

**FAILURE MODES EFFECTS ANALYSIS (FMEA) – CIL HARDWARE
NUMBER: 02-1D-192 -X**

**SUBSYSTEM NAME: LANDING DECELERATION - NWS - MECHANISM
REVISION: 2 02/21/92**

PART DATA

	PART NAME VENDOR NAME	PART NUMBER VENDOR NUMBER
LRU	: INWS HYDRAULIC ACTUATOR ASSY	MC621-0058-0019
SRU	: SERVO CONTROL VALVE	MC621-0058-0019B

**EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:
SERVO CONTROL VALVE**

REFERENCE DESIGNATORS:

**QUANTITY OF LIKE ITEMS: 1
ONE**

**FUNCTION:
METERS HYDRAULIC FLUID PRESSURE/VOLUME TO THE NOSE WHEEL STEERING ACTUATOR BY SIGNALS FROM THE NOSE WHEEL STEERING CONTROL BOX. THERE ARE TWO SEPERATED COILS, ONE FOR EACH OF THE TWO CONTROL CHANNELS, TO DRIVE THE SERVO VALVE.**

FAILURE MODES EFFECTS ANALYSIS FMEA - CIL FAILURE MODE
NUMBER: 02-1D-192-02

SUBSYSTEM NAME: LANDING DECELERATION - NWS - MECHANISM
LRU: INWS HYDRAULIC ACTUATOR ASSY
ITEM NAME: SERVO CONTROL VALVE
REVISION#: 3 08/03/97
CRITICALITY OF THIS FAILURE MODE: 1R3

FAILURE MODE:
ERRONEOUS RESPONSE

MISSION PHASE: DO DE-ORBIT

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

CAUSE:
CONTAMINATION OF SERVO VALVE NOZZLE OR ORIFICE, BINDING OF SPOOL.

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:
ACTUATOR WILL TRY TO STEER TO A "HARDOVER" POSITION UNTIL COMPUTER
DETECTS FAILURE. LOSS OF NOSE WHEEL STEERING. THE SYSTEM AUTOMATICALLY
REVERTS TO THE FREE CASTER MODE.

**FAILURE MODES EFFECTS ANALYSIS (FMEA) – CIL FAILURE MODE
NUMBER: 02-1D-192- 02**

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

**(C) MISSION:
NO EFFECTS 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 POSSIBLE LOSS OF CREW/VEHICLE.**

-DISPOSITION RATIONALE-

**(A) DESIGN:
SYSTEM IS DESIGNED TO COMPLY WITH THE REQUIREMENTS OF MIL-H-5440 AND MIL-C-
5503 WITH REGARDS TO PREVENTING CONTAMINATION. HYDRAULIC FLUID INLET HAS
A 5 MICRON NOMINAL AND 15 MICRON ABSOLUTE FILTER. ELECTRICAL CIRCUITS ARE
DESIGNED PER THE REQUIREMENTS OF MF0004-002.**

**(B) TEST:
QUALIFICATION TESTS: THE INWS QUAL TESTS INCLUDE: VIBRATION, ACCELERATION,
SHOCK, THERMAL SHOCK, THERMAL VACUUM, THERMAL CYCLE AND ENDURANCE
CYCLING. THE UNITS ARE SUBJECTED TO FUNCTIONAL TESTS BEFORE AND AFTER
EACH ENVIRONMENT TEST. THE INWS WAS ALSO QUALIFIED BY SIMILARITY BY THE
FOLLOWING TESTS: PROOF PRESSURE, SALT FOG, HUMIDITY, SAND AND DUST,
EXPLOSIVE ATMOSPHERE, PRESSURE IMPULSE CYCLING, AND OPERATING LIFE
CYCLING. DURING THE ORIGINAL QUALIFICATION TESTS THE SYSTEM SURVIVED 5400
ON/OFF (ENERGIZE/DE-ENERGIZE) CYCLES AT 30 CYCLES PER MINUTE WITHOUT
FAILURE. DURING PRESSURE IMPULSE CYCLING TESTS THE UNIT SURVIVED 120,482
IMPULSE CYCLES WITHOUT FAILURE OR INADVERTENT OPERATION. IMPULSE CYCLE
SEQUENCES FOR NOSEWHEEL STEERING WERE QUALIFIED BY SIMILARITY. THE
ORIGINAL NOSEWHEEL STEERING ACTUATOR IMPULSES WERE AS FOLLOWS:**

WITH HYDRAULIC PRESSURE HOOKED UP TO THE SUPPLY PORT -

**SEQUENCE #1: 30,312 CYCLES FROM 300 PSI TO 4,500 PSI AND BACK TO 300 PSI AT 3
CYCLES PER SECOND.**

**FAILURE MODES EFFECTS ANALYSIS (FMEA) – CIL FAILURE MODE
NUMBER: 02-1D-192-02**

SEQUENCE #2: 30,010 CYCLES FROM 3,000 PSI TO 1500 PSI AND BACK TO 3,000 PSI AT 3 CYCLES PER SECOND.

