SHUTTLE CRITICAL ITEMS LIST - ORBITER

SUBSYSTEM :ACTUATION MECH-RADIATORS FMEA NO 02-4G -180 -2 REV:03/07/88

ASSEMBLY :RADIATOR LATCH MECHANISM
P/N RI :MC287-0037-0004
P/N VENDOR:15820-11 HOOVER ELECTRIC
QUANTITY :4
:1 PER ASSEMBLY
:2 ASSEMBLIES PER SIDE

CRIT. FUNC: 1R
CRIT. HDW: 2

VEHICLE EFFECTIVITY:	102	103	104
	X	X	X

PHASE(S): PL LO OO X DO LS

REDUNDANCY SCREEN: A-PASS B-PASS C-PASS

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ITEM:
GEARBOX, POWER DRIVE UNIT

FUNCTION:
THE GEARBOX TRANSMITS ROTARY MOTION FROM THE MOTORS TO THE ROTARY ACTUATORS WHICH DRIVE THE LATCHES TO LATCH OR UNLATCH THE RADIATOR TO THE PAYLOAD BAY DOOR. GEAR RATIO IS 704.05 TO 1.

FAILURE MODE:
FAILS FREE

CAUSE(S):
SLIPS AT LESS THAN MINIMUM ALLOWABLE TORQUE, FAILURE/DEFLECTION OF INTERNAL PART, FATIGUE, VIBRATION

EFFECTS ON:
(A)SUBSYSTEM (B)INTERFACES (C)MISSION (D)CREW/VEHICLE

(A) LOSS OF CAPABILITY TO OPEN OR CLOSE SET OF SIX LATCHES ON ONE RADIATOR PANEL.

(B,C) NONE. REDUCED COOLING CAPACITY OF FREON COOLANT LOOPS (APPROXIMATELY 10%) IF RADIATOR CANNOT BE DEPLOYED.

(D) NONE - FIRST FAILURE; LATCHING OF RADIATORS IS NOT CRITICAL FOR SAFE ENTRY UNLESS THE OTHER FREON COOLANT LOOP HAS ALREADY BEEN LOST.

DISPOSITION & RATIONALE:
(A)DESIGN (B)TEST (C)INSPECTION (D)FAILURE HISTORY (E)OPERATIONAL USE

(A) DESIGN
GEARS ARE DESIGNED WITH HIGH MARGINS. MAXIMUM CALCULATED TOOTH BENDING STRESS APPROXIMATELY 80,000 PSI, ULTIMATE ALLOWABLE 180,000 PSI. BEARINGS INCORPORATE MULTIPLE ROTATING SURFACES. THE DRIVE ACTUATOR IS DESIGNED TO WITHSTAND FULL STALL TORQUE AT FULL INVERTOR AC POWER FOR A LIMITED TIME WITHOUT DAMAGE.

(B) TEST

QUALIFICATION TEST: A SIMILAR ACTUATOR HAS BEEN CERTIFIED BY CR-29-287-0037-0001G. QUALIFICATION TESTS INCLUDE: ACCEPTANCE TEST TO VERIFY CONFORMANCE WITH THE REQUIREMENTS NOTED BELOW FOR ACCEPTANCE TEST. HUMIDITY TEST - TEST IN ACCORDANCE WITH MIL-STD-810B, METHOD 507, PROCEDURE IV; QUALIFICATION ACCEPTANCE VIBRATION TEST (QAVT) - 20 TO 2,000 HZ RANGE WITH MAXIMUM OF 0.067 g2/HZ FROM 80 TO 350 HZ FOR 2.5 MINUTES PER AXIS; ORBITAL FLIGHT TEST - 20 TO 2,000 HZ RANGE WITH MAXIMUM OF 0.2 g2/HZ FROM 60 TO 300 HZ FOR 27 MINUTES PER AXIS AT LEVEL "B" AND WITH MAX OF 0.75 g2/HZ FROM 65 TO 300 HZ FOR 51 MINUTES PER AXIS AT LEVEL "A"; SHOCK TEST - TEST IN ACCORDANCE WITH MIL-STD-810B, METHOD 516.1, PROCEDURE I; THERMAL/VACUUM - THE ACTUATOR WAS THERMALLY CYCLED FIVE TIMES FROM +70 DEG F TO +330 DEG F TO +250 DEG F TO -167 DEG F TO -100 DEG F TO +70 DEG F IN A VACUUM OF 1 X 10 -6 TORR. DWELL AT EACH TEMPERATURE EXTREME WAS 60 MINUTES MINIMUM AFTER STABILIZATION. AT EACH +250 DEG F AND -100 DEG F, THE ACTUATOR WAS CYCLED 6 TIMES FOR DUAL MOTOR OPERATIONS AND 4 TIMES FOR SINGLE MOTOR OPERATIONS; ELECTRICAL CONTINUITY - MONITORED THROUGHOUT THE TEST. THERMAL TEST - THE ACTUATOR WAS THERMALLY CYCLED FIVE TIMES FROM +70 DEG F TO +330 DEG F TO +250 DEG F TO -167 DEG F TO -100 DEG F TO +70 DEG F. DWELL AT EACH TEMPERATURE EXTREME WAS 60 MINUTES MINIMUM AFTER STABILIZATION, AFTER EACH +250 DEG F AND -100 DEG F. THE ACTUATOR WAS CYCLED 6 TIMES FOR DUAL MOTOR OPERATIONS AND 4 TIMES FOR SINGLE MOTOR OPERATIONS. ELECTRICAL CONTINUITY MONITORED THROUGHOUT THE TEST.

