

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CRITICAL HARDWARE
 NUMBER: 06-1C-0116-X

3050260Y
 ATTACHMENT -
 PAGE 186 OF 4

SUBSYSTEM NAME: ARS - ARPCS

REVISION : 9 02/05/91

	PART NAME VENDOR NAME	PART NUMBER VENDOR NUMBER
LRU :	OXYGEN RESTRICTOR	V070-614100
■ SRU 01	RESTRICTOR, FLOW, 02 THE LEE COMPANY	ME251-0011-0006 VDCX05140008A
■ SRU 02	RESTRICTOR, FLOW, 02 THE LEE COMPANY	ME251-0011-0007 VDCX05139508A

 PART DATA

■ EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:
 OXYGEN RESTRICTOR

■ QUANTITY OF LIKE ITEMS: 3
 TWO 12 LB/HR RESTRICTORS IN SYS 2
 ONE 23.9 LB/HR RESTRICTOR IN SYS 1

■ FUNCTION:
 PROVIDES HEAT TO AND RESTRICTS THE OXYGEN FROM THE PRSD CRYOGENIC TANKS
 PRIOR TO THE GAS BEING SENT INTO CABIN FOR CREW USAGE. ONE 23.9 LB/HR
 RESTRICTOR IN SYSTEM 1 AND TWO 12 LB/HR RESTRICTORS IN SYSTEM 2 LIMIT
 OXYGEN FLOW TO 24 LB/HR PER SYSTEM. (SEE FMEA 06-1C-0250 FOR FAILURE
 EFFECTS ON THE FROD COOLANT LOOP)

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CRITICAL FAILURE MODE
NUMBER: 06-1C-0116-03

SOS0260Y
ATTACHMENT
PAGE 191 - 265

REVISION# 2 07/18/90

SUBSYSTEM: ARS - ARPCS
LRU : OXYGEN RESTRICTOR
ITEM NAME: RESTRICTOR, FLOW, O2

CRITICALITY OF THIS
FAILURE MODE: 1/1

FAILURE MODE:
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, INABILITY TO HEAT (FREON LOOP
STOPS)

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.

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CRITICAL FAILURE MODE
NUMBER: 06-1C-0116-03

(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.

(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

- DISPOSITION RATIONALE -

(A) DESIGN:
THE BODY ASSEMBLY IS MADE OF 303 CRES STAINLESS STEEL WHICH IS HIGHLY RESISTANT TO CORROSION IN AN OXYGEN ATMOSPHERE. THE RESTRICTOR IS CALLED A VISCO JET WHICH CONTAINS UNIQUELY DESIGNED PLATES WITHIN THE RESTRICTOR WHICH UTILIZE MULTIPLE OPENINGS IN LIEU OF THE USUAL SINGLE PASSAGE. THIS MAKES THE UNIT LESS SUSCEPTIBLE TO EROSION AND MORE RELIABLE. ALSO, THE FLOW PATTERN WITHIN THE PLATES IS UNIQUELY DESIGNED TO ALLOW LARGER OPENINGS THAN WOULD BE REQUIRED WITH A SINGLE ORIFICE. THE UNIT IS THUS MUCH LESS PRONE TO CONTAMINATION. THE O2 LINE IN THE RESTRICTOR ASSEMBLY IS MADE OF CRES 21-6-9 STAINLESS STEEL. THE TOTAL LENGTH OF THE O2 LINE IN THE ASSEMBLY IS 96 INCHES WITH A DIAMETER OF 1/8 INCH. THE RESTRICTOR SEAL MATERIAL IS VITON RUBBER ELASTOMER. ANALYSIS SHOWS THAT THE TEMPERATURE OF THE O2 REACHING THE LES WILL BE APPROXIMATELY 50 F IF THE RESTRICTOR FAILS TO HEAT. THEREFORE, THE FAILURE EFFECTS ARE BASED NOT ON THERMAL EFFECTS ON THE CREW, BUT ON CLOSURE OF ONE O2 SYSTEM NECESSITATED BY EXTERNAL LEAKAGE AT THE RESTRICTOR SEAL (CAUSED BY CRYOGENIC OXYGEN).

ROCKWELL TO UPDATE RESTRICTIONS

(B) TEST:
ACCEPTANCE TEST - FLOW TEST: TEN LB/HR RESTRICTOR - 9.65 +/- 0.46 LB/HR GN2 AT 60 +/- 5 F WITH AN INLET PRESSURE OF 800 PSIG. TWENTY LB/HR RESTRICTOR - 19.11 +/- 0.93 LB/HR GN2 AT 75 +/- 5 F WITH AN INLET PRESSURE OF 800 PSIG. PROOF PRESSURE ON OXYGEN SIDE - 1575 +50/-0 PSIG FOR A DURATION OF 5 MINUTES. LEAK TEST ON OXYGEN SIDE - 1050 +20/-0 PSIG. MAX LEAKAGE OF 1 X 10 EXP -4 SCCS GHE ACTUAL.

