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PRINT DATE: 08/27/93

FAILURE MODES EFFECTS ANALYSIS (FMEA) - CRITICAL HARDWARE

NUMBER: 06-1C-0121-X

SUBSYSTEM NAME: ARS - ARPCS

REVISION: 5 08/26/93

	PART NAME	PART NUMBER
	VENDOR NAME	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

PART DATA

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

FUNCTION:
PRESSURE REGULATOR, EMERGENCY OXYGEN

PROVIDES REGULATION CAPABILITY FOR THE EMERGENCY OXYGEN BREATHING STATIONS. INLET PRESSURE IS 900 PSIA. REGULATED OUTPUT IS 100 PSIG. THIS REGULATOR IS INTEGRAL TO THE ON/OFF VALVE AND RELIEF VALVE.

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SUBSYSTEM NAME: ARS - ARPCS
LRU: EMERGENCY O2 CONTROL PANEL
ITEM NAME: VALVE, RELIEF & REG. EM O2

CRITICALITY OF THIS
FAILURE MODE: 1R2

FAILURE MODE:
OPEN, INTERNAL 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, CONTAMINATION, CORROSION, PHYSICAL
BINDING/JAMMING

CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO

REDUNDANCY SCREEN A) PASS
B) PASS
C) PASS

PASS/FAIL RATIONALE:

A)
B)
C)

- FAILURE EFFECTS -

(A) SUBSYSTEM:
INCREASED OUTLET PRESSURE CAUSING RELIEF VALVE TO OPEN.

(B) INTERFACING SUBSYSTEM(S):
PRESSURE AT LES BREATHING STATIONS WOULD RISE TO RELIEF VALVE CRACK
PRESSURE AND OXYGEN WOULD FLOW INTO THE CABIN UNTIL CORRECTING ACTION
IS IMPLEMENTED. POSSIBLE HIGH CABIN PPO2 - MAY VIOLATE FLAMMABILITY LIMIT.

(C) MISSION:
POSSIBLE EARLY MISSION TERMINATION.

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WORST CASE FIRE IN CABIN - EXCESSIVE O2 FEEDING FIRE WHERE LES IS USED.

(E) FUNCTIONAL CRITICALITY EFFECTS:

SUBSEQUENT FAILURE OF REDUNDANT SYSTEM RESULTS IN LOSS OF OXYGEN SUPPLY TO LES BREATHING STATIONS.

-DISPOSITION RATIONALE-

(A) DESIGN:

THE VALVE BODY IS MADE OF ALUMINUM ALLOY 6061. THE REGULATOR IS AN INLET PRESSURE COMPENSATED, SPRING-REFERENCED TYPE EMPLOYING A 17-7 PH CONDITION C CRES DIAPHRAGM AS A SENSING ELEMENT AND DYNAMIC SEAL. 17-7 PH IS PRECIPITATION HARDENED CORROSION RESISTANT STEEL WHICH HAS A HIGH STRENGTH TO WEIGHT RATIO. THE DIAPHRAGM SEALS WHICH ARE MADE OF SILASTIC 675 SILICONE RUBBER HAVE EXCELLENT RESISTANCE TO OXYGEN, OUTGASSING, AND FATIGUE. THEY ELIMINATE THE FRICTION AND WEAR ASSOCIATED WITH PISTON TYPE SEALS. THE HELICAL/BELLEVILLE SPRING COMBINATION WHICH IS MADE OF 17-7 PH CRES PROVIDES REGULATION AND ASSURES A CLOSE TOLERANCE OPERATION OVER A WIDE FLOW RANGE. THE POPPET WHICH IS ALSO MADE OF 17-7 PH CRES WORKS AGAINST A POLYIMIDE VESPEL SP-1 SEAT WHICH ASSURES A LEAK FREE OPERATION. THE INLET AND OUTLET PORTS ARE FILTER PROTECTED TO 25 MICRONS.

(B) TEST:

ACCEPTANCE TEST - PROOF TEST AT 1875 +/- 25 PSIG FOR A MINIMUM OF 3 MINUTES. LEAK TESTED AT INLET PRESSURE 885 +/- 25 PSIG AND OUTLET PRESSURE 125 PSIG; 0.3 SCCM MAX LEAKAGE. INTERNAL LEAKAGE TEST PERFORMED AT THE SAME PRESSURE; 0.2 SCCM MAX LEAKAGE.

