

PAGE: 1

PRINT DATE: 01/09/90

SHUTTLE CRITICAL ITEMS LIST - ORBITER NUMBER: 03-2A-202150-X

SUBSYSTEM NAME: AFT REACTION CONTROL SYSTEM (RCS)

REVISION : 2 01/09/90

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

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EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:  
DISCONNECT, QUICK, HELIUM/PROPELLANT, SPRING LOADED POPPET WITH  
STRUCTURAL CAP (1/4" & 1/2" AND 1"). FAIRCHILD P/N'S 76301000,  
76306000 & 76311000. (MD215, 216, 223, 224, 315, 316, 323, 324)

QUANTITY OF LIKE ITEMS: 8  
4 PER POD  
2 PER PROPELLANT

FUNCTION:  
TO PROVIDE FOR VENTING AND BLEEDING PROPELLANT TANKS DURING SERVICING IN  
VERTICAL VEHICLE ORIENTATION. ONE INCH COUPLING, (FUEL-LEFT POD AND  
OX-RIGHT POD) SERVICES ARCS AND OMS. ITEM INCORPORATES SECONDARY  
INTERNAL SEALS AND HAS A PRESSURE CAP WHICH IS REDUNDANT SEAL. CAP  
INSTALLED PRIOR TO FLIGHT.

PAGE: 2

PRINT DATE: 01/09/90

SHUTTLE CRITICAL ITEMS LIST - ORBITER NUMBER: 03-2A-202150-01

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SUBSYSTEM: AFT REACTION CONTROL SYSTEM (RCS)  
LRU : COUPLING, PROPELLANT  
ITEM NAME: COUPLING, PROPELLANT

CRITICALITY OF THIS  
FAILURE MODE: 1R2

FAILURE MODE:  
FAILS OPEN. CAP LEAKS IN EXCESS OF ACCEPTABLE RATE, POPPET FAILS OPEN.

MISSION PHASE:

PL PRELAUNCH  
LO LIFT-OFF  
OO ON-ORBIT  
DO OE-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 SUBSYSTEM PROPELLANT AND REDUNDANT SEAL.

(B) INTERFACING SUBSYSTEM(S):  
NO EFFECT

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(C) MISSION:  
NO EFFECT

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

(E) FUNCTIONAL CRITICALITY EFFECTS:  
POTENTIAL CREW/VEHICLE LOSS IF PROPELLANT CANNOT BE UTILIZED OR DEPLETED. POSSIBLE LOSS OF VEHICLE CONTROL DURING ET SEP/ENTRY. DAMAGE TO STRUCTURE/TPS IF LEAKAGE OCCURS OR STRUCTURE AND ADJACENT HARDWARE IF CAP BLOWS OFF. LEAKAGE OF PROPELLANT VAPORS INTO POD. 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 IS DETECTABLE.

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- DISPOSITION RATIONALE -  
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(A) DESIGN:  
THE PROOF FACTOR OF SAFETY IS 2X THE MAX OPERATING PRESSURE (1.1 X THE MAX SURGE PRESSURE) AND THE BURST FACTOR OF SAFETY IS 3X THE MAX OPERATING (1.6X MAX SURGE PRESSURE). THE 1/4" SIZE WAS CERTIFIED BY ANALYSIS. TWO SIZES (1/2 AND 1") WERE CERTIFIED BY TEST.

GROUND HALF COUPLINGS AND LINES ARE SUPPORTED TO LIMIT STRESS ON COUPLINGS AND PREVENT DAMAGE TO SEALS AND WELD JOINTS. A COMPLETE STRESS ANALYSIS WAS PERFORMED.

THE CAP PROVIDES A REDUNDANT SEAL AND MINIMIZES THE LEAKAGE POTENTIAL. THE DESIGN ALLOWS REPLACEMENT OF THE NOSE SEAL DURING NORMAL MAINTENANCE PROCEDURES. THE GSE HALF INCLUDES A 10 MICRON SEAL TO HELP PRECLUDE CONTAMINATION FAILURES. MATERIALS ARE SELECTED THAT ARE COMPATIBLE WITH PROPELLANTS.

