

FAILURE MODES EFFECTS ANALYSIS (FMEA) – CRITICAL HARDWARE
NUMBER: 06-1C-0111-X

SUBSYSTEM NAME: ARS - ARPCS

REVISION: 4 08/26/93

	PART NAME VENDOR NAME	PART NUMBER VENDOR NUMBER
LRU	: N2/O2 CONTROL PANEL CARLETON TECHNOLOGIES	MC250-0002-1001 2720-0001
SRU	: VALVE, SOLENOID, OXYGEN	2722-0001-9

PART DATA

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

FUNCTION:
SOLENOID VALVE OXYGEN SYSTEM SELECTOR (1.19)

PROVIDES VALVING FOR THE TRANSFER OR ISOLATION OF AUXILIARY OXYGEN TO EITHER SYSTEM ONE OR SYSTEM TWO OXYGEN LOOPS, AND THE FLOW OF OXYGEN FROM PRSD CRYO SYSTEM TO THE LAUNCHENTRY SUITS (LES) AND AIRLOCK SYSTEMS. BOTH VALVES MUST REMAIN OPEN TO PROVIDE SUFFICIENT OXYGEN FLOW FOR LES USE. PROVIDES FOR CROSS TRANSFER OF PRSD OXYGEN TO EITHER OF THE ARPCS OXYGEN LOOPS. THE TRANSFER OF AUXILIARY OXYGEN IS APPLICABLE ONLY WHEN THE AUXILIARY OXYGEN TANK IS INSTALLED. THE LISTED FAILURE EFFECTS ARE FOR THE CASE WHEN THE AUX O2 TANK IS NOT INSTALLED. THE FAILURE EFFECTS FOR THE CASE OF THE TANK BEING INSTALLED WILL BE ADDRESSED IN THE MISSION KIT FMEA ON A MISSION BY MISSION BASIS.

FAILURE MODES EFFECTS ANALYSIS (FMEA) - CRITICAL FAILURE MODE
NUMBER: 06-1C-0111-03

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SYSTEM NAME: ARS - ARPCS
 LRU: N2/O2 CONTROL PANEL
 ITEM NAME: VALVE, SOLENOID, OXYGEN

CRITICALITY OF THIS
 FAILURE MODE: 1/1

FAILURE MODE:
 GROSS EXTERNAL LEAKAGE (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:
 MECHANICAL SHOCK, VIBRATION, CORROSION, CONTAMINATION, MATERIAL DEFECT,
 SEAL MATERIAL DEGRADATION

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:

UNCONTROLLED O2 FLOW INTO CABIN, SPECIFICALLY FOR LEAK UPSTREAM OF POPPET, CORRECTING ACTION (C/A) REDUCES SUBSYSTEM OPERATIONAL OPTIONS BY PRECLUDING CROSS-TIE CAPABILITY. LOSS OF REDUNDANCY - AUTOMATIC CONTROL THROUGH ONE O2 SYSTEM IS LOST.

(B) INTERFACING SUBSYSTEM(S):

POSSIBLE HIGH PPO2 IN CABIN UNTIL C/A TAKES EFFECT. C/A FOR LEAK DOWNSTREAM OF POPPET RESULTS IN LOSS OF AIRLOCK LES SUPPORT CAPABILITY. C/A FOR LEAK UPSTREAM OF POPPET RESULTS IN LOSS OF LES SUPPORT. POSSIBLE FLAMMABILITY LIMIT VIOLATION.

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ABORT DECISION. LES/AIRLOCK SUPPORT HAS BEEN LOST IF LEAK IS SIGNIFICANT. CABIN O2 MAKE-UP CAPABILITY IS STILL AVAILABLE.

