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PRINT DATE: 12/13/89

SHUTTLE CRITICAL ITEMS LIST - ORBITER NUMBER: 03-2F-101080-X

SUBSYSTEM NAME: FORWARD REACTION CONTROL SYSTEM (RCS)

REVISION : 2 12/12/89

	PART NAME VENDOR NAME	PART NUMBER VENDOR NUMBER
LRU :	COUPLING, PROPELLANT FAIRCHILD STRATOS	MC276-0018 76301000 & 76306000

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:
DISCONNECT, QUICK, PROPELLANT

REFERENCE DESIGNATORS: MD117
: MD118
: MD127
: MD128
: MD137
: MD138
: MD147
: MD148
: MD157
: MD158
: MD119
: MD120
: MD121
: MD122
: MD161
: MD162
: MD163
: MD164

QUANTITY OF LIKE ITEMS: 18
9 PER PROPELLANT
4 1/4" : 5 1/2" COUPLINGS

FUNCTION:
TO ALLOW GROUND PURGE OF PROPELLANT MANIFOLDS DURING TURNAROUND
OPERATIONS.

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SUBSYSTEM: FORWARD REACTION CONTROL SYSTEM (RCS)

LRU : COUPLING, PROPELLANT

ITEM NAME: COUPLING, PROPELLANT

CRITICALITY OF THIS
FAILURE MODE: 1R2

FAILURE MODE:

EXTERNAL LEAKAGE, CAP LEAKS, POPPET FAILS OPEN

MISSION PHASE:

PL PRELAUNCH
LO LIFT-OFF
OO ON-ORBIT
DO DE-ORBIT
LS LANDING SAFING

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

CAUSE:

SEALS DAMAGED OR DETERIORATED, CONTAMINATION, VIBRATION, MECHANICAL SHOCK, PIECE-PART STRUCTURAL FAILURE, IMPROPER USE, INADEQUATE MAINTENANCE OF GSE HALF, INADEQUATE LINE SUPPORT, SHAFT OR BORE BENT, OVERPRESSURE OF PANEL, EXCESS TORQUE

CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO

REDUNDANCY SCREEN A) FAIL
B) FAIL
C) PASS

PASS/FAIL RATIONALE:

A)

B)

C)

- FAILURE EFFECTS -

(A) SUBSYSTEM:

LOSS OF REDUNDANT SEAL. PROPELLANT MANIFOLD ISOLATION VALVE COULD ISOLATE LEAK.

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(B) INTERFACING SUBSYSTEM(S):
NO EFFECT

(C) MISSION:
NO EFFECT

(D) CREW, VEHICLE, AND ELEMENT(S):
NO EFFECT

(E) FUNCTIONAL CRITICALITY EFFECTS:
POSSIBLE CREW/VEHICLE LOSS - LOSS OF RCS ET-SEP PROPELLANT. POSSIBLE LOSS OF VEHICLE CONTROL DURING ET SEP. POSSIBLE DAMAGE TO STRUCTURE/TPS IF LEAKAGE OCCURS OR STRUCTURE AND ADJACENT HARDWARE IF CAP BLOWS OFF. 1R EFFECT ASSUMES LOSS OF ALL SEALS (POPPET AND CAP) BEFORE EFFECT IS MANIFESTED. CANNOT CHECK REDUNDANT SEALS WHEN CAP IS INSTALLED. REQUIRES BOTH SEALS TO LEAK ON ORBIT BEFORE FAILURE DETECTABLE.

- DISPOSITION RATIONALE -

(A) DESIGN:
THE DESIGN FACTOR OF SAFETY IS 2 X THE MAX OPER PRESSURE FOR PROOF AND 3 X THE MAX FOR BURST PRESSURE. THIS IS CERTIFIED BY ANALYSIS FOR 1/4" SIZE AND BY TEST FOR 1/2" AND 1" SIZES.

GROUND HALF COUPLINGS AND LINES ARE ADEQUATELY SUPPORTED TO LIMIT STRESS ON COUPLINGS AND PREVENT DAMAGE TO SEALS AND WELD JOINTS. A COMPLETE STRESS ANALYSIS HAS BEEN COMPLETED.

A SAFETY FEATURE DURING SERVICING AND PRIOR TO REMOVAL OF THE END CAP IS A PROVISION TO VENT OVERBOARD ANY LEAKAGE PAST THE AIRBORNE POPPET SEAL BY ROTATING A BLEED SCREW IN THE CAP.

THE CAP MINIMIZES LEAKAGE BY PROVIDING A REDUNDANT SEAL. THE COUPLING DESIGN ALLOWS REPLACEMENT OF THE NOSE SEAL DURING MAINTENANCE PROCEDURES. A 10 MICRON FILTER IN THE GSE HALF PREVENTS CONTAMINATION.

