

SRB CRITICAL ITEMS LIST

SUBSYSTEM: THRUST VECTOR CONTROL

ITEM NAME: Gas Generator Valve Module

PART NO.: 5902651  
5912183 (alternate)

FM CODE: A10

ITEM CODE: 20-01-14

REVISION: Basic

CRITICALITY CATEGORY: 1R

REACTION TIME: Seconds

NO. REQUIRED: 2

DATE: March 31, 2000

CRITICAL PHASES: Final Countdown, Boost

SUPERCEDES: March 31, 1999

FMEA PAGE NO.: A-52A

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SHEET 1 OF 7

APPROVED: S. Parvathaneni

FAILURE MODE AND CAUSES: Pulse (Primary) control valve (NO) fails to close and shutoff (Secondary) control valve (NC) fails to close or remain closed (Systems A and/or B) caused by (BI-2003):

- o Contamination
- o Defective poppet sealing surface
- o Spring failure (secondary valve)
- o Poppet/sleeve galling
- o Coining or deformation of valve seats
- o Electrical open circuit (connector, wiring, solenoid) [Primary Valve]
- o Bellows failure

FAILURE EFFECT SUMMARY: Fire and explosion will lead to loss of mission, vehicle and crew. One success path remains after the first failure. Operation is not affected until both paths are lost.

REDUNDANCY SCREENS AND MEASUREMENTS:

- 1) Pass - All units are subject to ATP during turnaround and refurbishment.
- 2) Pass - APU turbine speed measurements B46R1406C, B46R1407C, B46R1408C, B46R1409C.
- 3) Fail - Contamination

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## RATIONALE FOR RETENTION:

## A. DESIGN

- o The Gas Generator Valve Module is designed and qualified in accordance with end item specification 10SPC-0050. (All Failure Causes) (BI-1883)
- o The shutoff valve is normally closed. (Electrical Open Circuit [Connector, Wiring and Solenoid])
- o The shutoff valve and pulse control valve are 28 VDC direct acting poppet type solenoids. (Electrical Open Circuit [Connector, Wiring and Solenoid])
- o The shutoff valve is series redundant to the pulse control valve. (All Failure Causes)
- o Hydrazine is filtered through two 25 micron filter upstream of the GGVM. (Contamination)
- o Spring material is 17-7PH Cres CH900 contained in a protected environment. (Spring Failure [Secondary Valve])
- o The pulse control valve is normally open. (Electrical Open Circuit [Connector, Wiring and Solenoid])
- o Electrical connector, wiring and solenoid for PCV and SOV are physically separated. (Electrical Open Circuit [Connector, Wiring and Solenoid] Bellows Failure)
- o Bellows material is (sulphur free) nickel. Bellows assembly poppet and retainer material is CRES 304L. (Bellows Failure)
- o Poppet (stem) material is 303 stainless steel with an EPR O-ring which seals and maintains a standoff. (Defective Poppet Sealing Surface, Poppet/Sleeve Galling)
- o Sleeve (body/retainer) material is 6AL-4V Titanium. (Poppet/Sleeve Galling)
- o APU surfaces exposed to Hydrazine, except gas generator, are cleaned per 10PRC-0339. (Contamination)
- o Fluid procurement is controlled per SE-S-0073. (Contamination)
- o The APU controller has BITE capability to verify operation of the valves. (Spring Failure [Secondary Valve], Poppet/Sleeve Galling, Electrical Open Circuit [Connector, Wiring and Solenoid] Bellows Failure)
- o Aft skirt area is purged with GN2 prior to APU startup. This reduces the O2 concentration to less than four percent per OMRSD File II, Vol. 1, requirement number S00FM0.430. (All Failure Causes)

- o Qualification testing verified design requirements as reported in Sundstrand Qualification Test Report AER-1539-6, Rev. B and AER 1539-10, Rev. Basic. (All Failure Causes)

