

CRITICAL ITEMS LIST (CIL)

SYSTEM: Propulsion/Mechanical FUNCTIONAL CRIT: 1
 SUBSYSTEM: G02 Vent/Relief PHASE(S): b
 REV & DATE: J, 12-19-97 HAZARD REF: S.03, S.10
 DCN & DATE: 005, 6-30-00
 ANALYSTS: J. White/H. Claybrook

FAILURE MODE: Fails Open (Relief Mode)

FAILURE EFFECT: b) Loss of mission and vehicle/crew due to L02 tank structural failure.

TIME TO EFFECT: Seconds

FAILURE CAUSE(S):
 A: Structural Failure of Secondary Pilot Cap
 B: Disengagement of Secondary Pilot Cap Plug
 C: Low Primary Pilot Pressure Setting During Assembly
 D: Structural Failure of Main Poppet
 E: 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 |
|-------------------|-----------------------|-----------------------|--------|---------------------------------|
| 2.3.19.3 | PD4700187-079 -089 | G02 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): 2.3.19.3

REV & DATE: J, 12-19-97
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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: 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).
- B: The secondary pilot plugs are lockwired.
- C: 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.
- D: 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.
- E: 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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TEST:

The G02 V/R valve assembly is qualified. Reference COQ MMC-ET-TM06-094.

Development (PD4700187-059): 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 (PD4700187-059): Two qualification test valves, Type III, were initially fabricated and tested. Both valves were given relief mode response tests at various temperatures and pressures (altitude simulation). Also, functional and leak tests, minimum vent actuation pressure tests and 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 testing met criteria for relief and reseal pressures of 24 ± 1 psig and 22 psig minimum (MMC-ET-RA09-60).

Later, one of the valves was given an extended life cycle test in which the valve was cycled open and closed in the vent mode 5,000 additional cycles. Functional and leak checks were performed on the valve following the life cycle test. All leakage requirements and relief and reseal requirements were met (MMC-ET-RA09-60, Addendum).

After both valves had passed all qualification test requirements, the vibration level requirements were raised, requiring retest to the higher levels. The valve which went through the extended life cycle test was again selected for the delta qualification vibration test. The valve was tested and met all requirements including the post vibration leak and functional tests (MMC-ET-RA09-67).

When another vendor was selected to produce the valve, another Type III qualification valve was fabricated by the new vendor. The third qualification test valve received the same tests as the first two, except as follows.

- 1) It was tested to newer and higher vibration levels than the first two valves.
- 2) The life cycle test was 5750 vent cycles and 500 relief cycles.

All criteria for the test was met including the leak and functional which followed the vibration and life cycle test (MMC-ET-RA09-91).

The PD4700187-079 was qualified by similarity to the -059 valve, but underwent some additional development and qualification activities.

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).

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RATIONALE FOR RETENTION

TEST: (cont)

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

MAF - Total Assembly:

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

Launch Site:

A-E: Perform G02 V/R valve operation test (OMRSD File II).

INSPECTION:

Vendor Inspection - Lockheed Martin Surveillance:

A, D, E: Verify materials selection and verification controls (MMC-ET-SE16 and drawings 1419-265, 1419-50, CCC and 86651 for LWT-54 thru 114; K210-57, K210-31, K210-90 for LWT-115 & Up)
B, C: Witness assembly and pressure settings (drawing 86650 AP1, CCC for LWT-54 thru 114; K210-501 for LWT-115 & Up)
C: Inspect dimensions (drawing 86654, CCC for LWT-54 thru 114; K210-184 for LWT-115 & Up)

Lockheed Martin Procurement Quality Representative:

A-E: 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-E: Witness V/R Valve Operation Test (MMC-ET-TM04k).

Launch Site:

A-E: Witness 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.