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PRINT DATE: 06/28/95

FAILURE MODES EFFECTS ANALYSIS (FMEA) - CRITICAL HARDWARE

NUMBER: 02-1B-026 -X

SUBSYSTEM NAME: LANDING/DECELERATION - BRAKE/SKID CONTROL SYS

REVISION: 1 10/31/94

	PART NAME VENDOR NAME	PART NUMBER VENDOR NUMBER
	: BRAKE/SKID CONTROL (B/SC)	
LRU	: MLG BRAKE SYSTEM HYDRO-AIRE	MC621-0055 42-40315

PART DATA

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:
SKID AND LOCKED WHEEL CONTROL CIRCUIT CARD

QUANTITY OF LIKE ITEMS: 8
FOUR LEFT,
FOUR RIGHT
TWO EACH BRAKE

FUNCTION:
PROVIDES PROTECTION FOR THE TIRE/WHEEL ASSEMBLY BY REMOVING BRAKE
PRESSURE WHEN A SKID OR LOCKED WHEEL CONDITION IS DETECTED DURING
ACTIVE BRAKING.

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NUMBER: 02-1B-026 - 02**

SUBSYSTEM NAME: LANDING/DECELERATION - BRAKE/SKID CONTROL SYS
LRU: MLG BRAKE SYSTEM
ITEM NAME: MLG BRAKE SYSTEM

REVISION# 2 06/28/95
CRITICALITY OF THIS
FAILURE MODE: 1/1

FAILURE MODE:
NO OUTPUT - RESULTING IN LOSS OF SKID AND LOCKED WHEEL PROTECTION FOR THE
AFFECTED BRAKES.

MISSION PHASE:
DO DE-ORBIT

VEHICLE/PAYLOAD/KIT EFFECTIVITY:

102	COLUMBIA
103	DISCOVERY
104	ATLANTIS
105	ENDEAVOUR

CAUSE:
COMPONENT FAILURE, VIBRATION, MECHANICAL SHOCK

CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO.

REDUNDANCY SCREEN

A) N/A
B) N/A
C) N/A

PASS/FAIL RATIONALE:

A)

B)

C)

- FAILURE EFFECTS -

(A) SUBSYSTEM:
LOSS OF SKID AND LOCKED WHEEL PROTECTION ON HALF OF ONE BRAKE (WITH EACH
FAILURE). RESULTS IN POSSIBLE FAILURE OF AFFECTED TIRE IF A SKID OCCURS - THIS
STARTS A CHAIN OF EVENTS SIMILAR TO LANDING WITH A FLAT TIRE. THE RESULT IS
TOTAL LOSS OF BRAKING ON THE AFFECTED STRUT, POSSIBLE FAILURE OF THE STRUT
OR IT'S ATTACHMENTS OR, IF THE STRUT DOES NOT FAIL, CAUSE THE VEHICLE TO
DEPART THE RUNWAY.

(B) INTERFACING SUBSYSTEM(S):
SAME AS (A)

(C) MISSION:

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POSSIBLE LOSS OF MISSION/CREW/VEHICLE DUE TO TIRE SKID RESULTING IN FAILURE OF THE AFFECTED TIRE/WHEEL ASSEMBLY, SUBSEQUENT FAILURE OF ADJACENT TIRE/WHEEL ASSEMBLY AND LOSS OF 50 PERCENT BRAKING CAPABILITY WHICH COULD CAUSE THE VEHICLE TO DEPART THE RUNWAY.

(D) CREW, VEHICLE, AND ELEMENT(S):
SAME AS (C)

(E) FUNCTIONAL CRITICALITY EFFECTS:

-DISPOSITION RATIONALE-

(A) DESIGN:

BASIC DESIGN CONCEPT HAS BEEN PROVEN BY MANY HOURS ON COMMERCIAL AND MILITARY SERVICE. ELECTRONIC PARTS WERE SELECTED FROM ORBITER PROJECT PARTS LIST (OPPL). THOSE COMPONENTS NOT ON THE OPPL WERE AUTHORIZED ON AN IRREGULAR PARTS AUTHORIZATION REQUEST. THE CONTROL BOX IS DESIGNED TO OPERATE AFTER BEING SUBJECTED TO A SAWTOOTH SHOCK PULSE OF 20G PEAK MAGNITUDE FOR A DURATION OF 10 TO 12 MILLISECONDS. ELECTRICAL DESIGN REQUIREMENTS ARE IN ACCORDANCE WITH MF0004-002.

(B) TEST:

QUALIFICATION TESTS: ENVIRONMENTAL TESTING INCLUDES; HUMIDITY, SALT FOG, VIBRATION ACCELERATION & SHOCK - TEST SPECIMEN ARE SUBJECTED TO FUNCTIONAL TESTS BEFORE AND AFTER EACH ENVIRONMENT TEST. EQUIPMENT NORMALLY OPERATING DURING EXPOSURE TO THESE ENVIRONMENTS ARE ALSO FUNCTIONALLY MONITORED DURING QUALIFICATION TESTING. ACCEPTANCE VIBRATION TEST IN ACCORDANCE WITH NASA SPECIFICATION SP-T-0023B ARE PERFORMED ON THE BRAKE/SKID CONTROL BOX. THE BRAKE/SKID CONTROL SYSTEM IS SUBJECTED TO 10G UPWARD/7.5G DOWNWARD LANDING ACCELERATION IN THE VERTICAL AXIS AND 0.8 AFT/1G FORWARD IN THE LONGITUDINAL AXIS. THIS LANDING ACCELERATION IS MAINTAINED FOR A MINIMUM OF 5 MINUTES.