#### B. TESTING

- o Acceptance testing of the GGVM is performed per Marotta ATP 281951-9002 on each new unit. This includes visual and dimensional examination, dielectric strength test, insulation resistance test, resistance check, pull-in voltage, drop-out voltages, internal leakage, stem travel, response, flow test and valve cycle test and cleanliness level check. (All Failure Causes)
- o Abbreviated acceptance testing of units that only require rework of the solder joints is performed per Marotta AATP281951-9002. This includes visual and dimensional examination, internal leakage and cleanliness level check. (All Failure Causes)
- o Acceptance testing of the assembled APU is performed per Sundstrand ATP TS2409. This includes resistance checks, fuel shutoff valve verification, fuel pulse valve verification, verification of proper valve operation at all rated turbine speeds and decontamination and precision cleaning of the fuel system. (All Failure Causes)
- o During refurbishment and prior to reuse, the GGVM is tested per Sundstrand ATP TS2409. (All Failure Causes)
- o Helium (influent) is verified for cleanliness and composition (purity and particulate count) prior to fuel pump shaft seal leak check per 10REQ-0021, para. 2.3.2.5. (Contamination)
- o Helium is verified for cleanliness and composition (purity and particulate count) prior to introduction to on-board circuits per 10REQ-0021, para. 2.3.2.5. (Contamination)
- o Hydrazine is verified for cleanliness and composition (purity and particulate count) prior to introduction to on-board hydrazine circuits per 10REQ-0021, para. 2.3.2.1 and OMRSD File V, Vol. 1 requirement number B42AP0.010. (Contamination)
- o GN2 is verified for cleanliness and composition (purity and particulate count) prior to introduction to on-board hydrazine circuits per 10REQ-0021, para. 2.3.2.2 and OMRSD File V, Vol. 1 requirement number B42AP0.012. (Contamination)
- o GN2 (from MLP portable panels) is verified for cleanliness and composition (purity and particulate count) prior to introduction to on-board hydrazine circuits per OMRSD File V, Vol. 1 requirement number B42AP0.012. (Contamination)
- o HPU BITE test verifying speed control valve operation is performed per 10REQ-0021, para. 2.3.4. (Spring Failure [Secondary Valve] Poppet/Sleeve Galling, Electrical Open Circuit [Connector, Wiring and Solenoid] Bellows Failure)
- o Fuel system leak test at 395 +0/-20psia is performed per 10REQ-0021, para 2.3.6 prior to Hotfire. (Defective Poppet Sealing Surface, Spring Failure [Secondary Valve], Puppert/Sleeve Galling, Coining or Deformation of Valve Seats).

- o Verification of FSM bottle pressure for hydrazine system pressure check per File V, Vol. I, requirement number B42AP0.025. (Defective Poppet Sealing Surface Spring failure (secondary valve), Poppet/Sleeve galling, coining or deformation of valve seats)
- o BITE test verifying APU speed control valve operation is performed per OMRSD File V, Vol. 1 requirement number B42AP0.050 prior to rollout. (Spring Failure [Secondary Valve], Poppet Sleeve, Galling, Electrical Open Circuit [Connector, Wiring and Solenoid], Coining or Deformation of Valve Seats, Bellows Failure)
- o APU BITE test verifying speed control valve operation is performed during launch countdown (approximately T-11 hour) per OMRSD File V, Vol. 1 requirement numbers B42AP0.050 and .060. This is the last check of valve operation prior to APU startup. (Spring Failure [Secondary Valve], Poppet/Sleeve Galling, Electrical Open Circuit [Connector, Wiring and Solenoid], Bellows Failure)
- o APU BITE test is conducted per OMRSD File V, Vol. 1 requirement numbers B42AP0.050 and .060 (Spring Failure [Secondary Valve])

The above referenced OMRSD testing is performed every flight.

#### C. INSPECTION

##### VENDOR RELATED INSPECTIONS

- o Vendor inspection and test records are verified per SIP 1128 by USA SRBE PQAR. (All Failure Causes) (BI-1883)
- o Verification of test data from Marotta is performed per SIP 1128 by USA SRBE PQAR. (All Failure Causes)
- o Verification of GGVM assembly is performed in a 100K clean room per SIP 1128 by USA SRBE PQAR. (All Failure Causes)
- o Verification of final leak tests is performed per SIP 1128 by USA SRBE PQAR. (Defective Poppet Sealing Surface, Coining or Deformation of Valve Seats).
- o Verification of material certifications is performed per SIP 1128 by USA SRBE PQAR. (Defective Poppet Sealing Surface, Spring Failure, Poppet/Sleeve Galling, Coining or Deformation of Valve Seats, Bellows Failure)
- o Witnessing of acceptance testing is performed per SIP 1128 by USA SRBE PQAR. (All Failure Causes)
- o Verifications that are required on new units are performed on refurbished units per SIP 1128 by USA SRBE PQAR. (All Failure Causes)
- o Critical Processes/Inspections:
  - Solder per Marotta PS281951-9002 and NHB 5300.4 (3A-1)(BI-1883)
  - Heat treating per MIL-H-6875
  - Welding per Marotta Drawing 235272-9001 (Marotta procedure SP196-0071, AMS2680 & AMS2681)
  - Penetrant per MIL-STD-6866 and Marotta SP196-2100

## KSC RELATED INSPECTIONS

- o Helium (influent) cleanliness and composition (purity and particulate count) are verified prior to fuel pump shaft seal leak check per 10REQ-0021, para. 2.3.2.5. (Contamination)
- o Precision cleaning of tubes/hoses is verified by USA SRBE per 10REQ-0021, para. 2.3.0. (Contamination)
- o Helium cleanliness and composition (purity and particulate count) are verified prior to introduction to on-board circuits per 10REQ-0021, para. 2.3.2.5.(Contamination)
- o Hydrazine cleanliness and composition (purity and particulate count) are verified prior to introduction to on-board hydrazine circuits per 10REQ-0021, para. 2.3.2.1 and OMRSD File V, Vol. 1 requirement number B42AP0.010. (Contamination)
- o GN2 cleanliness and composition (purity and particulate count) are verified prior to introduction to on-board hydrazine circuits per 10REQ-0021, para. 2.3.2.2 and OMRSD File V, Vol. 1 requirement number B42AP0.012. (Contamination)
- o Verification of the fuel system leak test per 10REQ-0021, para 2.3.6 prior to Hotfire. (Defective Poppet Sealing Surface, Spring Failure [Secondary Valve], Puppert/Sleeve Galling, Coining or Deformation of Valve Seats).
- o Proper function of the TVC system is demonstrated during Hotfire operations per 10REQ-0021, para. 2.3.16. (Defective Poppet Sealing Surface, Spring Failure [Secondary Valve], Poppet/Sleeve Galling, Electrical Open Circuit [Connector, Wiring and Solenoid], Coining or Deformation of Valve Seats, Bellows Failure)
- o GN2 (from MLP portable panels) cleanliness and composition (purity and particulate count) are verified prior to introduction to on-board hydrazine circuits per OMRSD File V, Vol. 1 requirement number B42APO.012. (Contamination)
- o TVC Couplings (Both SRB and GSE) are inspected each time prior to mating per 10REQ-0021 para. 2.3. After transfer to SPC they are inspected prior to mating per File V, Vol. I, requirement number B42GEN.070. (Contamination).

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- o GN2 (from servicing cart) cleanliness and composition (purity and particulate count) are verified prior to introduction to on-board hydrazine circuits per OMRSD File V, Vol. 1 requirement number B42APO.012. (Contamination)
- o Hydrazine (from servicing cart) cleanliness and composition (purity and particulate count) are verified prior to introduction to on-board hydrazine circuits per OMRSD File V, Vol. 1 requirement number B42APO.010. (Contamination)
- o Verification of proper valve operation during BITE per OMRSD File V, Vol. 1 requirement number B42AP0.050. (Spring Failure [Secondary Valve], Poppet/Sleeve Galling, Electrical Open Circuit [Connector, Wiring and Solenoid], Bellows Failure)
- o Verification of FSM bottle pressure for hydrazine system pressure check per File V, Vol. I, requirement number B42AP0.025. (Defective Poppet Sealing Surface, Spring Failure [Secondary Valve], Poppet/Sleeve Galling, Coining or Deformation of Valve Seats)
- o Verification of APU BITE test per OMRSD File V, Vol. 1 requirement numbers B42AP0.050 and .060 (Spring Failure [Secondary Valve], Poppet/ Sleeve Galling, Electrical Open Circuit [Connector, Wiring and Solenoid], Bellows Failure)
- o Verification of proper performance of BITE test per OMRSD File V, Vol. 1 requirement numbers B42AP0.050 and .060. (Spring Failure [Secondary Valve], Poppet/Sleeve Galling, Electrical Open Circuit [Connector, Wiring and Solenoid], Bellows Failure)

#### D. FAILURE HISTORY

- o Failure Histories may be obtained from the PRACA database.

#### E. OPERATIONAL USE

- o Not applicable to this failure mode.

#### F. Waivers

- o BI-1883, dt 11-19-90, Level III approval SB3-01-3891, Level II approval PRCBD-S92144C
  - o Requirement: Per 10CEI-0001 para. 3.3.5.4 soldering of electrical connectors on the SRB & GSE/STE that directly interface with a space shuttle element shall be per NHB 5300.4 (3A-1).
  - o Departure from Requirement: Soldering of GGVM electrical connectors do not meet paragraph 3A704 of NHB 5300.4 (3A-1). Soldering joints have (i) Improper tinning, (ii) Separation of wire strands and (iii) Excessive solder.

- o Rationale for Approval of the Waiver: The original qualifications of APUs were completed with GGVMs soldered by the same technicians. A Delta Qualification was performed on additional GGVMs also soldered by the same technicians. GGVMs must pass ten functional and electrical tests at Sundstrand and USA SRBE prior to aisle transfer. The GGVM must also pass two Bite tests, the final test at T - 9 Hrs, prior to launch. There is no case of a solder related failure on GGVMs.
- o BI-2003, dt 5/20/99, Level III approval SB3-01-5300
  - o Requirement: Per Vendor Engineering drawings 281951-9002 and 234561-9001, the GGVM seat material should be Dupont Tefzel HT 2004 (material selection based on seat coining considerations).
  - o Departure from Requirement: Valves in fleet have improper seat material (Teflon with potentially different seat coining attributes)
  - o Rationale for Approval of the Waiver: Material evaluation and experience has shown Teflon to be a suitable substitute for Tefzel in this application. Additionally, extensive testing demonstrates proper operation of the valve seats prior to flight.

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