

PAGE: 1

PRINT DATE: 06/07/94

**FAILURE MODES EFFECTS ANALYSIS (FMEA) - CRITICAL HARDWARE**

NUMBER: 01-5B-380104-X

SUBSYSTEM NAME: PURGE, VENT, & DRAIN - ACTRS

REVISION: 1 06/02/94

---

	<b>PART NAME VENDOR NAME</b>	<b>PART NUMBER VENDOR NUMBER</b>
LRU	: BEARING SUPPORTS	V070-592502
LRU	: BEARING SUPPORTS	V070-592509

---

**PART DATA**

---

**EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:**  
BEARING SUPPORTS (TORQUE TUBE), VENTS 1 AND 2 (RCS & FWD)

**QUANTITY OF LIKE ITEMS: 4**  
(2 RH & 2 LH)  
(SHOWN AND OPPOSITE)

**FUNCTION:**  
THIS ITEM ACTS TO PROVIDE STRUCTURAL SUPPORT AND LOW-FRICTION BEARINGS  
FOR THE VENT DOOR (TORQUE TUBE) DRIVE SHAFTS.

**FAILURE MODES EFFECTS ANALYSIS (FMEA) – CRITICAL FAILURE MODE  
NUMBER: 01-5B-380104-01**

REVISION# 1 06/02/94

SUBSYSTEM NAME: PURGE, VENT, & DRAIN - ACTRS  
LRU: BEARING SUPPORTS  
ITEM NAME: BEARING SUPPORTS

CRITICALITY OF THIS  
FAILURE MODE: 1R3

**FAILURE MODE:**  
FAILS TO ROTATE (PHYSICAL BINDING/JAMMING)

**MISSION PHASE:**  
DO - DE-ORBIT

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

**CAUSE:**  
ADVERSE TOLERANCES/WEAR, CONTAMINATION/FOREIGN OBJECT/DEBRIS,  
CORROSION, DEFECTIVE PART/MATERIAL OR MANUFACTURING DEFECT, EXCESSIVE  
LOAD

**CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO**

**REDUNDANCY SCREEN**      **A) FAIL**  
                                 **B) FAIL**  
                                 **C) PASS**

**PASS/FAIL RATIONALE:**

**A)**  
FAILS REDUNDANCY SCREEN "A" SINCE THERE IS NO PRACTICAL OMRSD TEST FOR  
DETECTING THE FIRST FAILURE OF A BEARING; ALL BEARINGS HAVE DUAL ROTATING  
SURFACES.

**B)**  
FAILS REDUNDANCY SCREEN "B" SINCE THE FIRST FAILURE OF A BEARING TO ROTATE  
CANNOT BE DETECTED WHILE IN FLIGHT.

**C)**

**- FAILURE EFFECTS -**

**(A) SUBSYSTEM:**  
NONE. ALL BEARINGS EMPLOY DUAL ROTATING SURFACES SO THAT ROTATIONAL  
CAPABILITY WILL EXIST FOLLOWING SURFACE TO SURFACE BINDING OF ONE  
ROTATIONAL SURFACE.

**(B) INTERFACING SUBSYSTEM(S):**  
NO EFFECT FIRST FAILURE

**(C) MISSION:**

**FAILURE MODES EFFECTS ANALYSIS (FMEA) - CRITICAL FAILURE MODE  
NUMBER: 01-5B-380104-01**

NO EFFECT FIRST FAILURE

**(D) CREW, VEHICLE, AND ELEMENT(S):**  
NO EFFECT FIRST FAILURE**(E) FUNCTIONAL CRITICALITY EFFECTS:**

POSSIBLE LOSS OF CREW AND VEHICLE AFTER THREE FAILURES (1ST ROTATING SURFACE FAILS TO ROTATE, 2ND ROTATING SURFACE FAILS TO ROTATE, AND OPPOSITE VENT DOOR FAILS CLOSED) DUE TO LOSS OF VENTING CAPABILITY WHICH CAN RESULT IN STRUCTURAL OVERLOAD DUE TO PRESSURE DIFFERENTIAL ON ENTRY. FAILURE TO CLOSE, PRIOR TO ENTRY, WILL RESULT IN LOCALIZED THERMAL DAMAGE. THERMAL ANALYSIS (SAS-TA-RCC-78-152, -79-012 AND 79-065) SHOWS THAT CREW AND VEHICLE WILL SURVIVE.

---

**-DISPOSITION RATIONALE-**

---

**(A) DESIGN:**

THE VENT DOOR MECHANISM IS DESIGNED TO OPEN OR CLOSE (AS NEEDED) AND HOLD IN PLACE EACH OF THE VENT DOORS INTO THE ORBITER FUSELAGE/CAVITIES; TO REGULATE INTERNAL PRESSURE AND AIR (DURING PRE-FLIGHT, ASCENT, ORBIT AND DESCENT). THE VENT DOORS ARE OPENED OR CLOSED BY ELECTROMECHANICAL ACTUATORS CONNECTED TO TORQUE TUBE/BELLCRANKS AND ADJUSTABLE CONNECTING-RODS; THAT, IN COMBINATION WITH VENT DOORS, FORM A FOUR-BAR/OVER-CENTER HINGE/ACTUATION LINKAGE.

