

SHUTTLE CRITICAL ITEMS LIST - ORBITER

SUBSYSTEM :ELECT POWER DIST & CONT FMEA NO 05-6 -2012 -1 REV:05/03/88

ASSEMBLY :MAIN DC DIST ASSY 1,2,3	CRIT.FUNC: 1R
P/N RI :V070-764200,220,230	CRIT. HDW: 2
P/N VENDOR:	VEHICLE 102 103 104
QUANTITY :3	EFFECTIVITY: X X X
:THREE REQUIRED, ONE PER	PHASE(S): PL X LO X OO X DO X LS X
:MN DC DIST ASSY	

PREPARED BY:	REDUNDANCY SCREEN: A-PASS B-PASS C-PASS	APPROVED BY (NASA):
DES R PHILLIPS	APPROVED BY:	SSM <u>A.C. Stone 5/12/88</u>
REL M HOVE	DES <u>S.E. [Signature]</u>	REL <u>[Signature] 5/10/88</u>
QE J COURSEN	REL <u>[Signature] 5-6-88</u>	QE <u>[Signature]</u>

ITEM:
ESSENTIAL BUS - MAIN DC DISTRIBUTION ASSEMBLY 1, 2 AND 3

FUNCTION:
 SUPPLIES 28 VDC POWER TO CAUTION AND WARNING UNITS, CONTROL SIGNALS FOR MANUALLY SWITCHED POWER CONTROL DEVICES, LIGHTING, FUEL CELL ELECTRICAL CONTROL UNITS AND REACTANT VALVES, AND ESSENTIAL BUS IN CIRCUIT BREAKER PANEL. ESSENTIAL BUS JAB PROVIDES BACKUP FLIGHT CONTROL ENGAGE FUNCTION.

FAILURE MODE:
 LOSS OF POWER

CAUSE(S):
 PIECE PART FAILURE, CONTAMINATION, MECHANICAL SHOCK, VIBRATION, THERMAL STRESS, PROCESSING ANOMALY

EFFECT(S) ON:
 (A) SUBSYSTEM (B) INTERFACES (C) MISSION (D) CREW/VEHICLE (E) FUNCTIONAL CRITICALITY EFFECT:

- (A) LOSS OF ONE ESSENTIAL BUS OUT OF THREE AND ITS ASSOCIATED FUEL CELL.
- (B) LOSS OF REDUNDANCY FOR CRITICAL CIRCUITS.
- (C) LAUNCH DELAY. POSSIBLE ABORT DECISION IN FLIGHT.
- (D) NO EFFECT.
- (E) POSSIBLE LOSS OF CREW/VEHICLE IF ASSOCIATED FUEL CELL CANNOT BE DISCONNECTED FROM MAIN DC BUS (POWER CONTACTOR FAILED CLOSED). LOSS OF AN ESSENTIAL BUS RESULTS IN LOSS OF THE ASSOCIATED FUEL CELL COOLANT PUMP AS WELL AS CONTROL OF THAT FUEL CELL'S REACTANT VALVES. THIS NECESSITATES REMOVAL OF ALL LOAD FROM THE FUEL CELL IN ORDER TO

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EFFECT(S) ON (CONTINUED):

(A)SUBSYSTEM (B)INTERFACES (C)MISSION (D)CREW/VEHICLE (E)FUNCTIONAL
CRITICALITY EFFECT:

RENDER IT SAFE. INABILITY TO REMOVE THE BUS LOAD FROM THE FUEL CELL
UNDER THESE CIRCUMSTANCES WILL RESULT IN FUEL CELL OVERHEATING WITH
SUBSEQUENT RUPTURE AND/OR EXPLOSION/FIRE.

DISPOSITION & RATIONALE:

(A)DESIGN (B)TEST (C)INSPECTION (D)FAILURE HISTORY (E)OPERATIONAL USE:
(A,B,C,D) DISPOSITION AND RATIONALE

(A) DESIGN

EACH OF THREE ESSENTIAL BUSES IS ESTABLISHED AND CONTAINED WITHIN ONE OF
THE THREE MAIN DISTRIBUTION AND CONTROL ASSEMBLIES (MDCA'S). EXTENSIONS OF
THE ESSENTIAL BUSES WHICH ARE CONTAINED WITHIN OTHER POWER DISTRIBUTION AND
CONTROL ASSEMBLIES OR PANELS ARE INDIVIDUALLY FUSED AND ARE NOT TREATED
WITHIN THIS CIL ITEM.

EACH ESSENTIAL BUS IS CREATED IN THE FOLLOWING MANNER: THREE POWER SOURCES
(ONE DIRECTLY FROM A FUEL CELL AND THE OTHER TWO FROM EACH OF THE TWO MAIN
DC BUSES NOT ASSOCIATED WITH THAT FUEL CELL AND CONNECTED THROUGH 10 AMP
RPC'S) ARE CONNECTED TO EACH OF THREE 35 AMP DIODES IN THE MDCA. THE
ESSENTIAL BUS CONSISTS OF A SHORT LENGTH OF AWG 16 WIRE CONNECTED FROM THE
ANODE OF EACH DIODE TO A TERMINAL BLOCK (MIL-SPEC PART NO. NAS1060-2-8)
ALSO MOUNTED IN THE MDCA. THIS WIRING AND THE TERMINAL BLOCK MAKE UP THE
ESSENTIAL BUS. THE TERMINAL BLOCK CONTAINS A COPPER BUS BAR .032" X .250"
APPROXIMATELY 4" IN LENGTH AND IS VERY RUGGEDLY CONSTRUCTED RENDERING IT
NEARLY IMPERVIOUS TO FAILURE INDUCED BY ENVIRONMENTAL EXPOSURE. AS FURTHER
PROTECTION AGAINST SHORTING TO STRUCTURE (GROUND) THE TERMINAL BLOCK IS
CONFORMALLY-COATED WITH A SILICONE RUBBER RTV COMPOUND.

