

INDUCTION TO APPENDIX A

- ITEM 1 - TOGGLE SWITCH - ME452-0102-700X
- ITEM 2 - ROTARY SWITCH - ME452-0093
- ITEM 3 - PUSHBUTTON SWITCH - ME452-0060 AND ME452-0061
- ITEM 4 - LIMIT SWITCH - ME452-0123

FAILURE MODES AND CAUSES

THE FOLLOWING TABLE LISTS FAILURE MODES AND CAUSES WHICH WERE CONSIDERED IN DERIVING THE FAILURE MODES AND EFFECTS ANALYSIS (FMEA'S) FOR THE ABOVE ITEMS.

FAILURE MODE	FAILURES CAUSE	TOGGLE SWITCH	ROTARY SWITCH	P/B SWITCH	LIMIT SWITCH
FAILS OPEN, PREMATURE OPEN	(a) Piece Part Structural Failure	X	X	X	X
	(b) Contamination	X	X	X	X
	(c) Vibration	X	X	X	X
	(d) Mechanical Shock	X	X	X	X
	(e) Processing Anomaly	X	X	X	X
	(f) Thermal Stress	X	X	X	X
FAILS CLOSED, PREMATURE CLOSURE, CONTACT-TO-CONTACT SHORT	(a) Piece Part Structural Failure	X	X	X	X
	(b) Contamination	X	X	X	X
	(c) Vibration	X	X	X	X
	(d) Mechanical Shock	X	X	X	X
	(e) Processing Anomaly	X	X	X	X
	(f) Thermal Stress	X	X	X	X
SHORT-TO-CASE (GROUND)	(a) Piece Part Structural Failure	X	X	X	X
	(b) Contamination	X	X	X	X
	(c) Vibration	X	X	X	X
	(d) Mechanical Shock	X	X	X	X
	(e) Processing Anomaly	X	X	X	X
SOLE-TO-SOLE SHORT	(a) Piece Part Structural Failure	X	X	X	X
	(b) Contamination	X	X	X	X
	(c) Vibration	X	X	X	X
	(d) Mechanical Shock	X	X	X	X
	(e) Processing Anomaly	X	X	X	X
BROKEN STOP	(a) Piece Part Structural Failure	X	X	X	X
	(e) Processing Anomaly	X	X	X	X
LOSS OF ANNUNCIATOR / LENS ILLUMINATION, FAILS TO ILLUMINATE	(a) Piece Part Structural Failure		X	X	X
	(b) Contamination		X	X	X
	(c) Vibration		X	X	X
	(d) Mechanical Shock		X	X	X
	(e) Processing Anomaly		X	X	X
	(f) Thermal Stress		X	X	X

NOTE: PREMATURES CREATED BY THE TESTING OF TOGGLE SWITCHES ARE REVERSIBLE OR TEMPORARY CONDITIONS.

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APPENDIX A ITEM 2 - ROTARY SWITCH
ME452-0093-XXXX

DISPOSITION & RATIONALE

(A) DESIGN, (B) TEST, (C) INSPECTION, (D) FAILURE HISTORY:

(A) DESIGN

HERMETICALLY SEALED, STAINLESS STEEL CASE PREVENTS STRUCTURAL DAMAGE AND CONTAMINATION. THE DESIGN EMPLOYS COMPLETELY REDUNDANT PRINTED CIRCUIT DECK ASSEMBLIES THAT FEATURE MECHANICALLY SEPARATE BUT ELECTRICALLY CONNECTED CONTACT SURFACES AND WIPERS. THIS ARRANGEMENT PROVIDES INTIMATE CONTACT BETWEEN THE WIPER AND CONTACT EVEN UNDER SEVERE STRESSES OF VIBRATION AND SHOCK. DETENT ASSEMBLIES KEEP THE SWITCH IN ITS DESIRED POSITION BY MEANS OF TWO SPRING LOADED BEARINGS OPERATING AGAINST A PRECISION GEAR. SUFFICIENT INSULATION, SPACING, AND CLEARANCE BETWEEN CONDUCTING SURFACES IS PROVIDED TO GUARD AGAINST ELECTRICAL LEAKAGE AND SHORTS. APPLICATIONS MEET THE ORBITER PROJECT PARTS LIST (OPPL) CURRENT DERATING REQUIREMENTS FOR 2 AMPERE RATING. THE SWITCH IS DESIGNED, TESTED AND INSPECTED TO MEET THE REQUIREMENTS OF THE SPACE SHUTTLE PROGRAM DETAILED BY ROCKWELL INTERNATIONAL SPECIFICATION MC452-0049.

(B) TEST

QUALIFICATION/CERTIFICATION

QUALIFICATION TESTING COMPLETED AND APPROVED FOR ORBITER.
QUALIFICATION TESTS INCLUDE:

TEST	CAUSE CONTROL				
	a	b	c	d	e
FUNCTIONAL PERFORMANCE	X	X			
VIBRATION (0.2 g ² /HZ)	X	X			
THERMAL/VACUUM (1 X 10 ⁻⁴ MM OF MERCURY, 0-150 °F)	X		X		
SEAL TEST (1X10 ⁻⁶ SCC/SEC)		X			
MINIMUM SHAFT TORQUE (5 PLUS/MINUS 2 IN-LB)			X		
ENDURANCE (25,000 CYCLES)	X				X
CONTACT RESISTANCE	X	X	X	X	X
SHORT CIRCUIT TESTS					
OVERLOAD (50 CYCLES AT 150% OF RATED)					
INSULATION RESISTANCE (IR AT 500 VDC)		X			X

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APPENDIX A ITEM 2 CONT'D

ACCEPTANCE AND SCREENING

ALL SWITCHES ARE SUBJECTED TO ACCEPTANCE AND SCREENING TESTS ON A 100% BASIS AND INCLUDE THE FOLLOWING:

TEST	CAUSE CONTROL				
	a	b	c	d	e
EXAMINATIONS OF PRODUCT					
VIBRATION (0.04 g ² /HZ)	X		X		
CONTACT VOLTAGE DROP	X	X			X
CONTACT RESISTANCE	X	X	X	X	X
SEAL TEST (1X10 ⁻⁶ SCC/SEC)		X			
DIELECTRIC STRENGTH (500VRMS)		X			
MANUFACTURING TESTS INCLUDE HEADER (TERMINAL) PULL TESTS AND 250 CYCLE RUN-IN	X	X			X

ACCEPTANCE TEST AT THE NEXT ASSEMBLY:

TEST	CAUSE CONTROL				
	a	b	c	d	e
FUNCTIONAL	X	X			
CONTINUITY	X	X			
INSULATION RESISTANCE		X			X

(C) INSPECTION

RECEIVING INSPECTION

UPON RECEIPT, INSPECTION PERFORMS VISUAL AND DIMENSIONAL EXAMINATION OF ALL INCOMING PARTS AND VERIFIES THE MATERIALS USED. RECORDS ARE MAINTAINED CERTIFYING THE MATERIAL AND ITS PHYSICAL PROPERTIES.

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APPENDIX A ITEM 2 CONT'D

CONTAMINATION CONTROL (FAILURE CAUSE b)

SEALING OF SWITCH IS VERIFIED BY INSPECTION. QUALITY CONTROL (QC) VERIFIES ADHERENCE TO PROPER CLEANLINESS PROCEDURES/SHOP PRACTICES INCLUDING THOSE FOR THE LAMINAR FLOW BENCH OPERATION.

ASSEMBLY/INSTALLATION (FAILURE CAUSE a, e)

INSPECTION VERIFIES CRITICAL DIMENSIONS OF SWITCH CASE AND INTERNAL CONSTRUCTION UTILIZING CALIBRATED GAUGES. INSPECTION UNDER 10X MAGNIFICATION IS PERFORMED PRIOR TO CLOSEOUT.

CRITICAL PROCESSES (FAILURE CAUSE a, b, e)

CRITICAL PROCESSES ARE MONITORED AND VERIFIED BY QC. INSPECTION VERIFIES TUNGSTEN INERT GAS WELDING TO SWITCH INTERFACES. SOLDERING TO INTERFACE CONNECTORS AND SWITCH DECK VERIFIED UNDER 10X MAGNIFICATION. FORMAL CERTIFICATION IS MAINTAINED FOR SOLDERING AND WELDING OPERATORS.

TESTING

ALL PARTS OF ACCEPTANCE TESTING ARE OBSERVED AND VERIFIED BY QC.

HANDLING/PACKAGING (FAILURE CASE c, d)

ORBITER HARDWARE IS SEGREGATED AND NOT CO-MINGLED WITH OTHER HARDWARE. PARTS ARE PACKAGED, PROTECTED, AND VERIFIED BY INSPECTION.

(D) FAILURE HISTORY

FAILURE MODE: BROKEN STOP

CAR AD2239-110

DURING ORBITER OV-104 SUBSYSTEM CHECKOUT IN PALMDALE, THE TECHNICIAN OBSERVED THAT THE AC BUS SELECT ROTARY SWITCH HAD NO DETENT POSITIONS, FAILURE WAS CAUSED BY A BROKEN WELD BETWEEN THE DETENT GEAR AND SHAFT. THIS CONDITION WAS CAUSED BY INSUFFICIENT WELD PENETRATION. THIS WAS CONSIDERED TO BE AN ISOLATED ESCAPE AS THIS CONDITION SHOULD HAVE BEEN DETECTED IN VISUAL INSPECTION. THE ASSEMBLY ROUTE SHEET WAS REVISED TO INCORPORATE AN INSPECTION SIGN OFF BLOCK TO ASSURE THAT THE SHAFT ASSEMBLY IS INSPECTED PER TO REQUIREMENTS OF DRAWING 590015.

THERE ARE NO UNRESOLVED GENERIC ISSUES.

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APPENDIX A ITEM 2 CONT'D

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