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PRINT DATE: 08/27/93

FAILURE MODES EFFECTS ANALYSIS (FMEA) - CRITICAL HARDWARE  
NUMBER: 06-1C-0115-X

SUBSYSTEM NAME: ARS - ARPCS

REVISION: 3 08/26/93

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	PART NAME VENDOR NAME	PART NUMBER VENDOR NUMBER
LRU	FILTER, IN-LINE, O2 BRUNSWICK/WINTEC	ME286-0061-0001 15122-503

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PART DATA

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QUANTITY OF LIKE ITEMS: 2  
ONE PER LOOP  
TWO PER SUBSYSTEM

FUNCTION:  
FILTER, CRYOGENIC (1.5)

FILTERS SUPPLY OF OXYGEN FROM PRSD CRYOGENIC TANKS TO PROTECT OXYGEN  
RESTRICTOR FROM CONTAMINATION (STOPS PARTICLE SIZES GREATER THAN 70  
MICRONS).

**FAILURE MODES EFFECTS ANALYSIS (FMEA) – CRITICAL FAILURE MODE  
NUMBER: 06-1C-0115-01**

REVISION# 3 08/26/93 R

SUBSYSTEM NAME: ARS - ARPCS  
LRU: FILTER, IN-LINE, O2  
ITEM NAME: FILTER, IN-LINE, O2

CRITICALITY OF THIS  
FAILURE MODE: 1/1

**FAILURE MODE:**  
RESTRICTED FLOW  
AUX O2 TANK NOT INSTALLED

**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:**  
CONTAMINATION, CORROSION

**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:**  
UNABLE TO SUPPLY OXYGEN TO CABIN THROUGH THIS CRYO SYSTEM.

**(B) INTERFACING SUBSYSTEM(S):**  
LOSS OF ONE O2 SOURCE TO AIRLOCK AND LES.

**(C) MISSION:**  
POSSIBLE EARLY MISSION TERMINATION AS ONLY ONE OXYGEN SOURCE REMAINS  
FOR CABIN, AIRLOCK AND LES REQUIREMENTS.

**FAILURE MODES EFFECTS ANALYSIS (FMEA) - CRITICAL FAILURE MODE  
NUMBER: 06-1C-0115-01****(D) CREW, VEHICLE, AND ELEMENT(S):**

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:**

THE FILTER ASSEMBLY IS MADE OF 304L GRES CONDITION A STAINLESS STEEL, WHICH IS COMPATIBLE WITH OXYGEN. THEY HAVE EXCELLENT TOUGHNESS AT TEMPERATURES AS LOW AS LIQUID HELIUM (-452 F) AND ARE USEFUL FOR PARTS SUBJECTED TO SEVERE STRESSES AT ELEVATED TEMPERATURES. LIQUID O2 HAS A TEMPERATURE OF -361.12 F. THE FILTER SIZE IS 70 MICRONS ABSOLUTE. CLEANLINESS LEVEL IS 200A PER MAO110-301. THE FILTER CAN PASS A MINIMUM OF 6000 LBS OF OXYGEN WITHOUT EXCEEDING A PRESSURE DROP OF 40 PSID AT A FLOW RATE OF 10 LB/HR. THE MAIN PURPOSE OF THE FILTER IS TO PROTECT THE DOWNSTREAM RESTRICTOR AND SACRIFICE ITSELF IN THE CASE OF EXCESSIVE CONTAMINATION.

**(B) TEST:**

ACCEPTANCE TEST - THE FILTER SHALL WITHSTAND A MINIMUM INTERNAL PROOF PRESSURE OF 1.5 TIMES (1575 PSIG) ITS MAXIMUM OPERATING PRESSURE WITHOUT EXTERNAL LEAKAGE FOR 10 MINUTES. THE EXTERNAL LEAKAGE SHALL NOT EXCEED  $1 \times 10^{-4}$  SCCS GHE ACTUAL WHEN THE FILTER IS PRESSURIZED WITH GHE AT ANY PRESSURE FROM ZERO TO 1050 PSIA FOR 15 MINUTES. PRESSURE DROP TESTED 4.0 PSID MAX AT 20 LB/HR MIN.

QUALIFICATION TEST - THE FILTERS WERE MOUNTED IN A VIBRATION UNIT AND PRESSURIZED TO 970 PSIG WITH GN2. RANDOM VIBRATION - THE FILTERS WERE VIBRATED FOR 48 MINUTES IN EACH OF THE THREE AXES; VIBRATION FREQUENCY RANGE WAS 20 THROUGH 2000 HZ WITH AN OVERALL ACCELERATION OF 15.5 G RMS. SINUSOIDAL VIBRATION - ONE OCTAVE PER MINUTE SWEEP RATE OVER A FREQUENCY RANGE OF 5 THROUGH 35 HZ. UPON COMPLETION OF THE RANDOM AND SINUSOIDAL VIBRATION TESTS THE FILTER ASSEMBLIES WERE RETURNED TO WINTEC FOR AN EXTERNAL LEAKAGE TEST.

THERMAL SHOCK - THE FILTER ASSEMBLIES WERE SUBJECTED TO 100 THERMAL CYCLES.

