

**FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL HARDWARE
NUMBER: 02-1D-184 -X**

**SUBSYSTEM NAME: LANDING DECELERATION - NWS - MECHANISM
REVISION: 4 08/20/93**

PART DATA

PART NAME	PART NUMBER
VENDOR NAME	VENDOR NUMBER
LRU : INWS HYDRAULIC ACTUATOR ASSY	MC621-0058-0019

**EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:
HYDRAULIC ACTUATOR ASSEMBLY**

REFERENCE DESIGNATORS:

**QUANTITY OF LIKE ITEMS: 1
ONE**

**FUNCTION:
PROVIDES HYDRAULIC POWER STEERING AND SHIMMY DAMPING TO THE NOSE
WHEEL ASSEMBLY.**

FAILURE MODES EFFECTS ANALYSIS FMEA - CIL FAILURE MODE

NUMBER: 02-1D-184-01

REVISION#: 3 08/03/97

SUBSYSTEM NAME: LANDING DECELERATION - NWS - MECHANISM

LRU: INWS HYDRAULIC ACTUATOR ASSY

ITEM NAME: INWS HYDRAULIC ACTUATOR ASSY

CRITICALITY OF THIS FAILURE MODE: 1R3

FAILURE MODE:
STRUCTURAL FAILURE OF ACTUATOR ATTACHMENTS

MISSION PHASE: DO DE-ORBIT

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

CAUSE:
OVERSTRESS, DEFECTIVE PART/MATERIAL, FATIGUE.

CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO

REDUNDANCY SCREEN

- A) PASS
- B) FAIL
- C) PASS

PASS/FAIL RATIONALE:

A)

B)

FAILS SCREEN "B" SINCE INWS IS NOT POWERED UNTIL LANDING GEAR DOWN
COMMAND AND STEERING CANNOT BE ACTIVATED UNTIL WEIGHT ON NOSE GEAR.

C)

- FAILURE EFFECTS -

(A) SUBSYSTEM:

LOSS OF FUNCTION - NOSE WHEEL STEERING SYSTEM WILL DOWNGRADE TO THE
FREE CASTER MODE. LOSS OF SHIMMY DAMPING CAPABILITY.

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

(C) MISSION:
NO EFFECT WITH FIRST FAILURE.

(D) CREW, VEHICLE, AND ELEMENT(S):
POSSIBLE LOSS OF CREW/VEHICLE WITH TWO ADDITIONAL FAILURES - LOSS OF
DIFFERENTIAL BRAKING.(WHICH IS CONSIDERED UNLIKE REDUNDANCY).

(E) FUNCTIONAL CRITICALITY EFFECTS:
CRIT 1R BECAUSE LOSS OF NWS MAY ALLOW VEHICLE TO DEPART RUNWAY
RESULTING IN LOSS OF CREW/VEHICLE.

-DISPOSITION RATIONALE-

(A) DESIGN:
MATERIALS AND PROCESSES ARE IN ACCORDANCE WITH MC999-0096. ACTUATOR IS
DESIGNED TO COMPLY WITH THE REQUIREMENTS OF MIL-C-5503. EQUIPMENT
MOUNTING INTERFACES ARE DESIGNED TO WITHSTAND TERMINAL PEAK SAW TOOTH
PULSES OF +/-40 G'S IN ALL AXES FOR 11 MILLISECONDS DURATION. ACTUATOR
ATTACHMENTS ARE DESIGNED TO ACCOMMODATE PREDICTED FATIGUE/STRESS
LEVELS WITH A MINIMUM MARGIN OF SAFETY OF 1.5.

(B) TEST:
QUALIFICATION TESTS: QUAL TESTS INCLUDE: HUMIDITY, SALT FOG, SAND AND DUST,
VIBRATION ACCELERATION AND SHOCK. THE STEERING COLLAR ATTACHMENT IS
TESTED AS AN INTEGRAL PART OF THE NLG SHOCK STRUT.

SHOCK STRUT QUALIFICATION TESTS INCLUDE STATIC LOAD TESTS, DYNAMIC TESTS,
DROP TESTS AND FATIGUE LOAD TESTS.

THE STATIC TEST PROGRAM APPLIED DESIGN AND ULTIMATE LOADS IN LANDING, TAXI
AND GROUND HANDLING CONDITIONS. TWO COMBINATIONS OF VERTICAL LOADS (71
KIPS AND 87 KIPS) AND FWD/AFT LOADS (44.5 KIPS AND 57.7 KIPS) WERE APPLIED TO
THE STRUT DURING THE LANDING CONDITIONS TESTS. EIGHT DIFFERENT TAXI LOADS
TESTS AND FOUR GROUND HANDLING LOADS TESTS WERE ALSO PERFORMED.

TEN DROP TESTS WERE PERFORMED ON THE NLG SHOCK STRUT. THE MAXIMUM
DROP TEST LOAD WAS 109,400 LBS AND THE MAXIMUM SINK SPEED WAS 13.6 FPS. THE
NLG SHOCK STREET WAS CERTIFIED WITH THE RESTRICTION OF A SINK SPEED AT NLG

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CONTACT TO 11.5 FT/SEC. OR THE VALUE WHICH RESULTED IN A NLG LOAD OF 90 KLB, WHICHEVER IS LESS.

