

SHUTTLE CRITICAL ITEMS LIST - ORBITER

SUBSYSTEM :AFT - REACTION CONTROL FMEA NO 03-2A -221317-1 REV:12/01/8

ASSEMBLY :VERNIER THRUSTER
 P/N RI :MC467-0029
 P/N VENDOR:234834
 QUANTITY :4
 :1 PER THRUSTER

VEHICLE EFFECTIVITY:
 PHASE(S): PL LO OO X DO LS

CRIT. FUNC:	2
CRIT. HDW:	2
	102 103 10
	X X X

PREPARED BY: DES J B HUNT REL R P DIEHL QE W J SMITH

REDUNDANCY SCREEN: A- APPROVED BY: [Signature] B- APPROVED BY (NASA): [Signature] C- [Signature]

DES SSM REL QE

ITEM: HEATER, RESISTANCE TYPE 27 VOLT, 10 WATTS-VERNIER.

FUNCTION:
 ONE HEATER ELEMENT IS UTILIZED PER THRUSTER TO PREVENT PROP FREEZING AND POT SUBSEQ EFFECTS SUCH AS IGN PRESS SPIKES CAUSING STRUCT DAMAGE TO ON THRUSTER. THE HEATER ELEM IS NICHROME V WIRE AND THE SENSOR ELEM IS PURE PLATINUM WIRE. THE HEATER ASSY IS CONTAINED IN A METAL HOUSING BOLTED ON THE BACK FACE OF THE INJECTOR. TEMP SENSING IS REMOTE FROM THE HEATER AND FEEDS THE SIGNAL INTO A SOLID STATE CONTROLLER FOR HEATER SWITCHING. THE HEATER IS ON AT 145 +/- 5F AND OFF AT 189 +/- 10F.

FAILURE MODE:
 FAILS OPEN (OFF), PRECLUDING HEATING OF VALVES/INJECTOR.

CAUSE(S):
 OVER TEMP DUE TO EXCESS POWER INPUT, VIBRATION, SHOCK, FAB DEFICIENCY, ASS'Y DAMAGE, THERMAL STRAIN, DIELECTRIC FAIL, MOISTURE.

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

(A) LOSS OF FUNCTION (VERNIER THRUSTERS)-LOSS OF SINGLE (-2) VERNIER THRUSTER CAUSES LOSS (SHUTDOWN) OF VERNIER CONTROL.

(B) NO EFFECT

(C) MISSION MODIFICATION DUE TO LOSS OF VERNIER CONTROL. PRIMARY THRUSTER USAGE RESULTS IN HIGHER PROPELLANT CONSUMPTION. MISSION OBJECTIVES MAY NOT BE MET.

(D) NO EFFECT

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

DESIGN
 (A) DESIGN THE HEATER ELEMENT IS NICHROME V WIRE AND THE SENSOR ELEMENT IS PURE PLATINUM WIRE. THE HEATER ASSY IS CONTAINED IN A SEALED METAL HOUSING BOLTED ON THE BACK FACE OF THE INJECTOR.

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B) TEST

QUAL TEST INCLUDED ROUGH HANDLING, VIB (34 MIN/AXIS), FORWARD AND REVERSE INTERNAL LEAKAGE, EXT LEAKAGE, ABNORMAL OPERATION, ACCELERATED LIFE DUTY CYCLE, PROPELLANT COMPATIBILITY, BURST, HEATER OUT IGNITION, NOZZLE THERMAL TRANSIENT, MISSION DUTY CYCLE.

ACCEPTANCE TESTING INCLUDES PROOF PRESSURE OF THE NOZZLE (150 PSIG), EXTERNAL LEAKAGE, CLEANLINESS, THRUSTER PERFORMANCE. QUAL TESTS UTILIZED THREE UNITS.

OMRSD PERFORMS THE FOLLOWING: THRUSTER HEATER VERIFICATION FOR THE FIRST FLIGHT AND ON A CONTINGENCY BASIS THEREAFTER. CIRCUIT VERIFICATION FOR THE ORB/POD AND ORB/MOD THE FIRST FLIGHT, FIFTH FLIGHT AND EVERY FIVE FLIGHTS THEREAFTER AND ON A CONTINGENCY BASIS. REDUNDANT CIRCUIT VERIFICATION O/P AND O/M EVERY FLIGHT. THRUSTER HEATER VERIFICATION THE SECOND FLIGHT AND EVERY FLIGHT THEREAFTER.

(C) INSPECTION

RECEIVING INSPECTION

INSPECTION VERIFIES RAW MATERIAL AND PHYSICAL PROPERTIES.

CONTAMINATION CONTROL

CLEANLINESS IS VERIFIED BY INSPECTION. CORROSION PROTECTION IS VERIFIED BY INSPECTION.

ASSEMBLY/INSTALLATION

INSPECTION OF DIMENSIONS IS VERIFIED. TESTING OF ELECTRICAL COMPONENTS FOR IR AND DIELECTRIC STRENGTH IS VERIFIED BY INSPECTION. MANUFACTURING, ASSEMBLY, AND INSTALLATION OPERATIONS ARE VERIFIED BY INSPECTION.

NONDESTRUCTIVE EVALUATION

INSPECTION VERIFIES PENETRANT INSPECTION OF THE EXTERNAL ENCLOSURE, INCLUDING BRAZES AND EXTERNAL WELDS.

CRITICAL PROCESSES

INSPECTION VERIFIES WELDING AND BRAZING ARE TO TAYCO SPECIFICATION REQUIREMENTS. INSPECTION VISUALLY INSPECTS WELDS AND BRAZES. THE INTER-ELEMENT WELD IS ALSO GIVEN CONTINUITY CHECK AND A SAMPLE WELD IS FULL TESTED. EXTERNAL WELDS AND BRAZES ARE ALSO VERIFIED BY ATP HELIUM LEAK TEST.

TESTING

ATP IS WITNESSED AND VERIFIED BY INSPECTION.

HANDLING/PACKAGING

HANDLING, PACKAGING, AND STORAGE ENVIRONMENTS ARE VERIFIED BY INSPECTION.

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(D) FAILURE HISTORY

THERE HAVE BEEN NO HEATER FAILURES DURING TEST OR DURING FLIGHT ON VERNIER THRUSTERS.

CAR'S 05F001 AND AB1775:

THERE HAVE BEEN FAILED OFF HEATER FAILURES DUE TO MANUFACTURING PROBLEMS (WELD JOINTS OF HEATER WIRES) ON THE PRIMARY THRUSTERS WHICH ARE OF SIMILAR DESIGN.

CORRECTIVE ACTION WAS TO CHANGE SUPPLIERS. THE NEW SUPPLIER HAS HAD EXCELLENT RESULTS WITH THE HEATER WIRE WELD JOINTS.

(E) OPERATIONAL USE

IN THE EVENT OF LOSS OF VERNIER THRUSTER CAPABILITY, THE PRIMARY THRUSTERS CAN BE USED FOR THE VERNIER FUNCTION. SOME MISSION OBJECTIVES MAY NOT BE MET DUE TO INCREASED RATE OF PROPELLANT CONSUMPTION OF PRIMARY THRUSTERS.