

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL HARDWARE
NUMBER: 02-1E-066 -X

SUBSYSTEM NAME: LANDING DECELERATION - WHEEL, BRAKE & TIRE
REVISION: 0 03/07/88

PART DATA

	PART NAME	PART NUMBER
	VENDOR NAME	VENDOR NUMBER
	: CHASSIS ASSEMBLY - MLG	MC621-0051
LRU	: MLG WHEEL BRAKE ASSY B. F. GOODRICH	MC621-0075 2-1357-11

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:
MLG WHEEL BRAKE ASSEMBLY

REFERENCE DESIGNATORS:

QUANTITY OF LIKE ITEMS: 4
FOUR

FUNCTION:
PROVIDE VEHICLE BRAKING CAPABILITY

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REVISION#: 1 08/03/97

SUBSYSTEM NAME: LANDING DECELERATION - WHEEL, BRAKE & TIRE

LRU: MLG WHEEL BRAKE ASSY

CRITICALITY OF THIS

ITEM NAME: MLG WHEEL BRAKE ASSY

FAILURE MODE: 1R3

**FAILURE MODE:
REDUCED BRAKE CAPABILITY.**

MISSION PHASE: DO DE-ORBIT

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

**CAUSE:
BROKEN HYDRAULIC LINE, QUICK DISCONNECT SEPARATION**

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 THERE IS NO INDICATION OF THIS FAILURE UNTIL BRAKING IS APPLIED.**

C)

- FAILURE EFFECTS -

**(A) SUBSYSTEM:
LOSS OF 12.5% OF BRAKE EFFICIENCY WITH EACH BROKEN LINE. LOSS OF HYDRAULIC FLUID - WHICH CREATES A FIRE HAZARD.**

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

(C) MISSION:
EXTENDED ROLLOUT, PROBABLE LOSS OF MISSION/CREW/VEHICLE AFTER FOUR FAILURES.

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

(E) FUNCTIONAL CRITICALITY EFFECTS:

-DISPOSITION RATIONALE-

(A) DESIGN:

THE BASELINE BRAKE ASSEMBLY IS DESIGNED TO STOP THE VEHICLE WITH A SINGLE HYDRAULIC SYSTEM ON A BRAKE. THE HYDRAULIC BRAKE MODULE'S DISPLACEMENT LIMITER IS DESIGNED TO LIMIT FLUID LOSS TO 30 - 60 CUBIC INCHES AND THE BRAKE QUICK DISCONNECTS HAVE A SEALING POPPET.

THE PRESENT CONFIGURATION OF THE WHEEL BRAKE ASSEMBLY IS DESIGNED WITH 6 ORIFICES IN THE PISTON HOUSING AND ADDED THICKNESS TO THE #2 AND #3 STATORS, THIS INCREASES THE ENERGY ABSORBING CAPABILITY OF THE BRAKE AND IT'S ABILITY TO ACCOMODATE A SINGLE SYSTEM FAILURE.

(B) TEST:

QUALIFICATION TESTS: THE PRESENT "THICK STATOR" CONFIGURATION OF THE BRAKES WAS CERTIFIED BY SIMILARITY TO THE BASELINE BRAKES AND BY COMPLETING ADDITIONAL ENERGY STOPS.

THE FOLLOWING ENERGY STOPS WERE PERFORMED ON THE THICK STATOR WHEEL/BRAKE ASSEMBLY:

2 STOPS IN THE 25 MILLION FT-LBS ENERGY LEVEL RANGE
1 STOP IN THE 36.5 MILLION FT-LBS ENERGY LEVEL RANGE AND
2 STOPS IN THE 65.5 MILLION FT-LBS ENERGY LEVEL RANGE.

THESE STOPS WERE CONDUCTED UNDER VARIOUS CONDITIONS OF SINK RATES, BRAKE ON SPEED AND DESIGN LANDING LOAD PROFILES - THE WHEEL/BRAKE ASSEMBLY MET ALL THE STOPPING REQUIREMENTS.

BRAKE WEAR-IN ENERGY STOPS ARE PERFORMED AT 14 MILLION FT-LBS (WAS 2 MILLION FT-LBS FOR BASELINE BRAKE CONFIGURATION). THE ENVIRONMENTAL TESTING REQUIREMENTS FOR THE THICK STATOR BRAKE WERE MET BY ANALYSIS

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AND SIMILARITY TO THE BASIC BRAKE CONFIGURATION REQUIREMENTS - HUMIDITY, SALT FOG AND BENCH HANDLING SHOCK.
FLIGHT ENVIRONMENTS: LINEAR ACCELERATION - 20G UP AND DOWN (VERTICAL AXIS), 20G AFT AND FORWARD (LONGITUDINAL AXIS). THE BASELINE BRAKE WAS SUBJECTED TO A THERMAL SAWTOOTH SHOCK PULSE OF 50G PEAK AMPLITUDE FOR A PULSE DURATION OF 10 TO 12 MILLISECONDS. THE BRAKE WAS ALSO SUBMITTED TO TWO LEVELS OF RANDOM VIBRATION.