DESIGN SHOCK - THREE 20G SHOCK TESTS IN EACH DIRECTION OF EACH AXIS FOR A TOTAL OF 18 SHOCKS.

CLEAN FLOW/Delta P - EACH FILTER ASSEMBLY WAS SUBJECTED TO A CLEAN FLOW/Delta P TEST AT RATED CONDITIONS OF 100 LB/HR GN2 WITH A FILTER INLET PRESSURE OF 100 PSIA. THE FLOW VS Delta P PERFORMANCE FOR BOTH FILTER ASSEMBLIES WAS WITHIN SPEC LIMITS OF 100 LB/HR OF GN2 AT 100 PSIA INLET PRESSURE AND 2.0 PSID NET Delta P. CONTAMINATED FLOW/Delta P - EACH FILTER ASSEMBLY WAS INSTALLED INTO A CONTAMINANT CAPACITY TEST SYSTEM. THE FILTER ASSEMBLY NET Delta P INCREASED TO 13.8 PSID AFTER 4 GRAMS OF FINE DUST HAD BEEN INTRODUCED INTO THE FILTER ASSEMBLY. THIS IS WITHIN THE MAXIMUM NET Delta P OF 16 PSID.

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FILTRATION - THE FILTER ASSEMBLY WAS INSTALLED INTO A GLASS BEAD TEST SYSTEM. THE MAXIMUM SIZE PARTICLE PASSED AND THE EFFICIENCY OF THE FILTER ASSEMBLY WERE WITHIN SPECIFICATION LIMITS. COLLAPSE PRESSURE - FILTER ASSEMBLY WAS SUBJECTED TO A 2070 PSIG COLLAPSE PRESSURE TEST PER THE REQUIREMENTS OF PARAGRAPH 4.8 OF TP-222. THE FILTER ELEMENT DID NOT COLLAPSE.

BURST PRESSURE - FILTER ASSEMBLY WAS INSTALLED INTO A TEST SYSTEM AND SUBJECTED TO A BURST TEST. WITH THE OUTLET PORT SEALED THE INLET PORT WAS PRESSURIZED TO 2070 PSIG FOR A PERIOD OF FIVE MINUTES. THE FILTER ASSEMBLY DID NOT RUPTURE OR TAKE ON A PERMANENT DEFORMATION.

IN-VEHICLE TESTING - FLOW LIMITER (RESTRICTOR) TEST VERIFIES THE REQUIRED FLOW RATE FROM THE PRSD CRYO O2 SYSTEM.

OMRSD - O2 REGULATOR ASSEMBLY CHECKS, PERFORMED BEFORE THE FIRST REFLIGHT OF EACH ORBITER AND AT INTERVALS OF FIVE FLIGHTS. VERIFY REQUIRED FLOW FROM THE PRSD SYSTEM. THE PRSD SYSTEM IS SERVICED WITH GO2 PER SE-S-0073 AND THE GROUND HALF QUICK DISCONNECTS CONTAIN FILTERS.

**(C) INSPECTION:**

RECEIVING INSPECTION

MATERIAL CERTIFICATIONS AND TEST REPORTS ARE REVIEWED TO VERIFY THAT MATERIAL COMPOSITION, DIMENSIONS AND SURFACE CONDITIONS COMPLY WITH DESIGN REQUIREMENTS.

CONTAMINATION CONTROL

VAPOR DEGREASING AND ULTRASONIC CLEANING IS VERIFIED. PIECE PARTS CLEANLINESS IS CERTIFIED TO LEVEL 200A PER MAO110-301 PER ARP 599.

ASSEMBLY/INSTALLATION

PIECE PARTS ARE INSPECTED FOR BURRS. FITTING THREADS ARE INSPECTED AT 10X MAGNIFICATION FOR BURRS. COMPONENT ASSEMBLY PACKAGING AND SUBSEQUENT SUBASSEMBLY INSTALLATION ARE ACCOMPLISHED IN 100,000 CLASS CLEAN ROOM ENVIRONMENTS. COMPLETED ASSEMBLY IS VERIFIED TO LEVEL 200A.

CRITICAL PROCESSES

HOUSING PASSIVATION VERIFIED BY INSPECTION. RESISTANCE AND TIG WELDING VERIFIED BY INSPECTION.

TESTING

ATP VERIFIED BY INSPECTION.

HANDLING/PACKAGING

HANDLING AND PACKAGING ARE INSPECTED FOR INTEGRITY AND COMPLIANCE WITH MATERIAL HANDLING REQUIREMENTS.

**(D) FAILURE HISTORY:**

NO FAILURE HISTORY.

**(E) OPERATIONAL USE:**

CONSIDERATION WILL BE GIVEN TO DEPRESSURIZING THE CABIN TO 10.2 PSIA FOR CREW SIZES OF FIVE OR MORE (REDUCED PRESSURE REDUCES O2 FLOW RATE REQUIREMENT TO ACCEPTABLE LEVELS).

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- APPROVALS -

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

*Junda* 8/24/93  
*[Signature]* 8/31/93  
:S50260Y