PRINT DATE:

FAILURE MODES EFFECTS ANALYSIS (FMEA) – CRITICAL HARDWARE
NUMBER: P2-3A-A6 -X

SUBSYSTEM NAME: SEPARATION MECHANISMS - PYRO
REVISION: 1 03/27/95

		PART NAME VENDOR NAME	PART NUMBER VENDOR NUMBER
LRU	:	DETONATOR	SEB26100094
LRU	:	BOOSTER CARTRIDGE	SKD26100099-402

PART DATA

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:
TWO DETONATOR/BOOSTER CARTRIDGE SUBASSEMBLIES ARE INSTALLED IN EACH ORBITER/ET AFT ATTACH FRANGIBLE NUT (TWO FRANGIBLE NUTS PER VEHICLE). EACH DETONATOR/BOOSTER CARTRIDGE IS INDIVIDUALLY CAPABLE OF FRACTURING NUT WHEN DETONATOR IS ELECTRICALLY INITIATED.

REFERENCE DESIGNATORS:

QUANTITY OF LIKE ITEMS: 4

FUNCTION:
DELIVERS A SHOCK OUTPUT TO FRACTURE FRANGIBLE NUT WHICH, IN CONJUNCTION WITH A BOLT, STRUCTURALLY TIES TOGETHER THE ORBITER AND ET IN TWO PLACES AT THE AFT ATTACH POINTS.

PRINT DATE:

FAILURE MODES EFFECTS ANALYSIS (FMEA) – CRITICAL FAILURE MODE
NUMBER: P2-3A-A5 - 01

REVISION# 1 **03/27/95**

SUBSYSTEM NAME: SEPARATION MECHANISMS - PYRO
LRU: DETONATOR/BOOSTER CARTRIDGE
ITEM NAME: DETONATOR/BOOSTER CARTRIDGE

CRITICALITY OF THIS FAILURE MODE: 1R2

FAILURE MODE:
FAILS TO FUNCTION OR LOW ORDER FIRING

MISSION PHASE:
LO LIFT-OFF

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

CAUSE:
LOSS OF INPUT - ELECTRICAL/NASA STANDARD INITIATORS (NSI'S), STRUCTURAL FAILURE OF THREADS/BODY AT DETONATOR/BOOSTER INTERFACE, CONTAMINATION OR IMPROPER LOADING OF PYRO MIX, HANDLING DAMAGE

CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO

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

PASS/FAIL RATIONALE:
A)

B)

C)

- FAILURE EFFECTS -

(A) SUBSYSTEM:
FIRST FAILURE: LOSS OF REDUNDANCY
SECOND FAILURE: FRANGIBLE NUT DOES NOT FRACTURE, CAUSING LOSS OF SEPARATION CAPABILITY AT AFT ATTACH POINT

(B) INTERFACING SUBSYSTEM(S):
FIRST FAILURE: NONE
SECOND FAILURE: ET REMAINS STRUCTURALLY ATTACHED TO ORBITER AT AFT ATTACH POINT

(C) MISSION:

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CRITICAL FAILURE MODE NUMBER: P2-3A-A6 - 01

FIRST FAILURE: NONE
SECOND FAILURE: LOSS OF ABILITY TO SEPARATE ORBITER FROM ET

(D) CREW, VEHICLE, AND ELEMENT(S):
FIRST FAILURE: NONE
SECOND FAILURE: LOSS OF CREW/VEHICLE

(E) FUNCTIONAL CRITICALITY EFFECTS:

-DISPOSITION RATIONALE-

(A) DESIGN:
USING DEVICE (FRANGIBLE NUT) UTILIZES TWO (REDUNDANT) DETONATOR/BOOSTER CHARGES. EXPLOSIVE MIX IS RDX AND LEAD AZIDE. EACH DETONATOR/BOOSTER CHARGE IS DESIGNED TO FRACTURE A NUT WITH A WEB THICKNESS 15% GREATER THAN SPECIFIED. BOOSTER MATERIAL 304 CRES FOR CORROSION PROTECTION. HEAT TREAT TO 70 KSI MINIMUM. DETONATOR MATERIAL IS A286 CRES.

-402 BOOSTER CARTRIDGE IS SIMILAR TO -401. FOR THE -402, THE DIAMETER OF THE CHARGE CAVITY WAS INCREASED 20% AND COLUMN HEIGHT REDUCED (SAME PROPELLANT WEIGHT) TO PROVIDE MORE EFFICIENT DISTRIBUTION OF ENERGY FOR SEPARATION OF NUT.

(B) TEST:
COMPONENT QUALIFICATION TESTS OF -401 BOOSTER CARTRIDGE : 26 FIRED IN CONJUNCTION WITH 2.5 INCH NUT (-65 DEG F/AMBIENT/+200 DEG F), SALT FOG, VIBRATION W/HIGH/LOW TEMPERATURE, HIGH TEMPERATURE AT ALTITUDE, LOW TEMPERATURE AXIAL LOAD, SINGLE BOOSTER 120% WEB MARGIN FIRING, AND 8 FOOT DROP TEST. CERTIFICATION REQUIREMENTS (CR) 45-114-0018-0007.