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

GROSS EXTERNAL LEAKAGE RESULTS IN INADEQUATE O2 SUPPLY TO LES STATIONS. THE LOSS OF LES SUPPORT CAPABILITY MAY RESULT IN LOSS OF CREW IF LEAK RATE PROHIBITS LES SYSTEM PRESSURIZATION AND LES ARE REQUIRED. NOTE - IN AN 8.0 PSIA HOLE IN CABIN CONTINGENCY MODE, AN EXTERNAL LEAK ALLOWING FLOW INTO THE CABIN MAY NOT BE CATASTROPHIC SINCE THERE IS A POSSIBILITY OF SAFELY BREATHING THE CABIN AIR, INTO WHICH THE O2 IS LEAKING, BY RAISING LES VISORS. THE WORST CASE FAILURE WOULD BE IN THE CASE OF A CONTAMINATED CABIN ATMOSPHERE, WHEN LEAKAGE PREVENTS ADEQUATE FLOW TO LES STATIONS AND CABIN AIR MAY NOT BE SAFE FOR BREATHING.

(E) FUNCTIONAL CRITICALITY EFFECTS:

NONE

-DISPOSITION RATIONALE-

(A) DESIGN:

VALVE BODY IS MADE OF 6061-T651 ALUMINUM ALLOY ANODIZED FOR CORROSION RESISTANCE. FITTINGS ARE MADE OF 17-4 PH CONDITION A CRES AND 316 CRES CONDITION A. TYPE 316 IS A STANDARD GRADE STAINLESS STEEL WHICH OFFERS THE BEST CORROSION RESISTANCE OF THE STANDARD AUSTENITIC GRADES. 17-4 PH IS PRECIPITATION HARDENED CORROSION RESISTANT STEEL WHICH HAS A HIGH STRENGTH TO WEIGHT RATIO. STATIC SEALS ARE MADE OF SILASTIC 675 SILICONE RUBBER. 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. A NICKEL BELLOWS IS UTILIZED AS A DYNAMIC SEAL WHICH CONSIDERABLY REDUCES FRICTION, STICKING, AND WEAR. THE INLET AND OUTLET PORTS ARE FILTER PROTECTED WITH 25 MICRON ABSOLUTE FILTERS. GUIDE RINGS ARE MADE OF TEFLON; METAL-TO-METAL CONTACT WITH RESULTANT CONTAMINANT PROBLEMS IS ELIMINATED.

(B) TEST:

ACCEPTANCE TEST - ATP ON VALVE INCLUDES PROOF TEST AT 1875 PSIG (1.5 TIMES MAXIMUM OPERATING PRESSURE). LEAK TEST AT 1250 PSIG WITH 0.2 SCCM MAX LEAKAGE. ATP ON N2/O2 CONTROL PANEL AS AN ASSEMBLY INCLUDES EXAMINATION OF PRODUCT, RADIOGRAPHIC INSPECTION, PROOF PRESSURE AT 1870 +/- 20 PSIG, AND EXTERNAL LEAKAGE TEST (DECAY TEST USING GN2) AT 900 +/- 15 PSIG WITH NITROGEN SYSTEM AT A LOWER PRESSURE - ENTIRE PANEL LEAKAGE IS LIMITED TO 11.0 SCCM MAX.

QUALIFICATION TEST - LIFE CYCLE TESTING - THE VALVE WAS SUBJECTED TO 50 OPEN/CLOSE CYCLES AT 1280 PSIG AND TO 200 OPEN/CLOSE CYCLES AT 300 PSIG, PRECEDING AND FOLLOWING WHICH INTERNAL LEAKAGE TESTING WAS CONDUCTED. COMPONENT BURST PRESSURE IS 2500 PSIG (2 TIMES MAXIMUM OPERATING PRESSURE). SUBJECTED TO THE FOLLOWING AS PART OF THE N2/O2 CONTROL PANEL. RANDOM VIBRATION SPECTRUM - 20 TO 150 HZ INCREASING AT 6*DB/OCTAVE TO 0.03 G**2/HZ AT 150 HZ. CONSTANT AT 0.03 G**2/HZ FROM 150 TO 1000 HZ,

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DECREASING AT 6 DB/OCTAVE FROM 1000 TO 2000 HZ FOR 48 MINUTES PER AXIS FOR THREE ORTHOGONAL AXES. DESIGN SHOCK - 20G TERMINAL SAWTOOTH PULSE OF 11 MS DURATION IN EACH DIRECTION OF THREE ORTHOGONAL AXES. ATP TO VERIFY LEAKAGE IS PERFORMED AFTER SHOCK AND VIBRATION TESTING.

