FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL HARDWARE
NUMBER:03-2F-121317A -X

SUBSYSTEM NAME: FORWARD REACTION CONTROL SYSTEM
REVISION: 0 04/09/99

PART DATA

PART NAME VENDOR NAME	PART NUMBER VENDOR NUMBER
: FORWARD VERNIER THRUSTER HEATER	MC363-0067-0001
:TAYCO ENGINEERING INC.	

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:
HEATER, RESISTANCE TYPE, 27 VDC, 18 WATTS - FORWARD VERNIER

REFERENCE DESIGNATORS:

QUANTITY OF LIKE ITEMS: 2
ONE PER THRUSTER

FUNCTION:
ONE HEATER ELEMENT IS UTILIZED PER THRUSTER TO PREVENT PROP FREEZING & POTENTIAL SUBSEQUENT EFFECTS SUCH AS IGNITION PRESS SPIKES CAUSING STRUCTURE DAMAGE TO THE THRUSTER.

FAILURE MODES EFFECTS ANALYSIS FMEA -- CIL FAILURE MODE
NUMBER: 03-2F-121317A-01

REVISION#: 0 04/09/99

SUBSYSTEM NAME: FORWARD REACTION CONTROL SUBSYSTEM
LRU:
ITEM NAME: VERNIER THRUSTER HEATER

CRITICALITY OF THIS FAILURE MODE: 2/2

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

MISSION PHASE:
PL PRE-LAUNCH
LO LIFT-OFF
OO ON-ORBIT

VEHICLE/PAYLOAD/KIT EFFECTIVITY:
102 COLUMBIA
103 DISCOVERY
104 ATLANTIS
105 ENDEAVOUR
(EFFECTIVE FOR VEHICLES WITH 18 W HEATER INSTALLED)

CAUSE:
OVERTEMPERATURE DUE TO EXCESS POWER INPUT, VIBRATION, SHOCK, FABRICATION DEFECT, ASSEMBLY DAMAGE, THERMAL STRAIN, DIELECTRIC FAIL, CORROSION DUE TO MOISTURE.

CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO

REDUNDANCY SCREEN
A) N/A
B) N/A
C) N/A

PASS/FAIL RATIONALE:
A)

B)

C)

- FAILURE EFFECTS -

(A) SUBSYSTEM:
LOSS OF FUNCTION – INJECTOR WOULD COOL TO 130 °F WHERE LEAK DETECTION SYSTEM WOULD DESELECT THRUSTER. LOSS OF FUNCTION (VERNIER THRUSTERS) –

LOSS OF SINGLE (-Z) VERNIER THRUSTER CAUSES LOSS (SHUTDOWN) OF VERNIER CONTROL.

(B) INTERFACING SUBSYSTEM(S):
LOSS OF INTERFACE REDUNDANCY – THRUSTER MAY REQUIRE ISOLATION. FOR SOME STATION MISSIONS, PRIMARY THRUSTERS CAN NOT BE USED AS A BACKUP FOR VERNIER THRUSTER.

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

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

(E) FUNCTIONAL CRITICALITY EFFECTS:
POSSIBLE LOSS OF STATION MISSIONS AFTER FIRST FAILURE WHICH REQUIRES VERNIER ALTITUDE CONTROL CAPABILITY.

-DISPOSITION RATIONALE-

(A) DESIGN:
THE HEATER ELEMENT IS NICHROME V WIRE AND THE SENSOR ELEMENT IS PURE PLATINUM WIRE. THE HEATER ASSEMBLY IS CONTAINED IN A SEALED METAL HOUSING BOLTED ON THE BACK FACE OF THE INJECTOR. TEMPERATURE SENSING IS REMOTE FROM THE HEATER AND FEEDS THE SIGNAL INTO A SOLID STATE CONTROLLER FOR HEATER SWITCHING. THE HEATER IS ON AT 145 ± 5°F AND OFF AT 189 ± 10°F. THE HEATER SHALL PROVIDE THE EQUIVALENT OF 18 WATTS OF HEATING POWER WHEN PROPERLY CONNECTED TO A CONTROLLER WHICH IS ENERGIZED WITH 2Z VDC. THE CONTROLLER INSURES THAT THE HEATERS ARE ACTIVATED BEFORE THE SENSED TEMPERATURE DECREASES TO LESS THAN 145 °F, AND DEACTIVATE THE HEATERS BEFORE THE SENSED TEMEPERATURE INCREASES TO GREATER THAN 189 °F

(B) TEST:
QUAL TEST INCLUDED ROUGH HANDLING, VIB (34 MIN/AXIS), ABNORMAL OPERATION, ACCELERATED LIFE DUTY CYCLE, PROPELLANT COMPATIBILITY, ELECTRICAL TEST, HUMIDITY TEST, RANDOM VIBRATION, NOZZLE THERMAL TRANSIENT, MISSION DUTY CYCLE.

ACCEPTANCE TESTING INCLUDES EXAMINATION OF THE PRODUCT, FUNCTIONAL AND PERFORMANCE TESTS, VIBRATION TEST, AND CLEANLINESS.

GROUND TURNAROUND TEST
ANY TURNAROUND CHECKOUT TESTING IS ACCOMPLISHED IN ACCORDANCE WITH OMRSD.

(C) INSPECTION:
RECEIVING INSPECTION
INSPECTION VERIFIES RAW MATERIAL AND PHYSICAL PROPERTIES.

CONTAMINATION CONTROL
CLEANLINESS AND CORROSION PROTECTION ARE VERIFIED BY INSPECTION.

ASSEMBLY/INSTALLATION
VISUAL INSPECTION OF DIMENSIONS IS VERIFIED BY INSPECTION. ELECTRICAL COMPONENTS ARE TESTED FOR INSULATION RESISTANCE AND DIELECTRIC STRENGTH AND 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 PULL TESTED. EXTERNAL WELDS AND BRAZES ARE ALSO VERIFIED BY ATP HELIUM LEAK TEST.

TESTING
ATP IS WITNESSED AND VERIFIED BY INSPECTION.

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

(D) FAILURE HISTORY:
THIS IS NEW HARDWARE. NO FAILURE HISTORY AVAILABLE. FUTURE DATA ON TEST FAILURES, FLIGHT FAILURES, UNEXPLAINED ANOMALIES, AND OTHER FAILURES EXPERIENCED DURING GROUND PROCESSING ACTIVITY CAN BE FOUND IN THE PRACA DATA BASE.

(E) OPERATIONAL USE:
FOR SOME MISSIONS, PRIMARY THRUSTERS CAN BE USED IF VERNIER FUNCTION IS LOST. SOME MISSION OBJECTIVES MAY NOT BE MET DUE TO INCREASED RATE OF PROPELLANT CONSUMPTION. FOR VERNIER CRITICAL MISSIONS, SOME MISSION OBJECTIVES WILL NOT BE MET DUE TO LOSS OF VERNIER THRUSTERS.

- APPROVALS -

SS & PAE MANAGER	: D. F. KIP MIKULA	: P. Stern for 4/14/99
SS & PAE ENGINEER	: L. X. DANG	: [illegible]
BNA SSM	: D. L. PERRY	: [illegible] for 4/14/99
BNA DESIGN ENGINEER	: L. TOPANTA	: [illegible] 4/14/99
JSC NASA/MOD	: C. LARSON	: [illegible] 4/29/99
JSC NASA/SSMA	: S. JOHNSON	: [illegible] 4/27/99
USA SAM	: M. BURGHARDT	: M. C. Burghardt
USA ORBITER	: S. LITTLE	: [illegible] Little 5/5/99