COMPONENT DELTA QUALIFICATION TESTS OF -402 BOOSTER CARTRIDGE: VIBRATION WITH HIGH (200F) AND LOW (-65F) TEMPERATURE; TEN SINGLE CARTRIDGE FIRING TESTS WITH 270,000 LBS. PRELOAD AND ZERO PRELOAD, INCLUDING THREE MARGIN DEMONSTRATION TESTS WITH 115% WEB THICKNESS. ONE DUAL CARTRIDGE FIRING TEST WITH 270,000 LBS. PRELOAD. CR NO. EP-A-1-26100099-302.

SYSTEM QUALIFICATION TESTS OF -401 BOOSTER CARTRIDGE: 8 DUAL FIRINGS (AMBIENT) AFT ATTACH SEPARATION. CR45- 565201-001.

ACCEPTANCE TESTS: HELIUM LEAK TEST, N-RAY AND X-RAY (PRESENCE AND PROPER ORIENTATION OF PARTS AND EXPLOSIVE MIX), WEIGHT RECORDS FOR EXPLOSIVE MIX, LOT FIRING TEST ON RANDOM SAMPLES, AND TENSILE TEST COUPONS ON HOUSINGS/BODIES. CR45-114-0018-0007, ATP 5044, ATP 9634; SKD26100099.

SHELF LIFE TEST: SAMPLE OF 5 UNITS FIRED 4 YEARS AND 7 YEARS AFTER DATE OF MANUFACTURE UNTIL AGE LIFE EXPIRES.

OMRSD: TURNAROUND TESTS INCLUDE - POST-FLIGHT CHECK FOR EVIDENCE OF NO-FIRE, PYRO INITIATOR CONTROLLER (PIC) RESISTANCE TEST, CIRCUIT CHECKOUT, NSI PRE-FLIGHT BRIDGEWIRE CHECK, AND VERIFICATION OF ALL PARTS OF SEPARATION SYSTEM IN DEBRIS CONTAINERS. NEW HARDWARE INSTALLED EACH FLIGHT.

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(C) INSPECTION:
RECEIVING INSPECTION
RAW MATERIAL IS VERIFIED BY INSPECTION TO ASSURE SHUTTLE REQUIREMENTS ARE SATISFIED.

CONTAMINATION CONTROL
CONTAMINATION CONTROL AND CORROSION PROTECTION PROCESSES VERIFIED BY INSPECTION.

ASSEMBLY/INSTALLATION
SELECTED MANUFACTURING/ASSEMBLY STEPS ARE IDENTIFIED BY NASA AND QUALITY ASSURANCE AND VERIFIED BY GOVERNMENT INSPECTION MANDATORY INSPECTION POINTS (MIPS).

NONDESTRUCTIVE EVALUATION
PARTS ARE X-RAYED AND N-RAYED TO VERIFY CORRECT ASSEMBLY AND PRESENCE OF ALL DETAIL PARTS AND EXPLOSIVES. X-RAYS AND N-RAYS ARE REVIEWED BY VENDOR, DCAS, NASA QUALITY AND ENGINEERING.

CRITICAL PROCESSES
ALL MANUFACTURING PROCESSES SUCH AS WELDING, PLATING, HEAT TREATING, PASSIVATION ARE VERIFIED BY INSPECTION.

STORAGE
STORAGE ENVIRONMENTS ARE MONITORED AND VERIFIED BY INSPECTION.

TESTING
DESTRUCTIVE LOT ACCEPTANCE TESTING BY SAMPLE SIZE VERSUS LOT SIZE.

(D) FAILURE HISTORY:
-302 FRANGIBLE NUT FAILED TO SEPARATE IN DESTRUCTIVE LOT ACCEPTANCE TEST USING SINGLE DETONATOR AND BOOSTER CARTRIDGE OF OLD CONFIGURATION, P/N SKD26100099-401. NEW BOOSTER CARTRIDGE, P/N SKD26100099-402, PROVIDES GREATER ENERGY FOR FRANGIBLE NUT SEPARATION, AND RESTORES SINGLE CARTRIDGE/NUT SEPARATION MARGIN. DLAT FAILURE WAS ATTRIBUTED TO NEW LOT OF -302 FRANGIBLE NUTS WITH HIGHER STRENGTH PROPERTIES, REF. FIAR NO. JSCEP0183.

(E) OPERATIONAL USE:
NONE.

- APPROVALS -

PAE MANAGER	: K. L. PRESTON	: Stell for
DESIGN ENGINEERING	: P. YSON	: Pal Yson 3-29-95
PRODUCT ASSURANCE ENGR	: D. MAYNE	: D.M. Mayne 3-29-95
NASA SSMA	:	: Jeff Boedwart 5-2-95
NASA SUBSYSTEM MANAGER	:	: William C. Hoffman 5/2/95