- (B) TEST:
4 UNITS (2 EA. 1/2, AND 1") WERE USED IN THE QUAL TEST PROGRAM. INCLUDED IN THE PROGRAM WAS RANDOM VIBRATION (48 MIN IN EACH AXIS - POPPET OPEN AND CAP ON), ENDURANCE (600 CYCLES COUPLED AND DECOUPLED) THERMAL CYCLES (-30 TO +200 DEG F), BASIC AND BENCH HANDLING SHOCK, BENDING AND AXIAL LOADS (100 FT. LBS., 100LBS.) 2130 PSI BURST PRESSURE, SURGE PRESSURE (190,000 CYCLES TO 1300 PSI), PROPELLANT COMPATIBILITY.

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THE UNIT WAS ALSO INCLUDED IN THE VIBRO-ACOUSTIC TEST PROGRAM AT JSC (131 EQUIVALENT MISSIONS) AND THE HOT-FIRE TEST PROGRAM AT WSTF (24 EQUIVALENT MISSION DUTY CYCLES AND APPROX 7 YEARS OF PROPELLANT EXPOSURE).

ACCEPTANCE TESTING INCLUDES EXAMINATION OF PRODUCT, 1420 PSI PROOF PRESSURE, LEAKAGE, OPERATION, CLEANLINESS AND DRYING, AND CAP TESTING AS AN ASSEMBLY.

OMRSD PERFORMS THE FOLLOWING: LEAK CHECKS ON THE PROPELLANT QD COUPLING EVERY FIFTH FLIGHT. LEAK CHECKS ON THE QD CAPS FOR THE FIRST FLIGHT. ANY QD CAPS THAT ARE REMOVED DURING GROUND OPERATIONS SHALL BE LEAK TESTED BEFORE BEING INSTALLED ON THE QD COUPLING. TOXIC VAPOR LEAK CHECKS OF THE PROPELLANT TANKS AND PROPELLANT MANIFOLDS FOR THE FIRST FLIGHT AND ON A CONTINGENCY BASIS. A STATIC AIR SAMPLE THE SECOND FLIGHT AND EVERY FLIGHT THEREAFTER AND ON CONTINGENCY. AN EXTERNAL LEAK VERIFICATION OF THE SYSTEM FOR THE FIRST FLIGHT. A PROPELLANT SAMPLE FOR QUALITY THE SECOND FLIGHT WHEN TANKS OR MANIFOLDS ARE DRAINED. THE PROPELLANT LOADING FOR EACH FLIGHT. CANNOT CHECK REDUNDANT SEALS WHEN CAP IS ASSEMBLED.

(C) INSPECTION:

RECEIVING INSPECTION

TEST REPORTS AND MATERIAL CERTIFICATIONS CERTIFYING MATERIALS AND PHYSICAL PROPERTIES (WELDING, HEAT TREATMENT, AND PASSIVATION) ARE VERIFIED BY INSPECTION.

CONTAMINATION CONTROL

CLEANLINESS LEVEL OF 100A IS VERIFIED BY INSPECTION. CORROSION PROTECTION IS VERIFIED BY INSPECTION.

ASSEMBLY/INSTALLATION

TORQUING IS VERIFIED BY INSPECTION. SEALS ARE INSPECTED PER SNP 915. LOG OF CLEAN ROOM AND TOOL CALIBRATION IS VERIFIED BY INSPECTION. CRITICAL DIMENSIONS AND SURFACE FINISHES ARE VERIFIED BY INSPECTION. ASSEMBLY IS VERIFIED BY INSPECTION. INSPECTION VERIFIES BRAYCOTE IS APPLIED TO THREADS, SEALS AND SLIDING SURFACES.

NONDESTRUCTIVE EVALUATION

PENETRANT INSPECTION OF BODY ASSEMBLY TIG WELD AND FLANGE CASTING PER MIL-I-6866 TYPE I METHOD B IS VERIFIED BY INSPECTION. RADIOGRAPHIC INSPECTION OF THE FLANGE CASTING PER MIL-C-6021, CLASS 1A, GRADE C, IS VERIFIED BY INSPECTION.

CRITICAL PROCESSES

TIG WELD OF THE BODY ASSEMBLY PER MIL-W-8611 AND THE RESISTANCE WELD OF THE A.H.C. FILTER ASSEMBLY ARE VERIFIED BY INSPECTION.

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TESTING

ATP PER ATP7631002 OR ATP7631002-1 IS WITNESSED AND VERIFIED BY INSPECTION.

HANDLING/PACKAGING

PACKAGING PROCEDURES ARE VERIFIED BY INSPECTION.