QUALIFICATION TEST - LIFE CYCLE TESTING - 1000 CYCLES AT 875 +/- 25 PSIG. BURST PRESSURE IS 2500 PSIG. SUBJECTED TO THE FOLLOWING AS PART OF THE EMERGENCY O2 CONTROL PANEL DESIGN SHOCK - THE UNIT WAS SUBJECTED TO 3 SHOCKS OF A 20 G PEAK ACCELERATION PULSE APPROXIMATELY A SAWTOOTH AND HAVING A TOTAL DURATION OF 11 MILLISECONDS. THIS PULSE WAS APPLIED IN BOTH DIRECTIONS OF THE THREE PRINCIPLE AXES FOR A TOTAL OF 18 SHOCKS. 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 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 - O2 REGULATOR LOCKUP TEST; 925 - 950 PSIG INLET AND 90 - 125 PSIG OUTLET PRESSURE. O2 REG CREEP LEAKAGE TEST IS PERFORMED AT 900 - 950 PSIG INLET AND 200 PSIG MAXIMUM OUTLET PRESSURE, 10 SCCM MAX LEAKAGE.

OMRSD - REGULATOR LOCKUP TEST; 900 - 950 PSIG INLET AND 90 - 135 PSIG OUTLET PRESSURE PERFORMED BEFORE THE FIRST REFLIGHT OF EACH ORBITER AND AT INTERVALS OF FIVE FLIGHTS. REG LOCKUP CREEP LEAKAGE TEST IS VERIFIED AT THE SAME TIME, 200 PSIG MAX OUTLET PRESSURE WITH 10 SCCM MAX LEAKAGE.

(C) INSPECTION:

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RAW MATERIALS INCLUDING CHEMICAL AND MECHANICAL REQUIREMENTS ARE VERIFIED BY INSPECTION FOR MATERIAL AND PROCESS CERTIFICATION.

CONTAMINATION CONTROL

CLEANLINESS LEVEL 200A PER MAO110-301 AND 100 ML RINSE TESTS VERIFIED. SYSTEM GAS SAMPLES ANALYZED FOR CONTAMINATION.

ASSEMBLY/INSTALLATION

DIAMETER AND THREADS ON LOWER BELLOWS VERIFIED BY INSPECTION. VISUAL DIMENSIONAL, BELLOWS RATES AND CHECK FOR BELLOWS DAMAGE PERFORMED BY INSPECTION. TORQUES, BELLEVILLE SPRING FORCES, SURFACES AND SUB-SURFACE DEFECTS VERIFIED. 10X VISUAL INSPECTION ON SEAL RING VERIFIED.

NONDESTRUCTIVE EVALUATION

RADIOGRAPHIC AND PENETRANT INSPECTION OF WELDS ARE VERIFIED, INCLUDING 20X MAGNIFICATION VISUAL EXAM.

CRITICAL PROCESSES

PARTS PASSIVATION AND HEAT TREATMENT VERIFIED. LUBRICANT ON SEAL RING VERIFIED BY TECHNICIAN. POTTING APPLICATION AND SOLDER CONNECTIONS ARE VERIFIED BY INSPECTION. NICKEL FINISH ON BELLOWS VERIFIED BY INSPECTION.

TESTING

ATP VERIFIED BY INSPECTION.

HANDLING/PACKAGING

PARTS ARE PLACED IN CLEAN BAGS AND HEAT SEALED. PACKAGING FOR SHIPMENT VERIFIED BY INSPECTION.

(D) FAILURE HISTORY:

ONE FAILURE HAS OCCURRED: AC3288-010, 6/14/82, IN SUPPLIER ATP. THE EMERGENCY O2 CONTROL PANEL REGULATOR RESEAT PRESSURE WAS 162 PSIG, SHOULD BE 215 PSIG MINIMUM. THIS WAS CAUSED BY THE SPRING AND THRUST RING BEING INSTALLED SLIGHTLY TIPPED AND THE VALVE BEING ADJUSTED WITHOUT SET SCREWS TORQUED. AFTER BENCH CHECK, THE SET SCREWS WERE TIGHTENED AND RETEST WAS WITHIN SPEC. DURING FINAL ASSEMBLY IT WAS DISCOVERED THAT THE WRONG SET SCREWS WERE USED; THEY WERE REPLACED BUT THE VALVE WAS NOT RETESTED. CORRECTIVE ACTION - ASSEMBLY PROCEDURE WAS PREPARED TO SPECIFY THE PROPER SET SCREW TORQUE AND ALSO TO ADD A MEASUREMENT OF THE THRUST RING TO ENSURE IT IS NOT TIPPED.

(E) OPERATIONAL USE:

THE FAILED REGULATOR IS ISOLATED BY CLOSING THE APPROPRIATE EMERGENCY O2 SHUTOFF VALVE. REDUNDANCY REMAINS THROUGH THE OTHER SHUTOFF VALVE AND REGULATOR.

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- APPROVALS -

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