FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL HARDWARE
NUMBER: 03-1-0504 -X

SUBSYSTEM NAME: MAIN PROPULSION

REVISION: 1 07/27/00

PART DATA

	PART NAME / **VENDOR NAME**	**PART NUMBER** / **VENDOR NUMBER**
LRU	: GH2 ET TANK PRESSURIZATION FLOW CONTROL VALVES	MC280-0017-1301
	VACCO INDUSTRIES	80410-1301

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:
VALVE, FLOW CONTROL, SOLENOID, GH2 PRESSURANT, NORMALLY HIGH FLOW (0.625 INCH DIA INLET, 1.0 INCH DIA OUTLET).

REFERENCE DESIGNATORS: LV56
LV57
LV58

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 HYDROGEN TANK TO MAINTAIN ULLAGE PRESSURE FOR TANK STRUCTURAL STABILITY AND SSME NPSP. THE UNPOWERED SOLENOID VALVE POSITION IS HIGH FLOW. VALVE POSITION (HIGH FLOW-70%/LOW FLOW-31%) IS CONTROLLED BY STIMULI FROM THE ORBITER MOUNTED SIGNAL CONDITIONERS. SIGNAL CONDITIONER INPUT COMES FROM ET MOUNTED ULLAGE PRESSURE TRANSDUCERS. A SINGLE COCKPIT SWITCH ALLOWS THE CREW TO REMOVE POWER FROM THE SOLENOIDS RESULTING IN ALL THREE VALVES OPERATING IN THE HIGH FLOW POSITION.

FAILURE MODES EFFECTS ANALYSIS FMEA -- CIL FAILURE MODE

NUMBER: 03-1-0504-04

REVISION#: 1 07/27/00

SUBSYSTEM NAME: MAIN PROPULSION
LRU: VALVE, FLOW CONTROL (GH2)
ITEM NAME: GH2 FLOW CONTROL VALVES (LV56, 57, 58)

CRITICALITY OF THIS FAILURE MODE: 1/1

FAILURE MODE:
ORIFICE EROSION/BROKEN POPPET

MISSION PHASE: LO LIFT-OFF

VEHICLE/PAYLOAD/KIT EFFECTIVITY:

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 GH2 AT LOW ALTITUDE. POSSIBLE VIOLATION OF TANK MAXIMUM STRUCTURAL CAPABILITY REQUIREMENTS. POSSIBLE FIRE/EXPLOSION HAZARD EXTERNAL TO THE VEHICLE.

(B) INTERFACING SUBSYSTEM(S):

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SAME AS A.

(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 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 POPPET AND POPPET SEAL ARE MACHINED FROM 440 CRES AND THE POPPET SEAL IS NITRIDED AND THE ARMATURE IS GOLD PLATED TO PREVENT GALLING. CLEARANCE BETWEEN THE ARMATURE AND FLANGE IS 0.0005 INCH AND CLEARANCE BETWEEN THE SEAL AND SLEEVE IS 0.0004 INCH. STRUCTURAL ANALYSIS INDICATES POSITIVE MARGINS OF SAFETY FOR ALL CONDITIONS OF VALVE OPERATION. FRACTURE ANALYSES SHOW THAT ALL CRITICAL PARTS ARE SATISFACTORY FOR FOUR TIMES EXPECTED LIFE.

SYSTEM CONTAMINATION IS MINIMIZED BY AN ET SCREEN, A PREVALVE SCREEN, A GSE DEBRIS PLATE, A GSE FILTER AND GH2 FILTERS INSTALLED IN THE PRE-PRESSURIZATION AND IN EACH ENGINE LEG.

(B) TEST:
ATP

EXAMINATION OF PRODUCT

AMBIENT TESTS (GN2)
PROOF PRESSURE: VALVE HOUSING (9440 PSIA, TEMPERATURE CORRECTED)
TOTAL EXTERNAL LEAKAGE (800 PSIA)

ELECTRICAL CHARACTERISTICS

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INSULATION RESISTANCE
BONDING
DIELECTRIC STRENGTH
COIL RESISTANCE
COIL TEMPERATURE TEST

FLOW CALIBRATION VERIFICATION (GH2 AT 80 DEG F)
HI FLOW POSITION
INLET PRESSURE: 3300 PSIA
OUTLET PRESSURE: 800 PSIA MAXIMUM
LOW FLOW POSITION
INLET PRESSURE: 3300 PSIA
OUTLET PRESSURE: 800 PSIA MAXIMUM

FUNCTIONAL TEST
DEMONSTRATION DUTY CYCLE
INLET PRESSURE: 4,250 PSIA
PURGE FLOW TEMPERATURE: -130 DEG F
PERFORMANCE VERIFICATION (ELECTRICAL)

CERTIFICATION

FUNCTIONAL TESTS
DEMONSTRATION DUTY CYCLE
12 SETS OF INITIAL CONDITIONS:
GH2 AT -70 DEG F, +80 DEG F, +210 DEG F
1500 PSIA, 2500 PSIA, 3500 PSIA, 4500 PSIA
(EACH PRESSURE AT ALL THREE TEMPERATURES)

LIFE TESTS (10,000 CYCLES INCLUDING ATP AND QUALIFICATION TESTS)

OPERATIONAL CYCLES
INLET PRESSURE: 25 AND 3600 PSIA
INLET TEMPERATURE: 80 DEG F
PERFORMANCE VERIFICATION (ELECTRICAL AND FLOW)

AMBIENT CYCLES (5000 CYCLES)
INLET PRESSURE: 25 PSIA
INLET TEMPERATURE: AMBIENT
PERFORMANCE VERIFICATION (ELECTRICAL AND FLOW)

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

SOLENOID POWERED LIFE TEST
50 HOURS MINIMUM
INLET PRESSURE: 25 PSIA
VALVE BODY TEMPERATURE: +140 DEG F
ELECTRICAL POWER: +32 VOLTS DC

VIBRATION

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TRANSIENT: 5 TO 35 HZ AT +/- 0.25 GS
RANDOM: 13.3 HOURS IN EACH OF THREE AXES AT 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 +80 DEG F

BURST TEST
19,340 PSIA AT 300 DEG F

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 400 FOR HYDROGEN. 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
WELDS ARE VISUALLY EXAMINED AND VERIFIED BY X-RAY AND DYE PENETRANT INSPECTION. RADIFLOW INSPECTION IS PERFORMED ON SOLENOID ASSEMBLY.

TESTING
ATP IS VERIFIED BY INSPECTION.

HANDLING/PACKAGING
PACKAGING FOR SHIPMENT IS VERIFIED BY INSPECTION.

(D) FAILURE HISTORY:

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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