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 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

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.

PRINT DATE: 01/09/90

SHUTTLE CRITICAL ITEMS LIST - ORBITER NUMBER: 06-1C1-0121-02

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: 1F2

FAILURE MODE:
CLOSED

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

CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO

REDUNDANCY SCREEN A) PASS
B) FAIL
C) PASS

PASS/FAIL RATIONALE:
A)

B)
SCREEN B FAILS BECAUSE BOTH EMERGENCY REGULATOR INLET VALVES ARE NORMALLY OPEN; ONE OF THE TWO FLOW PATHS FAILING CLOSED IS THEREFORE UNDETECTABLE.

C)

- FAILURE EFFECTS -

(A) SUBSYSTEM:
LOSS OF REDUNDANCY.

(B) INTERFACING SUBSYSTEM(S):
NO EFFECT. REDUNDANT SYSTEM WILL MEET LES OXYGEN REQUIREMENTS.

(C) MISSION:
NO EFFECT. REDUNDANT SYSTEM WILL MEET LES OXYGEN REQUIREMENTS.

(D) CREW, VEHICLE, AND ELEMENT(S):
NO EFFECT. REDUNDANT SYSTEM WILL MEET LES OXYGEN REQUIREMENTS.

(E) FUNCTIONAL CRITICALITY EFFECTS:
FAILURE OF REDUNDANT FLOW PATH RESULTS IN LOSS OF LES O2 SYSTEM. THE LOSS OF LES SUPPORT CAPABILITY MAY RESULT IN LOSS OF CREW/VEHICLE IN THE EVENT THE LES ARE REQUIRED.

- 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 - LES SYSTEM FLOW VERIFICATION TEST PROVES OPEN FLOW PATH TO LES QD'S.

OMRSD - EMERGENCY BREATHING ~~SYS~~ SYSTEM REGULATOR CHECKOUT IS PERFORMED BEFORE THE FIRST REFLIGHT OF EACH ORBITER AND EVERY FIFTH FLIGHT. FLOW REQUIREMENT IS 34.7 LB/HR MINIMUM. LES MANUAL VALVES TEST (SAME EFFECTIVITY) AND INFLIGHT CHECKOUT DURING EACH MISSION VERIFY FLOW.

(C) INSPECTION:

RECEIVING INSPECTION

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

CONTAMINATION CONTROL

CLEANLINESS LEVEL 200A PER MA0110-301 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, SURFACE, AND SUB-SURFACE DEFECTS VERIFIED. 10X VISUAL INSPECTION ON SEAL RING VERIFIED. NICKEL FINISH ON BELLOWS VERIFIED BY INSPECTION.

CRITICAL PROCESSES

INLET FILTER WELD IS VERIFIED BY INSPECTION. PARTS PASSIVATION AND HEAT TREATMENT VERIFIED. LUBRICANT ON SEAL RING VERIFIED BY TECHNICIAN. POTTING APPLICATION AND SOLDER CONNECTIONS ARE 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

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

(D) FAILURE HISTORY:

NO FAILURE HISTORY APPLICABLE TO CLOSED FAILURE MODE. THE REGULATOR HAS SUCCESSFULLY BEEN USED THROUGH THE SHUTTLE PROGRAM CONSIDERING THIS FAILURE MODE.

(E) OPERATIONAL USE:

1. CREW ACTION
   NONE

2. TRAINING
   NONE

3. OPERATIONAL CONSIDERATION
   FAILURE OF THE REGULATOR IS NOT DETECTABLE EITHER ON BOARD OR THROUGH GROUND MONITORING UNLESS THERE IS A SUBSEQUENT FAILURE.

- APPROVALS -

RELIABILITY ENGINEERING	D. R. RISING DRR	
DESIGN ENGINEERING	K. KELLY KK	
QUALITY ENGINEERING	M. SAVALA	
NASA RELIABILITY		
NASA SUBSYSTEM MANAGER		
NASA QUALITY ASSURANCE		