WITH HYDRAULIC PRESSURE HOOKED UP TO THE RETURN PORT -

30,120 CYCLES OF SEQUENCE #1 AND 30,240 OF SEQUENCE #2 WERE PERFORMED.

DURING SUPPLY PROOF PRESSURE TEST THE INWS ACTUATOR IS PRESSURIZED TO 4500 PSIG AT A TEMPERATURE OF +275 DEG. F. PRESSURE IS APPLIED FOR 5 MINUTES MINIMUM WHILE THE ACTUATOR IS IN IT'S FULLY EXTENDED POSITION. DURING RETURN PROOF PRESSURE TEST THE ACTUATOR IS PRESSURIZED AT IT'S RETURN PORT AS ABOVE. SYSTEM MODE SELECTOR IS OFF DURING THE RETURN PROOF PRESSURE TEST. NO DAMAGE OR LEAKAGE IS TOLERATED DURING THESE TESTS.

THE QUAL TEST UNIT IS CYCLED A MINIMUM OF 8000 CYCLES (15 CYCLES PER MINUTE) AT NORMAL FULL STROKE WITH NO LOAD AND 3000 PSI. CHANNEL 1 AND 2 ALTERNATED EVERY 10 MINUTES AND TURNED OFF FOR 1 MINUTE DURING CYCLING. THE UNIT WAS ALSO CYCLED A MINIMUM OF 13,500 CYCLES (15 CYCLES PER MINUTE) AT HALF STROKE WITH NO LOAD AND 3,000 PSI. CHANNEL 1 AND 2 ALTERNATED EVERY 10 MINUTES AND TURNED OFF FOR 1 MINUTE DURING CYCLING WITHOUT FAILURE, DEGRADATION IN PERFORMANCE OR LEAKAGE. THE UNIT WAS ALSO COMMANDED TO MIDSTROKE TURNING CHANNEL 1 OFF AND ON FOR 2,500 CYCLES MINIMUM. REPEATED WITH CHANNEL 2. NO FAILURE OCCURRENCES FOR 5,000 MINIMUM OFF/ON CYCLES.

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

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: THE NWS SYSTEM IS EXERCISED THROUGHOUT IT'S NORMAL RANGE OF OPERATION IN BOTH NWS1 AND NWS2 MODES (THE NLG TORQUE LINKS ARE DISCONNECTED DURING THESE TESTS).

FREQUENCY - ALL VEHICLES AT 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 (100 PPM MAX).

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ASSEMBLY INSTALLATION

ALL DETAIL PARTS ARE INSPECTED AND FLUSHED WITH SOLVENT PRIOR TO ASSEMBLY. CRITICAL DIMENSIONS AND SURFACE FINISHES ARE VERIFIED BY INSPECTION. SEALS ARE VISUALLY EXAMINED FOR CLEANLINESS AND DAMAGE. APPLICATION OF O-RING SEAL LUBRICANT IS VERIFIED BY INSPECTION. TORQUING AND LOCKWIRING OF FASTENERS ARE VERIFIED BY INSPECTION.

NONDESTRUCTIVE EVALUATION

MAGNETIC PARTICLE AND PENETRANT INSPECTION OF MACHINED PARTS ARE VERIFIED BY INSPECTION.

CRITICAL PROCESSES

SURFACE TREATMENTS SUCH AS PASSIVATION AND ANODIZING, PLATING, AND HEAT TREATMENT ARE VERIFIED BY INSPECTION. SOLDERING PER NHB5300.4(3A) IS 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. NO FAILURE HISTORY APPLICABLE TO THIS PARTICULAR HARDWARE.

(E) OPERATIONAL USE:

NONE

- APPROVALS -

EDITORIALLY APPROVED	: BNA	: <u>J. Kimura 8/4/97</u>
EDITORIALLY APPROVED	: JSC	: <u>L. Searcy 9/9/97</u>
TECHNICAL APPROVAL	: VIA APPROVAL FORM	: 96-CIL-011_02-1D