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PRINT DATE: 10/19/94

FAILURE MODES EFFECTS ANALYSIS (FMEA) - CRITICAL HARDWARE

NUMBER: 03-2F-121313 -X

SUBSYSTEM NAME: FORWARD REACTION CONTROL SYSTEM (RCS)

REVISION: 3 10/18/94

	PART NAME VENDOR NAME	PART NUMBER VENDOR NUMBER
LRU	: THRUSTER, PRIMARY	MC467-0029
SRU	: NOZZLE EXTENSION	234240

PART DATA

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:

NOZZLE EXTENSION, COATED COLUMBIUM (WITH INSULATION BLANKET).

QUANTITY OF LIKE ITEMS: 14

ONE PER THRUSTER

FUNCTION:

TO PROVIDE ISENTROPIC EXPANSION OF COMBUSTION GASES FOR MAX EFF IN VACUUM. NOZ EXT IS CONSTRUCTED OF C-103 COLUMBIUM WITH R-512A OXIDATION RESISTANT COATING. THE NOZZLE EXPANSION RATIO IS 22 TO 1. THE NOZ EXT IS INTEGRAL WITH THE COMB CHAMB AND ENCLOSED IN AN INSULATION SHROUD (DYNAFLEX FOR OV102, 099, CEREACROME FOR OV103, 104) SO THAT THE EXT TEMP IS MAINTAINED PER THE PROCUREMENT SPECIFICATION REQMT.

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SUBSYSTEM NAME: FORWARD REACTION CONTROL SYSTEM (RCS)

LRU: THRUSTER, PRIMARY

ITEM NAME: NOZZLE EXTENSION

CRITICALITY OF THIS

FAILURE MODE: 1/1

FAILURE MODE:

HOT GAS LEAKAGE, BURN THROUGH

MISSION PHASE:

LO LIFT-OFF

OO ON-ORBIT

DO DE-ORBIT

VEHICLE/PAYLOAD/KIT EFFECTIVITY:

102	COLUMBIA
103	DISCOVERY
104	ATLANTIS

CAUSE:

HIGH TEMPERATURE IN LOCAL SPOT, CONTAMINATED INJECTOR COOLANT HOLES, WELD OR MATERIAL DEFECT, COATING DAMAGE, VIBRATION, SHOCK

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 REDUNDANCY-POSS LOSS OF 3 THRUSTERS IF MANIFOLD ISOL VALVE MUST BE CLOSED. POSSIBLE PRESSURIZED LINE OR TANK RUPTURE DUE TO HOT GAS IMPINGEMENT. LEAKAGE OF HOT GAS INTO THE COMPARTMENT.

(B) INTERFACING SUBSYSTEM(S):

INCREASED GN&C AND USE OF ALTERNATE THRUSTERS. POSSIBLE DAMAGE TO TPS. POSSIBLE DAMAGE TO THE POD DUE OVERPRESSURIZATION.

(C) MISSION:

MISSION MODIFICATION/ABORT DECISION IF FAILURE CAUSES DAMAGE PROPAGATION.

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(D) CREW, VEHICLE, AND ELEMENT(S):

LOSS OF CREW/VEHICLE. BURN THRU MAY CAUSE HIGH TEMP DAMAGE TO SURROUNDING STRUCT & ADJ THRUSTERS RESULTING IN POSSIBLE ENTRY HAZARD IF TPS IS DAMAGED. OVERPRESSURIZATION MAY OCCUR.

(E) FUNCTIONAL CRITICALITY EFFECTS:

-DISPOSITION RATIONALE-

(A) DESIGN:

HIGH THERMAL MARGINS IN NOZZLE EXTENSION WILL MINIMIZE FAILURE EFFECT. ENGINE IS DESIGNED TO INGEST 15 CUBIC INCHES OF GAS. THRUSTER CAN BE ISOLATED AT INLET OR MANIFOLD VALVE.

INTERMETALLIC DIFFUSION LAYER FORMS AN INTEGRAL BOND BETWEEN THE DISILICIDE COATING AND THE PARENT COLUMBIUM MATERIAL AND TENDS TO RESIST SHOCK LOADING. STRUCTURAL MARGINS (2.0 TO 4.0) MINIMIZE FAILURE EFFECT(S).

