1) CIL ITEM : F200-AB-01
2) FMEA CODE : F200-AB
3) COMPONENT : FUEL FLOWRATE SENSOR INTERFACE 01
4) PART NUMBER : RE1493
5) SYSTEM/SUBSYSTEM : CONTROLLER/F200-XN
6) FAILURE MODE : FAILURE OF THE FUEL FLOWRATE SENSOR INTERFACE

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 # : ME3-01-3285

PHASE	FAILURE DESCRIPTION/EFFECT	CRITICALITY
S 4-4	FAILURE OF ONE OR MORE SENSOR INTERFACES CAUSING ERRONEOUS SIGNALS FROM ONE OR MORE SENSORS SUFFICIENT TO CAUSE OFF-NOMINAL MIXTURE RATIO OPERATION MAY RESULT IN A TURBINE DISCHARGE TEMPERATURE SLE INDICATION AND CONTROLLER INITIATED SHUTDOWN. MISSION SCRUB. LOSS OF VEHICLE DUE TO TURBINE OR HEAT EXCHANGER FAILURE MAY RESULT IF TURBINE OVERTEMPERATURE CONDITION OCCURS AND IS NOT DETECTED. REDUNDANCY SCREENS: CONTROLLER SYSTEM - ENGINE SYSTEM: UNLIKE REDUNDANCY --- A: PASS. REDUNDANT HARDWARE ITEMS ARE CAPABLE OF CHECKOUT DURING NORMAL GROUND TURNAROUND. B: FAIL. LOSS OF A REDUNDANT HARDWARE ITEM IS NOT DETECTABLE DURING FLIGHT. C: PASS. LOSS OF REDUNDANT HARDWARE ITEMS COULD NOT RESULT FROM A SINGLE CREDIBLE EVENT.	1R HAZARD REF: ME-G6S,A
SM	FAILURE OF ONE OR MORE SENSOR INTERFACES SUCH THAT THE AVERAGED VALUE IS WITHIN QUALIFICATION LIMITS RESULTS IN OFF-NOMINAL MIXTURE RATIO. OFF NOMINAL PROPELLANT CONSUMPTION. MISSION ABORT MAY RESULT IF OFF-NOMINAL PROPELLANT CONSUMPTION LEADS TO A SLE INDICATION AND CONTROLLER INITIATED SHUTDOWN OR PREMATURE PROPELLANT DEPLETION. (SEE OPERATIONAL USE) REDUNDANCY SCREENS: CONTROLLER SYSTEM - ENGINE SYSTEM: UNLIKE REDUNDANCY --- A: PASS. REDUNDANT HARDWARE ITEMS ARE CAPABLE OF CHECKOUT DURING NORMAL GROUND TURNAROUND. B: FAIL. LOSS OF A REDUNDANT HARDWARE ITEM IS NOT DETECTABLE DURING FLIGHT. C: PASS. LOSS OF REDUNDANT HARDWARE ITEMS COULD NOT RESULT FROM A SINGLE CREDIBLE EVENT.	1R HAZARD REF: ME-G4M
M 4-3	FAILURE OF ALL SENSOR INTERFACES CAUSING ERRONEOUS SIGNALS FROM ALL SENSORS OUTSIDE QUALIFICATION LIMITS RESULTS IN SENSOR DISQUALIFICATION, A MCF INDICATION, AND ELECTRICAL LOCKUP RESPONSE. MISSION ABORT MAY RESULT IF LOCKUP OCCURS DURING MAX Q THROTTLING. (SEE OPERATIONAL USE.) REDUNDANCY SCREENS: CONTROLLER SYSTEM - ENGINE SYSTEM: UNLIKE 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-G4M

F20D-AB-01

PHASE	FAILURE DESCRIPTION/EFFECT	CRITICALITY
N 4-6	FAILURE OF ONE OR MORE SENSOR INTERFACES CAUSING ERROVEOUS SIGNALS FROM ONE OR MORE SENSORS SUFFICIENT TO CAUSE OFF-NOMINAL MIXTURE RATIO OPERATION MAY RESULT IN A SLE INDICATION AND CONTROLLER INITIATED SHUTDOWN. MISSION ABORT. REDUNDANCY SCREENS: CONTROLLER SYSTEM - ENGINE STIEN: UNLIKE REDUNDANCY ---------- A: PASS. REDUNDANT HARDWARE ITEMS ARE CAPABLE OF CHECKOUT DURING NORMAL GROUND TURNAROUND. B: FAIL. LOSS OF A REDUNDANT HARDWARE ITEM IS NOT DETECTABLE DURING FLIGHT. C: PASS. LOSS OF REDUNDANT HARDWARE ITEMS COULD NOT RESULT FROM A SINGLE CREDIBLE EVENT.	1R HAZARD REF: ME-GAN

CIL ITEM: F200-AB-01	DESIGN	DOCUMENT REF.
	ALL CAUSES: INPUT ELECTRONICS: FAILURE OF THE FLOW PULSE RATE CONVERTER INTERFACE (1)	(1) HONEYWELL BLOCK II FMEA VOL IV (E-F1D
	THE FUEL FLOW RATES ARE REDUNDANT ELEMENT SENSOR PAIRS (1). A FAILURE MUST OCCUR IN EACH CONTROLLER CHANNEL (MULTIPLE FAILURE) TO CAUSE LOSS OF FUNCTION (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 3.1.3:3 3.2.1:6.2 3.2.3:2.3 3.2.3:3 3.2.3:4 3.2.3:5 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) 85H03928, 85H03929 (2) 85H02704 (3) 85H03766 (4) 85H03876 (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) 85H03928 (4) ES24472-01 (5) HONEYWELL BLOCK II FMEA VOL I

CIL ITEM: F200-A8-01	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-A8-01	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.	DSNG8977A1
		TO PREVENT COMPONENT DAMAGE, STATIC ELECTRICAL DISCHARGE POTENTIAL IS CONTROLLED DURING MANUFACTURING PER SPECIFICATION REQUIREMENTS.	DSNG8977A1
	MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER SPECIFICATION REQUIREMENTS.	RC1493

CIL ITEM: F200-A8-01

POSSIBLE CAUSES	SIGNIFICANT CHARACTERISTICS	INSPECTION AND TEST 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.	B5N03928
		- 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.	B5N03928
		- 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-AB-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.	DSHG8977A1
		- CHASSIS CAVITY INSPECTION FOR CONTAMINATION.	RC1493
		- ELECTRICAL INTERFACE CONNECTORS.	RC1493
		- CARD INSTALLATION AND CONFIGURATION AUDIT.	DSHG8977A1
		- 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 V41ANG.040
	FLIGHT FLOW TESTING	THE FOLLOWING TESTS ARE PERFORMED DURING FLIGHT FLOW VEHICLE PROCESSING AND AFTER ANY MAINTENANCE OR REPLACEMENT:	
		- CONTROLLER CHECKOUT.	OMRSD V41ANG.035
		- SENSOR CHECKOUT.	OMRSD V41AQQ.010
		- FLIGHT READINESS TEST.	OMRSD V41ASD.030-A
		- SELF-TEST.	CP4D6R0008

CIL ITEM: F200-A8-01		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 CHECKOUT INCLUDING CONTROLLER AND SENSORS CHECKOUT. - SELF-TEST.	DMRSD S00FA0.215 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 BBRC09761.

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.