

SHUTTLE CRITICAL ITEMS LIST - ORBITER

SUBSYSTEM :ACTUATION MECH-RADIATORS FMEA NO 02-4G -182 -3 REV:03/07/88

ASSEMBLY :RADIATOR LATCH MECHANISM		CRIT. FUNC:	1R
P/N RI :MC147-0016-0001		CRIT. HW:	2
P/N VENDOR:181780-1 CURTISS-WRIGHT	VEHICLE	102	103 104
QUANTITY :12	EFFECTIVITY:	X	X X
:3 PER PANEL	PHASE(S):	PL	LO OO X DO LS
:6 PER SIDE			

PREPARED BY:		REDUNDANCY SCREEN:	A-PASS B-FAIL C-PASS
DES M. A. ALLEN	APPROVED BY:	APPROVED BY (NASA):	
REL M. B. MOSKOWITZ	<i>D. Campbell</i>	SSM	<i>R.C. Moore 3/18/88</i>
QE W. J. SMITH	<i>M.B. Moskowitz</i>	REL	<i>W.J. Smith</i>
	<i>W.S. Smith</i>	QE	<i>W.S. Smith</i>

ITEM:
GEARBOX, ROTARY ACTUATOR

FUNCTION:
PLANETARY GEARBOX ROTARY DEVICE DRIVEN BY SHAFTING FROM A POWER DRIVE UNIT (FDU). DRIVES PUSHRODS TO TRANSMIT MOTION TO BELLCRANKS TO LATCH OR UNLATCH DEPLOYABLE RADIATORS TO PAYLOAD BAY DOORS. GEAR RATIO IS 39 TO 1.

FAILURE MODE:
FAILS FREE

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

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

(A) LOSS OF CAPABILITY TO LATCH OR UNLATCH TWO 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.

FAILS REDUNDANCY SCREEN "B" SINCE A FLIGHT FAILURE OF THE GEARBOX CANNOT BE DETECTABLE.

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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 90,000 PSI, ULTIMATE ALLOWABLE 270,000 PSI. ACTUATOR IS DESIGNED TO ACCEPT FULL PDU OUTPUT WITHOUT FAILURE. ULTIMATE LOAD = 1.4 TIMES LIMIT LOAD. GEARBOXES ARE DESIGNED TO PRECLUDE ENTRY OF FOREIGN MATERIAL, LOSS OF LUBRICANT AND JAMMING OF GEARS.

(B) TEST

QUALIFICATION TESTS: THE ACTUATOR IS CERTIFIED BY CR-29-147-0016-0001A. QUALIFICATION TESTS INCLUDE: ACCEPTANCE TEST - TO CONFIRM ALL REQUIREMENTS SPECIFIED ON PARAGRAPH 4.2.2 OF PROCUREMENT SPEC ARE MET; VIBRATION TEST - 20 TO 2,000 HZ RANGE WITH MAXIMUM OF 1.0 g²/HZ FROM 200 TO 400 HZ FOR 5 MINUTES PER AXIS AT LEVEL "A" AND 0.6 g²/HZ FROM 200 TO 400 HZ FOR 34 MINUTES PER AXIS AT LEVEL "B"; THERMAL CYCLE - THE ACTUATOR THERMALLY CYCLED FIVE TIMES FROM +70 DEG F TO +330 DEG F TO +220 DEG F TO -100 DEG F TO -167 DEG F TO +70 DEG F. DWELL AT EACH TEMPERATURE WAS AT LEAST 60 MINUTES AFTER THERMAL STABILIZATION AT -100 DEG F AND +220 DEG F. THE ACTUATOR WAS CYCLED TWICE WITH 50 INCH-LB INPUT; STOPS TEST - THE ACTUATOR OPERATED AT 14.25 RPM AND NO LOAD INTO SIMULATED STRUCTURAL STOPS 100 TIMES IN EACH DIRECTION; FREEPLAY - THE ACTUATOR MOUNTED IN TEST FIXTURE WITH THE INPUT SHAFT FIXED WITH A TORQUE OF 100 INCH-LB APPLIED TO OUTPUT ARM; OPERATING LIFE TEST - THE ACTUATOR CYCLED 1,820 TIMES WITH A 50 INCH-LB INPUT; CERTIFICATION BY ANALYSIS/SIMILARITY - THESE INCLUDE FUNGUS, OZONE, PACKAGING, ULTIMATE LOAD/LIMIT LOAD, TRANSIENT SHOCK, LANDING SHOCK AND DESIGN SHOCK, THERMAL VACUUM HUMIDITY, AND ACCELERATION. 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, DIMENSIONS, CONSTRUCTION, CLEANLINESS, FINISH, IDENTIFICATION MARKING, TRACEABILITY, AND USE OF APPROVED MATERIALS AND PROCESS; NO-LOAD DRIVING TEST - THE INPUT DRIVE SHAFT ROTATED SLOWLY TO DRIVE THE ACTUATOR THROUGH IT FULL TRAVEL AND RETURN WITH NO LOAD ON THE OUTPUT. THE PEAK TORQUE DID NOT EXCEED 2.0 INCH-LB. FREEPLAY TEST - SEE QUALIFICATION TEST ABOVE; LOAD TEST - THE ROTARY ACTUATOR CYCLED 10 TIMES WITH A 75 INCH-LB INPUT; EFFICIENCY TEST - THE ACTUATOR WAS MOUNTED IN A TEST FIXTURE AND CYCLED 3 TIMES AGAINST A 500 INCH-LB LOAD. EFFICIENCY WAS CALCULATED WITH INPUT AND OUTPUT TORQUE MEASUREMENTS (INPUT TORQUE DID NOT EXCEED 17.1 INCH-LB).

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.

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(C) INSPECTION

RECEIVING INSPECTION

MATERIALS CERTIFICATION VERIFIED BY RECEIVING INSPECTION. ALL PURCHASED PARTS DATA PACKAGES INSPECTED BY RECEIVING INSPECTION.

CONTAMINATION CONTROL

DETAIL PARTS ARE CLEANED TO A 300 LEVEL AT SUPPLIER. SUPPLIER CONTAMINATION CONTROL AND CORROSION PROTECTION PROVISIONS VERIFIED BY INSPECTION.

ASSEMBLY/INSTALLATION

ALL MACHINED PARTS ARE DEBURRED AND VERIFIED PER DRAWING REQUIREMENTS. INSTALLATION PROCEDURE VERIFIED BY INSPECTION. DCAS MANDATORY INSPECTION POINTS (MIPS) IMPOSED ON MANUFACTURING, INSTALLATION AND ASSEMBLY OF ACTUATORS. INSPECTION VERIFIES SEAL INSTALLATION, BEARING INSTALLATION, AND LUBRICANT APPLICATION.

NONDESTRUCTIVE EVALUATION

INSPECTION VERIFIES ALL DETAIL PARTS MACHINED TO CURTISS-WRIGHT DRAWINGS ARE MAGNETIC PARTICLE OR PENETRANT INSPECTED. GEARS ARE MAGNETIC PARTICLE INSPECTED, VERIFIED BY INSPECTION.

CRITICAL PROCESSES

INSPECTION VERIFIES SHOT PEENING OF GEARS TO PRECLUDE FATIGUE, AND HEAT-TREATMENT.

TESTING

ROCKWELL HARDNESS OF GEARS IS VERIFIED BY INSPECTION. ATP VERIFIED BY INSPECTION.

HANDLING/PACKAGING

HANDLING, PACKAGING AND STORAGE REQUIREMENTS ARE 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.