.
THIRD FAILURE (INABILITY TO PERFORM EVA OR REMOVE 96 BOLTS HOLD DOCKING BASE TO EXTERNAL AIRLOCK) - INABILITY TO SEPARATE ORBITER FROM ISS RESULTING IN POSSIBLE LOSS OF ORBITER AND CREW. - 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: 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 SUFFICIENT TIME TO STOP AN EXTERNAL LEAK, MANEUVER ORBITER/ISS SUCH THAT EVA CREWMEMBERS ARE NOT EXPOSED TO THE SUN, OR PERFORM WORKAROUNDS TO SEPARATE ORBITER FROM ISS BEFORE AN EXTERNAL LEAKAGE OF EMU WASTE WATER BECOMES CATASTROPHIC TO CREW SAFETY OR

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EXTERNAL LEAKAGE OF CREW CABIN PRESSURE BECAME CRITICAL TO MISSION SUCCESS.

HAZARD REPORT NUMBER(S): ORBI 401, FF-09

HAZARD(S) DESCRIPTION:
INABILITY TO SAFELY SEPARATE ORBITER FROM MATED ELEMENT (ORBI 401), INABILITY TO SAFELY PERFORM EVA (FF-09).

- APPROVALS -

SS & PAE	:	M. W. GUENTHER	:
DESIGN ENGINEER	:	S. CASTILLO	: