

PAGE: 1

PRINT DATE: 04/01/92

192

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CRITICAL HARDWARE

NUMBER: M4-1BG-TX030-X

SUBSYSTEM NAME: ELECTRICAL POWER GENERATION - CRYO, GENERIC

REVISION: 1 11/12/91

	PART NAME VENDOR NAME	PART NUMBER VENDOR NUMBER
▣ LRU	HYDROGEN TANK SUBASSEMBLY	MC282-0063-0200
▣	BEECH	15548-1000
▣ LRU	TANK SUBASSEMBLIES, H2	MC282-0112-0200
▣	BALL AEROSPACE	163196-500

PART DATA

▣ EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:
TANK ASSEMBLIES, H2

▣ REFERENCE DESIGNATORS:

- : 40V45TK030
- : 40V45TK040
- : 40V45TK500
- : 40V45TK568
- : 40V45TK650
- : 40V45TK860
- : 40V45TK870
- : 40V45TK880
- : 40V45TK890

▣ QUANTITY OF LIKE ITEMS: 3-9
MISSION DEPENDENT

▣ FUNCTION:
PROVIDES STORAGE OF CRYOGENIC HYDROGEN FOR FUEL CELL OPERATION.

PAGE: 2

PRINT DATE: 04/01/92

193

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CRITICAL FAILURE MODE -
NUMBER: M4-1BG-TK030-01

SUBSYSTEM: ELECTRICAL POWER GENERATION - CRYO, GENERIC
LRU : HYDROGEN TANK SUBASSEMBLY
ITEM NAME: TANK SUBASSEMBLIES, H2

REVISION# 1 11/12/91 R
CRITICALITY OF THIS
FAILURE MODE: 1/1

■ FAILURE MODE:
RUPTURE

MISSION PHASE:

PL PRELAUNCH
LO LIFT-OFF
OO ON-ORBIT
DO DE-ORBIT
LS LANDING SAFING

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

□ CAUSE:

OVERPRESSURIZATION, CORROSION, MISHANDLING, STRUCTURAL FAILURE OF;
PRESSURE VESSEL SUPPORT STRAPS, TRUNNION MOUNTS OR STRUTS

■ 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:
FUNCTIONAL DEGRADATION - LOSS OF ONE H2 SUPPLY TANK AND POSSIBLE DAMAGE
TO SURROUNDING SUBSYSTEM COMPONENTS.

PAGE: 3

PRINT DATE: 04/01/92

19

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CRITICAL FAILURE MODE
NUMBER: M4-1BG-TK030-01

- (B) INTERFACING SUBSYSTEM(S):
REDUCED AMOUNT OF H2 CONSUMABLES AVAILABLE FOR FUEL CELL POWERPLANT OPERATION.
- (C) MISSION:
ABORT DECISION.
- (D) CREW, VEHICLE, AND ELEMENT(S):
POSSIBLE LOSS OF CREW/VEHICLE IF TANK RUPTURE RESULTS IN DAMAGE TO SURROUNDING SUBSYSTEMS AND EXPLOSIVE POTENTIAL RESULTING FROM H2 RELEASE.
- (E) FUNCTIONAL CRITICALITY EFFECTS:
N/A

- DISPOSITION RATIONALE -

- (A) DESIGN:
DESIGN SAFETY FACTOR EQUAL TO OR GREATER THAN 1.5. TANK CHECK VALVE PREVENTS IMMEDIATE LOSS OF OTHER TANKS' REACTANTS THRU FAILED TANK. AUTO PRESSURE CONTROL SYSTEM AND RELIEF VALVES PROVIDE OVERPRESSURIZATION PROTECTION. CAUTION & WARNING FOR OVERPRESSURE AND FAULT DETECTION AND ANNUNCIATION FOR OVERTEMPERATURE. SHEATH HEATER ELEMENT DESIGN PREVENTS SHORTING. REDUNDANT RELIEF CAPABILITY THRU MANIFOLD. RELIEF VALVE SIZED TO MAINTAIN ACCEPTABLE TANK PRESSURE FOR 1 ATM ANNULUS RUPTURE. PRESSURE VESSEL AND OUTER SHELL ARE ALUMINUM 2219, ALL WELDED CONSTRUCTION. ALL MATERIALS COMPATIBLE WITH H2. TANK SHIPPING CONTAINERS PREVENT SHIPPING DAMAGE. PRESSURE VESSEL IS DESIGNED TO YIELD BEFORE RUPTURE IF OVERPRESSURIZED. 60 PSI BURST DISC ON OUTER SHELL.
- (B) TEST:
QUALIFICATION TEST INCLUDE: MECHANICAL SHOCK (20 G), SINUSOIDAL VIBRATION (+/- 0.25 G PEAK), RANDOM VIBRATION (0.06 G SQ/HZ MAXIMUM FOR 48 MINUTES), ACCELERATION (+/- 5 G FOR 5 MINUTES PER AXIS). VIBRATION MET 100 MISSION EQUIVALENT WITH TANK FULL AND 25 MISSION EQUIVALENT WITH TANK OFFLOADED. PRESSURE VESSEL IS PRESSURE CYCLED FROM 0-335 PSIG FOR 1200 CYCLES, BURST TESTED TO 502 PSIG, AND CREEP CHECKED AT 335 PSIG FOR 90 DAYS.

