

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

NUMBER: M6-1C-0001-X

SUBSYSTEM NAME: ADDITIONAL NITROGEN - EDO MISSION KIT

REVISION : 1 01/22/91

	PART NAME VENDOR NAME	PART NUMBER VENDOR NUMBER
■ LRU :	TANK ASSY. NITROGEN STORAGE	MC282-0082-0140

## PART DATA

■ EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:  
TANK ASSEMBLY, NITROGEN STORAGE

■ QUANTITY OF LIKE ITEMS: 4  
TWO TANKS PER ARPCS SYSTEM

■ FUNCTION:  
STORES EDO ADDITIONAL NITROGEN WHICH SUPPLEMENTS THE ORBITER ARPCS SUPPLY. EACH TANK STORES 65.5 LBM OF GASEOUS NITROGEN. OPERATING PRESSURE RANGE IS 285 TO 3300 PSIG. TANKS PROVIDE NITROGEN FOR CABIN LEAKAGE, WET TRASH VENTING, EVA-AIRLOCK REPRESSURE, CO2 REMOVAL VENTING, NORMAL USAGE, AND EMERGENCY USAGE. EDO-TANKS ARE MANIFOLDED TOGETHER WITH EXISTING ARPCS NITROGEN TANKS IN SYSTEM 1 & 2.

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CRITICAL FAILURE MODE  
NUMBER: M6-1C-0001-01

REVISION# 1 01/22/91 R  
SUBSYSTEM: ADDITIONAL NITROGEN - EDO MISSION KIT  
LRU :TANK ASSY, NITROGEN STORAGE  
ITEM NAME: TANK ASSY, NITROGEN STORAGE  
CRITICALITY OF THIS FAILURE MODE:1/1

■ FAILURE MODE:  
STRESS RUPTURE

MISSION PHASE:

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

■ VEHICLE/PAYLOAD/KIT EFFECTIVITY: 102 COLUMBIA  
: 105 ENDEAVOUR

■ CAUSE:  
RUPTURE AT OPERATING PRESSURE CAN ONLY OCCUR AS A RESULT OF STRESS  
RUPTURE (STATIC FATIGUE) OF KEVLAR OVERWRAP.

■ 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 ONE HALF-OF NITROGEN SUPPLY (SINCE EDO TANKS ARE MANIFOLDED  
TOGETHER WITH ARPCS NITROGEN TANKS) PLUS A PORTION OF THE SYSTEM GAS  
WOULD BE LOST DURING LEAK ISOLATION REACTION TIME.

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- (B) INTERFACING SUBSYSTEM(S):  
REDUCED SUPPLY OF NITROGEN AVAILABLE.
- (C) MISSION:  
LOSS OF MISSION OBJECTIVES; MISSION SHORTENED BECAUSE ONLY ONE HALF OF TOTAL NITROGEN QUANTITY REMAINS.
- (D) CREW, VEHICLE, AND ELEMENT(S):  
POSSIBLE LOSS OF CREW/VEHICLE DUE TO DAMAGE TO SURROUNDING STRUCTURE AND SYSTEMS OR LACK OF SUFFICIENT NITROGEN TO SUPPORT CONTINGENCIES.
- (E) FUNCTIONAL CRITICALITY EFFECTS:  
NONE.

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- DISPOSITION RATIONALE -  
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- (A) DESIGN:  
THE TANKS ARE FILAMENT WOUND (500 KSI TENSILE STRENGTH KEVLAR-49) OVER A FORGED 6AL-4V TITANIUM LINER (0.05 INCH MINIMUM THICKNESS, 130 KSI ULTIMATE STRENGTH). THE TANK IS DESIGNED TO LEAK BEFORE BURST. BURST PRESSURE IS 4950 PSI WHICH IS 1.5 TIMES THE WORKING PRESSURE OF 3300 PSI. TANK IS DESIGNED TO WITHSTAND NEGATIVE ~~1~~15.23 PSID.
- (B) TEST:  
MANUFACTURING BUILDUP - THE LINER IS FLOURESCENT-PENETRANT INSPECTED AND RADIOGRAPHICALLY INSPECTED FOR MATERIAL AND WELD FLAWS. THE LINER IS PROOF PRESSURE TESTED AT 778 PSIG AND LEAK CHECKED AGAINST A  $1 \times 10^{-7}$  EXP -7 SCCS HELIUM REQUIREMENT.  
  
ACCEPTANCE TEST - EXAMINATION OF THE PRODUCT, LEAK, PROOF, AND RADIOGRAPHIC INSPECTION OF WELDS.  
  
