PRINT DATE: 03/29/96

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL HARDWARE
NUMBER: 04-1A-0101 -X

SUBSYSTEM NAME: ELECTRICAL POWER GENERATION: FUEL CELL
REVISION: 3 03/27/96

PART DATA

	PART NAME VENDOR NAME	PART NUMBER VENDOR NUMBER
LRU	: FUEL CELL POWERPLANT IFC	MC464-0115-3020 807100
LRU	: FUEL CELL POWERPLANT IFC	MC464-0115-3021 808100
LRU	:FUEL CELL POWERPLANT IFC	MC464-0115-3030 814100
LRU	:FUEL CELL POWERPLANT. IFC	MC464-0115-3031 815100

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:
FCP NO. 1, 2, 3

REFERENCE DESIGNATORS: 40V45A100
40V45A200
40V45A300

QUANTITY OF LIKE ITEMS:
TWO-RH
ONE-LH

FUNCTION:
THREE POWER SOURCES FOR MAIN ELECTRICAL POWER.

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REVISION#: 1 03/27/96

SUBSYSTEM NAME: ELECTRICAL POWER GENERATION: FUEL CELL
LRU: FUEL CELL POWERPLANT CRITICALITY OF THIS
ITEM NAME: FUEL CELL POWERPLANT FAILURE MODE: 1R2

FAILURE MODE:
REGULATOR FAILS CLOSED - FAILS TO SUPPLY REACTANTS TO STACK.

MISSION PHASE: LO LIFT-OFF
DO DE-ORBIT

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

CAUSE:
MECHANICAL SHOCK, VIBRATION, CONTAMINATION, PHYSICAL BINDING/JAMMING, BROKEN SPRING.

CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO

REDUNDANCY SCREEN
A) PASS
B) PASS
C) PASS

PASS/FAIL RATIONALE:
A)

B)

C)

- FAILURE EFFECTS -

(A) SUBSYSTEM:
LOSS OF REDUNDANCY - LOSS OF FCP. REQUIRES CREW ACTION TO SHUT DOWN FCP.

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(B) INTERFACING SUBSYSTEM(S):
DEGRADATION OF INTERFACE FUNCTION - REDUCED ELECTRICAL POWER SUPPLY TO EPD&C.

(C) MISSION:
NO EFFECT AFTER LOSS OF ONE FUEL CELL. MINIMUM DURATION MISSION INVOKED. (CAPABILITY EXISTS FOR SAFE RETURN ON 1 OF 3 FUEL CELLS.)

(D) CREW, VEHICLE, AND ELEMENT(S):
NO EFFECT ON CREW OR VEHICLE AFTER LOSS OF ONE FCP. LOSS OF TWO FCP'S DURING ASCENT WILL RESULT IN LOSS OF CREW AND VEHICLE. LOSS OF SECOND FCP DURING DESCENT LOSES CREW/VEHICLE IF INSUFFICIENT TIME IS AVAILABLE FOR AN ELECTRICAL LOAD RECONFIGURATION RESULTING IN THE INABILITY OF THE SINGLE REMAINING FUEL CELL TO SUPPLY ADEQUATE ELECTRICAL POWER.

(E) FUNCTIONAL CRITICALITY EFFECTS:
SAME AS (D).

-DISPOSITION RATIONALE-

(A) DESIGN:
THE REACTANTS ARE DELIVERED TO FUEL CELL THROUGH A 25 MICRON ABSOLUTE FILTER. REGULATOR INLET CONTAINS A 10 MICRON NOMINAL FILTER SCREEN TO PREVENT CONTAMINATION.

DESIGN MINIMIZES SLIDING PARTS; ANEROID UTILIZES TEFLON SLEEVE TO PREVENT BINDING. VALVE STEMS SLIDE IN GLASSED FILLED TEFLON GUIDES.

METALLIC AND NONMETALLIC MATERIALS FOR REGULATOR PARTS, AS WELL AS NEOPRENE, CHLOROPRENE AND LOCTITE FOR O-RINGS AND OTHER SEALS, AND KRYTOX 250 AB AS A LUBRICANT, ARE COMPATIBLE AND NONDEGRADING WITH REACTANTS.

(B) TEST:
PROOF PRESSURE TESTED TO 4500 PSIG INLET AND 130 PSIA REGULATED (OPERATING PRESSURE 65 PSIA NOMINAL).

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DEVELOPMENT VIBRATION TESTED TO GREATER THAN 10 TIMES FLIGHT EQUIVALENT DAMAGE OR ACCUMULATED ENERGY LEVELS. QUALIFICATION VIBRATION TESTED FOR A DURATION EQUIVALENT TO 60 MISSIONS.

SUBJECTED TO NUMEROUS PRESSURE AND THERMAL CYCLES IN ADDITION TO DEMONSTRATING 4100 HOURS OF OPERATION DURING THE FCP DEVELOPMENT PROGRAM.

FUEL CELL COMPONENTS HAVE DEMONSTRATED ABILITY TO WITHSTAND VIBRATION LEVELS HIGHER THAN FLIGHT LEVELS (DEVELOPMENT TEST).

OMRSD: REACTANT FLOW TO STACK IS REQUIRED FOR FCP OPERATION. FCP PERFORMANCE VERIFIED DURING PRELAUNCH FUEL CELL STARTUP AND FUEL CELL PERFORMANCE ON DC BUS OPERATIONS.

(C) INSPECTION:
RECEIVING INSPECTION
DIMENSIONAL INSPECTIONS ARE PERFORMED AT RECEIVING, IN PROCESS, AND ACCEPTANCE SEQUENCES. MATERIAL LOT SAMPLES ARE FORWARDED TO A TEST LAB FOR CERTIFICATION ANALYSIS. WELD FILLER METAL IS CERTIFIED BY LAB TESTING AND MATERIAL CONTROL LAB SPECIFICATIONS.

CONTAMINATION CONTROL
DETAIL PARTS AND ASSEMBLIES ARE SOLVENT CLEANED PER APPROVED PROCEDURES AND DOUBLE BAGGED AS REQUIRED TO PREVENT CONTAMINATION. ASSEMBLY OPERATIONS ARE PERFORMED UNDER CONTROLLED CONDITIONS USING PROCEDURES WHICH MAINTAIN CLEANLINESS AND WHICH SPECIFY APPROPRIATE HANDLING PRECAUTIONS. CLEANLINESS OF OPERATING/TEST FLUIDS IS MAINTAINED THROUGH SAMPLING AND/OR FILTRATION. THE ASSEMBLED FUEL CELL UTILIZES CAPS OR CLOSURES ON ALL FLUID FITTINGS AND THE SHIPMENT/STORAGE OF THE FUEL CELL IS IN A NITROGEN PRESSURIZED METAL SHIPPING CONTAINER.

ASSEMBLY/INSTALLATION
ALL TORQUING OPERATIONS ARE VERIFIED BY QC. INLET/OUTLET ACCESS TUBES BRAZING PROCESS AND SEQUENCE VERIFIED BY INSPECTION. ALL SOLDER CONNECTIONS ARE VISUALLY INSPECTED AT A MINIMUM OF 4X MAGNIFICATION IN ACCORDANCE WITH NHB 5300.4 (3A).

NONDESTRUCTIVE EVALUATION
ALL WELDS AND WELD REPAIRS REQUIRE 100% NONDESTRUCTIVE EVALUATION TESTING AS PER VISUAL (10X) AND X-RAY, IN ADDITION TO LEAK CHECK USING MASS SPECTROMETER WHICH IS VERIFIED BY INSPECTION.

TESTING
FUNCTIONAL AND LEAKAGE REQUIREMENTS ARE VERIFIED DURING ACCEPTANCE TEST. ALL PARTS OF THE ATP ARE OBSERVED AND VERIFIED BY QC.

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(D) FAILURE HISTORY:
CURRENT DATA ON TEST FAILURES, FLIGHT FAILURES, UNEXPLAINED ANOMALIES, AND OTHER FAILURES EXPERIENCED DURING GROUND PROCESSING ACTIVITY CAN BE FOUND IN THE PRACA DATA BASE.

THERE HAVE BEEN NO ACCEPTANCE TEST, QUALIFICATION TEST, FIELD OR FLIGHT FAILURES ASSOCIATED WITH THIS FAILURE MODE.

(E) OPERATIONAL USE:
CREW ACTION REQUIRED TO SHUTDOWN AFFECTED FUEL CELL. ONBOARD PROCEDURES MANAGE POWER FOR LOSS OF ONE OR TWO FCP(S).

- APPROVALS -

PAE MANAGER	: D. F. MIKULA	D F Mikula 29MAR96
PRODUCT ASSURANCE ENGR	: L. X. DANG	Lan Dang 3/29/96
DESIGN ENGINEERING	: MUSTIN, LLOYD	3-28-96
NASA SSMA	:	6/16/97
NASA SUBSYSTEM MANAGER	:	6/16/97