

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL HARDWARE

NUMBER: 03-1-0256 -X

SUBSYSTEM NAME: MAIN PROPULSION

REVISION: 2 11/08/00

PART DATA

	PART NAME	PART NUMBER
	VENDOR NAME	VENDOR NUMBER
LRU	: TANK, HELIUM STORAGE BRUNSWICK	MC282-0082-0001 BLD999010-1

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:

HELIUM TANK, 17.3 CUBIC FEET, 4500 PSIA. LOCATED IN THE MID FUSELAGE.

REFERENCE DESIGNATORS: TK6
TK8
TK10

QUANTITY OF LIKE ITEMS: 3
ONE PER ENGINE HE SUPPLY

FUNCTION:

STORES A PORTION OF THE HELIUM REQUIRED FOR MAIN ENGINE USAGE. ONE TANK, INTERCONNECTED WITH TWO 4.7 CUBIC FOOT TANKS (ONE LOCATED IN THE MID FUSELAGE AND ONE IN THE AFT FUSELAGE), IS DEDICATED TO EACH MAIN ENGINE. USES INCLUDE: PURGE OF LO2 HIGH PRESSURE OXIDIZER TURBOPUMP (HPOT) INTERMEDIATE SEAL; EMERGENCY SHUTDOWN; BLEED VALVE ACTUATION; FUEL SYSTEM PURGE (ANTI-ICE); AND POST SHUTDOWN PREBURNER PURGE. RESIDUAL HELIUM WILL BE USED FOR MPS LINE REPRESSURIZATION, AND ET UMBILICAL, OMS POD AND AFT COMPARTMENT PURGES. TANK TK8 IS USED TO SUPPLEMENT THE PNEUMATIC HELIUM SYSTEM BY CROSSOVER VALVE (LV10).

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LRU: SSME HELIUM STORAGE TANK, 17.3 CU FT

ITEM NAME: SSME HELIUM STORAGE TANK, 17.3 CU FT

CRITICALITY OF THIS

FAILURE MODE: 1/1

FAILURE MODE:

RUPTURE/LEAKAGE

MISSION PHASE:

PL PRE-LAUNCH
LO LIFT-OFF
DO DE-ORBIT

VEHICLE/PAYLOAD/KIT EFFECTIVITY:

102 COLUMBIA
103 DISCOVERY
104 ATLANTIS
105 ENDEAVOUR

CAUSE:

MATERIAL DEFECT, FATIGUE

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:

RESULTS IN LOSS OF HELIUM FROM ONE MAIN ENGINE'S HELIUM SUPPLY. POSSIBLE OVERPRESSURIZATION OF THE MID AND AFT COMPARTMENTS (PRELAUNCH, ASCENT, AND ENTRY).

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RUPTURE OF HELIUM SUPPLY TANK MAY RESULT IN UNCONTAINED ENGINE SHUTDOWN DUE TO LOSS OF ENGINE HELIUM SUPPLY.

EXCESSIVE HELIUM LEAKAGE WILL BE DETECTABLE ON GROUND USING HAZARDOUS GAS DETECTION SYSTEM (HGDS). POSSIBLE AFT COMPARTMENT OVERPRESSURIZATION AFTER HELIUM FILL. AFTER LIFTOFF, EXCESSIVE ENGINE HELIUM SUPPLY TANK AND/OR REGULATOR PRESSURE DECAY WILL BE INDICATED BY SM ALERT OR CAUTION AND WARNING.

DURING ENTRY, VENT DOORS ARE CLOSED TO PREVENT INGESTION OF RCS AND APU GASES. THIS FAILURE DURING THE TIME PERIOD THAT THE VENT DOORS ARE CLOSED MAY RESULT IN OVERPRESSURIZATION OF AFT COMPARTMENT. VENT DOORS ARE OPENED WHEN VEHICLE VELOCITY DROPS BELOW 2400 FT/SEC.

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

(C) MISSION:
POSSIBLE LAUNCH SCRUB DUE TO LCC VIOLATION. POSSIBLE ABORT DUE TO EARLY SHUTDOWN OF ONE ENGINE.

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

(E) FUNCTIONAL CRITICALITY EFFECTS:
NONE.

-DISPOSITION RATIONALE-

(A) DESIGN:
THE TANK LINER CONSISTS OF TWO FORGED HEMISPHERES FABRICATED FROM TITANIUM 6AL-4V ALLOY (0.05 INCH MINIMUM THICKNESS, 130 KSI ULTIMATE STRENGTH). THE TWO HEMISPHERES ARE WELDED TOGETHER. THE LINER IS WOUND WITH EPOXY-IMPREGNATED KEVLAR-49 FIBER (500 KSI TENSILE STRENGTH). FILAMENT WOUND CONSTRUCTION PRECLUDES FRAGMENTATION DAMAGE. THE DESIGN MEETS FRACTURE ANALYSIS REQUIREMENTS FOR 400 MISSIONS. FACTORS OF SAFETY ARE 1.33 PROOF AND 1.5 BURST.

TO PRECLUDE RUPTURE THE PRESSURE VESSEL IS DESIGNED TO ASSURE THAT UNDER NORMAL OPERATING CONDITIONS, ANY FAILURE RESULTING FROM METAL FATIGUE OR ANY OTHER DEFECTS WILL RESULT IN A LEAK BEFORE BURST FAILURE MODE.