A FATIGUE STRESS ANALYSIS (PERFORMED BY THE SUPPLIER) DETERMINED THE FATIGUE LIFE OF THE SHOCK STRUT ASSEMBLY. A SCATTER FACTOR OF 4.0 WAS APPLIED TO THE LIFE CYCLE OF THE STRUT. THE PRESENT CONFIGURATION OF THE STRUT HAS A MARGIN OF SAFETY OF 5 PERCENT (ABOVE ALLOWABLE YIELD LOADS) FOR THE TUBULAR SECTIONS AND 16 PERCENT (ABOVE ALLOWABLE YIELD LOADS) FOR THE LUG SECTIONS (JOINTS) OF THE STRUT. THE NOSE WHEEL STEERING ACTUATOR STRUCTURAL ATTACHMENTS HAVE A DESIGN FACTOR OF SAFETY OF 2.25.

ACCEPTANCE TESTS: ACCEPTANCE TESTS ARE PERFORMED ON ALL UNITS DELIVERED BY THE SUPPLIER THESE TESTS INCLUDE: COMPONENT FUNCTIONAL TEST, ACCEPTANCE VIBRATION TEST, PROOF PRESSURE TEST, AND ACTUATOR RESTRAINED PROOF TEST.

ACCEPTANCE TESTS OF THE NLG SHOCK STRUT INCLUDES A CHECK OF ALL DIMENSIONS, WEIGHTS AND FINISHES. THESE TESTS ALSO VERIFY THAT CERTIFIED MATERIALS AND PROCESSES HAVE BEEN USED.

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.

NWS1 AND NWS2 SWITCH -

VERIFIES THE ACTUATOR'S OPERATION THROUGHOUT ITS FULL RANGE OF MOTION; 9.00+/-0.56 DEGREES (NOSE WHEEL RIGHT & LEFT MOVEMENT WITH THE TORQUE LINKS DISCONNECTED). THESE TESTS ARE CONDUCTED USING BOTH NWS1 AND NWS2 POSITIONS.

OMRSD ALSO VERIFIES THE INTEGRITY OF THE NWS ACTUATOR STRUCTURAL ATTACHMENTS VIA A ZONAL DETAIL INSPECTION OF THE NLG WHEELWELL - THE ACTUATOR AND ITS ATTACHMENTS ARE INSPECTED FOR CONDITION AND SECURITY.

FREQUENCY - ALL VEHICLES AT EACH GROUND TURNAROUND.

(C) INSPECTION:

RECEIVING INSPECTION

RAW MATERIAL AND PROCESS CERTIFICATION ARE VERIFIED BY INSPECTION. TEST REPORTS AND RECORDS ARE MAINTAINED.

CONTAMINATION CONTROL

ALL HYDRAULIC FLUID INTERNAL SURFACES ARE MAINTAINED AT LEVEL 190 CLEANLINESS. SYSTEM CLEANLINESS IS VERIFIED ON A REGULAR BASIS BY FLUID SAMPLING ANALYSIS. SYSTEM HYDRAULIC FLUID IS ANALYZED FOR WATER AND FREON CONTENT (100PPM MAX).

ASSEMBLY/INSTALLATION

ALL DETAIL PARTS ARE INSPECTED AND FLUSHED WITH SOLVENT PRIOR TO ASSEMBLY. CRITICAL DIMENSIONS AND SURFACE FINISHES ARE VERIFIED BY

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INSPECTION. SEALS ARE VISUALLY EXAMINED FOR CLEANLINESS AND DAMAGE.
APPLICATION OF O-RING SEAL LUBRICANT IS VERIFIED BY INSPECTION.
TORQUING AND LOCKWIRING OF FASTENERS IS VERIFIED BY INSPECTION.

NONDESTRUCTIVE EVALUATION
MAGNETIC PARTICLE AND PENETRANT INSPECTION OF MACHINED PARTS ARE
VERIFIED BY INSPECTION. X-RAYS OF BRAZED TUBE AND FITTINGS ARE VERIFIED BY
INSPECTION.

CRITICAL PROCESSES
SURFACE TREATMENTS SUCH AS PASSIVATION AND ANODIZING, PLATING, HEAT
TREATMENT, SWAGING, BRAZING, ELECTRICAL BONDING ARE VERIFIED BY
INSPECTION. SOLDERING PER NHB5300.4(3A) AND CONFORMAL COATING OF PRINTED
WIRING BOARDS ARE VERIFIED BY INSPECTION.

TESTING
THE ATP WHICH IS WITNESSED AND VERIFIED BY INSPECTION INCLUDES FLUID
CLEANLINESS VERIFICATION, PROOF PRESSURE AND LEAK TESTING, PULL-IN AND
DROP OUT VOLTAGES, DIELECTRIC STRENGTH, INSULATION RESISTANCE, AND
WINDING RESISTANCE.

HANDLING/PACKAGING
PACKAGING AND HANDLING FOR SHIPMENT IS VERIFIED BY INSPECTION TO BE IN
ACCORDANCE WITH REQUIREMENTS.

(D) FAILURE HISTORY:
NONE

(E) OPERATIONAL USE:
NONE

- APPROVALS -

EDITORIALLY APPROVED : BNA : J. Kimura 8/4/97
EDITORIALLY APPROVED : JSC : A. Searcy 8/9/97
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