

**FAILURE MODES EFFECTS ANALYSIS (FMEA) - CRITICAL HARDWARE  
NUMBER: 06-1C-0191-X**

SUBSYSTEM NAME: ARS - ARPCS

REVISION: 3 01/12/94

	PART NAME VENDOR NAME	PART NUMBER VENDOR NUMBER
LRU	: LINES AND FITTINGS	V070-613130
LRU	: LINES AND FITTINGS	V070-634460
LRU	: LINES AND FITTINGS	V070-634465
SRU	: LINES AND FITTINGS MULTIPLE SOURCES	2720-0001-3

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**PART DATA**

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**EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:**  
LINES AND FITTING, OXYGEN

**QUANTITY OF LIKE ITEMS: 1**  
ONE SET PER SUBSYSTEM

**FUNCTION:**  
PROVIDES FOR THE MOVEMENT OF OXYGEN BETWEEN THE VARIOUS COMPONENTS IN THE ATMOSPHERIC MAKEUP CONTROL SUBSYSTEM. SYSTEMS ONE AND TWO ARE MADE UP BY PARALLEL TUBE RUNS BETWEEN REDUNDANT EQUIPMENT. INCLUDES ALL LINES & FITTINGS IN THE CRYO O2 FROM THE PRSD VALVES TO THE 8.0 & 14.7 REGULATORS.

**FAILURE MODES EFFECTS ANALYSIS (FMEA) - CRITICAL FAILURE MODE  
NUMBER: 06-1C-0191-01**

REVISION# 2 08/26/93 R

SUBSYSTEM NAME: ARS - ARPCS  
LRU: LINES AND FITTING  
ITEM NAME: LINES AND FITTING

CRITICALITY OF THIS  
FAILURE MODE: 1/1

FAILURE MODE:  
EXTERNAL LEAKAGE

**MISSION PHASE:**

PL PRELAUNCH  
LO LIFT-OFF  
OO ON-ORBIT  
DO DE-ORBIT  
LS LANDING SAFING

VEHICLE/PAYLOAD/KIT EFFECTIVITY: 102 COLUMBIA  
103 DISCOVERY  
104 ATLANTIS  
105 ENDEAVOUR

CAUSE:  
MECHANICAL SHOCK, VIBRATION, CORROSION, MATERIAL DEFECT, FATIGUE

CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO

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

**PASS/FAIL RATIONALE:**

A)

B)

C)

**- FAILURE EFFECTS -**

**(A) SUBSYSTEM:**

EXCESSIVE LOSS OF OXYGEN UNTIL O2 SUPPLY VALVE IS CLOSED.

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

POSSIBLE HIGH O2 PRESSURE IN CABIN (IF LEAK IS IN CABIN PORTION OF LINE) UNTIL LEAK IS ISOLATED. POSSIBLE FLAMMABILITY LIMIT VIOLATION. REDUCED OXYGEN FLOW PATHS AVAILABLE.

**(C) MISSION:**

EARLY MISSION TERMINATION FOR OXYGEN LEAK WHICH CAUSES LOSS OF ONE O2 SOURCE FOR AIRLOCK AND LES.

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

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LOSS OF ONE O2 SUPPLY SYSTEM RESULTS IN INSUFFICIENT OXYGEN FLOW TO LES SYSTEM. LOSS OF THIS EMERGENCY SYSTEM MAY RESULT IN LOSS OF CREW/VEHICLE.