THE FOLOWING IS A SUMMARY OF THE QUALIFICATION TESTING/CERTIFICATION OF THE ANTI-SKID BOX TO SPEEDS GREATER THAN 180 KNOTS:

QUAL TEST OF THE ANTI-SKID OPERATION FOR ORBITER HIGH SPEED BRAKING APPLICATIONS UP TO 250 KNOTS WAS COMPLETED ON 9/30/94 USING THE HYDRO-AIRE'S SIMULATION FACILITIES. THIS INCLUDED DUPLICATION OF THE ORBITER'S HYDRAULIC LINE LENGTHS, AND USED AN ACTUAL ORBITER REGULATOR, PRESSURE BRAKE VALVE, AND STRUCTURAL CARBON BRAKES. THIRTY (30) DIFFERENT CONFIGURATIONS WERE ASSESSED E.G., STRUT LOADS OF 25, 40, 77, & 230 KLBS, BRAKING PRESSURES OF 600, 800, & 1200 PSI, MAXIMUM RUNWAY/TIRE BRAKING FRICTION OF 0.5 AMD 0.3 AND INITIAL VELOCITY OF 225 & 250 KNOTS. THE TESTS PROVED THE ANTI-SKID CONTROL BOX WILL PREVENT WHEEL LOCK UP DURING BRAKING AT THESE HIGHER SPEEDS. THE TESTS/SIMULATION DID NOT SHOW ANY SIGNS OF GEAR INSTABILITY. HOWEVER, AT LIGHT GEAR LOADS, DURING HIGH ANGLE OF ATTACK, IF BRAKE PRESSURE IS APPLIED TOO RAPIDLY, THERE WILL BE SIGNIFICANT ANTI-SKID ACTIVITY TO REMOVE EFFECTIVE BRAKING FOR ONE (1) TO TWO (2) SECONDS. ENOUGH SLIPPAGE OF THE TIRE COULD OCCUR TO CAUSE SOME ADDITIONAL TIRE WEAR, BUT NOT AS MUCH AS SPIN UP WEAR AT TOUCHDOWN. BASED ON THE RESULTS OF THESE QUAL TESTS THE ANTI-SKID CONTROL BOX IS CERTIFIED

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TO THE HIGHER SPEED OF 225 KNOTS, WHICH IS 45 KNOTS ABOVE THE PREVIOUS LIMIT OF 180 KNOTS

GROUND TURNAROUND TEST
ANY TURNAROUND CHECKOUT TESTING IS ACCOMPLISHED IN ACCORDANCE WITH OMRSD.

(C) INSPECTION:

RECEIVING INSPECTION

MATERIAL AND PROCESS CERTIFICATION ARE VERIFIED BY INSPECTION. RECEIVING INSPECTION VERIFIES FUNCTIONAL CHARACTERISTICS. INSPECTION VERIFIES COUNT AND INSPECTS FOR IDENTITY AND DAMAGE.

CONTAMINATION CONTROL

INSPECTION VERIFIES CONTAMINATION AND CORROSION CONTROL REQUIREMENTS.

ASSEMBLY/INSTALLATION

FABRICATION IS CONTROLLED BY SEQUENCE. DESIGNATED SHUTTLE PROJECT FABRICATION AREA VERIFIED BY INSPECTION, ACCEPTABLE PRIOR TO FABRICATION.

CRITICAL PROCESSES

INSPECTION VERIFIES ORIENTATION IS CORRECT ON ORIENTATION SENSITIVE PARTS PRIOR TO SOLDERING. SOLDERING CONTROLLED PER NHB 5300.4. TECHNICIANS AND INSPECTOR CERTIFIED.

NONDESTRUCTIVE EVALUATION

INSPECTION VERIFIES BLACK-LIGHT INSPECTION FOR SOLDER RESIN RESIDUE.

TESTING

ATP IS VERIFIED BY INSPECTION, INCLUDING CIRCUIT BOARDS INSPECTED FOR CONTINUITY, RESISTANCE AND OUTPUT.

PACKAGING/HANDLING

HANDLING AND PACKAGING REQUIREMENTS ARE VERIFIED BY INSPECTION.

(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 DATABASE.

(E) OPERATIONAL USE:

CREW WILL USE NWS, AERO RUDDER AND DIFFERENTIAL BRAKING IN AN ATTEMPT TO MAINTAIN DIRECTIONAL CONTROL.

- APPROVALS -

EDITORIALLY APPROVED : RI
EDITORIALLY APPROVED : JSC
TECHNICAL APPROVAL : VIA CR

: *[Signature]*
: *[Signature]* 10/31/95
: ORB0005