

**FAILURE MODES EFFECTS ANALYSIS (FMEA) – CIL HARDWARE
NUMBER: 02-1D-191 -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	: CHECK VALVE (ANTI-CAVITATION)	MC621-0058-0019A

**EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:
CHECK VALVE, ANTI-CAVITATION**

REFERENCE DESIGNATORS:

**QUANTITY OF LIKE ITEMS: 2
TWO, ONE IN EACH PORT**

**FUNCTION:
PERMITS HYDRAULIC FLUID TO ENTER THE STEERING ACTUATOR PORTS FROM THE
RETURN LINE DURING SHIMMY CONDITIONS TO PRECLUDE ACTUATOR CAVITATION.
CHECK VALVE IS A FREE FLOATING BALL WITH NO SPRING.**

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REVISION#: 3 08/03/97

SUBSYSTEM NAME: LANDING DECELERATION - NWS - MECHANISM

LRU: INWS HYDRAULIC ACTUATOR ASSY

ITEM NAME: CHECK VALVE (ANTI-CAVITATION)

CRITICALITY OF THIS

FAILURE MODE: 1R3

FAILURE MODE:

FAILS OPEN (LEAKAGE)

MISSION PHASE: DO DE-ORBIT

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

CAUSE:

CONTAMINATION, GALLING, BINDING OF BALL

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 FLUID OUT OF ONE SIDE OF THE ACTUATOR RESULTING IN LOSS OF NOSEWHEEL STEERING. THE SYSTEM WILL FAIL TO THE FREE CASTER MODE WITH NO CAVITATION PROTECTION FOR THE AFFECTED SIDE OF THE ACTUATOR. FLUID CAN FLOW THROUGH THE FAILED CHECK VALVE(S) DIRECTLY TO RETURN. IN THE

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STEERING MODE RESULTS IN REDUCED STEERING RATE. IN THE BYPASS MODE RESULTS IN REDUCED SHIMMY DAMPING COEFFICIENT IN ONE DIRECTION.

(B) INTERFACING SUBSYSTEM(S):

NO EFFECT - NOSE LANDING GEAR CO-ROTATING WHEELS PROVIDE SUFFICIENT DAMPING AFTER LOSS OF ACTUATOR DAMPING FUNCTION.

(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 POSSIBLE LOSS OF CREW/VEHICLE.

-DISPOSITION RATIONALE-

(A) DESIGN:

SYSTEM IS DESIGNED TO PREVENT LEAKAGE AND CONTAMINATED FLUID; CYCLIC AND LEAK PROOF TESTS PER MIL-C-5503 AND CLEANLINESS REQUIREMENTS PER LEVEL 190 OF MA0110-301. HYDRAULIC FLUID FILTER IS A 5 MICRON NOMINAL AND 15 MICRON ABSOLUTE UNIT. THE CHECK VALVE IS DESIGNED TO PREVENT THIS FAILURE MODE; THERE IS 1500 PSI FLUID PRESSURE ACTING TO CLOSE THE VALVE DURING THE STEERING MODE.

(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

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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.

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

FREQUENCY - ALL VEHICLES AT GROUND TURNAROUND.

**(C) INSPECTION:
RECEIVING INSPECTION**

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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).

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.

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.

TESTING

THE ATP WHICH IS WITNESSED AND VERIFIED BY INSPECTION INCLUDES FLUID CLEANLINESS VERIFICATION, PROOF PRESSURE AND LEAK TESTING.

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	: <u>J. Kemura 8/4/97</u>
EDITORIALLY APPROVED	: JSC	: <u>d. Dancy 9/19/97</u>
TECHNICAL APPROVAL	: VIA APPROVAL FORM	: 96-CIL-011_02-1D