QUAL TESTS ALSO INCLUDE: CYCLING AT HIGH TEMPERATURE +250 DEG F EXTREME INCLUDED OPERATION AT THE MAXIMUM HEAT DISSIPATING MODE; CYCLING AT THE LOW TEMPERATURE -100 DEG F EXTREME INCLUDED OPERATION AT THE MINIMUM HEAT DISSIPATING MODE. OPERATING LIFE TEST - THE ACTUATOR WAS CYCLED 1,500 TIMES AT ROOM TEMPERATURE. MOTOR NO. 1 AND NO. 2 WERE CYCLED 250 TIMES EACH INDIVIDUALLY WITHIN 60 SEC/STROKE. IT WAS ALSO CYCLED 100 TIMES WITH BOTH MOTORS DRIVING TOGETHER WITHIN 30 SECONDS/STROKE; MECHANICAL STOP TEST - THE ACTUATOR WAS OPERATED AT FULL RATE AND NO LOAD INTO MECHANICAL STOP FOR 100 TIMES IN EACH DIRECTION; CERTIFICATION BY ANALYSIS - THESE INCLUDED FUNGUS, OZONE, SALT SPRAY, SAND/DUST, TRANSPORTATION PACKAGING, ACCELERATION, LANDING SHOCK, EXPLOSIVE ATMOSPHERE AND MARGIN OF SAFETY. THE ACTUATORS WERE SUBJECTED TO SYSTEM QUALIFICATION TESTS PER RADIATOR LATCHING MECHANISM INSTALLATION V070-594450 (REF. CR-29-594450-001E) AND RADIATOR DEPLOYMENT MECHANISM INSTALLATION V070-594400 (REF. CR-29-594400-001D).

ACCEPTANCE TESTS: ACCEPTANCE TESTS INCLUDE: EXAMINATION OF PRODUCT - WEIGHT, WORKMANSHIP, DIMENSION, CONSTRUCTION, CLEANLINESS, FINISH, IDENTIFICATION MARKING, TRACEABILITY AND USE OF APPROVED MATERIALS AND PROCESSES; ACCEPTANCE VIBRATION TEST - 20 TO 2,000 HZ WITH MAXIMUM OF 0.04 g2/HZ FROM 80 TO 350 HZ FOR 30 SECOND PER AXIS; ACCEPTANCE THERMAL TEST - THERMALLY CYCLED FROM 70 DEG F TO +310 DEG F TO +250 DEG F TO -147 DEG F TO -100 DEG F TO +310 DEG F TO +250 DEG F TO +70 DEG F. DWELL AT EACH TEMPERATURE WAS AT LEAST 60 MINUTES AFTER THERMAL STABILIZATION. AT EACH +250 DEG F AND -100 DEG F THE ACTUATOR WAS CYCLED 6 TIMES FOR DUAL MOTOR OPERATIONS AND 4 TIMES FOR SINGLE MOTOR OPERATIONS; POWER CONSUMPTION TEST - VERIFIED THE INPUT POWER DID NOT EXCEED 62 WATTS PER MOTOR AND THE INPUT CURRENT DID NOT EXCEED 0.36 AMP PER PHASE PER MOTOR WHEN OPERATING AT THE MAXIMUM LOAD.