QUALIFICATION TEST - 1000 PRESSURE CYCLES, BURST TEST, DESIGN SHOCK (20G SAWTOOTH PULSE FOR 11 MS IN EACH DIRECTION OF 3 ORTHOGONAL AXES, RANDOM VIBRATION AT 0.5 G\*\*2/HZ, PROOF PRESSURE AT 1.1 TIMES OPERATING PRESSURE, LEAK  $1 \times 10^{-7}$  SCCS HELIUM AT 3300 PSI, AND DYNAMIC LOADS.  
  
OMRSD - TANKS ARE DEPRESSURIZED TO LESS THAN 200 PSIA WHEN NON-OPERATING PERIOD IS IN EXCESS OF 8 WEEKS OR FOR VEHICLE STORAGE.  
*TANKS ARE DEPRESSURIZED BELOW 2000 PSIG AFTER LANDING (STRESS RUPTURE LIFE ASSURANCE PRESSURE).*

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■ (C) INSPECTION:

RECEIVING INSPECTION

MATERIAL AND PROCESS CERTIFICATIONS ARE VERIFIED BY INSPECTION. MICRO-EXAMINATION AND CHEM-ETCH INSPECTION FOR ALPHA SEGREGATION AND QUALITY TESTING PERFORMED ON FORGINGS ARE VERIFIED BY INSPECTION.

CONTAMINATION CONTROL

INTERNAL SURFACES CLEANED TO LEVEL 100A AND DRYNESS REQUIREMENTS ARE VERIFIED BY INSPECTION.

CRITICAL PROCESSES

WELD SCHEDULE OF VESSELS VERIFIED BY INSPECTION. MECHANICAL PROPERTIES AND CHEMICAL ANALYSIS FOR O<sub>2</sub>, N<sub>2</sub>, AND H<sub>2</sub> CONTENT OF HEMISPHERES AFTER FINAL HEAT TREATMENT ARE VERIFIED BY INSPECTION. FORGING, KEVLAR WRAPPING AND EPOXY CURE PROCESS ARE VERIFIED BY INSPECTION.

NONDESTRUCTIVE EVALUATION

SPECIAL NDE (PENETRANT LEVEL 7) FLOURESCENT PENETRANT INSPECTION OF MACHINED 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

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

HANDLING/PACKAGING

HANDLING, PACKAGING, STORAGE AND SHIPPING PROCEDURE VERIFIED BY INSPECTION.

■ (D) FAILURE HISTORY:

THERE HAVE BEEN NO FAILURES APPLICABLE TO RUPTURE FAILURE MODE. THE TANKS HAVE SUCCESSFULLY BEEN USED THROUGH THE SHUTTLE PROGRAM FOR THIS FAILURE MODE.

■ (E) OPERATIONAL USE:

1. CREW ACTION

PERFORM LEAK ISOLATION BY CLOSING THE AFFECTED N<sub>2</sub> SUPPLY VALVES AND

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APPROPRIATE SYSTEM RECONFIGURATION. DATA IS NOT AVAILABLE TO CREW DURING ASCENT AND ENTRY. RESPONSE WOULD BE BASED ON GROUND ADVISEMENT.

2. TRAINING

STANDARD ECLSS TRAINING COVERS THE EFFECTS OF THE GENERIC N2 PCS LEAK; LEAK ISOLATION, SYSTEM RECONFIGURATION AND MISSION DURATION.

3. OPERATIONAL CONSIDERATION

- A. REAL TIME DATA SYSTEM ALLOWS FOR GROUND MONITORING OF THE TANK ASSEMBLY PRESSURE AND TEMPERATURE.
- B. FLIGHT DATA FILE PROCEDURES COVER THE EFFECTS OF THIS FAILURE WITH THE EXCEPTION OF SYSTEM DESTRUCTION DUE TO RUPTURE.
- C. LENGTH OF MISSION AFFECTED BY THE REMAINING QUANTITY OF N2 ON BOARD.
- D. REFERENCE LOSS/FAILURE FLIGHT RULES.

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- APPROVALS -  
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RELIABILITY ENGINEERING:	H. M. TO	H.T. :	<u>E. O'Brien</u> 1/24/91
DESIGN ENGINEERING	: E. EDMUNDS	:	<u>E. O'Brien</u>
QUALITY ENGINEERING	: M. SAVALA	:	<u>M. Savala</u> 2/14/91 for 020
NASA RELIABILITY	:	:	<u>Bob H. Standridge</u> 3/6/91
NASA SUBSYSTEM MANAGER :		:	<u>D.M. Jones</u> 3/6/91
NASA QUALITY ASSURANCE :		HAF :	<u>[Signature]</u> 2/26/91