ALL BEARINGS INCORPORATE DUAL ROTATING SURFACES. BEARINGS ARE DESIGNED TO SUPPORT THE ROTATING TORQUE TUBES AND DEMONSTRATE GREATER THAN 1,000 HR B-10 LIFE IN ACCORDANCE WITH ANTI-FRICTION BEARING MANUFACTURING ASSOCIATION (AFBMA). BEARING MATERIAL IS 440C CRES STEEL WITH VITROLUBE (DRY FILM) LUBRICATION. BEARINGS HAVE DUAL ROTATING SURFACES. BEARING SUPPORTS ARE FABRICATED OF 2024-T8511 (WITH A FACTOR OF SAFETY OF 1.4 MINIMUM) AND EXHIBIT A POSITIVE MARGIN OF SAFETY (0.02) WHEN SUBJECTED TO ULTIMATE LOADS.

**(B) TEST:**

QUALIFICATION TESTS: QUAL-CERTIFIED PER CR-28-592501-001. AS PART OF THE QUALIFICATION OF THE FWD VENT DOOR MECHANISM. CERTIFICATION BY ANALYSIS INCLUDED: FACTOR OF SAFETY (OUTLINED IN REPORT SD77-SH-0178, SECTION 11.17), FUNGUS AND OZONE (NO FUNGUS/OZONE SUSCEPTIBLE MATERIALS ARE USED), SALT FOG/SAND & DUST (MECHANISM IS WITHIN AN ENCLOSED AREA OF THE VEHICLE; TESTING IS NOT REQUIRED; WHEN THE DOORS ARE OPEN IN A SALT FOG/SAND & DUST ENVIRONMENT, THEY ARE IN THE PURGE POSITION, WITH THE ORBITER BEING PURGED); LANDING SHOCK (1.5 G'S MAX), DESIGN SHOCK (20 G'S), AND ACCELERATION (+/-5 G'S) ARE ALL MINIMAL WHEN COMPARED TO THE MECHANISM DESIGN LOADS. CERTIFICATION BY ANALYSIS/SIMILARITY TO THE AFT FUSELAGE VENT DOOR MECHANISM (CR-28-595591-001) BECAUSE THE BEARINGS, ROD-ENDS, MATERIALS AND PROCESSES ARE IDENTICAL. TESTS INCLUDED: TEMPERATURE CYCLE (MECHANISM MUST FUNCTION BETWEEN -100 DEG F AND +350 DEG F), HUMIDITY (UP TO 100% PER MIL-STD-810C, METHOD 507, PROCEDURE IV), VIBRATION (16-8,000 HZ FOR 1,740 SECONDS AND 4,000 SECONDS) AND OPERATING LIFE (2,000 CYCLES OF OPENING/CLOSING UNDER MAXIMUM LOAD).

**FAILURE MODES EFFECTS ANALYSIS (FMEA) - CRITICAL FAILURE MODE  
NUMBER: 01-5B-380104-01**

ACCEPTANCE TESTS: INSTALLED AND RIGGED PER ML0308-0013. FUNCTIONALLY TESTED DURING RIGGING AT PALMDALE AND FUNCTIONALLY TESTED AT KSC.

GROUND TURNAROUND TEST:  
NO PRACTICAL OMRSD TEST IS AVAILABLE TO DETECT FIRST FAILURE.

**(C) INSPECTION:**  
RECEIVING INSPECTION  
MATERIAL AND PROCESS CERTIFICATIONS ARE VERIFIED BY INSPECTION.

**CONTAMINATION CONTROL**  
CLEANLINESS TO LEVEL GC PER MA0110-301 IS VERIFIED BY INSPECTION. CORROSION PROTECTION PER MA0608-301 IS VERIFIED BY INSPECTION.

**ASSEMBLY/INSTALLATION**  
MANUFACTURING PROCESSES, INCLUDING PARTS PROTECTION, VERIFIED BY INSPECTION. CRITICAL DIMENSIONS AND SURFACE FINISHES VERIFIED BY INSPECTION.

**NONDESTRUCTIVE EVALUATION**  
PENETRANT INSPECTION AFTER MACHINING IS VERIFIED BY INSPECTION.

**CRITICAL PROCESSES**  
DRY FILM LUBRICATION AND ANODIZING ARE VERIFIED BY INSPECTION.

**TESTING**  
ATP IS VERIFIED BY INSPECTION.

**HANDLING/PACKAGING**  
HANDLING AND PACKAGING REQUIREMENT ARE VERIFIED BY INSPECTION.

**(D) FAILURE HISTORY:**  
CURRENT DATA ON TEST FAILURES, FLIGHT FAILURES, UNEXPLAINED ANOMALIES, AND OTHER FAILURES EXPERIENCED DURING GROUND PROCESSING ACTIVITY CAN BE FOUND IN THE PRACA DATABASE.

**(E) OPERATIONAL USE:**  
THE GROUND CREW MAY USE REAL TIME COMMANDS (RTC) TO CYCLE THE VENT DOOR (TO ATTEMPT TO DISLODGE DEBRIS OR LOOSEN A STALLED/JAMMED MECHANISM), DEPENDING ON THE FAILURE MODE (OPEN, CLOSED) AND MISSION PHASE REQUIREMENT. RTC CAPABILITY IS ONLY AVAILABLE ON ORBIT AND POST-LANDING (OPERATIONS SEQUENCE 2 AND 9). THE SPEC 51 OVERRIDE PROVIDES LIMITED COMMAND CAPABILITY TO FLIGHT CREW TO OPEN OR CLOSE THE VENT DOORS IN OPS 3.

**- APPROVALS -**

PAE MANAGER	: K. L. PRESTON	: <u>Stell Jan 6/8/94</u>
PRODUCT ASSURANCE ENG.	: T. AI	: <u>Jan 6/15/94</u>
DESIGN ENGINEERING	: A. P. YSON	: <u>Jan 6/15/94</u>
NASA SSMA	:	: <u>Jan 7/6/94</u>
NASA SUBSYSTEM MANAGER	:	: <u>R.E. Davis 7/6/94</u>