

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL HARDWARE**NUMBER: 03-1-0707 -X****SUBSYSTEM NAME:** MAIN PROPULSION**REVISION:** 1 11/08/00

PART DATA

	PART NAME	PART NUMBER
	VENDOR NAME	VENDOR NUMBER
LRU	: SEALS LANGLEY/HYDRODYNE	ME261-0045
LRU	: SEALS LANGLEY/HYDRODYNE	RS008846-027
LRU	: SEALS LANGLEY/HYDRODYNE	RS008846-033

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:

SEALS, GO2/GH2 FLANGE FACE (NAFLEX SEALS)

REFERENCE DESIGNATORS:**QUANTITY OF LIKE ITEMS:** 10**FUNCTION:**

PROVIDES A SEAL BETWEEN THE GO2 AND GH2 FLOW CONTROL MANIFOLD ASSEMBLIES AND THE 2 INCH PRESSURIZATION LINES; BETWEEN THE 2 INCH PRESSURIZATION LINES AND THE ORBITER/ET 2 INCH DISCONNECTS (PD4,5); AT THE INTERFACE OF ORBITER AND ENGINE PRESSURIZATION SYSTEMS.

FAILURE MODES EFFECTS ANALYSIS FMEA -- CIL FAILURE MODE

NUMBER: 03-1-0707-01

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SUBSYSTEM NAME: MAIN PROPULSION

LRU: NAFLEX FLANGE SEAL, SILVER COATED

ITEM NAME: NAFLEX FLANGE SEAL, SILVER COATED

CRITICALITY OF THIS

FAILURE MODE: 1/1

FAILURE MODE:

RUPTURE/LEAKAGE

MISSION PHASE:

PL PRE-LAUNCH
LO LIFT-OFF
DO DE-ORBIT

VEHICLE/PAYLOAD/KIT EFFECTIVITY:

102 COLUMBIA
103 DISCOVERY
104 ATLANTIS
105 ENDEAVOUR

CAUSE:

FATIGUE, MATERIAL DEFECT, DAMAGED SEALING SURFACE

CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO

REDUNDANCY SCREEN

A) N/A
B) N/A
C) N/A

PASS/FAIL RATIONALE:

A)

B)

C)

- FAILURE EFFECTS -

(A) SUBSYSTEM:

GO2, GH2 AND/OR GHE LEAKAGE INTO THE AFT COMPARTMENT. POSSIBLE OVERPRESSURIZATION OF THE AFT COMPARTMENT AND FIRE/EXPLOSION HAZARD. GHE LEAKAGE FROM ANTI-ICING PURGE DETECTABLE ON GROUND USING HAZARDOUS GAS DETECTION SYSTEM (HGDS) PRIOR TO T-9 MINUTES.

**FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL FAILURE MODE
NUMBER: 03-1-0707-01**

GO2/GH2 FLOW CONTROL VALVES WILL OPEN IN AN ATTEMPT TO MAINTAIN ULLAGE PRESSURE. LOSS OF ET LO2/LH2 ULLAGE PRESSURE WILL RESULT IN VIOLATION OF TANK MINIMUM STRUCTURAL CAPABILITY REQUIREMENTS. POSSIBLE PREMATURE SSME SHUTDOWN DUE TO LOW LH2 NPSP. MASS OF LO2 AND VEHICLE ACCELERATION SHOULD BE SUFFICIENT TO MAINTAIN PROPER ENGINE NPSP UNTIL LATE IN POWERED FLIGHT.

POSSIBLE LOSS OF ADJACENT CRITICAL COMPONENTS DUE TO IMPINGEMENT OF HIGH PRESSURE GAS.

(B) INTERFACING SUBSYSTEM(S):

SAME AS A.

(C) MISSION:

POSSIBLE LAUNCH SCRUB DUE TO LCC VIOLATION.

(D) CREW, VEHICLE, AND ELEMENT(S):

POSSIBLE LOSS OF CREW/VEHICLE.

(E) FUNCTIONAL CRITICALITY EFFECTS:

NONE.

-DISPOSITION RATIONALE-

(A) DESIGN:

THE NAFLEX SEALS USED WITH THE MPS LOW PROFILE FLANGES WERE CERTIFIED ON THE SATURN II PROGRAM. THE DESIGN UTILIZES STATIC FACE PRESSURE ASSISTED COMPRESSION TYPE PRIMARY SEALS. THE GH2 AND GO2 SEALS ARE MANUFACTURED FROM INCONEL 718 ALLOY. THE GH2 SEALING SURFACE IS TEFLON COATED (TEMPERATURE RANGE IS -423 TO +350 DEG F) AND THE GO2 ORBITER AND ALL SSME INTERFACE SEALING SURFACES (H2 AND O2) ARE SILVER PLATED (TEMPERATURE RANGE IS -320 TO +660 DEG F). THE MAXIMUM DESIGN LEAKAGE ALLOWABLE FOR THE LOW PROFILE FLANGE COMPRESSION SEAL ASSEMBLY IS 1×10^{-2} STANDARD CUBIC CENTIMETERS/SECOND (SCCS) PER CIRCUMFERENTIAL INCH OF SEAL. THE DESIGN INCLUDES A STRUCTURAL BARRIER THAT RESTRICTS THE LEAKAGE IF THE PRIMARY SEAL FAILS. THE DESIGN INCORPORATES A LEAK CHECK PORT TO MEASURE FLANGE/SEAL JOINT LEAKAGE.

EXTERNAL LEAKAGE FROM THE GO2 OR GH2 NAFLEX SEAL JOINTS CAN OCCUR FROM A DAMAGED/DEFECTIVE NAFLEX SEAL OR DAMAGE TO THE SEALING SURFACE. THE SEALING SURFACE HAS AN 8 MICRON FINISH AND IS EXAMINED PRIOR TO INSTALLATION OF THE NAFLEX SEAL. THE NAFLEX SEAL JOINT IS LEAK TESTED AFTER INSTALLATION.

**FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL FAILURE MODE
NUMBER: 03-1-0707-01**

(B) TEST:

ATP

EXAMINATION OF PRODUCT

THE SEALS WERE PROOF PRESSURE TESTED AT 950 PSIG AND LEAK CHECKED AT 550 PSIG AFTER INSTALLATION INTO THE VEHICLE.

CERTIFICATION

THE SEALS WERE CERTIFIED BY SIMILARITY TO THE NAFLEX SEALS USED ON THE SATURN II PROGRAM.

FUNGUS, HUMIDITY, OZONE, AND SALT SPRAY (BY ANALYSIS)

THE GO2 AND GH2 2 INCH NAFLEX SEAL WAS QUALIFIED BY SIMILARITY TO THE 17 AND 13.6 INCH NAFLEX SEALS WHICH WERE SUBJECTED TO THE FOLLOWING TESTS:

CYCLE TEST

25 CYCLES

BODY TEMPERATURE: -320 DEG F (LN2)

INTERNAL PRESSURE: 200 PSIG

STRUCTURAL MOMENT LOAD OF 220,800 INCH-LBS APPLIED

10 CYCLES

BODY TEMPERATURE: -300 DEG F

INTERNAL PRESSURE: 150 PSIG

STRUCTURAL MOMENT LOAD OF 77,500 INCH-LBS APPLIED

15 CYCLES

BODY TEMPERATURE: -400 DEG F

INTERNAL PRESSURE: 55 PSIG

STRUCTURAL MOMENT LOAD OF 155,000 INCH-LBS APPLIED

OMRSD

ANY TURNAROUND CHECKOUT IS ACCOMPLISHED IN ACCORDANCE WITH OMRSD.

(C) INSPECTION:

RECEIVING INSPECTION

PARTS ARE VERIFIED TO REQUIREMENTS WITH RESPECT TO MATERIALS, DIMENSIONS, MARKING AND WORKMANSHIP.

CONTAMINATION CONTROL

CLEANLINESS IS MAINTAINED AND VERIFIED TO LEVEL 100A.

ASSEMBLY/INSTALLATION

PRIOR TO JOINT ASSEMBLY, FLANGE SEALING SURFACES AND SEAL ARE VISUALLY INSPECTED AND CLEANLINESS IS VERIFIED. SEALS ARE PROOF PRESSURE TESTED AND LEAKED CHECK AFTER INSTALLATION INTO THE VEHICLE.

**FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL FAILURE MODE
NUMBER: 03-1-0707-01**

CRITICAL PROCESSES

HEAT TREATMENT VERIFIED BY INSPECTION AND TEFLON COATED PER SUPPLIER PROCESS SPECIFICATION.

