PRINT DATE: 08/03/97

FAILURE MODES EFFECTS ANALYSIS (FMEA) – CIL HARDWARE
NUMBER: 02-1D-201 -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 (RETURN LINE)	MC621-0058-0019H

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:
CHECK VALVE RETURN LINES (SERVO VALVE PROTECTION CHECK)

REFERENCE DESIGNATORS:

QUANTITY OF LIKE ITEMS: 1
ONE

FUNCTION:
LOCATED IN THE RETURN LINE BETWEEN THE SERVO AND THE COMPENSATOR (ACCUMULATOR). PREVENTS REVERSE FLOW THROUGH SERVO VALVE FIRST STAGE FROM COMPENSATOR WHEN FLUID IS LOST FROM HYDRAULIC SYSTEM, AND RETAINS FLUID IN COMPENSATOR. VALVE IS NORMALLY OPEN DURING STEERING OPERATION AND CLOSED DURING DAMPING OPERATION. ALSO PROTECTS THE SERVO VALVE FROM BACK PRESSURE DURING GEAR RETRACTION.

PRINT DATE: 08/04/97

FAILURE MODES EFFECTS ANALYSIS FMEA – CIL FAILURE MODE
NUMBER: 02-1D-201- 02

REVISION#: 3 08/03/97

SUBSYSTEM NAME: LANDING DECELERATION - NWS - MECHANISM
LRU: INWS HYDRAULIC ACTUATOR ASSY
ITEM NAME: CHECK VALVE (RETURN LINE)

CRITICALITY OF THIS FAILURE MODE: 1R3

FAILURE MODE:
FAILS OPEN (DURING NLG RETRACTION)

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) FAIL
B) FAIL
C) PASS

PASS/FAIL RATIONALE:

A)
FAILS SCREEN "A" SINCE THERE IS NO PRACTICAL TEST TO DETECT THIS FAILURE MODE.

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:
POSSIBLE SERVO CONTROL VALVE DAMAGE DUE TO HIGH PRESSURE (3000 PSI) BUILDUP IN THE RETURN LINE DURING NLG RETRACTION (HYDRAULIC FLUID FLOWS BACKWARDS THROUGH THE ACTUATOR DURING GEAR RETRACTION).

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(B) INTERFACING SUBSYSTEM(S):
POSSIBLE LOSS OF NOSE WHEEL STEERING IF SERVO CONTROL VALVE IS DAMAGED

(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 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 DESIGNED TO COMPLY WITH ANTI CONTAMINATION SPECIFICATIONS OF MIL-H-5440 AND MIL-C-5503. HYDRAULIC FLUID INLET HAS A 5 MICRON NOMINAL AND 15 MICRON ABSOLUTE FILTER. WEAR SURFACES (BALL/SEAT) ARE DESIGNED TO BE SUFFICIENTLY SMOOTH SO AS TO MINIMIZE THE METAL WEAR PARTICLES THAT MAY CAUSE BINDING/GALLING. DESIGNED TO WITHSTAND PROOF PRESSURE OF 4500 PSIG WITH ZERO EXTERNAL LEAKAGE.

(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.

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.

OMRSD: NONE - THE DESIGN, QUALIFICATION AND ACCEPTANCE TEST DATA PROVIDE THE RATIONALE FOR NOT PERFORMING A TEST SPECIFICALLY DESIGNED TO UNCOVER THIS FAILURE MODE. HOWEVER, HYDRAULIC FLUID CLEANLINESS CHECKS ARE PERFORMED EACH FLIGHT TO PREVENT CONTAMINATION FROM BEING A PROBLEM. STUDIES/TESTS TO PROVIDE DATA ON THIS FAILURE MODE HAVE BEEN PROPOSED AND ARE UNDER INVESTIGATION.

(C) INSPECTION:
RECEIVING INSPECTION
RAW MATERIAL AND PROCESS CERTIFICATION ARE VERIFIED BY INSPECTION. 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

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

NONDESTRUCTIVE EVALUATION
N/A

CRITICAL PROCESSES
N/A

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	: J. Kymura 8/4/97
EDITORIALLY APPROVED	: JSC	: A. Searcy 9/9/97
TECHNICAL APPROVAL	: VIA APPROVAL FORM	: 96-CIL-011_02-1D