

**FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL HARDWARE**

NUMBER: 03-1-0519 -X

SUBSYSTEM NAME: MAIN PROPULSION

REVISION: 1 07/26/00

**PART DATA**

PART NAME	PART NUMBER
VENDOR NAME	VENDOR NUMBER
LRU : GO2 ET TANK PRESSURIZATION FLOW CONTROL VALVES	MC280-0017-1447, -2492
VACCO INDUSTRIES	84400-2492

**EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:**

VALVE, FLOW CONTROL, SOLENOID, GO2 PRESSURANT, NORMALLY HIGH FLOW (0.625 INCH DIA INLET 1.0 INCH DIA OUTLET) (LV53, 54, 55).

**REFERENCE DESIGNATORS:** LV53  
LV54  
LV55

**QUANTITY OF LIKE ITEMS:** 3

**FUNCTION:**

THREE FLOW CONTROL VALVES (ONE PER SSME SYSTEM) CONTROL THE FLOW OF PRESSURIZATION GAS FROM THE ENGINES TO THE OXYGEN TANK TO MAINTAIN ULLAGE PRESSURE FOR TANK STRUCTURAL STABILITY AND SSME NPSP.

FOR ACTIVE CONFIGURATION VALVES (-1447) THE UNPOWERED SOLENOID VALVE POSITION IS HIGH FLOW. VALVE POSITION (HIGH FLOW / LOW FLOW) IS CONTROLLED BY STIMULI FROM THE ORBITER MOUNTED SIGNAL CONDITIONERS. SIGNAL CONDITIONER INPUT COMES FROM ET MOUNTED ULLAGE PRESSURE TRANSDUCERS.

FOR FIXED ORIFICE VALVES (-2492) THE VALVES ARE SHIMMED TO A FIXED FLOW SETTING (78% FLOW) AND THE SIGNAL CONDITIONER IS DISCONNECTED FROM THE VALVE SOLENOIDS.

**FAILURE MODES EFFECTS ANALYSIS FMEA -- CIL FAILURE MODE**

**NUMBER: 03-1-0519-06**

**REVISION#: 1 07/26/00**

**SUBSYSTEM NAME: MAIN PROPULSION**

**LRU: VALVE, FLOW CONTROL (GO2)**

**ITEM NAME: GO2 FLOW CONTROL VALVES (LV53, 54, 55)**

**CRITICALITY OF THIS**

**FAILURE MODE: 1/1**

---

**FAILURE MODE:**

ORIFICE EROSION/BROKEN POPPET

**MISSION PHASE: LO LIFT-OFF**

<b>VEHICLE/PAYLOAD/KIT EFFECTIVITY:</b>	102	COLUMBIA
	103	DISCOVERY
	104	ATLANTIS
	105	ENDEAVOUR

**CAUSE:**

FATIGUE, MATERIAL DEFECT, DAMAGED/DEFECTIVE POPPET, CONTAMINATION

**CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO**

---

**REDUNDANCY SCREEN**

- A) N/A
- B) N/A
- C) N/A

**PASS/FAIL RATIONALE:**

A)

B)

C)

---

**- FAILURE EFFECTS -**

---

**(A) SUBSYSTEM:**

RESULTS IN VENTING OF GO2 AT LOW ALTITUDE. POSSIBLE VIOLATION OF TANK MAXIMUM STRUCTURAL CAPABILITY REQUIREMENTS. POSSIBLE FIRE/EXPLOSION HAZARD EXTERNAL TO THE VEHICLE.

**(B) INTERFACING SUBSYSTEM(S):**

SAME AS A.

**FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL FAILURE MODE  
NUMBER: 03-1-0519-06**

**(C) MISSION:**  
SAME AS A.

**(D) CREW, VEHICLE, AND ELEMENT(S):**  
POSSIBLE LOSS OF CREW/VEHICLE.

**(E) FUNCTIONAL CRITICALITY EFFECTS:**  
NONE.

---

**-DISPOSITION RATIONALE-**

---

**(A) DESIGN:**  
THE FIXED ORIFICE CONFIGURATION HAS HAD THE POPPET SHIMMED TO A 78% FLOW SETTING AND THE SIGNAL CONDITIONER INPUTS DISCONNECTED FROM THE VALVE SOLENOIDS. THE ACTIVE CONFIGURATION VALVE IS A SINGLE FLOW PATH, DUAL POSITION TYPE. IT IS SHIMMED TO ALLOW FLOW AT THE REQUIRED HIGH AND LOW FLOW SETTINGS. IT IS SPRING LOADED TO THE HIGH FLOW POSITION AND SOLENOID ACTUATED TO THE LOW FLOW POSITION. A LABYRINTH-DESIGN SEAL REDUCES THE POTENTIAL FOR MARGINAL POPPET FORCE BALANCE BY MINIMIZING ACTUATION FORCE REQUIRED FROM THE SOLENOID.

THE POPPET AND SLEEVE IS MANUFACTURED FROM MONEL 500 AND POPPET GUIDE FROM INCONEL 718. STRUCTURAL ANALYSIS INDICATES POSITIVE MARGINS OF SAFETY FOR ALL CONDITIONS OF VALVE OPERATION AND FRACTURE ANALYSIS SHOWS THAT ALL CRITICAL PARTS ARE SATISFACTORY FOR FOUR TIMES EXPECTED LIFE.

CONTAMINATION IS FILTERED UPSTREAM OF THE VALVE BY THE ENGINE ANTI- FLOOD VALVE FILTER (100 MICRON GLASS BEAD RATING). SYSTEM CONTAMINATION IS FURTHER MINIMIZED DUE TO THE PRESENCE OF AN ET SCREEN, A PREVALVE SCREEN, A GSE DEBRIS PLATE, AND A GSE FILTER.

**(B) TEST:**  
ATP

EXAMINATION OF PRODUCT

AMBIENT TESTS

PROOF PRESSURE: VALVE HOUSING (9,860 PSIA OF GN2, TEMP CORRECTED)  
PRIMARY SEAL LEAKAGE (600 PSIA OF HELIUM)  
SECONDARY SEAL LEAKAGE (400 PSIA OF HELIUM)  
TOTAL EXTERNAL LEAKAGE (600 PSIA OF HELIUM)

**FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL FAILURE MODE  
NUMBER: 03-1-0519-06**

ELECTRICAL CHARACTERISTICS

- INSULATION RESISTANCE
- BONDING
- DIELECTRIC STRENGTH
- COIL RESISTANCE
- COIL TEMPERATURE TEST

FLOW CALIBRATION VERIFICATION (GO2 AT +380 DEG F)

- HI FLOW POSITION
  - INLET PRESSURE: 3700 PSIA OR LESS
  - OUTLET PRESSURE: 600 PSIA MAXIMUM
- LOW FLOW POSITION
  - INLET PRESSURE: 3700 PSIA
  - OUTLET PRESSURE: 600 PSIA MAXIMUM

FUNCTIONAL TEST

- DEMONSTRATION DUTY CYCLE (720 SECONDS OF GO2 FLOW)
  - INLET PRESSURE (LOW FLOW): 3700 PSIA
  - GO2 FLOW TEMPERATURE: +380 DEG F
- PERFORMANCE VERIFICATION (ELECTRICAL)

CERTIFICATION

FUNCTIONAL TESTS

- DEMONSTRATION DUTY CYCLE (720 SECONDS OF GO2 FLOW)
- 12 SETS OF INITIAL CONDITIONS:
  - GO2 AT 260°F, 380°F, 530°F
  - 1,500 PSIA, 2,500 PSIA, 3,500 PSIA, 4,500 PSIA
  - (ALL PRESSURES AT ALL THREE TEMPERATURES)
- HIGH TEMPERATURE (4 DUTY CYCLES OF 600 SECONDS EACH)
  - GO2 AT 710°F
  - 3,600 (LOW FLOW) TO 4,200 PSIA (HIGH FLOW)
- ONE HUNDRED MISSION FLOW (51 DUTY CYCLES)
  - GO2 AT 380°F AND 3,700 PSIA

SEAL LEAKAGE TESTS

- PRIMARY SEAL (PERFORMED DURING OFF-LIMIT TEMPERATURE TEST)
- SECONDARY SEAL
  - HELIUM AT AMBIENT
  - 400 PSIA AT PRIMARY TEST PORT

LIFE TESTS

- OPERATIONAL CYCLES (5000 CYCLES)
  - INLET PRESSURE: 4500 PSIA
  - INLET TEMPERATURE: +380 DEG F
  - PERFORMANCE VERIFICATION (ELECTRICAL AND FLOW)
- AMBIENT CYCLES (5000 CYCLES)
  - INLET PRESSURE: 25 PSIA
  - INLET TEMPERATURE: AMBIENT

**FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL FAILURE MODE  
NUMBER: 03-1-0519-06**

PERFORMANCE VERIFICATION (ELECTRICAL AND FLOW)

