FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL HARDWARE
NUMBER: 03-1-0766 -X

SUBSYSTEM NAME: MAIN PROPULSION

REVISION: 0 07/12/88

PART DATA

	PART NAME / **VENDOR NAME**	**PART NUMBER** / **VENDOR NUMBER**
LRU	: SPACER, INVAR BOEING	V070-410039

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:
SPACER, INVAR

REFERENCE DESIGNATORS:

QUANTITY OF LIKE ITEMS: 252

FUNCTION:
PROVIDES THERMAL STABILITY AT LH2/LO2 ORBITER/SSME 12 INCH FEEDLINE MANIFOLD INTERFACES. SPACER IS PLACED BETWEEN A BOLTHEAD AND FLANGE TO MAINTAIN A SPECIFIC PRELOAD (TORQUE) DURING THERMAL CHANGES.

FAILURE MODES EFFECTS ANALYSIS FMEA -- CIL FAILURE MODE

NUMBER: 03-1-0766-01

REVISION#: 1 02/21/01

SUBSYSTEM NAME: MAIN PROPULSION
LRU: LH2/LO2 12" INTERFACE INVAR SPACER **CRITICALITY OF THIS**
ITEM NAME: LH2/LO2 12" INTERFACE INVAR SPACER **FAILURE MODE:** 1/1

FAILURE MODE:
FAILURE TO MAINTAIN INTERFACE PRELOAD DURING THERMAL CHANGES

MISSION PHASE:
PL PRE-LAUNCH
LO LIFT-OFF

VEHICLE/PAYLOAD/KIT EFFECTIVITY:
102 COLUMBIA
103 DISCOVERY
104 ATLANTIS
105 ENDEAVOUR

CAUSE:
PIECE PART STRUCTURAL FAILURE

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 SPACER (LOSS OF PRELOAD) RESULTS IN PROPELLANT LEAKING INTO THE AFT FUSELAGE. POSSIBLE LOSS OF CRITICAL COMPONENTS DUE TO CRYOGENIC EXPOSURE. POSSIBLE AFT COMPARTMENT OVERPRESS AND FIRE/EXPLOSION HAZARD. LEAKAGE DETECTABLE ON GROUND USING HAZARD GAS DETECTION SYSTEM (HGDS).

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(B) INTERFACING SUBSYSTEM(S):
SAME AS A.

(C) MISSION:
ON GROUND, VIOLATION OF HGDS LCC WILL RESULT IN LAUNCH SCRUB.

(D) CREW, VEHICLE, AND ELEMENT(S):
POSSIBLE LOSS OF CREW/VEHICLE.

(E) FUNCTIONAL CRITICALITY EFFECTS:
NONE.

-DISPOSITION RATIONALE-

(A) DESIGN:
THE INVAR SPACER IS A THICK WASHER (0.40 INCH THICK AND 0.768 INCH DIAMETER) MADE OF INVAR 36 MATERIAL (36% NI, 63% FE). THE SPACER IS UTILIZED IN ADDITION TO THE WASHER UNDER A BOLTHEAD TO MAINTAIN REQUIRED BOLT PRELOAD WHICH WAS DETERMINED BY STRESS ANALYSIS. THE SPACER (A METAL WITH A LOW COEFFICIENT OF THERMAL CONTRACTION) IS DESIGNED TO COMPENSATE FOR THE DIFFERENT RATES OF THERMAL CONTRACTION BETWEEN THE INCONEL FEEDLINE FLANGE, THE NAFLEX INCONEL SEAL, THE ALUMINUM TURBOPUMP FLANGE, AND THE SILVER PLATED NP35 BOLT. THE SURFACES OF THE SPACER IS FINISHED TO 16 MICROINCH AND COATED WITH DRY FILM LUBRICANT.

STRUCTURAL ANALYSIS INDICATES POSITIVE MARGINS OF SAFETY FOR ALL CONDITIONS OF OPERATIONS.

(B) TEST:
ATP

EXAMINATION OF PRODUCT
DIMENSION AND MATERIAL

CERTIFICATION

THE INVAR SPACER WAS CERTIFIED WITH THE MAIN PROPULSION TEST ARTICLE (MPTA) WHICH INCORPORATES ALL CONFIGURATIONS UTILIZED IN THE MPS SYSTEM. MPTA EXPERIENCED NUMEROUS FULL DURATION STATIC FIRINGS OF THE MAIN ENGINE AT DIFFERENT PERFORMANCE LEVELS. THESE STATIC FIRINGS IMPARTED WORST CASE ENVIRONMENTS AT MAXIMUM OPERATING TEMPERATURES AND PRESSURES.

OMRSD

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ANY TURNAROUND CHECKOUT IS ACCOMPLISHED IN ACCORDANCE WITH OMRSD.

(C) INSPECTION:
RECEIVING INSPECTION
INCOMING MATERIAL IS VERIFIED FOR MATERIAL AND PROCESS CERTIFICATIONS.

CONTAMINATION CONTROL
CORROSION PROTECTION OF PARTS IS VERIFIED PER REQUIREMENT. GENERALLY CLEANING IS VERIFIED.

ASSEMBLY/INSTALLATION
MACHINED PARTS ARE INSPECTED DIMENSIONALLY TO THE TOLERANCE SPECIFICATION. THICKNESS OF CHROME PLATING CLASS 2 PROCESS IS VERIFIED PER DRAWING REQUIREMENT. SURFACE FINISHED TO 16 MSR AFTER PLATING AND ELECTROLESS NICKEL PLATING ARE VERIFIED PER DRAWING REQUIREMENT.

MANDATORY INSPECTION POINTS ARE INCLUDED IN MANUFACTURING PROCESS.

CRITICAL PROCESSES
DRY FILM LUBRICANT APPLIED TO THE SPACER SURFACE IS VERIFIED BY INSPECTION PER REQUIREMENT.

NONDESTRUCTIVE EVALUATION
N/A

TESTING
ATP IS VERIFIED BY INSPECTION.

HANDLING/PACKAGING
HANDLING, PACKAGING, STORAGE, AND SHIPPING REQUIREMENTS ARE VERIFIED BY INSPECTION.

(D) FAILURE HISTORY:
CURRENT DATA ON TEST FAILURE, FLIGHT FAILURE, UNEXPLAINED ANOMALIES, AND OTHER FAILURES EXPERIENCED DURING GROUND PROCESSING ACTIVITY CAN BE FOUND IN THE PRACA DATABASE.

(E) OPERATIONAL USE:
FLIGHT: NO CREW ACTION CAN BE TAKEN

GROUND: GROUND OPERATIONS SAFING PROCEDURES CONTAIN SAFING SEQUENCE OF EVENTS FOR MAJOR LEAKS IN THE PROPELLANT SYSTEMS.

- APPROVALS -

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S&R ENGINEERING	: W.P. MUSTY	:/S/ W.P. MUSTY
S&R ENGINEERING ITM	: P. A. STENGER-NGUYEN	:/S/ P.A. STENGER-NGUYEN
DESIGN ENGINEERING	: LEE DURHAM	:/S/ LEE DURHAM
MPS SUBSYSTEM MGR.	: TIM REITH	:/S/ TIM REITH
MOD	: JEFF MUSLER	:/S/ JEFF MUSLER
USA SAM	: MIKE SNYDER	:/S/ MIKE SNYDER
USA ORBITER ELEMENT	: SUZANNE LITTLE	:/S/ SUZANNE LITTLE
NASA SR&QA	: ERICH BASS	:/S/ ERICH BASS