FAILURE MODES EFFECTS ANALYSIS (FMEA) – CRITICAL HARDWARE
NUMBER: 01-5B-380107-X

SUBSYSTEM NAME: PURGE, VENT, & DRAIN - ACTRS
REVISION: 1 06/02/94

		PART NAME VENDOR NAME	PART NUMBER VENDOR NUMBER
LRU	:	DOOR DRIVE ACTUATOR ELLANEF	MC147-0009 A1058A010
SRU	:	GEARBOX/DIFFERENTIAL	
SRU	:	TORQUE LIMITER	

PART DATA

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:
FOR 01-5B-380107-01:
GEARBOX/DIFFERENTIAL, DOOR DRIVE ACTUATOR, VENTS 1 AND 2 (RCS & FWD)

FOR 01-5B-380107-02, 01-5B-380107-03:
TORQUE LIMITER, DOOR DRIVE ACTUATOR, VENTS 1 AND 2 (RCS & FWD)

QUANTITY OF LIKE ITEMS: 2
(1 RH & 1 LH)
(1 PER ACTUATOR)

FUNCTION:
FOR 01-5B-380107-01:
TO TRANSMIT/DISTRIBUTE PROPER POWER/TORQUE FROM EITHER ONE OR BOTH ELECTRIC MOTORS TO THE DOOR DRIVE MECHANISM (TO OPEN/CLOSE THE VENT DOORS).

FOR 01-5B-380107-02, 01-5B-380107-03:
TO PROTECT THE ACTUATOR MOTOR/GEARS BY ALLOWING PREDETERMINED SLIPPAGE WHEN THE VENT DOOR MECHANISM STALLS OR JAMS.

FAILURE MODES EFFECTS ANALYSIS (FMEA) – CRITICAL FAILURE MODE
NUMBER: 01-5B-380107-03

REVISION# 1 06/02/94

SUBSYSTEM NAME: PURGE, VENT, & DRAIN - ACTRS
LRU: DOOR DRIVE ACTUATOR
ITEM NAME: TORQUE LIMITER

CRITICALITY OF THIS FAILURE MODE: 1R3

FAILURE MODE:
TORQUE LIMITER FAILS TO SLIP AT MAXIMUM ALLOWABLE TORQUE

MISSION PHASE:
DO DE-ORBIT

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

CAUSE:
ADVERSE TOLERANCES/WEAR, CHANGE IN MATERIAL PROPERTIES, CONTAMINATION/FOREIGN OBJECT/DEBRIS, DEFECTIVE PART/MATERIAL OR MANUFACTURING DEFECT, TEMPERATURE

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 ARE NO PRACTICAL TURNAROUND TESTS TO VERIFY THIS FAILURE MODE OF THE TORQUE LIMITER.

B)
FAILS SCREEN "B" SINCE THIS FAILURE IS NOT DETECTABLE, WHILE IN FLIGHT, UNTIL A JAM OR STALL CONDITION OCCURS.

C)

- FAILURE EFFECTS -

(A) SUBSYSTEM:
POSSIBLE DAMAGE TO LINKAGE DOOR STRUCTURE OR ACTUATOR IF STALLED OR JAMMED CONDITION OCCURS. LOSS OF ABILITY TO CONTROL POSITION OF VENT DOORS, VENTING OR REPRESSURIZATION OF COMPARTMENTS.

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

(C) MISSION:

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NO EFFECT FIRST FAILURE

(D) CREW, VEHICLE, AND ELEMENT(S):
NO EFFECT FIRST FAILURE

(E) FUNCTIONAL CRITICALITY EFFECTS:
POSSIBLE LOSS OF CREW/VEHICLE AFTER THREE FAILURES (TORQUE LIMITER FAILURE, MECHANISM SUBSEQUENT TO THE TORQUE LIMITER JAMMED, AND THE OPPOSITE DOOR FAILS CLOSED) DUE TO STRUCTURAL DAMAGE FROM PRESSURE DIFFERENTIAL ON ENTRY. LOCALIZED THERMAL DAMAGE ONLY, IF DOORS ARE FAILED OPEN ON ENTRY; 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 SUBSYSTEM CONSISTS OF SEALED DOORS INTO THE FUSELAGE CAVITIES (THAT ARE OPENED OR CLOSED TO REGULATE INTERNAL PRESSURE) AND ARE POSITIONED BY ELECTROMECHANICAL DOOR DRIVE ACTUATORS CONNECTED TO TORQUE TUBES, BELLCRANKS AND CONNECTING-RODS. EACH VENT DOOR ACTUATOR CONSISTS OF A PLANETARY GEARBOX/DIFFERENTIAL AND A SPRING-LOADED (4) BALL-DETENT TORQUE LIMITER DRIVEN BY TWO (REDUNDANT) 3-PHASE ELECTRIC MOTORS; EACH MOTOR HAS AN INTEGRAL SPRING-LOADED FRICTION BRAKE: WITH LIMIT SWITCHES, SOFT (LEAF SPRING) STOPS AND HARD MECHANICAL STOPS TO CONTROL/LIMIT ACTUATOR MOVEMENT/ROTATION. THE ACTUATOR HOUSING IS FABRICATED OF 6AL-4V TI AND DESIGNED TO PRECLUDE THE ENTRY OF FOREIGN PARTICLES. GEARS MADE OF PH13-8MO AND 15-5PH CRES; INCONEL 718. BEARINGS MADE OF 440 AND OTHER CRES. PARTS ARE CLEANED TO LEVEL 300, PER MA0110-301 (PRIOR TO ASSEMBLY); ASSEMBLED IN A CLASS 100,000 CLEAN ROOM (PER FED-STD-209). DUAL ROTATING SURFACES ON BEARINGS, SAFETY FACTOR 1.4 MINIMUM. PROVISION EXISTS TO CYCLE THE ACTUATOR (TO LOOSEN A STALLED/JAMMED MECHANISM). BRAKES MUST BE ELECTRICALLY ENERGIZED TO DISENGAGE AND ARE DESIGNED TO FAIL IN THE ENGAGED POSITION. DIFFERENTIAL IS DESIGNED TO DISTRIBUTE POWER FROM EITHER ONE OR BOTH (REDUNDANT) MOTORS. MOTORS ARE DESIGNED TO OPERATE IN AN EMERGENCY 2-PHASE CONDITION. THE TORQUE LIMITER IS DESIGNED TO PROTECT BOTH MOTORS AND THE DRIVE-TRAIN FROM AN OVERLOAD FAILURE.

(B) TEST:
QUALIFICATION TESTS: QUAL-CERTIFIED PER CR-28-147-0009-0003 (WHICH DELETES AND REPLACES CR-28-147-0009-0001). QUALIFICATION TESTS INCLUDE: HUMIDITY TEST (PER MIL-STD-810B), QUAL ACCEPTANCE VIBRATION TEST (QAVT) (ACOUSTIC VIBRATIONS FROM 20-2,000 HZ; PER MF0004-32), FLIGHT VIBRATION TEST (20-2,000 HZ FOR 70 MINUTES), SHOCK TEST (PER MIL-STD-810, PROCEDURE I, METHOD 516.1), THERMAL VACUUM TEST (0.000001 TORR FOR 55 HOURS, WITH TEMPERATURE CYCLED BETWEEN -170 DEG F AND +330 DEG F, AND ACTUATOR CYCLED), THERMAL CYCLE TEST (TEMPERATURE CYCLED BETWEEN -170 DEG F AND +330 DEG F; INCLUDES MOTOR 1 AND MOTOR 2 CYCLED 500 TIMES EACH, ALONE, AND WITHIN 10 SEC/DIRECTION UNDER LOAD FROM CLOSE-OPEN-CLOSE; 500 CYCLES WITH BOTH MOTORS AT 5 SEC/DIRECTION FROM CLOSE-OPEN-CLOSE; AND 250 CYCLES WITH BOTH MOTORS FROM CLOSE-OPEN-INTERMEDIATE-CLOSE) AND MECHANICAL STOPS TEST (ACTUATOR OPERATED AT FULL RATE AND WITH NO LOAD OR BRAKES; 100 TIMES IN

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HANDLING/PACKAGING
PROPERLY MONITORED STORAGE ENVIRONMENT VERIFIED. PARTS PROTECTION IS 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:
NONE.

- APPROVALS -

PAE MANAGER	: K. L. PRESTON	: 6/8/94
PRODUCT ASSURANCE ENG.	: T. AI	:
DESIGN ENGINEERING	: A. P. YSON	: 6/9/94
NASA SSMA	:	: 7/6/94
NASA SUBSYSTEM MANAGER	:	: 7/6/94