CRITICAL ITEMS LIST (CIL)

SYSTEM:	Propulsion/Mechanical	FUNCTIONAL CRIT:	1
SUBSYSTEM:	GH2 Vent/Relief	PHASE(S):	b, c
REV & DATE:	J, 12-19-97	HAZARD REF:	P.06, S.04, S.10
DCN & DATE:	005, 6-30-00		
ANALYSTS:	J. White/H. Claybrook		

FAILURE MODE: Fails To Reseat

FAILURE EFFECT:
b) Loss of mission and vehicle/crew due to fire/explosion or LH2 tank structural failure.
Loss of mission due to premature engine shutdown caused by loss of NPSP.
c) Loss of life due to ET impact outside designated footprint.

TIME TO EFFECT: Seconds

FAILURE CAUSE(S):
A: Seizure of Main Shaft and Bearing
B: Structural Failure of Secondary Pilot Cap
C: Disengagement of Secondary Pilot Cap Plug
D: Seizure of Secondary Pilot Piston Shaft and Bearing
E: Binding Between Primary Pilot Poppet Stem and Retainer
F: Low Primary Pilot Pressure Setting During Assembly
G: Structural Failure of Main Poppet
H: Clogged Metering Orifice
I: Binding of Main Piston in Bore
J: Broken Switch Lever
K: Structural Failure of Main Poppet Fairing
L: Loss of Belleville Force

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
2.8.14.6	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:

SYSTEM: Propulsion/Mechanical
SUBSYSTEM: GH2 Vent/Relief
FMEA ITEM CODE(S): 2.8.14.6

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

RATIONALE FOR RETENTION

DESIGN:

The GH2 Vent/Relief (V/R) valve assembly design is based on the Saturn S-II configuration. Poppet flow control, actuation and relief sensing system concepts have been incorporated. The ET GH2 valve was designed to meet the required ultimate safety factors (1.4 for loads and 2.0 for pressure) and the required yield safety factors (1.1 for loads and 1.5 for pressure) (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 conformance of composition, material compatibility and properties.

A: Seizure of 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.

B: The secondary pilot cap is machined from 6061-T651 aluminum alloy plate. The cap was designed to meet the required ultimate safety factor (1.4 for loads and 2.0 for pressure).

C: The secondary pilot plugs are lockwired.

D: Seizure of secondary pilot piston 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 to be compatible with temperature. The piston rings are slitted teflon riding on CRES wavy springs.

E: The primary pilot poppet stem and retainer is a matched set machined to very close tolerances. 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 done per PS-413 (Calmec).

F: 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 ambient and cryogenic temperatures.

G: The main poppet is machined from 6061-T651 aluminum alloy plate. It was designed to meet the required ultimate safety factors (1.4 for loads and 2.0 for pressure).

H: Orifice diameter is .130 inch. A metering pin slides back and forth inside the orifice to give a variable flow area with piston position. The movement of the pin inside the orifice prevents orifice blockage.

I: Binding of main piston in the bore is precluded by requirements for concentricity, surface finish, dimensional tolerances and clearances. 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 are made of the same material, aluminum alloy, which precludes binding due to thermal expansion or contraction.

J: Switch lever is fabricated from 304 Cres. It was designed to meet the required ultimate safety factor of 1.4 for loads and the yield safety factor of 1.1 for loads.

K: The main poppet fairing is made from 321 CRES sheet and configured for optimum flow, pressure drop and stiffness. The stiffness of the fairing is sufficient to move its resonant frequency outside the range of those frequencies generated by the gas flow through the valve.

L: Ni Span-C was selected as the best material for the Belleville spring. The spring rate is very near constant over the temperature range required, and hysteresis is low. Hysteresis is further reduced by coating the convex side of the spring with teflon. Extensive testing was done to develop the coating process and the heat treat process of the spring. The spring material has been thoroughly tested to assure its mechanical properties meet the requirements for this value. The final configuration of the spring selected has also been thoroughly tested. Burst pressure tests have been run on four qualification test valves in which the Belleville was exposed to 74 psig with no damage. Every production unit receives a proof pressure test of 56 psig and the operation of the pilot valve is subsequently checked.

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SUBSYSTEM:	GH2 Vent/Relief	DCN & DATE:	005, 6-30-00
FMEA ITEM CODE(S):	2.8.14.6		

RATIONALE FOR RETENTION

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, GO2 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 GO2 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 reseat 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-L: Perform proof pressure, internal and external leakage, and functional tests (document T-290, CCC for LWT-54 thru 84, 89-93; 88690 ATP1 for LWT-85 thru 88, 94 thru 114; 8-480-798 for LWT-115 & Up).

MAF - Total Assembly:

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

Launch Site:

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

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RATIONALE FOR RETENTION

INSPECTION:

Vendor Inspection - Lockheed Martin Surveillance:

B,G,I, J-L: Verify materials selection and verification controls (MMC-ET-SE16 and drawings 1419-4, 1419-17, 1419-7, 1419-251-1, 1419-265, 1419-47, and 1419-50, CCC for LWT-54 thru 114; K210-5, K210-3, K210-35, K210-90, K210-57, K210-29, K210-31 for LWT-115 & Up).

A,D,E, F,I: Inspect dimensions (drawings 1419-25, 1419-44, 1419-262, 1419-286, 1419-292, 1419-258 and 1419-313, CCC for LWT-54 thru 114; K210-28, K210-24, K210-56, K210-85, K210-80, K210-130, K210-123 for LWT-115 & Up).

C, F: Witness assembly and pressure settings (PS-413, CCC for LWT-54 thru 84, 89-93; 88691 AP1 LWT-85 thru 88, 94 thru 114; AIS-K210-502 for LWT-115 & Up).

H: Witness cleaning (procedure PS-422, CCC for LWT-54 thru 114; 8-440369 for LWT-115 & Up).

Lockheed Martin Procurement Quality Representative:

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

MAF Quality Inspection:

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

Launch Site:

A-L: 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.