QUALIFICATION TEST - BURST PRESSURE - OXYGEN TUBE: 2580 +/- 100 PSIG AT

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CRITICAL FAILURE MODE
NUMBER: 06-1C-0116-03S050260Y
ATTACHMENT -
PAGE 193 OF 265

A RATE NOT TO EXCEED 300 PSI PER MINUTE FOR A TOTAL DURATION OF 5 MINUTES. DESIGN SHOCK - 20G TERMINAL SAWTOOTH SHOCK PULSE OF 11 MILLISECONDS DURATION IN EACH OF THREE ORTHOGONAL AXES. BENCH HANDLING SHOCK - THE SPECIMEN WAS RAISED 4" ABOVE A HARDWOOD TABLE AND ALLOWED TO DROP. NO VISIBLE INDICATION OF DAMAGE TO THE SPECIMEN RESULTED FROM THE SHOCK TEST. VIBRATION TESTING - RANDOM VIBRATION FOR 84 MINUTES PER AXIS INCREASING AT 6 DB/OCTAVE FROM 20 TO 80 HZ, CONSTANT AT 0.3 G**2/HZ FROM 80 TO 300 HZ, DECREASING AT 6 DB/OCTAVE FROM 300 TO 2000 HZ. TRANSIENT VIBRATION - THE OVERALL EFFECT OF TRANSIENT EVENTS ARE ACCOUNTED FOR BY A SWEEP SINUSOIDAL VIBRATION ENVIRONMENT IMPOSED IN THE FREQUENCY RANGE FROM 5 TO 35 HZ AT AN ACCELERATION AMPLITUDE OF PLUS OR MINUS 0.25 G PEAK. LIFE CYCLE TESTING - THERE ARE NO MOVING PARTS ASSOCIATED WITH THE OXYGEN RESTRICTOR; WEAR, THEREFORE, DOES NOT BECOME A CONSIDERATION IN THE LIFE CERTIFICATION PROCESS.

IN-VEHICLE TESTING - LINES ARE OVERPRESSURE (1070-1255 PSIG) AND LEAK (925 - 950 PSIG, 1 X 10 EXP -7 GHE MAX) TESTED, WITH COMPONENTS INSTALLED.

OMRSD - SYSTEM LEAK TEST IS PERFORMED BEFORE THE FIRST REFLIGHT OF EACH ORBITER AND AT INTERVALS OF FIVE FLIGHTS, AT 900 - 950 PSIG, 70 SCCM MAX LEAKAGE. INFIGHT 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 MAQ110-301 AND 100 ML RINSE TESTS VERIFIED BY INSPECTION. PARTS CORROSION PROTECTION APPLICATION VERIFIED BY INSPECTION.

ASSEMBLY/INSTALLATION
FABRICATION OF PARTS/COMPONENTS PER DRAWING VERIFIED BY INSPECTION. DIMENSIONAL INSPECTIONS ARE PERFORMED AND VERIFIED BY INSPECTION. RIGID TUBING INSTALLATION PER DRAWING INCLUDING LUBRICANT AND TORQUES VERIFIED BY INSPECTION.

CRITICAL PROCESSES
PARTS PASSIVATION AND ELECTRO POLISHING PROCESS VERIFIED BY INSPECTION. BRAZING OF TUBING AND COMPONENTS VERIFIED BY INSPECTION. APPLICATION OF LUBRICANT ON SEAL RING VERIFIED BY INSPECTION.

TESTING

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CRITICAL FAILURE MODE
NUMBER: 06-1C-0116-03

S050260Y
ATTACHMENT -
PAGE 194 OF 2

ATP IS VERIFIED BY INSPECTION.

HANDLING/PACKAGING
PACKAGING, HANDLING, STORAGE AND SHIPPING PROCEDURES ARE VERIFIED BY INSPECTION.

(D) FAILURE HISTORY:
14F022-000, 9/17/84: FLOW RESTRICTOR LEAKED DURING FLIGHT DUE TO INSTALLATION ERROR; IT WAS INSTALLED BACKWARD. SINCE THE O2 WAS NOT HEATED BY THE FREON COOLANT LOOP PRIOR TO REACHING THE SEAL, THE CRYO TEMPERATURE CAUSED THE SEAL TO LEAK. REMEDIAL ACTION - OV103 INSTALLATION WAS MODIFIED TO CORRECT THE INSTALLATION ERROR. ALL OTHER ORBITER INSTALLATIONS WERE VERIFIED TO BE CORRECT. DRAWING CHECK INDICATED NO DRAWING CHANGE WAS REQUIRED.

(E) OPERATIONAL USE:

~~186~~

- APPROVALS -

RELIABILITY ENGINEERING:	D. R. RISING	<i>DRR</i>	:	<i>E. Ockon 2/10/91</i>
DESIGN ENGINEERING	: K. KELLY	<i>KK</i>	:	<i>[Signature]</i>
QUALITY ENGINEERING	: M. SAVALA	<i>JMS</i>	:	<i>M. Savala for OSD 2/8/91</i>
NASA RELIABILITY	:		:	<i>[Signature] 4-2-91</i>
NASA SUBSYSTEM MANAGER	:		:	<i>D. M. [Signature] 4/3/91</i>
NASA QUALITY ASSURANCE	:		:	<i>[Signature] 2/12/91</i>

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