ACCEPTANCE TESTS ALSO INCLUDE: THE INPUT POWER REQUIREMENT OF 117 WATTS AND INPUT CURRENT OF 0.67 AMP WERE ALSO VERIFIED UNDER STARTING CONDITIONS; INSULATION RESISTANCE TEST - THE INSULATION RESISTANCE AT 500 VDS WAS MEASURED BETWEEN MUTUALLY INSULATED CONDUCTORS AND BETWEEN CONDUCTORS AND THE FRAME, CASE OR GROUND; DIELECTRIC STRENGTH TEST - 750 VRMS AT 60 HZ APPLIED BETWEEN EACH CONDUCTOR PIN AND THE CASE. CYCLING - ACTUATOR WAS CYCLED 80 TIMES TOTAL WITH MOTORS NO. 1 AND NO. 2 CYCLED 10 TIMES EACH INDIVIDUALLY WITHIN 60 SECONDS/STROKE. IT WAS ALSO CYCLED 60 TIMES WITH BOTH MOTORS DRIVING TOGETHER WITHIN 30 SECOND/ STROKE; FREEPLAY TEST - FREEPLAY AT THE ACTUATOR OUTPUT SHAFT NOT TO EXCEED 2.0 DEGREES WITH 10 INCH-LB LOAD APPLIED IN EACH DIRECTION; STALL/MAXIMUM TORQUE - THE ACTUATOR'S STALL/MAXIMUM OUTPUT NOT TO EXCEED 100 INCH-LB OR BE LESS THAN 50 INCH-LB; IRREVERSIBILITY - THE ACTUATOR WAS CHECKED TO BE IRREVERSIBLE TO LOAD OF 50 INCH-LB; MECHANICAL STOP TEST - ACTUATOR OPERATED AT FULL RATE AND NO LOAD INTO ITS MECHANICAL STOPS FOR 100 TIMES IN EACH DIRECTION; ELECTRICAL/MECHANICAL LIMIT TEST -THE OUTPUT ARM OF THE ACTUATOR MOVED THROUGH THE FULL CLOCKWISE TO COUNTER-CLOCKWISE TO CLOCKWISE ELECTRICAL LIMIT TRAVEL.

OMRSD: GROUND TURNAROUND INCLUDES MONITORING FUNCTIONAL TEST OF RADIATORS AND VERIFYING PROPER FUNCTION OF GEARBOXES. THESE TESTS ARE PERFORMED FIRST FLIGHT AND FOR EVERY FLIGHT WHERE THE RADIATORS WILL BE DEPLOYED.

(C) INSPECTION

RECEIVING INSPECTION
CERTIFICATION OF COMPLIANCE, TEST COUPONS, PHYSICAL AND CHEMICAL RECORDS ARE MAINTAINED IN THE MASTER FILE. HISTORICAL FOLDERS, WHICH INCLUDE INSPECTION RECORDS, ARE MAINTAINED FOR EVERY DETAIL PART. RECEIVING INSPECTION PERFORMS VISUAL AND DIMENSIONAL EXAMINATION OF ALL INCOMING PARTS. QUALITY CONTROL MAINTAINS SURVEILLANCE OF RAW MATERIAL, LIMITED LIFE MATERIALS, CHEMICAL AND METALLURGICAL TESTS AND REPORTS. RECEIVING INSPECTION VERIFIES MATERIAL AND PROCESS CERTIFICATIONS.

CONTAMINATION CONTROL
A CLASS 100,000 CLEAN ROOM FACILITY IS USED FOR ASSEMBLY. ALL METAL PARTS ARE VERIFIED BY INSPECTION TO BE CLEANED AND PROPERLY PACKAGED. FINAL INSPECTION INCLUDES CHECKS FOR CONTAMINATION USING BORESCOPES, 5X AND 10X MAGNIFICATION DEVICES, AND MEMBRANE FILTRATION METHODS.

ASSEMBLY/INSTALLATION
INSPECTION VERIFIES AND RECORDS DIMENSIONS OF ALL DETAIL PARTS. GEARS ARE HARDNESS CHECKED AND VERIFIED BY INSPECTION. SPRINGS ARE MANUFACTURED AND CHECKED BY HOOVER SUPPLIERS. CERTIFICATION IS ON FILE. INSPECTION VERIFIES THAT GEARBOXES ARE PROPERLY LUBRICATED.

NONDESTRUCTIVE EVALUATION
ALL DETAIL PARTS MACHINED TO HOOVER DRAWINGS ARE MAGNETIC PARTICLE INSPECTED PER MIL-I-6868 OR FLUORESCENT PENETRANT INSPECTED PER MIL-I-6866, DEPENDING ON ALLOY, VERIFIED BY INSPECTION.

CRITICAL PROCESSES
HEAT TREATING IS VERIFIED BY INSPECTION.

TESTING
ACCEPTANCE TESTING OF ACTUATOR VERIFIED BY INSPECTION.

HANDLING/PACKAGING
POLYETHYLENE SHEETING, USED TO BAG AND SEAL PARTS AFTER CLEANING, IS VERIFIED BY INSPECTION. HANDLING AND PACKAGING REQUIREMENTS VERIFIED BY INSPECTION.

(D) FAILURE HISTORY
THERE HAVE BEEN NO ACCEPTANCE TEST, QUALIFICATION TEST, FIELD OR FLIGHT FAILURES ASSOCIATED WITH THIS FAILURE MODE.

(E) OPERATIONAL USE
NONE.