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## FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CRITICAL HARDWARE

NUMBER: H4-1BG-TK010-X

SUBSYSTEM NAME: ELECTRICAL POWER GENERATION - CRYO, GENERIC

REVISION: 1 11/12/91

	PART NAME VENDOR NAME	PART NUMBER VENDOR NUMBER
<del>■ LRU</del>	<del>OXYGEN TANK SUBASSEMBLY BEECH</del>	<del>MC282-0063-0100 15548-1000</del>
■ LRU	TANK SUBASSEMBLIES, O2 BEECH	MC232-0033-0300 15548-1001
■ LRU	TANK SUBASSEMBLIES, O2 BALL AEROSPACE	MC282-0112-0100 163195-500

## PART DATA

■ EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:  
TANK ASSEMBLIES, O2

■ REFERENCE DESIGNATORS:

- : 40V45TK010
- : 40V45TK020
- : 40V45TK400
- : 40V45TK450
- : 40V45TK600
- : 40V45TK760
- : 40V45TK770
- : 40V45TK780
- : 40V45TK790

■ QUANTITY OF LIKE ITEMS: 3-9  
MISSION DEPENDENT

■ FUNCTION:  
PROVIDES STORAGE OF CRYOGENIC OXYGEN FOR ECLSS AND FUEL CELL OPERATION.

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FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CRITICAL FAILURE MODE  
NUMBER: M4-1BG-TK010-01

SUBSYSTEM: ELECTRICAL POWER GENERATION - CRYO, GENERIC  
LRU : OXYGEN TANK SUBASSEMBLY  
ITEM NAME: TANK SUBASSEMBLIES, O2

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 O2 SUPPLY TANK AND POSSIBLE DAMAGE  
TO SURROUNDING SUBSYSTEM COMPONENTS.

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FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CRITICAL FAILURE MODE  
NUMBER: M4-18G-TX010-01

- (B) INTERFACING SUBSYSTEM(S):  
REDUCED AMOUNT OF O2 CONSUMABLES AVAILABLE FOR THE ECLSS AND 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.
- (E) FUNCTIONAL CRITICALITY EFFECTS:

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- DISPOSITION RATIONALE -  
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- (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. CURRENT LEVEL DETECTORS PREVENT EXCESSIVE HEATER CURRENT. CAUTION & WARNING FOR OVERPRESSURE AND OVERTEMPERATURE. DOUBLE SHEATH HEATER ELEMENT DESIGN PREVENTS SHORTING. REDUNDANT RELIEF CAPABILITY THRU MANIFOLD. RELIEF VALVE SIZED TO MAINTAIN ACCEPTABLE TANK PRESSURE FOR BOTH HEATERS FAILED ON AND 1 ATM ANNULUS RUPTURE. PRESSURE VESSEL IS INCONEL 718 - ALL WELDED, NOT PRONE TO CORROSION. ALL MATERIALS COMPATIBLE WITH O2. TANK SHIPPING CONTAINERS PREVENT SHIPPING DAMAGE. PRESSURE VESSEL IS DESIGNED TO YIELD BEFORE RUPTURE IF OVERPRESSURIZED. OUTER SHELL IS ALUMINUM 2219. ALL WELDED CONSTRUCTION. 60 PSID BURST DISC ON OUTER SHELL.
- (B) TEST:  
QUALIFICATION TEST INCLUDE: MECHANICAL SHOCK (20 G), SINUSOIDAL VIBRATION (+/- 0.25 G PEAK), RANDOM VIBRATION (0.008 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 0-1050 PSIG FOR 1200 CYCLES, BURST TESTED TO 1575 PSIG. AND CREEP CHECKED AT 1050 PSIG FOR 90 DAYS.  
  
ACCEPTANCE TESTS INCLUDE: AT THE PRESSURE VESSEL COMPONENT LEVEL, PROOF PRESSURE TEST AT 1250 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 1155 PSIG FOR 5 MINUTES AND A CRYOGENIC SHOCK TEST WHICH VERIFIES THE TANK

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CRITICAL FAILURE MODE  
NUMBER: M4-1BG-TK010-01

ASSEMBLY WELDS WITH EXPOSURE TO LN2.

CMRSD: TANK ASSEMBLY IS STRUCTURALLY INSPECTED DURING EVERY ORBITER MAINTENANCE DOWN PERIOD (CMDP). REACTANT MOISTURE VERIFIED 20 PPM MAX AT LOADING. VAC-ION PUMP IS ENERGIZED TO RE-ESTABLISH/VERIFY ANNULUS PRESSURE PRIOR TO EACH CRYO LOADING AND EVERY SIX MONTHS DURING TANK STORAGE.

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 NDT 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 INCLUDING HANDLING REQUIREMENT FOR FRACTURE-CRITICAL HARDWARE.

■ (D) FAILURE HISTORY:

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

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CRITICAL FAILURE MODE  
NUMBER: M4-189-TK010-01

(E) OPERATIONAL USE:

CREW WILL RESPOND TO PRESSURE, TEMPERATURE, OR ELECTRICAL FAULT  
ANNUNCIATION BY DEACTIVATING HEATERS.

- APPROVALS -

RELIABILITY ENGINEERING: M. D. WEST  
DESIGN ENGINEERING : M. M. SCHEIERN  
QUALITY MANAGER : D. C. BUTTNER  
NASA RELIABILITY :  
NASA SUBSYSTEM MANAGER :  
NASA QUALITY ASSURANCE :

: M. D. West = OK  
: M. M. Scheiern  
: D. C. Buttner  
: W. H. Strussling  
: W. H. Strussling 4/1/92  
: W. H. Strussling 4/1/92 RTF