HYDRAULIC SYSTEM PRESSURE TEST (BASELINE BRAKES):
THIS PROOF PRESSURE TEST WAS PERFORMED (INDIVIDUALLY) ON EACH BRAKE HYDRAULIC SYSTEM. EACH SYSTEM WAS PRESSURIZED TO 4500 PSIG AND HELD THERE FOR ONE MINUTE WHILE THE BRAKE WAS MAINTAINED AT A TEMPERATURE OF 275 DEGREES F. - 100 CYCLES WERE PERFORMED WITHOUT HYDRAULIC LEAKAGE OR STRUCTURAL DISTORTION.

HEAT AGING AND BURST TEST (BASELINE BRAKES):
THE BRAKE ASSEMBLY, FILLED WITH FLUID, WAS HEATED TO 275 DEGREES F AND HELD THERE FOR 100 HOURS. THE BRAKE WAS THEN COOLED TO AMBIENT TEMPERATURE AND PRESSURIZED, A SINGLE HYDRAULIC SYSTEM AT A TIME, TO 6000 PSIG. THIS PRESSURE WAS HELD FOR 5 MINUTES - THERE WAS NO RUPTURE, LEAKING OR STRUCTURAL FAILURE.

GROUND TURNAROUND TEST
ANY TURNAROUND CHECKOUT TESTING IS ACCOMPLISHED IN ACCORDANCE WITH OMRSD. THE OMRSD DATA PROVIDED BELOW IS NO LONGER BEING KEPT UP-TO-DATE. IF THERE IS ANY DISCREPANCY BETWEEN THE GROUND TESTING DATA PROVIDED BELOW AND THE OMRSD, THE OMRSD IS THE MORE ACCURATE SOURCE OF THE DATA.

LMG/RMG ZONAL DETAIL INSPECTION;
ALL HYDRAULIC LINES, QUICK DISCONNECTS AND BRAKE CONNECTIONS ARE INSPECTED FOR CONDITION AND SECURITY.

BRAKE QUICK DISCONNECT INSPECTION:
ALL BERYLLIUM BRAKE QUICK DISCONNECTS ARE CHECKED FOR ACTUATION SLEEVE FREE PLAY AND GAP DISTANCE BETWEEN EACH HALF PER THE MLO308-0029 SPECIFICATION.

FREQUENCY - ALL VEHICLES AT GROUND TURNAROUND.

(C) INSPECTION:
RECEIVING INSPECTION
RECEIVING INSPECTION VERIFIES MATERIALS AND PROCESSES CERTIFICATION.

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

ASSEMBLY/INSTALLATION
ASSEMBLED BRAKE ASSEMBLIES INSPECTED FOR PROPER ASSEMBLY. DETAIL PARTS INSPECTED FOR DAMAGE. CRITICAL DIMENSIONS AND CRITICAL SURFACE FINISHES. FABRICATION AND ASSEMBLY PROCESSES VERIFIED BY INSPECTION.

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CRITICAL PROCESSES
BERYLLIUM MACHINING IS VERIFIED BY INSPECTION.

NONDESTRUCTIVE EVALUATION
BOLTS ARE FLUORESCENT PENETRANT INSPECTED, VERIFIED BY INSPECTION.
BERYLLIUM PORTION OF STATORS, ROTORS, BACKPLATE AND PRESSURE PLATE ARE
FLUORESCENT PENETRANT INSPECTED AND VERIFIED BY INSPECTION. CARBON PADS
ARE RADIOGRAPHICALLY INSPECTED AND VERIFIED BY INSPECTION. WHEEL DRIVE
INSERTS ARE MAGNETIC PARTICLE INSPECTED AND VERIFIED BY INSPECTION. TZX
BRAKE PAD RETAINING WASHERS ARE EDDY CURRENT INSPECTED. AND VERIFIED BY
VISUAL 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 DATA BASE. THE FAILURE HISTORY DATA PROVIDED BELOW IS
NO LONGER BEING KEPT UP-TO-DATE.

FROM 1975 TO 1987, NUMEROUS DESIGN CHANGES WERE MADE AS A RESULT OF
TEST/FIELD FAILURES IN AN ATTEMPT TO UPGRADE BRAKE/WHEEL PERFORMANCE
CULMINATING IN THE "THICK STATOR" CONFIGURATION WHICH WILL BE INSTALL PRIOR
TO STS-26. THESE CHANGES ARE FULLY DOCUMENTED BY MCR PROCESS.
ADDITIONALLY, A NEW BRAKE/WHEEL DESIGN (STRUCTURAL CARBON, 5 ROTOR
CONFIGURATION) IS PRESENTLY UNDER DEVELOPMENT.

(E) OPERATIONAL USE:

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

- APPROVALS -

EDITORIALLY APPROVED : BNA : *Jerry Kemira 8/3/97*
EDITORIALLY APPROVED : JSC : *D. O'Leary 9-12-97*
TECHNICAL APPROVAL : VIA APPROVAL FORM : 96-CIL-011_02-1E