

CRITICAL ITEMS LIST (CIL)

SYSTEM:	Propulsion/Mechanical	FUNCTIONAL CRIT:	1
SUBSYSTEM:	GH2 Vent/Relief	PHASE(S):	a, b, c
REV & DATE:	J, 12-19-97	HAZARD REF:	P.03, S.06, S.11, T.03
DCN & DATE:			
ANALYSTS:	J. Schnackel/H. Claybrook		

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.
 c) Loss of life due to ET impact outside designated footprint.

TIME TO EFFECT: Seconds

FAILURE CAUSE(S): A: Structural Failure of Hardline Component
 C: Structural Failure of Bellows Assembly
 D: Structural Failure/Seizure of Gimbal Joint
 E: Structural Failure of Tie Rod Support Assy Component
 F: Seizure of Tie Rod Support Bearing
 G: Structural Failure of Tie Rod Fitting
 H: Structural Failure of Hinge Support Assy Component
 I: Seizure of Hinge Support Bearing
 J: Structural Failure of Hinge Support Fitting
 K: Fracture of One Attachment Bolt

REDUNDANCY SCREENS: Not Applicable

FUNCTIONAL DESCRIPTION: Conducts vented gases from the GH2 vent/relief valve, located on the LH2 tank forward dome, to the 7 inch quick disconnect on the intertank carrier plate assembly.

<u>FMEA ITEM CODE(S)</u>	<u>PART NO.</u>	<u>PART NAME</u>	<u>QTY</u>	<u>EFFECTIVITY</u>
2.8.1.1	PD4800181-020	GH2 Vent Line	1	LWT-54 & Up

REMARKS:

CRITICAL ITEMS LIST (CIL)
CONTINUATION SHEET

SYSTEM: Propulsion/Mechanical
SUBSYSTEM: GH2 Vent/Relief
FMEA ITEM CODE(S): 2.8.1.1

REV & DATE: J, 12-19-97
DCN & DATE:

RATIONALE FOR RETENTION

DESIGN:

The line assembly consists of floating flanges, straight tube sections, a single tube bend section, an unrestricted argon jacketed bellows joint, and an argon jacketed bellows gimbal joint. The line is vertically supported in the Intertank by a hinged assembly attached to the LH2 tank dome and to a bracket on the vent line. Similarly, lateral support is provided by a tie rod assembly.

A,C-K: The line and support assemblies have 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 D1442, Metal Bellows). Material selected in accordance with MMC-ET-SE16 and controlled per MMA Approved Vendor Product Assurance Plan assures conformance of composition, material compatibility and properties.

The line assembly is fabricated from 321 and 304L CRES and meets the operational and nonoperational requirements of P04800181. Emphasis has been placed on joint geometry to enhance weld integrity. Fusion, spot and seam welding specifications, processes, and quality controls are in accordance with CPS1012 and CPS1009 (Metal Bellows).

C, D: The unrestricted argon jacketed bellows joint and gimbal joint vacuum jacketed bellows are fabricated from 2 plies of .008 inch thick material (321 CRES). Each tube is rolled and butt welded. The tubes are telescoped one within the other and the convolutes are roll formed. The gimbal assembly utilizes a universal pinned joint to facilitate installation tolerances and recurring and nonrecurring motions.

E: The tie rod is fabricated from 304 CRES tube stock. Swiveling is provided by use of spherical bearings which allow for fabrication misalignments and relative motions during tanking and boost.

F, I: Bearing selection is made to accommodate installation, motion and load requirements. Vitrolube is applied to prevent seizure of the ball and race.

G: The tie rod fitting is machined from 2219-T87 aluminum and welded to the LH2 forward dome.

H: The hinge is fabricated from 304 CRES bar stock. Swiveling is provided by use of spherical bearings which allow for fabrication misalignments, and relative motions during tanking and boost.

J: The hinge support fitting is machined from 2219-T87 aluminum alloy plate and welded to the LH2 tank forward dome.

K: Attachment bolts were selected from the approved standard parts list (ASPL 826-3500), installed per STP2014 and torqued using values specified on Engineering drawings.

TEST:

The Vent Line Assembly is qualified. Reference COQ MMC-ET-TM06-026.

Gimbal Joint Development: Testing of one gimbal joint assembly included leakage of the pressure carrier bellows and jacketed bellows (performed at 37 psig and 14.7 psig respectively), proof load/operating pressure cycle (2,563 lbs at 80 psig), 500 operating life/operating pressure cycles, and ultimate load test (4,061 lbs at 148 psig). Visual inspection showed no evidence of wear, deterioration or any conditions that would affect normal operation of the gimbal joint (CR 493, Metal Bellows Corp).

Qualification: Testing of one line assembly included proof pressure (44.4 psig for line assembly, 10 psig for bellows), proof load/pressure (2,563 at 80 psig), bellows spring rate deflection, operating pressure/leakage (1 cycle for pressure carrier bellows at 37 psig and argon jacketed bellows assembly at 14.7 psig), 1,000 operating life cycles, 10 thermal cycles, random vibration, resistance bonding test, collapse pressure (at 9.6 psi), and ultimate load (axial tensile of gimbal bellows at 4,061 lbs and 148 psig, bracket load of 1,286 lb applied at 34° and 50 psig, and tube bending at 929 lb and 148 psig). There was no evidence of rupture or deformation (MMC-ET-RA09-27).

