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FAILURE MODES EFFECTS ANALYSIS (FMEA) - CIL HARDWARE

NUMBER: M8-1MR-E021-X

SUBSYSTEM NAME: ECLSS - MIR

REVISION: 2 9/15/95

	PART NAME VENDOR NAME	PART NUMBER VENDOR NUMBER
LRU	: DUCT, FLEXIBLE	V727-634104-001
	: DUCT, RIGID	V727-634107-001
	: DUCT, RIGID	V727-634110-001
	: DUCT, RIGID	V727-634112-001
	: DUCT, FLEXIBLE	V828-643020-001
	: DUCT, RIGID	V828-643022(QTY-2)
	: DUCT, RIGID	V828-643104-001
	: DUCT, RIGID	V828-643106-001
	: DUCT, RIGID	V828-643107-001(QTY-2)
	: DUCT, RIGID	V828-643108-001
	: DUCT, RIGID	V828-643109-001(QTY-2)
	: DUCT, RIGID	V828-643110-001
	: DUCT, RIGID	V828-643111-001
	: DUCT, RIGID	V828-643112-001
	: DUCT, RIGID	V828-643113-001
	: DUCT, RIGID	V828-643114-001
	: DUCT, RIGID	V828-643116-001
	: DUCT, FLEXIBLE	V828-643121-001
	: DUCT, RIGID	V828-643122-001
	: DUCT, RIGID	V828-643123-001

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PART DATA

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:
MIR ECLSS RIGID & FLEXIBLE DUCTING

REFERENCE DESIGNATORS:

QUANTITY OF LIKE ITEMS: 24
TWENTY FOUR

FUNCTION:
PROVIDES AIRFLOW PATH FROM ORBITER AIRPCS FLOOR SUPPLY PORT THROUGH
FAN PACKAGE TO EXTERNAL AIRLOCK FOR EXTERNAL AIRLOCK, VESTIBULE TUNNEL,
AND MIR ENVIRONMENT AIR MAKEUP. GENERATES AIRFLOW WHEN THE CREW CABIN
HATCH AND EXTERNAL AIRLOCK UPPER HATCH ARE OPEN.

REFERENCE DOCUMENTS: V727-634104
V727-634107
V727-634110
V727-634112
V828-643001
V828-643020
V828-643022
V828-643107
V828-634108
V828-634109
V828-634110
V828-634111
V828-634112
V828-634113
V828-634114
V828-634115
V828-634121
V828-634122
V828-634123
V828-634130
M072-643400
M072-643829

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FAILURE MODES EFFECTS ANALYSIS (FMEA) - CIL FAILURE MODE
NUMBER: M8-1MR-E021-02

REVISION# 2 9/15/95

SUBSYSTEM NAME: ECLSS - INTERNAL/EXTERNAL AIRLOCK
 LRU: DUCT, RIGID/FLEXIBLE
 ITEM NAME: DUCT, RIGID/FLEXIBLE

CRITICALITY OF THIS
 FAILURE MODE: 2/2

FAILURE MODE:
 RESTRICTED FLOW (CLOGGED)

MISSION PHASE:
 OO ON-ORBIT

VEHICLE/PAYLOAD/KIT EFFECTIVITY: 104 ATLANTIS

CAUSE:
 PHYSICAL DAMAGE, VIBRATION, CONTAMINATION, MECHANICAL SHOCK

CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO

CRITICALITY 1R2 DURING INTACT ABORT ONLY (AVIONICS ONLY)? N/A

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

PASS/FAIL RATIONALE:

A)
 N/A

B)
 N/A

C)
 N/A

METHOD OF FAULT DETECTION:
 PHYSICAL OBSERVATION - LOSS OF OUTPUT AIRFLOW.

- FAILURE EFFECTS -

(A) SUBSYSTEM:
 LOSS OF CABIN AIRFLOW TO INTERNAL AIRLOCK, TUNNEL ADAPTER, EXTERNAL
 AIRLOCK, VESTIBULE TUNNEL, MIR AND SPACELAB ENVIRONMENT (MIR 1 ONLY).

(B) INTERFACING SUBSYSTEM(S):
 NO EFFECT ON INTERFACING ORBITER SUBSYSTEMS.

(C) MISSION:
 EARLY MISSION TERMINATION IF FAILURE OCCURS PRIOR TO COMPLETION OF IVA.
 LOSS OF AIRFLOW TO EXTERNAL AIRLOCK/VESTIBULE TUNNEL INTERFACE COULD
 CAUSE FOGGING OF EXTERNAL AIRLOCK UPPER HATCH WINDOW. REDUCED

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VISIBILITY CAUSED BY WINDOW FOGGING WOULD PRECLUDE MIR DOCKING CAPABILITIES.

