

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

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 PART DATA  
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■ 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)

PAGE: 2

PRINT DATE: 02/05/91

S050260Y  
ATTACHMENT -  
PAGE 187 OF 26

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CRITICAL FAILURE MODE  
NUMBER: 06-1C-0116-01

REVISION# 2 07/18/90 R

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

CRITICALITY OF THIS  
FAILURE MODE: 1/1

FAILURE MODE:  
RESTRICTED FLOW (BLOCKED AS WORST CASE)  
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:  
CONTAMINATION, CORROSION

CRITICALITY 1/I 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-0116-01

8050260Y  
ATTACHMENT  
PAGE 128 OF

(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

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- DISPOSITION RATIONALE -  
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(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.

(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.

RI TO  
UPDATE  
RESTRICTOR

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

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CRITICAL FAILURE MODE  
NUMBER: 06-1C-0116-01

S050260Y  
ATTACHMENT -  
PAGE 189 OF 265

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 SWEPT 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 - FLOW LIMITER (RESTRICTOR) TEST VERIFIES THE REQUIRED FLOW RATE FROM THE PRSD CRYO O2 SYSTEM.

OMRSD - O2 REGULATOR ASSEMBLY CHECKS, PERFORMED BEFORE THE FIRST REFLIGHT OF EACH ORBITER AND AT INTERVALS OF FIVE FLIGHTS, VERIFY REQUIRED FLOW FROM THE PRSD SYSTEM. THE PRSD SYSTEM IS SERVICED WITH GO2 PER SE-S-0073 AND THE GROUND HALF QUICK DISCONNECTS CONTAIN FILTERS.

(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. 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  
ATP IS VERIFIED BY INSPECTION.

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

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CRITICAL FAILURE MODE  
NUMBER: 06-1C-0116-01

6050260Y  
ATTACHMENT  
PAGE 190 OF 265

(D) FAILURE HISTORY:

ONE FAILURE HAS OCCURRED:  
AC8049-010, 5/2/84 IN COMPONENT TEST IN DOWNEY. RESTRICTOR FLOW RATE WAS 1.985 SCFM, SHOULD BE 2.04 TO 2.37 SCFM. TWO OF OV-104'S THREE RESTRICTORS WERE FOUND TO BE CONTAMINATED ALTHOUGH DOCUMENTATION INDICATED 200A CLEANLINESS HAD BEEN MAINTAINED. NO CORRECTIVE ACTION - CLOSEOUT WAS EXPLAINED, PROBLEM BEING SCREENABLE BY INSPECTION AND TEST.

(E) OPERATIONAL USE:

~~FDS~~

- APPROVALS -

RELIABILITY ENGINEERING:	D. R. RISING	<i>DRR</i>	:	<u><i>E. Johnson</i></u>
DESIGN ENGINEERING	: M. PRICE	<i>MP</i>	:	<u><i>[Signature]</i></u>
QUALITY ENGINEERING	: M. SAVALA		:	<u><i>M. Savala for 038 2/8/91</i></u>
NASA RELIABILITY	:		:	<u><i>[Signature]</i></u>
NASA SUBSYSTEM MANAGER	:	<i>APB</i>	:	<u><i>[Signature]</i></u>
NASA QUALITY ASSURANCE	:		:	<u><i>[Signature]</i></u>

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).