An additional line assembly with support hardware and V/R Valve actuation and sense lines attached was subjected to testing that included random vibration, operating pressure and leakage. Inspection showed no evidence of failure and/or damage to the line assembly and attached hardware (MMC-ET-RA09-82 and -88).

CRITICAL ITEMS LIST (CIL)
CONTINUATION SHEET

SYSTEM: Propulsion/Mechanical
SUBSYSTEM: GH2 Vent/Relief
FMEA ITEM CODE(S): 2.8.1.1

REV & DATE: J, 12-19-97
DCN & DATE: 005, 6-30-00

RATIONALE FOR RETENTION

TEST: (cont)

Qualification - Support Strut End Bearings: Testing included radial static limit load (3000 lbs) and radial ultimate load (4500 lbs). Axial static limit load (300 lbs) and axial static ultimate load (450 lbs) were also performed. The bearing met all structural requirements (MMC-ET-RA09-107).

MPIA Firings/Tankings: The GH2 vent line has been operational during 23 cryogenic cycles and has accumulated 62.5 minutes of firing time. There was no evidence of structural damage prior to or after all static firings.

Acceptance:

Vendor - (Line Assembly):

A,C,D: Perform proof and leakage test (ATP 75890, Metal Bellows for LWT-54 thru 113; 2075890, Stainless Steel Products for LWT-114 & Up).

C,D: Perform deflection test (ATP 75890, Metal Bellows for LWT-54 thru 113; 2075890, Stainless Steel Products for LWT-114 & Up).

K: Attachment bolts are procured and tested to Standard drawing 26L4.

INSPECTION:

Vendor Inspection - Lockheed Martin Surveillance:

A,C,D, E,G,H, J,K: Verify materials selection and verification controls (MMC-ET-SE16, drawings PD4800181, 80921021034, 80914100997, Standard drawings 26L4 and 36L11; Metal Bellows drawings 75471, 74467, 74406, 74404, 74405, 75469, 74403, 75459, 74400, 75432, 75432-1, 75430, 75430-2, 75468, 75468-2, 75431, 75433 and 75435 for LWT-54 thru 113; Stainless Steel Products drawings 2075471, 2074467, 2074406, 2074404, 2074405, 2075469, 2074403, 2075459, 2074400, 2075432, 2075432-001, 2075430, 2075430-001,002, 2075431, 2075433 and 2075435 for LWT-114 & Up).

A, C: Verify assembly (drawing 75890 Metal Bellows for LWT-54 thru 113; 2075890, Stainless Steel Products for LWT-114 & Up).

A,C,D: Inspect welding (CPS 1012, Metal Bellows for LWT-54 thru 113; SSP MPD-24, Stainless Steel Products for LWT-114 & Up).

A, C: Penetrant inspect welding (CPS 3011, Metal Bellows, Type 1, Method A, Sensitivity Group VI for LWT-54 thru 113; SSP MPD-44, Stainless Steel Products for LWT-114 & Up).

A,C,D: Verify x-ray results (CPS 3124 Metal Bellows for LWT-54 thru 113; SSP MPD-83/Supp. 1, Stainless Steel Products for LWT-114 & Up).

A: Ultrasonic inspect (drawings 74400, 75469 and 74403, Metal Bellows for LWT-54 thru 113; 2074400, 2075469, 2074403 Stainless Steel Products for LWT-114 & Up).

D: Inspect dimensions (drawings 75431, 75433 and 75435, Metal Bellows for LWT-54 thru 113; 2075431, 2075433, 2075435 Stainless Steel Products for LWT-114 & Up).

F, I: Inspect dimensions, lubricant, radial clearance and misalignment (Standard drawing 36L11).

Lockheed Martin Procurement Quality Representative:

A,C,D: Witness Proof Pressure, Bellows deflection and Leakage test (ATP 75890, Metal Bellows for LWT-54 thru 113; 2075890, Stainless Steel Products for LWT-114 & Up).

MAF Quality Inspections:

E,H,K: Verify installation (drawing 80921021039).

F, I: Inspect bearing for freedom of movement and visually free of contamination (drawing 80921021309).

K: Inspect installation of cotter pin (STP2013).

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.

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 SUBSYSTEM: GH2 Vent/Relief
 REV & DATE: J, 12-19-97
 DCN & DATE:
 ANALYSTS: J. Attar/H. Claybrook

FUNCTIONAL CRIT: 1R
 PHASE(S): b, c
 HAZARD REF: P.01

FAILURE MODE: Blockage

FAILURE EFFECT: b) Loss of mission and vehicle/crew due to structural failure of LH2 tank.
 c) Loss of life due to early LH2 tank structural failure resulting in impact outside designated footprint.

TIME TO EFFECT: Seconds

FAILURE CAUSE(S): Foreign Object

REDUNDANCY SCREENS: Screen A: PASS
 Screen B: FAIL - No detection method for failure mode in flight.
 Screen C: PASS

FUNCTIONAL DESCRIPTION: Provides backup sensing and bleeding capabilities within the intertank to the sense line.

<u>FMEA ITEM CODE(S)</u>	<u>PART NO.</u>	<u>PART NAME</u>	<u>QTY</u>	<u>EFFECTIVITY</u>
2.8.11.1	80923021030-002	Bleed Orifice	1	LMT-54 & Up

REMARKS: