1) CIL ITEM : F200-AX-01
2) FMEA CODE : F200-AX
3) COMPONENT : PROPELLANT VALVE ACTUATOR POSITION CONTROL
4) PART NUMBER : RE1493
5) SYSTEM/SUBSYSTEM : CONTROLLER/F200-XX
6) FAILURE MODE : FAILURE OF THE ACTUATOR CONTROL LOOP TO PROPERLY POSITION OR CONTROL A PROPELLANT VALVE

7) PREPARED : SSME RELIABILITY
8) APPROVED :
9) DATE : 04-19-96
10) REVISION/CHANGE : -001/0
11) EFFECTIVITY : -05
12) HAZARD REFERENCE : SEE LISTINGS BELOW
13) CCBD # : me3-01-3286

PHASE	FAILURE DESCRIPTION/EFFECT	CRITICALITY
H 4-2	FOLLOWING A CHANNEL A FAILURE, DETECTION OF A CHANNEL B FAILURE RESULTS IN DISQUALIFICATION OF ACTUATOR CHANNELS AND HYDRAULIC LOCKUP RESPONSE. MISSION ABORT MAY RESULT IF LOCKUP OCCURS DURING MAX Q THROTTLING. (SEE OPERATIONAL USE.) REDUNDANCY SCREENS: CONTROLLER SYSTEM: LIKE REDUNDANCY --- A: PASS. REDUNDANT HARDWARE ITEMS ARE CAPABLE OF CHECKOUT DURING NORMAL GROUND TURNAROUND. B: PASS. LOSS OF A REDUNDANT HARDWARE ITEM IS DETECTABLE DURING FLIGHT. C: PASS. LOSS OF REDUNDANT HARDWARE ITEMS COULD NOT RESULT FROM A SINGLE CREDIBLE EVENT.	1R HAZARD REF: ME-82H, ME-86H, ME-87H, ME-C15,H ME-C3H ME-64H

CIL ITEM: F200-AX-01	DESIGN	DOCUMENT REF.
	ALL CAUSES: OUTPUT ELECTRONICS: SERVOVALVE DRIVER CIRCUIT, RVDT DEMODULATOR, SERVOACTUATOR MONITOR (1)	(1) HONEYWELL BLOCK II FMEA VOL V OE-F20
	EACH PROPELLANT VALVE HAS REDUNDANT CONTROL FROM EACH CONTROLLER CHANNEL (1). A FAILURE IN BOTH CONTROLLER CHANNELS (MULTIPLE FAILURE), RESULTING IN LOSS OF FUNCTION, RESULTS IN HYDRAULIC LOCKUP (2). THE CONTROLLER (WITH SOFTWARE) IS CONFIGURED TO DETECT AND RESPOND PROPERLY TO OUT OF QUALIFICATION LIMIT FAILURES, IMPLEMENT THE APPROPRIATE REDUNDANCY MANAGEMENT RESPONSE, AND COMMAND A SAFE ENGINE STATE WHEN CONTROLLER REDUNDANCY IS LOST (2). HOWEVER, THE CONTROLLER (WITH SOFTWARE) IS NOT CAPABLE OF DETECTING OR RESPONDING TO A FAILURE WHICH RESULTS IN THE LIMITS BEING MONITORED FAILING WITHIN ENGINE REDLINE LIMITS OR WITHIN NORMAL ENGINE OPERATING CONDITIONS (2).	(1) DSHG8977A1 (2) CP406R0008 3.1.3:4 3.2.1:6.3 3.2.3:2.3 3.2.3:3 3.2.3:6 3.2.4
	ELECTRICAL, MECHANICAL, AND ELECTROMECHANICAL PARTS FOR THE CIRCUITS INVOLVED IN THIS FUNCTION HAVE BEEN SELECTED FROM THE CLASS S OR EQUIVALENT APPROVED PARTS SELECTION LIST (1), QUALITY ASSURANCE AND SCREENING REQUIREMENTS FOR HIGH RELIABILITY MICROCIRCUITS (2), AND THE SPECIFICATION CONTROL DRAWING FOR MICROCIRCUITS, MONOLITHIC SILICON, AND TRANSISTOR-TRANSISTOR LOGIC (TTL) FAMILY OF DEVICES (3). PRIOR TO INSTALLATION ON THE CARD ASSEMBLIES, COMPONENTS ARE SUBJECTED TO A BURN-IN PERIOD WHERE PARTS ARE EXERCISED AT TEMPERATURES IN EXCESS OF NORMAL CONTROLLER OPERATING ENVIRONMENT, BUT LESS THAN COMPONENT MAXIMUM SPECIFIED OPERATING ENVIRONMENT, TO SCREEN FOR INFANT MORTALITY (4). IN ADDITION TO THESE REQUIREMENTS, ALL COMPONENTS ARE DERATED FROM THE MAXIMUM RATING AT OPERATING EXTREMES (5). CLEANLINESS AND ALL PROCESSES USED DURING MANUFACTURE ARE CONTROLLED BY SPECIFICATION REQUIREMENTS (5).	(1) 85ND3928, 85ND3929 (2) 85N02704 (3) 85N03766 (4) 85N03876 (5) DSHG8977A1
	THE CONTROLLER DESIGN MEETS ALL CEI FAIL-OPERATE/FAILSAFE REQUIREMENTS FOR THIS FAILURE MODE (1). REDUNDANT CONTROLLER CHANNEL FUNCTIONS ARE PHYSICALLY SEPARATED WITHIN THE CONTROLLER HOUSING (2). CIRCUITS ARE DESIGNED TO PREVENT BRIDGING (2), ALL EEE PARTS ARE REQUIRED TO HAVE CONFORMAL COATING, AND INTERNAL WIRING IS INSULATED TO PREVENT SHORT CIRCUITS FROM CONDUCTIVE CONTAMINATION (3). ALL ELECTRICAL COMPONENTS ARE CONTAINED WITHIN THE CASE STRUCTURE WHICH IS PRESSURIZED WITH A POSITIVE PRESSURE INERT GAS BACKFILL TO PREVENT CONTAMINATION (2). WHERE APPLICABLE, ELECTROMAGNETIC INTERFERENCE SHIELDING IS PROVIDED AND CIRCUIT INTERCONNECTS USE TWISTED PAIR WIRING (2). ALL CIRCUIT CARDS ARE KEYED TO THEIR RESPECTIVE CONNECTION LOCATIONS TO PRECLUDE IMPROPER INSTALLATION (2). RAMP CLAMPS ARE UTILIZED TO PRECLUDE VIBRATION INDUCED CARD FAILURES (2). DESIGN OF CIRCUIT CARDS AND DETERMINATION OF COPPER PATH TRACE SPACING, WEIGHT, AND WIDTH IS CONTROLLED BY SPECIFICATION (2). EACH UNIT (PRODUCTION AND RECYCLE) IS REQUIRED TO PASS A FUNCTIONAL ACCEPTANCE TEST UNDER ENVIRONMENTAL CONDITIONS BEYOND THOSE SEEN DURING NORMAL FIELD OPERATION WITHOUT DEGRADATION OF HARDWARE LIFE EXPECTANCY (2). A WORST CASE CIRCUIT ANALYSIS WAS PERFORMED TO VERIFY NOMINAL OPERATION AT SPECIFICATION LIMITS (4). AN ANALYSIS WAS PERFORMED BY HONEYWELL TO ASSURE NO SINGLE POINT COMPONENT FAILURES ARE INHERENT TO THE CONTROLLER DESIGN (5).	(1) CP320R0003B (2) DSHG8977A1 (3) 85ND3928 (4) ES24472-01 (5) HONEYWELL BLOCK II FMEA VOL I

CIL ITEM: F200-AX-01	DESIGN	DOCUMENT REF.
	DESIGN QUALIFICATION TESTING OF THE CONTROLLER ASSEMBLY HAS BEEN PERFORMED INCLUDING: FAULT INSERTION TESTING (1), ASSEMBLY THERMAL CYCLING (2), CASE AND ASSEMBLY VIBRATION TESTING (3), ELECTROMAGNETIC INTERFERENCE AND SUSCEPTIBILITY TESTING (4), ACOUSTICAL NOISE TESTING (5), CASE ULTIMATE PRESSURE TESTING (6), AND ASSEMBLY BREAK OPEN INSPECTION (7).	(1) TR34079282 TR34080202 TR34088258 TR34088259 (2) TR34080203 TR34080207 (3) TR34080204 TR34080205 TR34080206 TR34087499 (4) TR34080209 (5) TR34080210 (6) TR34085021 (7) TR34085022

CIL ITEM: F200-AX-01	INSPECTION AND TEST		
POSSIBLE CAUSES	SIGNIFICANT CHARACTERISTICS	INSPECTION(S)/TEST(S)	DOCUMENT REF.
ALL CAUSES:	RE1493 - CONTROLLER		RE1493
	ASSEMBLY INTEGRITY	CLEANLINESS REQUIREMENTS ARE VERIFIED PER SPECIFICATION DURING MANUFACTURING OF THE CONTROLLER ASSEMBLY.	RC1493
		ENVIRONMENT CONTROLS (TEMPERATURE, HUMIDITY) ARE ENFORCED DURING ASSEMBLY AND TESTING PER SPECIFICATION REQUIREMENTS.	OSHG8977A1
		TO PREVENT COMPONENT DAMAGE, STATIC ELECTRICAL DISCHARGE POTENTIAL IS CONTROLLED DURING MANUFACTURING PER SPECIFICATION REQUIREMENTS.	OSHG8977A1
	MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER SPECIFICATION REQUIREMENTS.	RC1493

CIL ITEM: F200-AX-01		INSPECTION AND TEST	
POSSIBLE CAUSES	SIGNIFICANT CHARACTERISTICS	INSPECTION(S)/TEST(S)	DOCUMENT REF.
		PROTECTIVE FINISHES AND MATERIAL SELECTION TO PREVENT DETRIMENTAL EFFECTS FROM ENVIRONMENTAL EXPOSURE, STRESS CORROSION, AND ELECTROLYTIC CORROSION ARE VERIFIED PER SPECIFICATION REQUIREMENTS.	RC1493 MSFC-SPEC-250
		FLAMMABILITY REQUIREMENTS ARE VERIFIED PER SPECIFICATION REQUIREMENTS.	RC1493
	INTEGRITY OF ELECTRONICS	THE FOLLOWING PROCESSES ARE VERIFIED PER SPECIFICATION DURING MANUFACTURING OF THE CARD ASSEMBLIES:	
		· CONSTRUCTION OF PRINTED CIRCUIT BOARDS.	RL10005
		· INSTALLATION OF TERMINALS.	RL10007
		· PLASTICS AND ELASTOMERS FOR ELECTRONIC ENCAPSULATION.	RL10008
		· SOLDERED ELECTRICAL CONNECTIONS.	RL10009
		· POST-SOLDERING INSPECTION FREE OF SPLATTER AND CONTAMINATION.	RL10009
		· ELECTRICAL BONDING.	RC1493
		· COMPONENT LEAD AND INTERCONNECTION MATERIAL SELECTION.	85M03928
		· FREE OF CONTAMINATION AFTER CONFORMAL COATING.	RC1493
	WELD INTEGRITY	ALL WELDS ARE VERIFIED TO DRAWING AND SPECIFICATION REQUIREMENTS.	RL10011
	PRE-CLOSEOUT TESTING AND INSPECTION	THE FOLLOWING TESTS ARE PERFORMED AT THE CARD/COMPONENT LEVEL DURING MANUFACTURING:	
		· PARTICAL IMPACT NOISE DETECTION (PIND) TEST ON HYBRID MICROCIRCUITS AND CAVITY TYPE DEVICES.	DSHG8977A1
		· ULTRASONIC SCAN TEST FOR DELAMINATION CERAMIC ON CAPACITORS (CKR05 AND CKR06).	DSHG8977A1
		· BURN-IN PERIOD FOR ELECTRICAL PARTS.	85M03928
		· INSULATION RESISTANCE AND CONTINUITY TEST.	DSHG8977A1
		· DIELECTRIC WITHSTANDING VOLTAGE.	DSHG8977A1
		· FUNCTIONAL TEST.	DSHG8977A1
		· X-RAY OF CONTROLLER INTERNAL CABLES AND WIRES.	DSHG8977A1

CIL ITEM: F200-AX-01		INSPECTION AND TEST	
POSSIBLE CAUSES	SIGNIFICANT CHARACTERISTICS	INSPECTION(S)/TEST(S)	DOCUMENT REF.
		THE FOLLOWING INSPECTIONS ARE PERFORMED ON THE COMPLETED ASSEMBLY PRIOR TO FINAL CLOSURE:	
		- INTERNAL AND EXTERNAL CLEANLINESS.	RC1493
		- CARD DIMENSIONS ARE VERIFIED AT CARD ASSEMBLY.	DSNC8977A1
		- CHASSIS CAVITY INSPECTION FOR CONTAMINATION.	RC1493
		- ELECTRICAL INTERFACE CONNECTORS.	RC1493
		- CARD INSTALLATION AND CONFIGURATION AUDIT.	DSNC8977A1
		- CONFORMAL COATING OF EEE PARTS.	85M03928
	ACCEPTANCE TESTS	THE FOLLOWING TESTS ARE PERFORMED BY HONEYWELL DURING ACCEPTANCE TESTING:	
		- HERMETIC SEAL AND PRESSURIZATION PORT LEAK TEST.	RC1493
		- FUNCTIONAL TEST INCLUDING:	RC1493
		- OUTPUT INTERFACE,	RC1493
		- CHECKOUT,	RC1493
		- OPERATION,	RC1493
		- CONTROLLER CHECKOUT.	RC1493
		- HIGH TEMPERATURE OPERATION.	RC1493
		- LOW TEMPERATURE OPERATION.	RC1493
		- VIBRATION TESTING.	RC1493
		- FINAL FUNCTIONAL TEST.	RC1493
	HOT FIRE ACCEPTANCE TESTING (GREEN RUN)	CONTROLLER OPERATION IS VERIFIED THROUGH ENGINE HOT FIRE ACCEPTANCE TESTING.	RL00461
	HERMETIC SEAL INTEGRITY	INTERNAL PRESSURE IS MONITORED DURING CONTROLLER OPERATION.	OMRSD V41AB0.048
	FLIGHT FLOW TESTING	THE FOLLOWING TESTS ARE PERFORMED DURING FLIGHT FLOW VEHICLE PROCESSING AND AFTER ANY MAINTENANCE OR REPLACEMENT:	
		- CONTROLLER CHECKOUT.	OMRSD V41AN0.035
		- ACTUATOR CHECKOUT.	OMRSD V41AS0.010
		- FLIGHT READINESS TEST.	OMRSD V41AS0.030-A
		- SELF-TEST.	CP406R0008

CIL ITEM: F200-AX-01		INSPECTION AND TEST	
POSSIBLE CAUSES	SIGNIFICANT CHARACTERISTICS	INSPECTION(S)/TEST(S)	DOCUMENT REF.
	PRE-FLIGHT CHECKOUT	THE FOLLOWING TESTS ARE PERFORMED DURING LAUNCH COUNTDOWN:	
		- PRE-CRYO LOADING CONTROLLER CHECKOUT.	OMRSD S00FRO.213
		- SELF-TEST.	CP406R0008
		CONTROLLER OPERATION IS VERIFIED BY THE GROUND LAUNCH SEQUENCER PRIOR TO ENGINE START BY ACCEPTANCE OF COMMANDS PURGE SEQUENCE 4, POWER LEVEL, AND START ENABLE.	LAUNCH COMMIT CRITERIA 86E-4-1126
	CONTINUOUS SELF-TEST	BITE TEST IS PERFORMED EVERY MAJOR CYCLE TO VERIFY HARDWARE INTEGRITY. (LAST TEST)	CP406R0008
FAILURE HISTORY:	COMPREHENSIVE FAILURE HISTORY DATA IS MAINTAINED IN THE PROBLEM REPORTING DATABASE (PRAMS/PRACA). REFERENCE: NASA LETTER SA21/88/308 AND ROCKETDYNE LETTER B8RC09761.		

OPERATIONAL USE: FAILURE MODE CAN BE DETECTED IN REALTIME BY THE FLIGHT CONTROL TEAM WHO WILL EVALUATE EFFECTS UPON VEHICLE PERFORMANCE AND ABORT CAPABILITY. BASED ON THIS EVALUATION THE APPROPRIATE ABORT MODE OR SYSTEM CONFIGURATION WILL BE SELECTED. FAILURE DETECTION CUES AND ASSOCIATED SSME PERFORMANCE DATA HAVE BEEN COORDINATED BETWEEN THE ENGINEERING AND FLIGHT OPERATIONS ORGANIZATIONS WITH THE RESPONSES DOCUMENTED IN MISSION FLIGHT RULES.