THRUSTERS HAVE LIMITED LIFE BASED ON USAGE.

(B) TEST:

THE QUALIFICATION TEST PROGRAM INCLUDED ROUGH HANDLING, VIBRATION (34 MIN/AXIS), FORWARD AND REVERSE INTERNAL LEAKAGE, EXTERNAL 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 (525 PSIG), EXTERNAL LEAKAGE, CLEANLINESS, THRUSTER PERFORMANCE.

OMRSD PERFORMS THE FOLLOWING: A THRUSTER VISUAL INSPECTION EACH FLIGHT BEGINNING WITH THE 2ND FLIGHT USING A FLASHLIGHT AND MIRROR. THRUSTER INSPECTION ON A FIFTH FLIGHT INTERVAL USING A BORESCOPE. A THRUSTER INSPECTION AFTER USING PRESSURE PLUGS ON A CONTINGENCY BASIS. CONTROL OF COATING SURFACE PROTECTION.

(C) INSPECTION:

RECEIVING INSPECTION

RECORDS AND TEST REPORTS ARE MAINTAINED CERTIFYING MATERIAL AND PHYSICAL PROPERTIES (RAW MATERIAL, ANNEALING).

ASSEMBLY/INSTALLATION

FINAL INSPECTION OF ALL DIMENSIONS IS VERIFIED. DRILL ANGLE IS CHECKED PRIOR TO, AND AFTER, DRILLING. INJECTOR COOLANT HOLES ARE OPEN AFTER EXCESS WELD BEAD REMOVAL IS VERIFIED BY INSPECTION.

NONDESTRUCTIVE EVALUATION

FUSED DISILICIDE COATING THICKNESS IS VERIFIED BY EDDY CURRENT. WELDS ARE RADIOGRAPHIC INSPECTED PER MPS-909 AND ARE ALSO EITHER MAGNETIC PARTICLE OR PENETRANT INSPECTED.

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CRITICAL PROCESSES

WELDING AND APPLICATION OF DISILICIDE COATING IS VERIFIED BY INSPECTION. TEST SPECIMENS OF THE COATING ARE INSPECTED AND TESTED PER MPS-0545 REQUIREMENTS. THE COATED ASSEMBLIES ARE ALSO HEATED TO 2500 DEG F TO VERIFY COATING INTEGRITY. THE SURFACE IS THEN INSPECTED WITH A BORESCOPE AND A VIDEO TAPE RECORD IS MADE OF THE COATING CONDITION.

TESTING

ATP IS WITNESSED AND VERIFIED BY INSPECTION. WATER FLOW TESTS, PER INTERNAL TEST PROCEDURE, VERIFIES BY INSPECTION NO OCCLUDED PASSAGES. TEST FIRING WITH HEAT SENSORS VERIFY BY INSPECTION THAT THERE ARE NO HOT SPOTS.

(D) FAILURE HISTORY:

CARS AD0169 KSC, AD1606 ATP, AD1706 ATP, AND AD0169: COATING DAMAGE WAS REPORTED ON THREE THRUSTERS. INSTALLATION AND REMOVAL OF THE RCS THROAT PLUG CAUSED THE DAMAGE. CORRECTIVE ACTION - TO PRECLUDE DAMAGE WHEN INSTALLING THE THROAT PLUGS, THE OMRSD LIMITS THE PRESSURE APPLIED FOR TESTING WHEN PLUG IS INSTALLED. THE THRUSTERS ARE INSPECTED WITH BORESCOPE AFTER PLUG USAGE AND AFTER EVERY FLIGHT FOR COATING DAMAGE.

ONE THRUSTER WITH COATING DAMAGE WAS FIRED TO DETERMINE IF THE ENGINE COULD GO ONE MISSION WITH MINOR COATING DAMAGE. NO DEGRADATION OF COATING WAS OBSERVED IN THE AREA OF DAMAGE.

(E) OPERATIONAL USE:

NONE

- APPROVALS -

EDITORIALLY APPROVED : RJ
 EDITORIALLY APPROVED : JSC
 TECHNICAL APPROVAL : VIA CR

[Signature]
 : *[Signature]* 10-31-94
 : S50250B