NONDESTRUCTIVE EVALUATION

FORGINGS ARE ULTRASONICALLY INSPECTED. PRIOR TO APPLICATION OF TEFLON COATING, MACHINED DISK IS PENETRANT INSPECTED.

TESTING

ACCEPTANCE TEST IS VERIFIED BY INSPECTION.

HANDLING/PACKAGING

PACKAGING, HANDLING, AND TRANSPORTATION IS IN ACCORDANCE WITH APPLICABLE REQUIREMENTS AND IS VERIFIED BY INSPECTION.

(D) FAILURE HISTORY:

DURING AN ENGINEERING TEST, THE SEAL EXHIBITED EXCESSIVE LEAKAGE WITH LN2 (REFERENCE CAR A5212). THE FAILURE OCCURRED FROM LOCALIZED DAMAGE IN THE TEFLON COATING CAUSED BY IMPROPER HANDLING. PERSONNEL WERE CAUTIONED AS TO EMPLOYING THE CORRECT HANDLING PROCEDURES.

AT PALMDALE, LEAKAGE WAS DETECTED AT THE SEAL INTERFACE (REFERENCE CARS AB2523, AB2545, AB2544, AB2563, AB2577, AB2574, AB2470, AB2471, AB2522, AB2546, AB2561). VISUAL INSPECTION INDICATED CONTAMINANTS WERE PRESENT IN THE MATED CONDITION. THE FAILURE WAS ATTRIBUTED TO MISHANDLING DURING THE SEAL INSTALLATION. REPLACEMENT OF THE SEAL RESOLVED THE LEAKAGE.

AT NSTL, THE SEAL WAS FOUND TO BE LEAKING BEYOND THE MAXIMUM ALLOWABLE OF 0.0246 SCCMS (REFERENCE CAR AB1751). THE PRIMARY SEALING SURFACE HAD NICKS ATTRIBUTED TO IMPROPER INSTALLATION. THE SEAL WAS REPLACED AND THE PERSONNEL WERE WARNED TO USE CARE DURING SEAL INSTALLATION.

EXCESSIVE LEAKAGE AT THE SEAL INTERFACE WAS REPORTED AT NSTL (REFERENCE CAR A9495). THE NAFLEX SEAL HAD BEEN DAMAGED. THE SEAL WAS REPLACED AND SENT BACK TO THE VENDOR FOR POSSIBLE REFURBISHMENT.

DAMAGED SEALS WERE DETECTED AT KSC (REFERENCE CARS AD3413, AD3414). THE SEALS WERE REPLACED AND SENT BACK TO THE VENDOR FOR POSSIBLE REFURBISHMENT.

CURRENT DATA ON TEST FAILURE, FLIGHT FAILURE, UNEXPLAINED ANOMALIES, AND OTHER FAILURES EXPERIENCED DURING GROUND PROCESSING ACTIVITY CAN BE FOUND IN THE PRACA DATABASE.

(E) OPERATIONAL USE:

FLIGHT: WHEN THE ULLAGE PRESSURE DROPS BELOW 28 PSI, THE CREW WILL OPEN THE LH2 FLOW CONTROL VALVE WITH THE COCKPIT SWITCH. WHEN THIS IS INEFFECTIVE AND

**FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL FAILURE MODE
NUMBER: 03-1-0707-01**

THE NPSP DROPS BELOW A PREFLIGHT ACCEPTED VALUE, THE CREW WILL ABORT TO TAL OR ACLS.

- APPROVALS -

S&R ENGINEERING	: W.P. MUSTY	:/S/ W.P. MUSTY
S&R ENGINEERING ITM	: P. A. STENGER-NGUYEN	:/S/ P.A. STENGER-NGUYEN
DESIGN ENGINEERING	: EARL HIRAKAWA	:/S/ EARL HIRAKAWA
MPS SUBSYSTEM MGR.	: TIM REITH	:/S/ TIM REITH
MOD	: BILL LANE	:/S/ BILL LANE
USA SAM	: MIKE SNYDER	:/S/ MIKE SNYDER
USA ORBITER ELEMENT	: SUZANNE LITTLE	:/S/ SUZANNE LITTLE
NASA SR&QA	: ERICH BASS	:/S/ ERICH BASS