

CRITICAL ITEMS LIST (CIL)

SYSTEM:	Propulsion/Mechanical	FUNCTIONAL CRIT:	1
SUBSYSTEM:	G02 Pressurization	PHASE(S):	a, b, c
REV & DATE:	J, 12-19-97	HAZARD REF:	P.03, P.06,
DCN & DATE:			P.07, P.09,
ANALYSTS:	J. Attar/H. Claybrook		P.10, S.03,
			S.07, S.11

FAILURE MODE: Leakage

FAILURE EFFECT: a) Loss of mission and vehicle/crew due to fire/explosion.
 b) Loss of mission and vehicle/crew due to fire/explosion or LO2 tank structural failure.
 c) Loss of life due to ET impact outside designated footprint.

TIME TO EFFECT: Seconds

FAILURE CAUSE(S): A: Structural Failure of Hardline Component
 B: Flange Mating Surface Defects
 C: Structural Failure of Sliding Bellows Component
 D: Structural Failure of Flex Joint Component
 E: Seizure of Flex Joint
 F: Fracture of One Attachment Bolt
 G: Seizure of Sliding Bellows Component

REDUNDANCY SCREENS: Not Applicable

FUNCTIONAL DESCRIPTION: Transports GHe/G02 during prelaunch and G02 during ascent to maintain LO2 tank ullage pressure requirements.

<u>FMEA ITEM CODE(S)</u>	<u>PART NO.</u>	<u>PART NAME</u>	<u>QTY</u>	<u>EFFECTIVITY</u>
2.2.4.1	P04800180-090 -520	Mid Line Assy (Flex)	1	LWT-54 thru 88
			1	LWT-89 & up

REMARKS:

CRITICAL ITEMS LIST (CIL)
CONTINUATION SHEET

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SUBSYSTEM: G02 Pressurization
FMEA ITEM CODE(S): 2.2.4.1

REV & DATE: J, 12-19-97
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RATIONALE FOR RETENTION

DESIGN:

- The Mid Line Assembly (Intertank) consists of fixed flanges, straight tube sections, two bellows type flexible joints and a sliding bellows assembly. The line assembly is installed to a fixed support at sta 1082.00. Attachment points are included on the line assembly and provide for limited line motion through a pivoting action.
- A, C, D, E: The line assembly is an all welded configuration fabricated from Inconel 718 and Armco 21-6-9 CRES. Emphasis has been placed on joint geometry to enhance weld integrity. The line assembly has been designed to meet the required ultimate safety factors (1.4 for loads and 1.5 for pressure) and the required yield safety factors (1.1 for loads and 1.25 for pressure) (ET Stress Report 826-2188 and Arrowhead ET10-SR-0001-1). The line assembly also meets the other operating and nonoperating requirements specified per PD4800180. Material selected in accordance with MMC-ET-SE16 and controlled per MMMA Approved Vendor Product Assurance Plan assures conformance of composition, material compatibility and properties. Fusion and seam welding specifications, processes, and quality controls are in accordance with MPS-MPQ-103 (Arrowhead).
- B: Mating surface flatness, waviness and finish are specified on engineering drawings to assure performance within the capability of the seal.
- C, G: The Sliding Bellows Assembly is fabricated from Inconel 718 and consists of a three bellows welded assembly with internal and external guide tubes. Vitrolube is applied to prevent seizure. The bellows is a three ply construction with relatively low convolution height and open pitch. Each tube (.008 inch thick) is rolled and welded with a longitudinal butt weld. The tubes are telescoped one within the other and the convolutes are roll formed.
- D, E: The Flexible Joint Assemblies provide for installation misalignments and recurring motions during loading and boost. The pressure carrier bellows is fabricated from three plies of .008 inch thickness material and the joint design provides isolation from flow induced vibration. The ball located within the ball strut assembly is fabricated from Inconel 718. Vitrolube is applied to prevent seizure of the ball and strut and sliding bellows components. Compatibility testing for oxygen service is specified per (NHB 8060.1).
- F: Attachment fasteners were selected from the Approved Standard Parts List (ASPL 826-3500), installed per STP2014 and torqued using values specified on engineering drawings.

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TEST:

The Mid Line Assembly (Intertank) is qualified. Reference COQ MMC-ET-TM06-024.

Fretting/Structural Test: This test evaluated the ability of the Mid Line Assembly and sliding bellows component ability to withstand projected flight conditions high temperature (aero heating) and continuous vibration (generated during phase b). Testing of a similar line assembly included sine and random vibration (with line pressurized at 25 psig and exposed to 500 ° F). There was no evidence of metallic particles generated which would ignite in a hot oxygen environment. (MSFC ET G02-TR-001).

