PRINT DATE: 06/28/95

FAILURE MODES EFFECTS ANALYSIS (FMEA) – CRITICAL HARDWARE
NUMBER: 02-1B-051 -X

SUBSYSTEM NAME: LANDING/DECELERATION - BRAKE/SKID CONTROL SYS
REVISION: 1 11/28/94

		PART NAME VENDOR NAME	PART NUMBER VENDOR NUMBER
	:	BRAKE/SKID CONTROL	
LRU	:	MLG BRAKE SYSTEM HYDRO AIRE	MC621-0055 40-901

PART DATA

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:
COIL-WHEEL SPEED SENSOR ASSEMBLY

QUANTITY OF LIKE ITEMS: 8
TWO EACH WHEEL

FUNCTION:
THE BRAKE/SKID CONTROL SYSTEM UTILIZES FOUR WHEEL SPEED SENSORS (ONE FOR EACH OF THE MAIN WHEELS). EACH WHEEL SPEED SENSOR CONTAINS TWO COILS. THE WHEEL SPEED INFORMATION FROM THE COILS PROVIDES SKID CONTROL PROTECTION FOR THE BRAKES.

FAILURE MODES EFFECTS ANALYSIS (FMEA) – CRITICAL FAILURE MODE
NUMBER: 02-1B-051 - 02

REVISION# 2 06/28/95
SUBSYSTEM NAME: LANDING/DECELERATION - BRAKE/SKID CONTROL SYS
LRU: MLG BRAKE SYSTEM **CRITICALITY OF THIS**
ITEM NAME: MLG BRAKE SYSTEM **FAILURE MODE:** 1R2

FAILURE MODE:
STRUCTURAL FAILURE

MISSION PHASE:
DO DE-ORBIT

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

CAUSE:
FOREIGN OBJECT DAMAGE CAUSING BROKEN WIRING

CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO

REDUNDANCY SCREEN
A) PASS
B) FAIL
C) PASS

PASS/FAIL RATIONALE:
A)

B)
SCREEN "B" FAILS BECAUSE CREW DOES DOES NOT HAVE SUFFICIENT TIME TO INITIATE CORRECTIVE ACTION FOLLOWING ANT-SKID LIGHT ANNUNCIATION.

C)

- FAILURE EFFECTS -

(A) SUBSYSTEM:
LOSS OF WHEEL SPEED SIGNAL FOR ALL BRAKE CHAMBERS ON ONE MAIN WHEEL.

(B) INTERFACING SUBSYSTEM(S):
LOSS OF 25% OF TOTAL BRAKING CAPACITY - EXTENDED ROLLOUT.

(C) MISSION:
POSSIBLE LOSS OF MISSION/CREW/VEHICLE AFTER TWO FAILURES ON THE SAME SIDE.

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

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(E) FUNCTIONAL CRITICALITY EFFECTS:

-DISPOSITION RATIONALE-

(A) DESIGN:
THE COIL ASSEMBLY INCLUDES A ALNICO V PERMANENT MAGNET, A 2200 TURN AWG39 MAGNET WIRE COIL AND TWO REDUNDANT ELECTRICALLY ISOLATED CIRCUITS. WHEEL SPEED SENSOR IS DESIGNED TO OPERATE AFTER BEING SUBJECTED TO A SAWTOOTH SHOCK PULSE OF 50-G PEAK MAGNITUDE FOR A DURATION OF 10 TO 12 MILLISECONDS.

(B) TEST:
QUALIFICATION TEST: ENVIRONMENTAL TESTING INCLUDES; HUMIDITY, SALT FOG, VIBRATION ACCELERATION AND 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. LANDING ACCELERATION: WHEEL SPEED SENSORS ARE SUBJECTED TO 20G UP AND DOWN IN THE VERTICAL AXIS AND 20G AFT AND FORWARD IN THE LONGITUDINAL AXIS. THIS LANDING ACCELERATION IS MAINTAINED FOR A MINIMUM OF 5 MINUTES.

ACCEPTANCE TEST INCLUDE VERIFICATION THAT CERTIFIED MATERIALS AND PROCESSES WERE USED. INBOARD AND OUTBOARD COIL RESISTANCE AND PEAK TO PEAK VOLTAGE ARE RECORDED.

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 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:

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NUMBER: 02-1B-051 - 02

RECEIVING INSPECTION
MATERIALS AND PROCESS CERTIFICATIONS ARE VERIFIED BY INSPECTION.

CONTAMINATION CONTROL
CONTAMINATION CONTROL, CLEANLINESS AND CORROSION PROTECTION REQUIREMENTS ARE VERIFIED BY INSPECTION.

ASSEMBLY/INSTALLATION
COIL IS VISUALLY AND DIMENSIONALLY VERIFIED DURING FABRICATION.

CRITICAL PROCESSES
SOLDERING IS VERIFIED BY INSPECTION.

NONDESTRUCTIVE EVALUATION
BLACK-LIGHT INSPECTION FOR SOLDER RESIN RESIDUE AND OTHER CONTAMINATION IS VERIFIED BY INSPECTION.

TESTING
ATP IS VERIFIED BY INSPECTION.

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 CAN COMPENSATE EITHER BY CHANGING BRAKING PROCEDURE AND/OR USE NWS TO MAINTAIN DIRECTIONAL CONTROL.

- APPROVALS -

EDITORIALLY APPROVED	: RI	:
EDITORIALLY APPROVED	: JSC	: Dennis C. Baker 10/31/95
TECHNICAL APPROVAL	: VIA CR	:ORB0005