(D) CREW, VEHICLE, AND ELEMENT(S):
NO EFFECT ON CREW AND VEHICLE.

(E) FUNCTIONAL CRITICALITY EFFECTS:
N/A

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

(F) RATIONALE FOR CRITICALITY DOWNGRADE:
N/A (THERE ARE NO WORKAROUNDS TO CIRCUMVENT THIS FAILURE).

- TIME FRAME -

TIME FROM FAILURE TO CRITICAL EFFECT: HOURS TO DAYS

TIME FROM FAILURE OCCURRENCE TO DETECTION: SECONDS

TIME FROM DETECTION TO COMPLETED CORRECTIVE ACTION: N/A

IS TIME REQUIRED TO IMPLEMENT CORRECTIVE ACTION LESS THAN TIME TO EFFECT?
NO

RATIONALE FOR TIME TO CORRECTING ACTION VS TIME TO EFFECT:
THERE IS NO CORRECTIVE ACTION TO RESTORE AIRFLOW THROUGH A CLOGGED RIGID OR FLEXIBLE DUCT.

HAZARDS REPORT NUMBER(S): DM2SHA03(F)

HAZARD(S) DESCRIPTION:
LOSS OF AIR CIRCULATION IN ODS/DOCKING MODULE HABITABLE ENVIRONMENT.

-DISPOSITION RATIONALE-

(A) DESIGN:

INTERNAL AIRLOCK DUCTS ARE 4 INCHES IN DIAMETER. EXTERNAL AIRLOCK DUCTS ARE 3 INCHES IN DIAMETER AND THE FOUR DUCT SECTIONS THAT MAKE UP THE HALO ARE 2 INCHES IN DIAMETER. THESE DUCTS CONSIST OF TWO BASIC TYPES: HARD DUCTS AND FLEXIBLE DUCTS.

HARD DUCT PORTIONS ARE FABRICATED FROM EPOXY RESIN IMPREGNATED ARAMID FABRIC. HARD DUCTS WITHIN THE INTERNAL AIRLOCK INCLUDE: CABIN APS FLOOR SUPPLY PORT DUCT ELBOW AND FAN PACKAGE INLET & OUTLET DUCT ELBOWS. HARD DUCTS WITHIN THE EXTERNAL AIRLOCK INCLUDE: FOUR (4) HORIZONTAL/VERTICAL DUCTS, THREE(3) ELBOW DUCTS, THREE(3) TEE DUCTS (LOWER, UPPER, AND DIFFUSER), AND FOUR(4) HALO DUCTS. SECTIONS ARE HARD MOUNTED TO THE STRUCTURE BY A BRACKET/BAND CLAMP ASSEMBLY. A 0.5 INCH STRESS RELIEF GAP IS PROVIDED BETWEEN DUCT SECTIONS. THIS GAP IS BRIDGED BY FLEXIBLE SILICONE/FIBERGLASS SLEEVES HELD IN PLACE BY BAND CLAMPS AND GROOVES THAT

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ARE PERFORMED INTO EACH CLAMPS AND GROOVES THAT ARE PERFORMED INTO EACH DUCT SEGMENT.

FLEXIBLE DUCTS ARE FABRICATED FROM SILICONE IMPREGNATED FIBERGLASS FABRIC OVER STEEL HELICAL SPRING WIRE WHICH IS CAPABLE TO ABSORB VIBRATION, REDUCE SOUND TRANSMISSION AND PROVIDE FOR INSTALLATION TOLERANCES. BAND CLAMPS ARE USED TO HOLD FLEXIBLE DUCTS TO RIGID DUCT INTERFACES. INTERNAL AIRLOCK FLEXIBLE DUCTS ARE LOCATED IN THREE AREAS: (1) BETWEEN THE CABIN AREA ORBITER ARS FLOOR SUPPLY PORT ELBOW AND FAN PACKAGE INLET; (2) BETWEEN THE FAN PACKAGE OUTLET FITTING AND INLET OF THE TUNNEL ADAPTER RIGID DUCT; AND (3) AT THE END OF THE TUNNEL ADAPTER EXTENSION RIGID DUCT. EXTERNAL AIRLOCK FLEXIBLE DUCTS ARE LOCATED IN TWO AREAS: (1) BETWEEN THE EXTERNAL AIRLOCK RIGID DUCT ELBOW OUTLET AND THE SPACELAB INLET DUCT ELBOW; (2) AT THE END OF THE VERTICAL RIGID DUCT THAT EXTENDS INTO THE MIR.

