

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 Flex Joint Component
 D: Seizure of Flex Joint
 E: Fracture of One Disconnect Attachment Bolt

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>
2.2.6.1	PD4800180-080	Lower Line Assy (Flex)	1	LWT-54 & Up

REMARKS:

CRITICAL ITEMS LIST (CIL)
CONTINUATION SHEET

SYSTEM: Propulsion/Mechanical
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FMEA ITEM CODE(S): 2.2.6.1

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

DESIGN:

- A: The Lower Line Assembly (Flex) consists of fixed flanges, straight tubing, tube bend sections and 3 bellows type flexible joints. Each flexible joint contains a pressure carrier bellows and a ball strut assembly. The line assembly is an all welded configuration fabricated of 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 ET10-SR-0001-1 Arrowhead). The line assembly also meets the 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-MPO-103 (Arrowhead).
- B: Mating surface flatness, waviness and finish are specified on engineering drawings to assure performance within the capability of the seal.
- C, D: The Flexible Joint Assemblies provide for installation misalignments and recurring motions during loading and boost. The pressure carrier bellows is fabricated from 3 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. Compatibility testing for oxygen service is specified per MHB 8060.1. Joint assembly angles/dimensions are specified for line assembly installation to assure flight motion capability.
- E: Attachment fasteners were selected from the Approved Standard Parts List (ASPL 826-3500), installed per STP2014 and torqued using values specified on engineering drawings.

TEST:

The Lower Line Assembly (Flex) is qualified. Reference COQ MMC-ET-TM06-025.

BSTRA Development Test: Five ball-strut tie rod assembly flexible joints were subjected to development tests to determine the torsional loading capability. In each test, loading was applied incrementally until failure occurred. Should binding occur, test results have shown that the BSTRA can resist up to 6,800 in-lb which is more than twice the flight load (ET-DTR-10950-73, Arrowhead).

Qualification: Testing of one similar line assembly (reduced tube wall thickness) included load deflection, proof loads/operating pressure, deflection and leakage for acceptance, 500 motion/operating pressure cycles while pressurized to 600 psig, leakage, electrical bonding (for impedance), sine and random vibration, and an ultimate load test (at 3,025 psig). There was no evidence of damage or permanent deformation. Leakage criteria was no bubbles at 300 psig, (MMC-ET-RA09-30).

Delta Qualification: Testing of one line assembly included proof loads/operating pressure, deflection, and leakage test for acceptance, sine and random vibration at 600 psig, leakage and an ultimate load (at 22,775 lbs tensile for 60 seconds). There was no evidence of damage or permanent deformation. Leakage criteria was no bubbles at 300 psig, (MMC-ET-RA09-93).

MPTA Firings/Tankings: The Lower Line Assembly 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: Perform load versus deflection test on each BSTRA joint (ATP 180-380-3 or ATP 14180-380-3, Arrowhead as applicable).
- A, C, D: Perform proof load tests on subassembly welds (ET10-ATP 1000 or ATP 14180 as applicable).

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TEST: (cont)

Vendor - (Line Assembly):

- A, C, D: Perform proof loads/operating pressure test (ATP 180-380-3 or ATP 14180-380-3, Arrowhead as applicable).
- C, D: Perform 4 deflection tests (2 with line unpressurized and 2 with line pressurized) (ATP 180-380-3 or ATP 14180-380-3, Arrowhead as applicable).
- A-D: Perform leakage rate test after proof loads/operating pressure test and deflection tests (ATP 180-380-3 or ATP 14180-380-3, Arrowhead as applicable).

MAF - (Line Assembly):

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

INSPECTION:

Vendor Inspection - Lockheed Martin Surveillance:

- A, C, E: Verify materials selection and verification controls (MMC-ET-SE16, Standard drawing 26L2 and drawings 14180-33, 14180-107, 14180-101, 14179-59-9, 14180-85, 14180-103, 10950-53-13, 10950-53-15-5, 10950-53-15-3, and 10950-15-7, Arrowhead).
- A, C, D: Verify results of proof loads tests on subassembly welds (ET10-ATP 1000 or ATP 14180-380-3, Arrowhead as applicable).
- A, C: Inspect welding (MPS-MPQ-103, Arrowhead).
- A, C: Witness penetrant inspection (MIL-I-6866, Type I, Method A, Sensitivity Group VI).
- A, C: Verify X-ray results (QCI-16-057, Arrowhead).
- B: Inspect mating surface flatness, finish and dimensions (drawing 14180-33 14180-107, Arrowhead).
- D: Inspect dimensions (drawing 10950-73-23, Arrowhead).
- D: Verify lubrication application (MPS-MPQ-121 Arrowhead).
- D: Witness cleaning (MPS-MPQ-105, Arrowhead).

Lockheed Martin Procurement Quality Representative:

- A, C: Verify post proof x-ray results (drawing 14180-380, Arrowhead).
- A-D: Witness loads vs deflection, proof load/operating pressure, deflection and leakage tests (ATP 180-380-3 or ATP 14180-380-3, Arrowhead as applicable).

MAF Quality Inspection:

- B: Inspect sealing surfaces for freedom of nicks, radial scratches or other imperfections (acceptance drawing 82620000001).
- B, E: 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.