

CRITICAL ITEMS LIST (CIL)

SYSTEM: Propulsion/Mechanical  
 SUBSYSTEM: GH2 Vent/Relief  
 REV & DATE: J, 12-19-97  
 DCN & DATE: 005, 6-30-00  
 ANALYSTS: J. White/H. Claybrook

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

FAILURE MODE: Loss of Relief Capability

FAILURE EFFECT: a) Loss of mission and vehicle/crew due to LH2 tank over-pressurization.  
 b) Loss of mission and vehicle/crew due to LH2 tank over-pressurization.  
 c) Loss of life due to ET impact outside designated footprint.

TIME TO EFFECT: Seconds

FAILURE CAUSE(S): A: Structural Failure of Primary Pilot Spring  
 B: Binding of Secondary Pilot Piston Shaft and Bearings Including Pistons in Bore  
 C: Binding of Main Piston Bore  
 D: Seizure of Main Shaft and Bearing  
 E: Disengagement of Main Poppet  
 F: Disengagement of Main Shaft Nut  
 G: Disengagement of Primary Pilot Plug  
 H: Blockage of Primary/Secondary Pilot Bleed Line  
 I: Blockage of Primary Pilot Dump Line  
 J: Binding Between Primary Pilot Poppet Stem and Retainer  
 K: Disengagement of Primary Pilot Bias Spring Adjusting Plug  
 L: High Primary Pilot Pressure Setting During Assembly  
 M: Blockage of Purge Orifice  
 N: Disengagement of Secondary Pilot Nut  
 O: Seizure of Secondary Pilot Adapter and Bearing  
 P: Disengagement of Threaded Orifice, Secondary Pilot

REDUNDANCY SCREENS: Not Applicable

FUNCTIONAL DESCRIPTION: The vent/relief valve limits maximum tank pressure through relief operation and provides a manual venting capability during prelaunch operation.

FMEA ITEM CODE(S)	PART NO.	PART NAME	QTY	EFFECTIVITY
2.8.14.4	PD4700189-029	GH2 Vent/Relief Valve	1	LWT-54 thru 84, 89-93
	-039		1	LWT-85 thru 88, 94 thru 114
	-040		1	LWT-115 & Up

REMARKS:

CRITICAL ITEMS LIST (CIL)  
CONTINUATION SHEET

SYSTEM: Propulsion/Mechanical  
SUBSYSTEM: GH2 Vent/Relief  
FMEA ITEM CODE(S): 2.8.14.4

REV & DATE: J, 12-19-97  
DCN & DATE: 004, 6-30-99

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RATIONALE FOR RETENTION

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DESIGN:

The GH2 Vent/Relief (V/R) valve assembly is based on the Saturn S-II configuration. Poppet flow control, actuation and relief sensing concepts have been incorporated. The ET GH2 valve was designed to meet the required ultimate safety factor of 1.4 (ET Stress Report 826-2188 and Calmec Stress Report TR-4-1). Material selected in accordance with MMC-ET-SE16 and controlled per MMMA Approved Vendor Product Assurance Plan assures repetitive conformance of composition and properties.

- A: The primary pilot bias spring is made from 302 CRES wire of different diameters. Spring selection is made at time of assembly to provide the required cracking pressure.
- B: Binding of the secondary pilot shaft and bearing is precluded by vendor specified dimensional tolerances that provide clearance. The bearing is a slit configuration and is made from Fluorogold which is considered compatible with the required temperature range. Piston rings are slit configuration with adequate end gap to preclude binding.
- C: Binding of main piston in bore is precluded by requirements for concentricity, surface finish and dimensional tolerances. Two slitted Fluorogold rings with a 301 CRES wavy spring to hold them in contact with the cylinder bore are used in the piston groove. The piston and cylinder bore are made of the same material, aluminum alloy, which precludes binding due to thermal expansion or contraction.
- D: Seizure of the main shaft and bearing is precluded by vendor specified dimensional tolerances that provide clearance. The bearing is a slit configuration and is made from Fluorogold which is considered compatible with the required temperature range.
- E: The main poppet is threaded onto the main shaft and locked in place by a set screw which is staked to the main poppet.
- F: The main shaft nut is threaded onto the shaft and locked by a set screw which is staked to the nut.
- G: The primary pilot plug is lockwired.
- H: Prior to assembly, passageway parts are cleaned per MSFC-SPEC-164, except particle size is limited to 1000 microns, and maintained clean during assembly and test. The source of gas flow through the passage is the ET ullage which is under contamination control.
- I: Prior to assembly, the pilot dump line is a tube assy with a flow passage of .21 inch diameter. Prior to assembly, parts are cleaned per MSFC-SPEC-164, except particle size is limited to 1000 microns, and maintained clean during assembly and test. The source of gas flow through the line is the ET ullage which is under contamination control.
- J: Binding is precluded by vendor specified dimensional tolerances that provide clearance. The stem is teflon coated per PS-425 (Calmec). Cleanliness is maintained per PS-422 (Calmec). Assembly and testing of the stem and retainer at the subassembly level is performed during the build cycle per PS-413 (Calmec).
- K: Gross leakage past this plug could cause the valve to relieve at a higher pressure than specified. The pilot valve body and plug sealing surfaces are machined to a 16 finish and a teflon gasket is used.
- L: The primary pilot is very carefully assembled by highly trained technicians. Intermediate tests and inspections are frequently made to assure a good quality assembly which will meet all pilot valve requirements. Before the pilot valve is installed on the main valve, it is placed in a test fixture with sufficient instrumentation to precisely determine stroke, flow rate and leakage rates at sense pressures between zero and 36 psig. This test is run at cryogenic and ambient temperatures. The operation of the pilot is again checked after installation on the main valve at cryogenic and ambient temperatures.
- M: The flow restrictor (orifice) is installed in the purge line between the vent actuator and the primary pilot ambient pressure sense port. The restrictor is in the line to prevent damage to the primary pilot from over-pressure. The restrictor is a plug of porous sintered monel powder in the passageway. It is cleaned prior to assembly per MSFC-SPEC-164, except particle size is limited 1000 microns, and maintained clean during assembly and test. The purge gas flow through the restrictor is from the GH2 vent actuation system which is under contamination control.

