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PRINT DATE: 06/07/94

**FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CRITICAL HARDWARE**  
NUMBER: 01-5B-380128-X

SUBSYSTEM NAME: PURGE, VENT, & DRAIN - ACTRS

REVISION: 1 06/02/94

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	<b>PART NAME</b>	<b>PART NUMBER</b>
	<b>VENDOR NAME</b>	<b>VENDOR NUMBER</b>
LRU	: BEARING HOUSING	V070-595515
LRU	: BEARING HOUSING	V070-595533

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**PART DATA**

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**EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:**  
BEARING HOUSING (TORQUE TUBE), VENTS 8 AND 9 (AFT)

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

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

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SUBSYSTEM NAME: PURGE, VENT, & DRAIN - ACTRS

LRU: BEARING HOUSING

ITEM NAME: BEARING HOUSING

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

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(C) MISSION:  
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.

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-DISPOSITION RATIONALE-

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(A) DESIGN:  
THE VENT DOOR MECHANISMS ARE 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 TUBES, BELLCRANKS AND ADJUSTABLE CONNECTING-RODS; THAT, IN COMBINATION WITH THE VENT DOORS, FORM A FOUR-BAR/OVER-CENTER HINGE/ACTUATION LINKAGE.

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-28-595501-001) AS PART OF THE SUBSYSTEM CERTIFICATION OF THE AFT FUSELAGE VENT DOOR MECHANISMS. QUALIFICATION TESTS INCLUDE: ELECTRICAL BOND TEST (ELECTRICAL BONDING PER MF0004-002, CLASS R OF MIL-B-5087; WITH RESISTANCE NOT TO EXCEED 0.0025 OHMS BETWEEN STRUCTURAL COMPONENTS), HUMIDITY TEST (PER MIL-STD-810, METHOD 507, PROCEDURE 1V), ACOUSTIC VIBRATION TEST (QAVT) (25-8,000 HZ; SIMULATING LIFT-OFF FOR 34 MINUTES AND AERODYNAMIC LOADING FOR 30 MINUTES), TEMPERATURE CYCLE TEST (MECHANISM THERMALLY CYCLED 5 TIMES UNDER LIMIT LOAD, WITH TEMPERATURES BETWEEN -100 DEG F AND +350 DEG F), OPERATING LIFE CYCLE TEST (CYCLED OVER 2,000 TIMES AT ROOM TEMP; INCLUDES 1,800 CYCLES, FROM CLOSE-OPEN-CLOSE, DUAL MOTOR; AND INCLUDES 100 CYCLES, FROM CLOSE-OPEN-INTERMEDIATE-CLOSE, DUAL MOTOR; AND INCLUDES 200 CYCLES, FROM CLOSE-OPEN-CLOSE, SINGLE MOTOR 1 AND 2) AND EXTREME TEMPERATURE TEST (MECHANISM CYCLED 5 TIMES AT -150 DEG F, WITH CLOSING TORQUE AND LOADS MEASURED). CERTIFICATION BY ANALYSIS INCLUDED: FACTOR OF SAFETY/MARGIN OF SAFETY, FUNGUS, OZONE, SALT SPRAY, SAND/DUST, LANDING SHOCK AND LAUNCH ACCELERATION.

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ACCEPTANCE TESTS: INSTALLED AND RIGGED PER ML0308-0017. FUNCTIONALLY TESTED DURING RIGGING AT PALMDALE AND FUNCTIONALLY TESTED AT KSC.

GROUND TURNAROUND TEST:

NO PRACTICAL 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 ARE VERIFIED BY INSPECTION.

ASSEMBLY/INSTALLATION

MANUFACTURING PROCESSES, INCLUDING PARTS PROTECTION ARE VERIFIED BY INSPECTION. CRITICAL DIMENSIONS AND SURFACE FINISHES ARE VERIFIED BY INSPECTION.

NONDESTRUCTIVE EVALUATION

PENETRANT INSPECTION IS VERIFIED BY INSPECTION.

CRITICAL PROCESSES

DRY FILM LUBRICATION IS VERIFIED BY INSPECTION.

TESTING

ATP IS VERIFIED BY INSPECTION.

HANDLING/PACKAGING

HANDLING AND PACKAGING REQUIREMENTS 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 TO OPEN.

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- APPROVALS -

PAE MANAGER : K. L. PRESTON  
PRODUCT ASSURANCE ENG. : T. AI  
DESIGN ENGINEERING : A. P. YSON  
NASA SSMA :  
NASA SUBSYSTEM MANAGER :

*Still for 6/8/94*  
*W. B. K. 6/8/94*  
*W. B. K. 6/8/94*  
*W. B. K. 7/6/94*  
*P. E. 7/6/94*