IN-VEHICLE TESTING - AFTER INSTALLATION THE N2/O2 CONTROL PANEL IS OVERPRESSURE (1070 - 1255 PSIG) TESTED.

OMRSD - 900, 100 PSI O2 EMERGENCY BREATHING SYSTEM 1 & 2 LEAK TEST IS PERFORMED PRIOR TO FIRST REFLIGHT AND EVERY FIVE FLIGHTS AT 900-950 PSI, 70 SCCM MAX LEAKAGE, INFLIGHT CHECKOUT DURING EACH MISSION WILL VERIFY NO GROSS EXTERNAL LEAKAGE.

(C) INSPECTION:

RECEIVING INSPECTION

RAW MATERIAL VERIFIED BY INSPECTION FOR MATERIAL AND PROCESS CERTIFICATION.

CONTAMINATION CONTROL

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

ASSEMBLY/INSTALLATION

TORQUES VERIFIED AND SPRING FORCES VERIFIED BY INSPECTION. DIMENSIONAL CHECKS PERFORMED BY INSPECTION. MIPS FOR CONCENTRICITY AND PERPENDICULARITY. 10X VISUAL INSPECTION ON SEAL RING VERIFIED.

CRITICAL PROCESSES

PARTS PASSIVATION, ANODIZING AND HEAT TREATMENT VERIFIED. SOLDER CONNECTIONS VERIFIED BY INSPECTION IN ACCORDANCE WITH SPECIFICATION NHBS300.4(3A). POTTING VISUALLY INSPECTED BY INSPECTION. APPLICATION OF LUBRICANT ON SEAL RING VERIFIED BY TECHNICIAN. INLET FILTER WELD VERIFIED BY INSPECTION.

NONDESTRUCTIVE EVALUATION

LEAK TEST IS VERIFIED BY INSPECTION.

TESTING

ATP VERIFIED BY INSPECTION. BUBBLE POINT AND DELTA P TEST OF INLET FILTER VERIFIED BY INSPECTION.

HANDLING/PACKAGING

HANDLING, PACKAGING, STORAGE AND SHIPPING PROCEDURES ARE VERIFIED.

(D) FAILURE HISTORY:

NO FAILURE HISTORY APPLICABLE TO EXTERNAL LEAKAGE FAILURE MODE. THE SOLENOID VALVE (1.19) HAS SUCCESSFULLY BEEN USED THROUGH THE SHUTTLE PROGRAM FOR THIS FAILURE MODE.

(E) OPERATIONAL USE:

1. CREW ACTION
PERFORM LEAK ISOLATION AND HIGH O2 CONCENTRATION TROUBLESHOOTING.
2. TRAINING

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STANDARD ECLSS TRAINING COVERS THE GENERIC HIGH O2 CONCENTRATION EFFECT OF THIS FAILURE.

- 3. OPERATIONAL CONSIDERATION
 - DOWNSTREAM OF POPPET
 - A. REQUIRES PCS O2 SYSTEM 1/SYSTEM 2 ISOLATION.
 - B. VALVES ARE NORMALLY OPEN.
 - C. REFERENCE LOSS/FAILURE FLIGHT RULES.
 - D. REAL TIME DATA SYSTEM ALLOWS FOR GROUND MONITORING.
 - E. PRECLUDES USE OF LES UNLESS LEAK IS SMALL ENOUGH TO PERMIT SIMULTANEOUS LES USE PLUS O2 LEAKAGE TO CABIN.

UPSTREAM OF POPPET

- A. AUTOMATIC PRESSURE CONTROL FROM ONE O2 SYSTEM ONLY.
- B. SINGLE O2 SYSTEM SUPPLY TO LES WITH LEAK ISOLATED

- APPROVALS -

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

[Handwritten signatures and dates]
 8/27/93
 8/31/93
 :SEC60E