(B) TEST

QUALIFICATION/CERTIFICATION

CERTIFICATION AT THE NEXT ASSEMBLY:

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(B) TEST (CONTINUED)

CERTIFICATION TESTS AT THE NEXT ASSEMBLY LEVEL WITHIN THE MAIN DISTRIBUTION AND CONTROL ASSEMBLY INCLUDE:

TEST	CAUSE CONTROL					
	a	b	c	d	e	f
CAUSES a Piece part failure d Mechanical shock b Contamination e Processing anomaly c eVibration f Thermal stress						
QUALIFICATION ACCEPTANCE VIBRATION (QAVT AT 0.67 g ² /HZ, 5 MIN/AXIS)	X		X			
RANDOM VIBRATION (FLIGHT AT 0.023 g ² /HZ, 84 MIN/AXIS)	X		X			
THERMAL CYCLING (1 X 10 ⁻⁶ TORR, 6 CYCLES -45 TO 165 °F, 3 HOURS MIN AT EACH TEMPERATURE EXTREME)	X					X
DESIGN SHOCK (20G PEAK, 11 MSEC, 3 DROPS/AXIS, 18 TOTAL)	X			X		
THERMAL VACUUM (1 X 10 ⁻⁶ TORR, 200 °F, 7 HOURS)	X					X

ACCEPTANCE AND SCREENING

ACCEPTANCE TEST AT THE NEXT ASSEMBLY (MAIN DC DISTRIBUTION AND CONTROL ASSEMBLY):

TEST	CAUSE CONTROL					
	a	b	c	d	e	f
CAUSES a Piece part failure d Mechanical shock b Contamination e Processing anomaly c Vibration f Thermal stress						
INSULATION RESISTANCE (100 MEGOHMS AT 500 VDC)	X	X			X	
DIELECTRIC WITHSTANDING VOLTAGE (500 VDC, 2 mA LEAKAGE CURRENT)	X	X			X	
VIBRATION (AVT, 0.04 g ² /HZ, 1 MINUTE/ AXIS)	X		X		X	
VISUAL EXAMINATION	X				X	
FUNCTIONAL	X				X	

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(B) TEST (CONTINUED)

GROUND TURNAROUND TEST

VERIFY ESSENTIAL BUS 1BC (2CA,3AB) BY ISOLATING VOLTAGE SOURCES AND MONITORING POWER STIMULI COMMANDS, SWITCH SCAN MEASUREMENTS, DISCRETE EVENTS, AND BUS VOLTAGES. TEST IS PERFORMED FOR ALL FLIGHTS.

(C) INSPECTION

RECEIVING INSPECTION (FAILURE CAUSE e)

RECEIVING INSPECTION PERFORMS VISUAL AND DIMENSIONAL EXAMINATIONS OF ALL INCOMING PARTS. TEST REPORTS AND RECORDS ARE MAINTAINED CERTIFYING MATERIALS AND PHYSICAL PROPERTIES.

CONTAMINATION CONTROL (FAILURE CAUSE b)

A GOOD HOUSEKEEPING AREA IS VERIFIED FOR ASSEMBLY. THE CONTACT SURFACES OF ALL ELECTRICAL TERMINATIONS ARE VERIFIED TO BE FREE OF ALL FOREIGN MATTER. ASSEMBLIES ARE VERIFIED TO BE FREE OF CHIPS, LOOSE HARDWARE, OIL, GREASE, OR OTHER FOREIGN MATTER, AND QUALITY CONTROL (QC) INSPECTION IS PERFORMED PRIOR TO FINAL CLOSE OUT OF THE UNITS.

ASSEMBLY/INSTALLATION (FAILURE CAUSE a,b,e)

ASSEMBLY PROCESSES ARE MONITORED AND CONTROLLED BY ML0303-0029 WHICH ESTABLISHES THE REQUIRED TECHNIQUES FOR ALL PHASES OF BOX COMPONENT AND HARNESS FABRICATION. DETAILED INSPECTION IS PERFORMED ON PARTS PRIOR TO THE NEXT ASSEMBLY OPERATION. WIRE AND CABLE PREPARATION AND PROPER HARNESS FABRICATION ARE VERIFIED. TORQUE VALUES APPLIED AND TORQUE TOOL NUMBERS ARE RECORDED IN THE MANUFACTURING OPERATION RECORDS.

CRITICAL PROCESSES (FAILURE CAUSE b,e)

ALL CRITICAL PROCESSES AND CERTIFICATIONS ARE MONITORED AND VERIFIED BY INSPECTION. THE CRITICAL PROCESSES ARE SOLDERING, CRIMPING, CONFORMAL COATING, POTTING AND ELECTRICAL BONDING.

TESTING

THE ACCEPTANCE TEST PROCEDURE IS OBSERVED AND VERIFIED BY QC, INCLUDING PRE-TEST, FUNCTIONAL AND VIBRATION.

HANDLING/PACKAGING (FAILURE CAUSE c,d)

PARTS PACKAGED AND PROTECTED ARE VERIFIED BY INSPECTION TO APPLICABLE REQUIREMENTS.

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(D) FAILURE HISTORY

THERE HAVE BEEN NO FAILURES OF AN ESSENTIAL BUS IN THE SHUTTLE ORBITER PROGRAM.

(E) OPERATIONAL USE

CAUTION AND WARNING SYSTEM ALERTS FLIGHT CREW TO PERFORM FUEL CELL SHUTDOWN PROCEDURE WITHIN SIX MINUTES, THEN POWERDOWN FOR LOSS OF ONE FUEL CELL.

05-6-35