

CRITICAL ITEMS LIST (CIL)

SYSTEM: Propulsion/Mechanical
 SUBSYSTEM: GO2 Vent/Relief
 REV & DATE: J, 12-19-97
 DCN & DATE: 005, 6-30-00
 ANALYSTS: J. White/H. Claybrook

FUNCTIONAL CRIT: 1
 PHASE(S): b
 HAZARD REF: S.03, S.10

FAILURE MODE: Fails To Reset
 FAILURE EFFECT: b) Loss of mission and vehicle/crew due to LO2 tank structural failure.
 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 operations.

FMEA ITEM CODE(S)	PART NO.	PART NAME	QTY	EFFECTIVITY
2.3.19.6	PD4700187-079 -089	GO2 Vent/Relief Valve	1 1	LWT-54 thru 114 LWT-115 & Up

REMARKS:

CRITICAL ITEMS LIST (CIL)
CONTINUATION SHEET

SYSTEM: Propulsion/Mechanical
SUBSYSTEM: G02 Vent/Relief
FMEA ITEM CODE(S): 2.3.19.6

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

RATIONALE FOR RETENTION

DESIGN:

- The G02 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 G02 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 provides 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 (2.0 for pressure and 1.4 for loads).
- C: The secondary pilot plugs are lockwired.
- D: Seizure of secondary pilot piston shaft and bearing is precluded by vendor specified dimensional tolerances that provides 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 86650 AP1, CCC.
- 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 applicable sense pressures. 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 factor of 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 50 psig with no damage. Every production unit receives a proof pressure test and the operation of the pilot valve is subsequently checked.

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RATIONALE FOR RETENTION

TEST:

The G02 V/R Valve Assembly is qualified. Reference COQ MMC-ET-TM06-094.

The PD4700187-089 (Ketema) G02 V/R Valve will be qualified by test and similarity. Test criteria is specified in the Procurement Drawing (PD4700187). Ketema will have all testing responsibility. Applicable test reports will be identified in this section at the conclusion of all testing.

The PD4700187-079 valve was qualified by similarity to the -059 valve with the following additional testing performed. (See FMEA Item Code 2.3.19.3 for full description of the -059 valve development/qualification).

Development (PD4700187-079): A new Belleville Primary Pilot Assembly (31 ± 1 PSIG relief pressure setting) was installed on a refurbished G02 Vent/Relief Valve. Proof pressure and external leakage tests were performed on the development valve. The valve was then installed on the test tank and 42 relief mode life cycles at ambient and cryogenic temperatures were run using either the GN2 or Helium prepress (Memo MMC-ET-3515-89-024).

Qualification (PD4700187-079): The Belleville spring in the G02 vent/relief valve was modified in order to accommodate the new higher relief pressure setting (31 ± 1 PSIG). Testing was performed on 1 Type VI valve which included 250 relief mode life cycles (150 at cryogenic temperature and 100 at ambient). All testing met criteria for relief and reseal pressures of 31 ± 1 PSIG and 29 PSIG minimum. The rest of the valve parts were unchanged and qualified by similarity to the PD4700187-059 valve (MMC-ET-RA09-119).

MPTA Firings/Tankings: One flight configuration valve assembly installed on MPTA has accumulated 60.5 minutes of firing time, 18 cryogenic cycles and 24 pressurization cycles. One relief function was performed by special test (SF-10). Audible relief and reseal pilot valve tests were performed which verified relief operation of the primary and secondary pilot sections.

Acceptance:

Vendor:

A-L: Perform proof pressure, external and internal leak, and ambient and cryogenic functional tests (drawing 86650 ATP 1, CCC for LWT-54 thru 114; and 8-480797 for LWT-115 & Up).

MAF - Total Assembly:

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

Launch Site:

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

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INSPECTION:

Vendor Inspection - Lockheed Martin Surveillance:

- B, G, I-L: Verify materials selection and verification controls (MMC-ET-SE16 and drawings 1419-4, 1419-17, 1419-7, 1419-265, 1419-47, 1419-50 and 86651, CCC for LWT-54 thru 114; K210-5, K210-17, K210-35, K210-57, K210-29, K210-31, K210-90 for LWT-115 & Up).
- A, D-F, I: Inspect dimensions (drawings 1419-25, 1419-44, 1419-262 1419-4, 1419-17, 1419-286, 1419-292, 1419-258 and 86654, CCC for LWT-54 Thru 114; K210-28, K210-24, K210-56, K210-5, K210-17, K210-85, K210-80, K210-130, K210-184 for LWT-115 & Up).
- C, F: Witness assembly and pressure settings (drawing 86650 AP1, CCC for LWT-54 thru 114; AIS-K210-501 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, external and internal leakage, and ambient and cryogenic functional tests (drawing 86650 ATP 1, CCC for LWT-54 thru 114; 8-480797 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.