

SHUTTLE CRITICAL ITEMS LIST - ORBITER

SUBSYSTEM :ACTUATION MECH-RADIATORS FMEA NO 02-4G -151 -2 REV:03/07/88

ASSEMBLY :RADIATOR DEPLOYMENT			CRIT. FUNC: 1
P/N RI :MC147-0016-0002			CRIT. HDW: 1
P/N VENDOR:181780-2 CURTISS-WRIGHT	VEHICLE	102 103 104	
QUANTITY :8	EFFECTIVITY:	X X X	
:FOUR PER SIDE	PHASE(S):	PL LC OO X DO LS	

		REDUNDANCY SCREEN: A-	B-	C-
PREPARED BY:		APPROVED BY:	APPROVED BY (NASA):	
DES M. A. ALLEN	DES <i>D. Campbell</i>	SSM <i>20177000 8/10/88</i>		
REL M. B. MOSKOWITZ	REL <i>M.B.M. Moskowitz</i>	REL <i>J. Moskowitz</i>		
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ITEM:  
GEARBOX, ROTARY ACTUATOR

FUNCTION:  
PLANETARY GEARBOX TYPE ROTARY DEVICE DRIVEN BY SHAFTING FROM A POWER DRIVE UNIT WHICH CONVERTS DRIVE SHAFT TORQUE INTO RADIATOR MOVEMENT. ROTARY ACTUATOR AMPLIFIES TORQUE SHAFT POWER 39 TO 1.

FAILURE MODE:  
PHYSICAL BINDING/JAMMING

CAUSE(S):  
ADVERSE TOLERANCES/WEAR, CONTAMINATION/FOREIGN OBJECT/DEBRIS, LOSS OF LUBRICANT, FAILURE/DEFLECTION OF INTERNAL PART, TEMPERATURE

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

(A) MECHANISM FAILS TO STOW RADIATOR OR DEPLOY RADIATOR.

(B) POSSIBLE INTERFERENCE WITH PAYLOAD BAY DOOR CLOSING, IF RADIATOR CANNOT BE STOWED.

(C) IF RADIATOR CANNOT BE DEPLOYED, REDUCED COOLING CAPACITY OF FREON COOLANT LOOP WILL RESULT, POSSIBLY RESTRICTING MISSION.

(D) NO EFFECT ON CREW/VEHICLE IF RADIATOR CANNOT BE DEPLOYED. POSSIBLE LOSS OF CREW/VEHICLE IF RADIATOR CANNOT BE STOWED, RESULTING IN INTERFERENCE WITH CLOSING OF PAYLOAD BAY DOORS.

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DISPOSITION & RATIONALE:

(A)DESIGN (B)TEST (C)INSPECTION (D)FAILURE HISTORY (E)OPERATIONAL USE

(A) DESIGN

ACTUATOR IS DESIGNED TO ACCEPT FULL POWER DRIVE UNIT (PDU) OUTPUT WITHOUT FAILURE. ULTIMATE LOAD = 1.4 TIMES LIMIT LOAD. GEARBOXES ARE DESIGNED TO PRECLUDE ENTRY OF FOREIGN MATERIALS, LOSS OF LUBRICANT AND JAMMING OF GEARS. DESIGN OF THE ACTUATION SYSTEM PERMITS PARTIAL WORKAROUND OF THIS FAILURE MODE BY EXTRAVEHICULAR ACTIVITY (EVA) CREW IF PAYLOAD DOES NOT LIMIT ACCESS AND IF RADIATOR IS FULLY DEPLOYED.

(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 g<sup>2</sup>/HZ FROM 200 TO 400 HZ FOR 5 MINUTES PER AXIS AT LEVEL "A" AND 0.6 g<sup>2</sup>/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 ITS FULL TRAVEL AND RETURN WITH NO LOAD ON THE OUTPUT. THE PEAK TORQUE DID NOT EXCEED 2.0 INCH-LB. FREE-PLAY 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 300 LEVEL AT SUPPLIER. SUPPLIER CONTAMINATION CONTROL AND CORROSION PROTECTION PROVISIONS VERIFIED BY INSPECTIONS.

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 TESTING OF GEARS 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

EVA WORKAROUND IS POSSIBLE IF RADIATORS ARE FULLY DEPLOYED.