(D) FAILURE HISTORY:

A TOTAL OF 266 FAILURES HAVE BEEN RECORDED FOR ALL APPLICATIONS OF THIS COUPLING FOR THE EXTERNAL (SEAL) LEAKAGE MODE. OF THESE, 214 OCCURRED DURING ACCEPTANCE, 7 DURING SUPPLIER QUAL TEST, 20 AT WSTF, 23 AT KSC AND 2 DURING TEST AT DOWNEY. THE CAUSES FOR THESE FAILURES INCLUDED INSTALLATION/HANDLING DAMAGE, INSTALLATION TECHNIQUE, INSUFFICIENT TORQUE ON THE POPPET SEAL RETAINER, IMPROPER TEST, O-RING FLASH, INADEQUATE LUBE, SEAT FINISH, MISSING SEALS, CONTAMINATION, PROPELLANT RESIDUE, IRON NITRATE LEVEL, GALLING AND BINDING BETWEEN POPPET AND PROBE. CORRECTIVE ACTION - THESE FAILURES WERE CORRECTED BY DRAWING AND DESIGN CHANGES, INSTALLATION/ASSEMBLY/PROCEDURE CHANGES, OPERATIONAL USE (MATING) REQUIREMENTS, CAUTION NOTES, CORROSION PROTECTION, IMPROVED SURFACE FINISHES, CHANGED TORQUE VALUES, INSPECTION CHANGES, CONTAMINATION CONTROL, PREVENTIVE MAINTENANCE PROCEDURES, CONTROL OF N2O4 IRON NITRATE LEVEL AND GSE CHANGES TO PROTECT THE VEHICLE.

A TOTAL OF TEN FAILURES WERE RECORDED AGAINST THE OMS SYSTEM. OF THESE 7 OCCURRED DURING ACCEPTANCE, 1 AT WSTF AND 2 AT KSC. THE CAUSES OF THE OMS FAILURES INCLUDED CONTAMINATION, SEAL MISSING, O-RING DAMAGE, O-RING FLASH AND ASSEMBLY/HANDLING DAMAGE.

CAR AC0985:

ONE CASE OF A STUCK OPEN POPPET AT WSTF ATTRIBUTED TO CONTAMINATION. CORRECTIVE ACTION - EXISTING CLEANLINESS CONTROLS WERE RE-EMPHASIZED (MLO0310-032).

CAR ACB625:

DURING THE CHECKOUT OF OV-099 RCS (STS41-G) THE CAP PRESSURE BLEED WOULD NOT STOP. THE FAILURE WAS ATTRIBUTED TO CONTAMINATION, IMBEDDED PARTICLES AND A SCRATCHED POPPET SEAT. CORRECTIVE ACTION - THE EXISTING CLEANLINESS CONROLS WERE RE-EMPHASIZED (MLO0310-032).

CAR AC4955:

A CASE OF A POPPET PROBE STUCK OPEN WAS REPORTED DURING WSTF TESTING. THIS WAS ATTRIBUTED TO OUT OF PRINT PARTS AND MISHANDLING DURING ASSEMBLY.

CAR AC0550:

THE MOST SIGNIFICANT FAILURE OF THIS COUPLING OCCURRED WITH THE GROUND HALF DURING CHECKOUT OF THE OV-102 FRCS FOR STS-2. THIS FAILURE

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RESULTED IN A PROPELLANT SPILL ONTO THE VEHICLE CAUSED BY BINDING BETWEEN THE POPPET/PROBE AND DYNAMIC HEAD. THIS WAS ATTRIBUTED TO CLEARANCES WITHIN THE COUPLING AND EXCESS IRON NITRATE IN THESE AREAS.

CORRECTIVE ACTION - COMPONENT DESIGN CHANGES WERE IMPLEMENTED AND THE IRON NITRATE LEVEL IS BEING CONTROLLED.

THIS FAILURE REVEALED THE EXISTANCE OF A LEAK PATH FOR PROPELLANT INTO THE ORBITER. CORRECTIVE ACTION FOR THIS WAS ADDRESSED IN CAR ACO646. MCR10409 WAS ISSUED TO PROVIDE GSE CHANGES TO PREVENT LEAK INTO THE ORBITER THROUGH VENT HOLES AND OTHER PANEL CLEARANCES. PREVENTIVE MAINTENANCE AND HANDLING/TEST PROCEDURES WERE IMPLEMENTED AND CAUTION NOTES ADDED TO CHECK OUT PROCEDURES.

(E) OPERATIONAL USE:

REQUIRES DUAL SEAL FAILURE BEFORE ACTION IS REQUIRED. SECURE THE SYSTEM AND ISOLATE THE LEAK. DURING ASCENT IF LEAK RATE DOES NOT SUPPORT ET-SEP AND IS ABOVE THE TANK ISOLATION VALVES, A CONTINGENCY AFT ONLY SEPARATION IS PERFORMED.

- APPROVALS -

RELIABILITY ENGINEERING: F.E. BARCENAS
DESIGN ENGINEERING : B. DIPONTI
QUALITY ENGINEERING : M. SAVALA
NASA RELIABILITY :
NASA SUBSYSTEM MANAGER :
NASA QUALITY ASSURANCE :

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