AT COMPLETION OF AMBIENT CYCLE TEST REPEAT PERFORMANCE VERIFICATION (ELECTRICAL) AND ELECTRICAL CHARACTERISTICS TEST

VIBRATION

RANDOM: 13.3 HOURS IN EACH OF THREE AXES PRESSURIZED WITH 600 PSIG GHE AT AMBIENT TEMPERATURE

DESIGN SHOCK (PER MIL-STD-810)

THERMAL SHOCK (100 CYCLES)

BODY TEMPERATURE: AMBIENT

INLET PRESSURE: 4500 PSIA

INLET TEMPERATURE: +70 DEG F TO -160 DEG F TO +380 DEG F

PARTICLE IMPACT TEST

10 MG SAMPLE MIXTURE OF 5 TO 250 MICRON DIAMETER INCONEL, ALUMINUM, AND CRES 21-6-9 PARTICLES 40 HIGH FLOW AND 40 LOW FLOW TESTS AT TEMPERATURES OF 490°F AND 620°F (160 TESTS TOTAL).

BURST TEST

19,340 PSIA AT 300 DEG F

NOTE: CERTIFICATION TESTING OF THIS COMPONENT IS STILL IN PROCESS.

GROUND TURNAROUND TEST

ANY TURNAROUND CHECKOUT IS ACCOMPLISHED IN ACCORDANCE WITH OMRSD.

**(C) INSPECTION:**

RECEIVING INSPECTION

ALL INCOMING MATERIALS ARE INSPECTED FOR MATERIAL AND PROCESS CERTIFICATION.

CONTAMINATION CONTROL

ASSEMBLIES ARE MAINTAINED TO CLEANLINESS LEVEL 100A FOR OXYGEN. CORROSION PROTECTION PROVISIONS ARE VERIFIED BY INSPECTION.

ASSEMBLY/INSTALLATION

ALL PARTS ARE CLEANED PRIOR TO ASSEMBLY. DIMENSIONS AND SURFACE FINISHES ARE VERIFIED BY INSPECTION. MANDATORY INSPECTION POINTS ARE ESTABLISHED TO VERIFY ASSEMBLY PROCEDURES. TORQUE REQUIREMENTS AND ELECTROCHEMICAL ETCH MARKINGS ARE VERIFIED BY INSPECTION.

CRITICAL PROCESSES

WELDING, INCLUDING SECTIONING WELD SAMPLES, AND SOLDERING ARE VERIFIED BY INSPECTION. ALL SOLDER JOINTS, INSULATED WITH HEAT SHRINK SLEAVINGS, ARE VERIFIED PER APPLICABLE REQUIREMENTS AND POTTED TO PROVIDE STABILITY. ELECTRO POLISHING AND PASSIVATION ARE VERIFIED BY INSPECTION.

NONDESTRUCTIVE EVALUATION

**FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL FAILURE MODE  
NUMBER: 03-1-0519-06**

WELDS ARE VISUALLY EXAMINED AND VERIFIED BY X-RAY AND DYE PENETRANT INSPECTION. RADIFLOW INSPECTION IS PERFORMED ON SOLENOID ASSEMBLY. ALL MATERIALS ARE EVALUATED FOR OXYGEN COMPATIBILITY.

**TESTING**

ATP IS VERIFIED BY INSPECTION.

**HANDLING/PACKAGING**

PACKAGING FOR SHIPMENT IS VERIFIED BY INSPECTION.

**(D) FAILURE HISTORY:**

CURRENT DATA ON TEST FAILURE, FLIGHT FAILURE, UNEXPLAINED ANOMALIES, AND OTHER FAILURES EXPERIENCED DURING GROUND PROCESSING ACTIVITY CAN BE FOUND IN THE PRACA DATABASE.

**(E) OPERATIONAL USE:**

NO CREW ACTION CAN BE TAKEN.

---

**- APPROVALS -**

---

S&R ENGINEERING	: W.P. MUSTY	:/S/ W. P. MUSTY
S&R ENGINEERING ITM	: P. A. STENGER-NGUYEN	:/S/ P. A. STENGER-NGUYEN
DESIGN ENGINEERING	: CHARLES EBERHART	:/S/ CHARLES EBERHART
MPS SUBSYSTEM MGR.	: TIM REITH	:/S/ TIM REITH
MOD	: JEFF MUSLER	:/S/ JEFF MUSLER
USA SAM	: MICHAEL SNYDER	:/S/ MICHAEL SNYDER
USA ORBITER ELEMENT	: SUZANNE LITTLE	:/S/ SUZANNE LITTLE
NASA SR&QA	: BILL PRINCE	:/S/ BILL PRINCE