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DCN & DATE: 006, 6-30-00

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RATIONALE FOR RETENTION

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DESIGN: (cont)

- N: The secondary pilot nut is locked with a KEL-F friction plug.
- O: Seizure of the secondary pilot adapter and shaft is precluded by vendor specified dimensional tolerances that provide clearance. The bearing is a slit configuration and is made from Fluorogold which is considered compatible with the required temperature range.
- P: Disengagement of the secondary pilot threaded orifice could cause loss of relief capability. The orifice is threaded into the secondary pilot piston and torqued to 40 inch pounds. A KEL-F friction plug provides locking to prevent disengagement. It is restricted to a one time entry.

TEST:

The GH2 V/R Valve Assembly is qualified. Reference COQ MMC-ET-TM06-065.

The PD4700189-040 (Ketema) GH2 V/R Valve will be qualified by test and similarity. Test criteria is specified in the Procurement Drawing (PD4700189). Ketema will have all testing responsibility. Applicable test reports will be identified in this section at the conclusion of all testing.

Development: Two development valves, G02 and GH2, were fabricated and tested to develop the relief mechanism and provide confidence to proceed with qualification test. Cryogenic and ambient functional checks were run which included vent mode response and relief mode response, life cycle and leakage test (MMC-T-77-18-2). Development vibration testing was accomplished on the GH2 valve using a composite of the two required vibration spectra for the G02 and GH2 valves (MMC-T-77-18-1).

Qualification: Two GH2 qualification valves were fabricated and tested. Both valves were given relief mode response tests at various temperature and pressure (altitude simulation). Also, functional and leak tests, minimum vent actuation pressure tests, vent mode response, life cycle tests (500 relief and 500 vent), vibration, post vibration cryogenic functional and leak test, and burst pressure tests were run. All test requirements were met; relief and reseal pressures were within the required limits (MMC-ET-RA09-61 and MMC-ET-RA09-84).

The GH2 valve was later qualified by similarity for 5000 vent mode cycles (MMC-ET-RA09-60 addendum). It was also qualified by similarity to new and higher vibration levels (MMC-ET-RA09-91).

MPTA Firings/Tankings: One flight configuration valve assembly installed on MPTA has accumulated 60.9 minutes of firing time, 17 cryogenic cycles and 33 pressurization cycles.

Acceptance:

Vendor:

- A-P: Perform proof pressure test, internal and external leak tests, and functional test (T-290, CCC LWT-54 thru 84, 89-93; 88690 ATP1 for LWT-85 thru 88, 94 thru 114; 8-480798 for LWT-115 & Up).

MAE:

- A-P: Perform V/R valve operation test after installation (MMC-ET-TM04k).

Launch Site:

- A-P: Perform V/R valve operation test (OMRSD File II).

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INSPECTION:

Vendor Inspection - Lockheed Martin Surveillance:

- A: Verify materials selection and verification controls (MMC-ET-SE16 and drawing 1419-305, CCC for LWT-54 thru 114; K210-138 for LWT-115 & Up).
- B-D,J,  
L,O: Inspect dimensions (drawings 1419-262, 1419-258, 1419-253, 1419-4, 1419-313, 1419-252, 1419-257, 1419-25, 1419-44, 1419-286, and 1419-292 CCC for LWT-54 thru 114; K210-56, K210-130, K210-48, K210-5, K210-123, K210-46, K210-124, K210-28, K210-24, K210-85 and K210-80 for LWT-115 & Up).
- E-G,  
K-P: Witness valve assembly (PS-413 CCC for LWT-54 thru 84, 89-93; 88691 AP1 for LWT-85 thru 88, 94 thru 114; AIS-K210-502 for LWT-115 & Up).
- L: Witness pressure settings (PS-413 CCC for LWT-54 thru 84, 89-93; 88691 AP1 for LWT-85 thru 88, 94 thru 114; AIS-K210-502 for LWT-115 & Up).
- H, I,  
M: Witness Cleaning (PS-422, CCC for LWT-54 thru 114; 8-440369 for LWT-115 & Up).

Lockheed Martin Procurement Quality Representative:

- A-P: Witness proof pressure, internal and external leakage, and functional tests (document T-290, CCC for LWT-54 thru 84, 89-93; 88690 ATP1 LWT-85 thru 88, 94 thru 114; 8-480798 for LWT-115 & Up).

MAF Quality Inspection:

- A-P: Witness V/R valve operation test (MMC-ET-TM04k).

Launch Site:

- A-P: Witness V/R valve operation test (OMRSD File II).

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.