(E) FUNCTIONAL CRITICALITY EFFECTS:  
NONE

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**-DISPOSITION RATIONALE-**

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**(A) DESIGN:**

LINES ARE FABRICATED OF 21-6-9 STAINLESS STEEL WITH A THICKNESS OF 0.016 INCH. FITTINGS ARE DYNATUBES MADE OF 17-4 PH STAINLESS STEEL AND ARE BRAZED INTO THE SYSTEM. 21-6-9 STAINLESS STEEL HAS GOOD CORROSION RESISTANCE, HIGH MECHANICAL PROPERTIES, GOOD IMPACT STRENGTH, AND HIGH STRENGTH TO WEIGHT RATIO. 17-4 PH CONDITION A CRES IS PRECIPITATION HARDENED CORROSION RESISTANT STEEL WHICH HAS A HIGH STRENGTH TO WEIGHT RATIO. BOTH MATERIALS ARE COMPATIBLE WITH GO2. EXTENSIVE FLIGHT EXPERIENCE STS-1 TO PRESENT PROVIDES CONFIDENCE IN DESIGN INTEGRITY.

**(B) TEST:**

QUALIFICATION TEST - TESTING OF 21-6-9 STAINLESS TUBING AS FOLLOWS: PRETEST PROOF (2X OPERATING PRESSURE) AND EXTERNAL LEAK TEST (1 X 10 EXP -6 SCCS HE MAX), BURST TEST (BURST AT GREATER THAN OR EQUAL TO 4X OPERATING PRESSURE), IMPULSE FATIGUE TEST (TWO HUNDRED THOUSAND CYCLES OF IMPULSE WAVES), FLEXURE FATIGUE TEST (TEN MILLION CYCLES OF FLEXURE), RANDOM VIBRATION, POST TEST LEAK TEST (1 X 10 EXP -6 SCCS HE MAX). DYNATUBE COUPLINGS ARE AUTHORIZED BY RI SPEC MF0004-0100 "MECHANICAL - ORBITER PROJECT PARTS LIST."

IN-VEHICLE TESTING - O2 LINES ARE OVERPRESSURE (1070 - 1255 PSIG) AND LEAK TESTING IS PERFORMED AT 925 - 950 PSIG, 1 10 EXP-7 SCCM MAX LEAKAGE.

OMRSD - 900, 100 PSI EMERGENCY BREATHING SYSTEM 1 & 2 LEAK CHECK IS PERFORMED PRIOR TO THE FIRST REFLIGHT OF EACH ORBITER AND EVERY FIVE FLIGHTS AT 900-950 PSIG, 70 SCCM MAX LEAKAGE. INFLIGHT CHECKOUT DURING EACH MISSION VERIFIES NO GROSS EXTERNAL LEAKAGE.

**(C) INSPECTION:****RECEIVING INSPECTION**

RAW MATERIAL VERIFIED BY INSPECTION FOR MATERIAL AND PROCESS CERTIFICATION AND MAINTAINED BY INSPECTION.

**CONTAMINATION CONTROL**

CLEANLINESS LEVEL 200A PER MA0110-301 PRIOR TO AND DURING OPERATIONS, 100 ML RINSE TEST VERIFIED BY INSPECTION. ELECTROPOLISHING IS VERIFIED BY INSPECTION.

**ASSEMBLY/INSTALLATION**

FABRICATION OF PARTS/COMPONENTS PER DRAWING VERIFIED BY INSPECTION. DIMENSIONAL INSPECTIONS ARE PERFORMED AND VERIFIED BY INSPECTION. RIGID TUBING INSTALLATION PER DRAWING INCLUDING LUBRICANTS AND TORQUES VERIFIED BY INSPECTION.

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**CRITICAL PROCESSES**

PARTS PASSIVATION AND ELECTRICAL BONDING APPLICATION VERIFIED BY INSPECTION. BRAZING OF TUBING AND COMPONENTS VERIFIED BY INSPECTION.

**NONDESTRUCTIVE EVALUATION**

RADIOGRAPHIC INSPECTION OF INDUCTION BRAZES VERIFIED BY INSPECTION. FLUORESCENT PENETRANT INSPECTION PER MIL-I-6866 PERFORMED AND VERIFIED BY INSPECTION.

**TESTING**

LEAK TEST VERIFIED BY INSPECTION. PRESSURE LEAK TEST VERIFIED BY INSPECTION.

**HANDLING/PACKAGING**

HANDLING, PACKAGING, STORAGE AND SHIPPING PROCEDURES ARE VERIFIED BY INSPECTION.

**(D) FAILURE HISTORY:**

FOUR FAILURES OF THIS HARDWARE TYPE HAVE OCCURRED:

AB9765-010, 6/25/81. DURING A PRESSURE TEST OF THE N2/O2 CONTROL PANEL IT WAS NOTED THAT DYNATUBE FITTINGS LEAKED. THE CAUSE WAS DETERMINED TO BE DAMAGED SEALING SURFACES. ALL DYNATUBE INTERFACE AND TEST POINT FITTINGS WERE REINSPECTED AND THOSE FOUND TO BE DAMAGED WERE REPLACED. CORRECTIVE ACTION: PANEL LEVEL ATP WAS REVISED TO IMPROVE SCREENING FOR EXTERNAL LEAKS. TRAINING PROCEDURES HAVE BEEN IMPLEMENTED TO NOT ALLOW ROTATIONAL MOVEMENT BETWEEN DYNATUBE FACES. THE SUPPLIER INITIATED THE USE OF SOFT SEATS FOR DYNATUBE INTERFACES EXCEPT FOR THE FINAL CONNECTION PRIOR TO LEAK TEST.

AC0479-000, 9/10/81. DURING SUPPLIER ATP, N2O2 CONTROL PANEL EXTERNAL LEAKAGE WAS 12.865 SCCM OF GN2. SHOULD BE 9.8 SCCM MAX. THIS PANEL HAD BEEN SUBJECTED TO QUALIFICATION VIBRATION TESTS EQUIVALENT TO MORE THAN 200 MISSIONS. THIS OUT OF SPEC LEAKAGE WAS THEREFORE CONSIDERED TO BE THE RESULT OF OVER-TEST. THIS QUAL TEST PANEL WAS ASSIGNED FOR USE AS AN ENGINEERING TEST PANEL. NO CORRECTIVE ACTION REQUIRED.

AC4061-000, 9/27/82. DURING THERMAL TESTING OF THE N2/AUX O2 SUPPLY PANEL AT THE SUPPLIER AT -65 F, EXTERNAL LEAKAGE WAS 16.5 SCCM. MAX ALLOWABLE LEAK RATE WAS 5.8 SCCM. THE LEAKAGE WAS CONSIDERED ACCEPTABLE, AND THE ALLOWABLE LEAK RATE AT -65 F WAS INCREASED TO 17.4 SCCM.

AD2285-010, 1/21/85 AT PALMDALE. O2 PAYLOAD LINE IN THE N2O2 CONTROL PANEL LEAKED DUE TO A LOOSE FITTING. TORQUE APPLIED WAS 5 FT-LB; THE 20 FT-LB FINAL TORQUE HAD BEEN OMITTED AT THE SUPPLIER. CORRECTIVE ACTION - ASSEMBLY WORKSHEETS WERE REVISED TO INCLUDE A CHECKLIST TO ASSURE FINAL TORQUE IS APPLIED, AND ALSO TO TRACK FITTINGS LOOSENEED DURING ASSEMBLY PROCESS.

**(E) OPERATIONAL USE:**

1. CREW ACTION
  - PERFORM LEAK ISOLATION AND HIGH O2 CONCENTRATION TROUBLE SHOOTING.
2. TRAINING

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STANDARD ECLSS TRAINING COVERS THE GENERIC HIGH O2 CONCENTRATION.

3. OPERATIONAL CONSIDERATION

- A. PRECLUDES USE OF LES UNLESS LEAK IS SMALL ENOUGH TO PERMIT SIMULTANEOUS LES USE PLUS O2 LEAKAGE TO CABIN.
- B. HIGH O2 CONCENTRATION HAS FLAMMABILITY CONCERN

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- APPROVALS -

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EDITORIALLY APPROVED : RI  
 EDITORIALLY APPROVED : JSC  
 TECHNICAL APPROVAL : VIA CR

*Handwritten signature and date:*  
 8/27/93  
 8/31/93  
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