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(B) TEST:

ATP

LINER

EXAMINATION OF PRODUCT

HEAT TREAT VERIFICATION
COUPON TENSILE TEST

WELD EVALUATION
DIMENSIONALLY AND RADIOGRAPHICALLY INSPECTED

PROOF PRESSURE
1057 PSIG

EXTERNAL LEAKAGE
INTERNAL PRESSURE: 953 PSIG
MAXIMUM LEAKAGE: 1X10-7 SCC/SECOND OF HELIUM

PENETRANT INSPECTION FOR SURFACE FLAWS

TANK

EXAMINATION OF PRODUCT

LEAKAGE TEST
INTERNAL PRESSURE: 4500 PSIG
MAXIMUM LEAKAGE: 1X10-7 SCC/SECOND OF HELIUM

RADIOGRAPHIC INSPECTION
INTERNAL PRESSURE: 685 PSIG

CERTIFICATION

PRESSURE CYCLE TEST
1000 CYCLES
PRESSURE RANGE: 0 TO 4500 PSIG
PRESSURANT: WATER AT AMBIENT TEMPERATURE

EXTERNAL LEAKAGE
INTERNAL PRESSURE: 4500 PSIG
MAXIMUM LEAKAGE: 1X10-7 SCC/SECOND OF HELIUM

CREEP TEST
90 DAYS
INTERNAL PRESSURE: 4500 PSIG (HELIUM)
AMBIENT TEMPERATURE

RANDOM VIBRATION
60 MINUTE IN EACH OF 2 AXES

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INTERNAL PRESSURE: 4500 PSIG

RADIOGRAPHIC INSPECTION

BURST/RUPTURE TEST
PRESSURIZED UNTIL RUPTURE OCCURS

GROUND TURNAROUND TEST
ANY TURNAROUND CHECKOUT IS ACCOMPLISHED IN ACCORDANCE WITH OMRSD.

(C) INSPECTION:

RECEIVING INSPECTION
MATERIALS AND PROCESS CERTIFICATIONS ARE VERIFIED BY INSPECTION. MICRO-EXAMINATION AND CHEM-ETCH INSPECTION FOR ALPHA SEGREGATION IS VERIFIED BY INSPECTION. QUALITY TESTING PERFORMED ON FORGING IS VERIFIED BY INSPECTION.

CONTAMINATION CONTROL
CLEANLINESS OF INTERNAL SURFACES TO LEVEL 100A IS VERIFIED BY INSPECTION.
CORROSION PROTECTION PROVISIONS ARE VERIFIED BY INSPECTION.

ASSEMBLY/INSTALLATION
PART PROTECTION, MANUFACTURING PROCESSES, FINISHES, ASSEMBLY AND INSTALLATION PER SHOP TRAVELER ARE VERIFIED BY INSPECTION. PRESSURIZATION CYCLE HISTORY LOG AND SCHEDULES OF VESSELS ARE VERIFIED BY INSPECTION.

CRITICAL PROCESSES
WELDING, KEVLAR WRAPPING, EPOXY CURE PROCESS AND HEAT TREATMENT ARE VERIFIED BY INSPECTION. MECHANICAL PROPERTIES AND CHEMICAL ANALYSIS FOR OXYGEN, NITROGEN, AND HYDROGEN CONTENT OF HEMISPHERES AFTER FINAL HEAT TREATMENT ARE VERIFIED BY INSPECTION.

NONDESTRUCTIVE EVALUATION
FLUORESCENT PENETRANT INSPECTION (SPECIAL LEVEL NDE) OF LINERS AND GIRTH WELDS, AND RADIOGRAPHIC INSPECTION OF GIRTH WELDS (BOTH BEFORE AND AFTER PROOF SIZING) ARE USED TO SCREEN POTENTIALLY DETRIMENTAL PARENT MATERIAL OR WELD DEFECTS. PROOF SIZING OF THE PRESSURE VESSEL ABOVE THE YIELD STRESS FOR THE LINER AIDS IN SCREENING FLAWS.

TESTING
ATP IS WITNESSED AND VERIFIED BY INSPECTION. PRESSURIZATION CYCLE HISTORY LOG AND SCHEDULE ARE VERIFIED BY INSPECTION.

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

(D) FAILURE HISTORY:

CRACK INDICATIONS WERE FOUND IN POST PROOF TEST X-RAYS OF THE WELD AREA (REFERENCE CARS AB8397, AB8398). INVESTIGATION WAS CONDUCTED IN CONJUNCTION

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WITH SIMILARLY FAILED VESSELS (REFERENCE CARS A9902, AB8282, AC0968). THE VESSEL WITH THE WORST CRACK WAS PRESSURE CYCLED 479 TIMES TO FAILURE. SPECIFICATION REQUIRES 1000 CYCLES. THE MINOR CRACKS PRESENT SUSTAINED THE 1000 CYCLES BEFORE LEAKAGE. CRACKS PRESENT IN THE TANKS BELOW THE LEVELS OF X-RAY DETECTION WILL NOT PROPAGATE TO LEAKAGE WITHIN THE USEFUL LIFE OF THE TANK AS TESTING VERIFIED. THE PROOF PRESSURE SIZING OPERATION AND RADIOGRAPHIC INSPECTION ARE SUFFICIENT SCREENING TO PRECLUDE THIS FAILURE MODE.

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:

NO CREW ACTION CAN BE TAKEN.

- APPROVALS -

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	: EARL HIRAKAWA	:/S/ EARL HIRAKAWA
MPS SUBSYSTEM MGR.	: TIM REITH	:/S/ TIM REITH
MOD	: BILL LANE	:/S/ BILL LANE
USA SAM	: MIKE SNYDER	:/S/ MIKE SNYDER
USA ORBITER ELEMENT	: SUZANNE LITTLE	:/S/ SUZANNE LITTLE
NASA SR&QA	: ERICH BASS	:/S/ ERICH BASS