Qualification: Testing of one line assembly included proof loads/operating pressure, deflection and leakage for acceptance, 500 motion/operating pressure cycles while pressurized at 600 psig, leakage test, 10 thermal cycles, electrical bonding (for impedance), sine and random vibration while pressurized at 600 psig, post vibration leak test, and ultimate load test of the sliding bellows at 1000 psig. Ultimate load tests were then performed on line assembly segments to verify pressure carrier and fixed support bracket welds. There was no evidence of damage or permanent deformation. Leakage criteria was no bubbles for the line assembly and less than 1×10^{-5} SCCS for the sliding bellows at 300 psig helium, (MMC-ET-RA09-37). The Mid Line Assembly was qualified by similarity, analysis for higher loads, and the above test.

MPTA Firings/Tankings: A similar Mid Flex Line Assembly (except that hard mount attachments are incorporated) has accumulated 62.5 minutes of firing time, 27 cryogenic cycles, and 42 pressurization cycles. There was no evidence of structural damage.

Acceptance:

Vendor - (Subassembly):

- A, C, D, E: Perform load versus deflection test on each BSTRA joint and on the sliding joint (ATP 180-390 or ATP 14180-390, Arrowhead as applicable for LWT-54 thru 88; ATP 14180-520 for LWT-89 & up).

Vendor - (Line Assembly):

- C: Perform proof loads/operating pressure test on the sliding bellows assembly (ATP 180-390 or ATP 14180-390, Arrowhead as applicable for LWT-54 thru 88; ATP 14180-520 for LWT-89 & up).
- A, D, E: Perform proof loads/operating pressure test to verify weld integrity (ATP 180-390 or ATP 14180-390, Arrowhead as applicable for LWT-54 thru 88; ATP 14180-520 for LWT-89 & up).
- A, D: Perform 4 deflection tests (2 with line unpressurized and 2 with line pressurized to 600 psig) (ATP 180-390 or ATP 14180-390, Arrowhead as applicable for LWT-54 thru 88; ATP 14180-520 for LWT-89 & up).

MAF - (Line Assembly)

- B: Perform dual seal leakage rate test for flange joints after installation (MMC-ET-TM04k).

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RATIONALE FOR RETENTION

INSPECTION:

Vendor Inspection - Lockheed Martin Surveillance:

- A, C, D, F, G: Verify materials selection and verification controls (MMC-ET-SE16, Standard drawing 26L2 and drawings 14180-81, 14180-3, 14180-63, 14180-59, 14180-5-21, 14180-5-19, 14180-5-13, 14180-5-7, 14180-71, 14180-69, 14180-67, 14180-89, 14180-87-3, 14180-87-5, 14180-87-7, 14180-87-9, 14180-87-11, 14180-65, 10950-55-5, 10950-53-15, and 10950-55-7, Arrowhead).
- A, C, D: Inspect welding (MPS-MPQ-103, Arrowhead).
- A, C, D: Witness penetrant inspection (MIL-I-6866, Type I, Method A).
- A, C, D: Verify x-ray results (QCI-16-057, Arrowhead).
- B: Inspect mating surface flatness, finish and dimensions (drawings 14180-81 and 14180-3, Arrowhead).
- E, G: Inspect dimensions (drawings 10950-75-25, 14180-71, 14180-59, 14180-5-13, 14180-63, 14180-67, 14180-87-3, 14180-87-5, 14180-87-7 and 14180-69, Arrowhead).
- E, G: Verify lubrication application (MPS-MPQ-121, Arrowhead).
- E, G: Witness cleaning (MPS-MPQ-105, Arrowhead).

Lockheed Martin Procurement Quality Representative:

- A, C, D: Verify post proof x-ray results (drawing 14180-390, Arrowhead, for LWT-54 thru 88; drawing 14180-520 for LWT-89 & up).
- A-E, G: Witness load vs deflection on BSTRA and sliding joints, proof load/operating pressure, deflection and leakage test (ATP 180-390 or ATP 14180-390, Arrowhead, for LWT-54 thru 88; ATP 14180-520 for LWT-89 & up).

MAF Quality Inspection:

- B: Inspect sealing surfaces for freedom of nicks, radial scratches or other imperfections (acceptance drawing 82620000001).
- F: Verify installation and witness torque (drawing 80921021009).
- B: Witness seal flange leakage tests (MMC-ET-TM04k)

FAILURE HISTORY:

Current data on test failures, unexplained anomalies and other failures experienced during ground processing activity can be found in the PRACA data base.