(B) TEST:

QUALIFICATION TESTS (RIGID DUCTS) - TESTS OF SIMILAR MATERIAL SHOW THAT RIGID EPOXY/ARAMID DUCTS ARE UNAFFECTED BY HUMIDITY WITHIN THE LIMITS IMPOSED BY THE CABIN ATMOSPHERE. MATERIAL TESTS OF KEVLAR/EPOXY LAMINATES CONDUCTED AT TEMPERATURES OF -250 AND 350 DEGREES F SHOWED NO DEGRADATION IN MATERIAL. TENSILE STRENGTH (42 KSI) REMAINED UNCHANGED AFTER EXPOSURE TO 100 PHM OZONE AT 70 DEGREES F FOR 1000 HOURS.

TOLERANCE TO SALINITY WAS DEMONSTRATED BY ANALYSIS BASED ON TEST OF SIMILAR MATERIAL IN SALT WATER FOR 125 DAYS. TRANSIENT VIBRATIONS, RANDOM VIBRATIONS, AND CRASH LOADS WERE CERTIFIED BY ANALYSIS.

QUALIFICATION TEST (FLEXIBLE DUCTS) - THE SILICONE/FIBERGLASS FLEX DUCTS WERE CERTIFIED BY SIMILARITY AND WERE SHOWN TO WITHSTAND TEMPERATURES FROM -50 DEGREES F TO 600 DEGREES F WITHOUT PROBLEMS. NON-NUTRIENT TO FUNGUS DEMONSTRATED BY TEST. SALINITY TOLERANCE DEMONSTRATED BY TEST OF IDENTICAL MATERIAL EXPOSED TO A 20% SALT SOLUTION AT 95 DEGREES F AND 85% RELATIVE HUMIDITY FOR 50 HOURS WITH NO EFFECT. BURST PRESSURE WAS DEMONSTRATED BY TEST TO BE GREATER THAN 200 PSIG. TRANSIENT AND RANDOM VIBRATIONS WERE CERTIFIED BY TEST OF THE SIMILAR DUCTS AND CRASH LOADS BY ANALYSIS.

LIFE - CERTIFIED FOR 100 MISSIONS/10 YEARS. THE DUCTING IS NOT AGE SENSITIVE AND IS RESISTANT TO ORBITER ENVIRONMENTS.

IN-PROCESS AND ACCEPTANCE TEST (INTEGRATED) - THREE SEPARATE AIR SYSTEM FLOWRATE (DUCT) TESTS PERFORMED WITH INLET PRESSURE BETWEEN 1 IN/H2O AND 3 IN/H2O. (1) NOMINAL WITH NO BRANCHES BLOCKED - FLOW RATE AT MIR DIFFUSER VERIFIED TO BE 160-290 LB/HR AND FLOW RATE AT SPACELAB INTERFACE VERIFIED TO BE 170-320 LB/HR WITH INLET FLOW RATE OF 470-860 LB/HR; (2) WITH SPACELAB INTERFACE BLOCKED - FLOW RATE AT MIR DIFFUSER VERIFIED TO BE 170-300 LB/HR WITH INLET FLOW RATE OF 380-680 LB/HR; AND (3) WITH MIR DIFFUSER BLOCKED - FLOW RATE AT SPACELAB INTERFACE VERIFIED TO BE 180-320 LB/HR WITH INLET FLOW RATE OF 410-740 LB/HR.

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

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

CONTAMINATION CONTROL
CLEANLINESS REQUIREMENTS TO THE GENERALLY CLEAN (GC) LEVEL.

ASSEMBLY/INSTALLATION
INSPECTION VERIFIES THE FOLLOWING: PROCESS REQUIREMENTS RELATIVE TO MATERIALS PREPARATION, FABRICATION OF DUCT SECTIONS (INCLUDING DUCT LENGTH AND WALL THICKNESS) AND CURE CYCLES IN ACCORDANCE WITH REQUIREMENTS. INSTALLATION OF CURED SECTIONS INTO THE DUCT SYSTEM (BONDING, SPLICING, SEAL COATING, INSTALLATION OF CLAMPS, FASTENERS, TAPE AND INSULATION) IN ACCORDANCE WITH DRAWING AND SPECIFICATION REQUIREMENTS.

CRITICAL PROCESSES
CURING IS VERIFIED BY INSPECTION.

TESTING
ATP/OTP/OMRSD VERIFIED BY INSPECTION.

HANDLING/PACKAGING
PARTS PROTECTION AND HANDLING 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:
NONE

*** APPROVALS ***

PRODUCT ASSURANCE ENGR .	:	M. W. GUENTHER	:	<u>M. W. Guenther</u>
PAE MANAGER	:	W. R. MARLOWE	:	<u>W. R. Marlowe</u>
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SEP 22 9 12 AM '95
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