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PRINT DATE: 08/27/93

FAILURE MODES EFFECTS ANALYSIS (FMEA) - CRITICAL HARDWARE  
NUMBER: 06-1C-0120-X

SUBSYSTEM NAME: ARS - ARPCS

REVISION: 4 -08/26/93

	PART NAME VENDOR NAME	PART NUMBER VENDOR NUMBER
LRU	: EMERGENCY O2 CONTROL PANEL CARLETON TECHNOLOGIES	MC250-0002-0120 2735-0001
SRU	: VALVE; RELIEF & REG, EM O2	1-4-00-58-15 <i>OKAY</i>

PART DATA

QUANTITY OF LIKE ITEMS: 2  
ONE PER FLOW PATH  
TWO PER PANEL

FUNCTION:  
SHUTOFF VALVE - EMERGENCY O2 PANEL REG INLET

PROVIDES MANUAL FLOW CONTROL (ON-OFF) AT THE INLET OF THE EMERGENCY OXYGEN CONTROL REGULATOR. THIS VALVE IS INTEGRAL TO THE REGULATOR/RELIEF VALVE.

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SHUTTLE CRITICAL ITEMS LIST - ORBITER

NUMBER: 06-1C1-0120-03

REVISION# 2 01/09/90

SUBSYSTEM: ARS - ARPCS

LRU :EMERGENCY O2 CONTROL PANEL

ITEM NAME: VALVE, RELIEF & REG, EM O2

CRITICALITY OF THIS

FAILURE MODE:1/1

■ FAILURE MODE:

GROSS EXTERNAL LEAKAGE (UPSTREAM OF POPPET AS WORST CASE)

MISSION PHASE:

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

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

CAUSE:

MECHANICAL SHOCK, VIBRATION, CONTAMINATION, CORROSION, 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.

(B) INTERFACING SUBSYSTEM(S):

POSSIBLE HIGH PPO2 UNTIL CORRECTING ACTION (C/A) TAKES EFFECT.  
POSSIBLE FLAMMABILITY LIMIT VIOLATION.

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**(C) MISSION:**

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

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 - DISPOSITION RATIONALE -  
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**(A) DESIGN:**

VALVE BODY IS MADE OF 6061-T6 ALUMINUM ANODIZED FOR CORROSION RESISTANCE. POSITIVE OPEN/CLOSED OPERATION. BELLEVILLE SPRING LOADED TOGGLE DETENT ASSURES FULL OPEN OR CLOSED VALVE POSITION. INLET/OUTLET PORTS ARE FILTER PROTECTED TO 25 MICRONS. POPPET IS PRESSURE COMPENSATED THROUGH THE USE OF SILASTIC 675 SILICONE RUBBER DYNAMIC SEALS AT EACH END OF THE POPPET. 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. THE 17-7 PH COLD DRAWN TO CONDITION C CRES POPPET WORKS AGAINST THE VESPEL-SP-1 SEAT WHICH IS UTILIZED FOR OXYGEN COMPATIBILITY AND LEAK-FREE OPERATION. 17-4 PH IS PRECIPITATION HARDENED CORROSION RESISTANT STEEL WHICH HAS A HIGH STRENGTH TO WEIGHT RATIO. THE MOST PROBABLE LEAK (TWO CUT O-RINGS WORST CASE) IS ESTIMATED AT 100 SCCM (0.0175 LB/HR).

**(B) TEST:**

ACCEPTANCE TEST - PROOF PRESSURE 1885 PSIG, LEAK TESTED FOR 1.0 SCCM MAX LEAKAGE AT 900 PSIG.

QUALIFICATION TEST - LIFE CYCLE TESTING - 1000 CYCLES AT 875 PSIG. BURST PRESSURE IS 2500 PSIG. SUBJECTED TO THE FOLLOWING AS PART OF THE EMERGENCY O2 CONTROL PANEL. DESIGN SHOCK - 20G TERMINAL SAWTOOTH PULSE OF 11 MS DURATION IN EACH DIRECTION OF THREE ORTHOGONAL AXES. RANDOM VIBRATION SPECTRUM ENVELOPE - 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

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TO 1000 HZ, DECREASING AT 6 DB/OCTAVE FROM 1000 TO 2000 HZ FOR 48 MINUTES PER AXIS FOR THREE ORTHOGONAL AXES. ATP TO VERIFY LEAKAGE IS PERFORMED AFTER SHOCK AND VIBRATION TESTING.

IN-VEHICLE TESTING - AFTER INSTALLATION THE EMERGENCY BREATHING SYSTEM IS OVERPRESSURE (1070 - 1266 PSIG) TESTED. LES VALVE AND QD INTERNAL LEAK TEST IS PERFORMED AT 900 PSIG, WHICH WOULD DETECT REGULATOR INLET VALVE EXTERNAL LEAKAGE.

OMRSD - 900, 100 PSI O2 EMERGENCY BREATHING SYSTEM 1 & 2 LEAK CHECK IS PERFORMED PRIOR TO 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 AT SUPPLIER.

## CONTAMINATION CONTROL

CLEANLINESS LEVEL 200A PER MAQ110-301 AND 100 ML RINSE TESTS VERIFIED BY INSPECTION.

## ASSEMBLY/INSTALLATION

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

## CRITICAL PROCESSES

INLET FILTER WELD IS VERIFIED BY INSPECTION. PARTS PASSIVATION AND ANODIZING VERIFIED BY INSPECTION. HEAT TREATMENT VERIFIED BY INSPECTION. SOLDER CONNECTIONS VERIFIED BY INSPECTION TO BE PER NH85300.4(3A). POTTING VISUALLY VERIFIED BY INSPECTION. APPLICATION OF LUBRICANT ON SEAL RING VERIFIED BY TECHNICIAN.

## 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 SHUTOFF VALVE HAS SUCCESSFULLY BEEN USED THROUGH THE SHUTTLE PROGRAM.

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CONSIDERING THIS FAILURE MODE.

(E) OPERATIONAL USE:

- 1. CREW ACTION
  - PERFORM LEAK ISOLATION AND HIGH O2 CONCENTRATION TROUBLESHOOTING.
- 2. TRAINING
  - STANDARD ECLSS TRAINING COVERS THE GENERIC HIGH O2 CONCENTRATION EFFECT OF THE FAILURE.
- 3. OPERATIONAL CONSIDERATION
  - A. REQUIRES PCS O2 SYSTEM ISOLATION (NORMALLY CROSS-TIED).
  - B. PRECLUDES USE OF LES UNLESS LEAK IS SMALL ENOUGH TO PERMIT SIMULTANEOUS LES USE PLUS O2 LEAKAGE TO CABIN.
  - C. REFERENCE LOSS/FAILURE FLIGHT RULES.
  - D. REAL TIME DATA SYSTEM ALLOWS FOR GROUND MONITORING.
  - E. HIGH O2 CONCENTRATION IN THE CABIN REQUIRES FAILURE OR LES USAGE.

- APPROVALS -

RELIABILITY ENGINEERING: D. R. RISING *DRR* : *[Signature]*  
 DESIGN ENGINEERING : K. KELLY *KK* : *[Signature]*  
 QUALITY ENGINEERING : M. SAVALA *MS* : *[Signature]*  
 NASA RELIABILITY : *TD* : *[Signature]*  
 NASA SUBSYSTEM MANAGER : *[Signature]*  
 NASA QUALITY ASSURANCE : *[Signature]*