ACCEPTANCE TESTS INCLUDE: AT THE PRESSURE VESSEL COMPONENT LEVEL, PROOF PRESSURE TEST AT 369 PSIG FOR 5 MINUTES AND A CRYOGENIC SHOCK TEST WHICH VERIFIES THE PRESSURE VESSEL GIRTH RING WELD WITH EXPOSURE TO LN2. AT THE TANK ASSEMBLY LEVEL, PROOF PRESSURE TEST AT 369 PSIG FOR 5 MINUTES AND A CRYOGENIC SHOCK TEST WHICH VERIFIES THE TANK ASSEMBLY

PAGE: 4

PRINT DATE: 04/01/92

195

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NUMBER: M4-1BG-TK030-01

WELDS WITH EXPOSURE TO LN2.

OMRSG: TANK ASSEMBLY IS STRUCTURALLY INSPECTED DURING EVERY ORBITER MAINTENANCE DOWN PERIOD (OMDP). REACTANT MOISTURE VERIFIED 20 PPM MAX MAX AT LOADING.

NOTE: ONLY 25 LAUNCHES ARE ALLOWED WITH THE FILL QUANTITIES LESS THAN 90% TO ENSURE ACCEPTABLE STRAP LOADING.

■ (C) INSPECTION:

RECEIVING INSPECTION

ALLOY COMPOSITION AND HEAT TREAT CERTIFICATION VERIFIED BY INSPECTION.

CONTAMINATION CONTROL

CLEANLINESS LEVEL OF 200A IS MAINTAINED.

ASSEMBLY/INSTALLATION

WELDING PIECE MISMATCHES ARE VERIFIED WITHIN ACCEPTABLE RANGES.

NONDESTRUCTIVE EVALUATION

WELDMENTS VERIFIED BY A SPECIAL LEVEL PENETRANT INSPECTION. ULTRASONIC AND RADIOGRAPHIC INSPECTION BY QUALIFIED/CERTIFIED NOT PERSONNEL.

CRITICAL PROCESSES

WELDING IS CONTROLLED AND VERIFIED BY MANUFACTURING OPERATING PROCEDURE, CERTIFICATION OF OPERATORS, VISUAL INSPECTION, THERMOGRAPH, AND X-RAY. PROCESS CONTROL COUPON, AFTER FORMING AND BEFORE WELDING, IS ANALYZED FOR COMPOSITION, GRAIN STRUCTURE AND TENSILE STRENGTH. HEAT TREATMENT AND KOROPON COATING APPLICATION IS VERIFIED BY INSPECTION.

TESTING

TANK ANNULUS IS EVACUATED AT ELEVATED TEMPERATURE FOR 21 DAYS; THE ANNULUS VACUUM LEVEL IS VERIFIED BY TANK ION PUMP INSTRUMENTATION AT THE VENDOR AND PERIODICALLY DURING STORAGE. MATERIALS ARE VERIFIED COUPON TESTED FOR LOAD STRENGTH. VESSELS ARE PRESSURE-TESTED AND LEAK TESTED AND VERIFIED BY INSPECTION.

PACKAGING/HANDLING

INSPECTION VERIFIES PARTS ARE PACKAGED AND PROTECTED PER REQUIREMENTS

■ (D) FAILURE HISTORY:

THERE HAS BEEN NO ACCEPTANCE TEST, QUALIFICATION TEST, FIELD OR FLIGHT FAILURES ASSOCIATED WITH THIS FAILURE MODE.

■ (E) OPERATIONAL USE:

CREW WILL RESPOND TO PRESSURE AND TEMPERATURE FAULT ANNUNCIATION BY

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NUMBER: M4-1BG-TK030-01

DEACTIVATING HEATERS.

- APPROVALS -

RELIABILITY ENGINEERING: M. D. WEST
 DESIGN ENGINEERING : M. H. SCHEIERN
 QUALITY MANAGER. : O. J. BUTTNER
 NASA RELIABILITY :
 NASA SUBSYSTEM MANAGER :
 NASA QUALITY ASSURANCE :

M. D. West = *ocho*
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1544