- (B) TEST:  
THE QUALIFICATION TEST PROGRAM INCLUDED TWO 1/2" AND TWO 1" UNITS. THE TESTING INCLUDED RANDOM VIBRATION (POPPET OPEN AND CAP ON), ENDURANCE (600 CYCLES COUPLED AND UNCOUPLED), THERMAL CYCLES (-30 to +200 DEG F), BASIC AND BENCH HANDLING SHOCK, BENDING AND AXIAL LOADS (100 FT-LBS AND 100 LBS), 2130 PSI BURST PRESSURE, SURGE PRESSURE (190,000 CYCLES TO 1300 PSI) AND PROPELLANT COMPATIBILITY.

ACCEPTANCE TESTING INCLUDES EXAMINATION OF PRODUCT, 1420 PSI PROOF PRESSURE, LEAKAGE, OPERATION, CLEANLINESS AND TESTING OF THE CAP AS A SEPARATE ASSEMBLY.

OMRSD PERFORMS THE FOLLOWING: LEAK CHECKS ON THE QD COUPLING THE FIFTH

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FLIGHT AND EVERY FIVE FLIGHTS THEREAFTER AND ON A CONTINGENCY BASIS. LEAK CHECKS OF 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. A TOXIC VAPOR LEAK CHECK OF THE PROPELLANT TANKS 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 LEAKAGE VERIFICATION OF THE SYSTEM FOR THE FIRST FLIGHT AND ON A CONTINGENCY. A PROPELLANT SAMPLE FOR THE SECOND FLIGHT AND ON A CONTINGENCY BASIS. THE PROPELLANT LOADING FOR EACH FLIGHT. THE REGULATOR LEAK/FUNCTIONAL TEST EVERY FLIGHT AND ON A CONTINGENCY BASIS. A REGULATOR RESPONSE TEST EVERY FLIGHT AND ON A CONTINGENCY BASIS. A LOW PRESSURE REGULATOR RESPONSE TEST ON A CONTINGENCY BASIS. A HELIUM SYSTEM LOW PRESSURE DECAY TEST EVERY MISSION. 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

CORROSION PROTECTION IS VERIFIED BY INSPECTION. CLEANLINESS LEVEL OF 100 FOR MMH AND 100A FOR NTO 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.

## NONDESTRUCTIVE EVALUATION

PENETRANT INSPECTION OF THE 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.

## TESTING

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

## HANDLING/PACKAGING

PACKAGING PROCEDURES ARE VERIFIED BY INSPECTION.

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**(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 M204 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 AC8625:**

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 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.

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THIS FAILURE REVEALED THE EXISTENCE OF A LEAK PATH FOR PROPELLANT INTO THE ORBITER. CORRECTIVE ACTION FOR THIS WAS ADDRESSED IN CAR AC0646. 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.

IF FAILURE OCCURS PRIOR TO ET SEP USE CROSSFEED.

FOR NOTICEABLE LEAK RATES ON-ORBIT DUMP ONBOARD PROPELLANT. USE CROSS-FEED FOR ENTRY. THIS MAY NOT BE SUFFICIENT PROPELLANT FOR NOMINAL ENTRY.

IF LEAK OCCURS DURING ENTRY USE FAILED SYSTEM DOWN TO ZERO PVT. SWITCH TO CROSSFEED FOR REMAINDER OF ENTRY.

- APPROVALS -

RELIABILITY ENGINEERING:	F.E. BARCENAS	:	<i>[Signature]</i>
DESIGN ENGINEERING	: B. DIPONTI	:	<i>[Signature]</i>
QUALITY ENGINEERING	: - M. SAVALA -	:	<i>[Signature]</i>
NASA RELIABILITY	:	:	<i>[Signature]</i>
NASA SUBSYSTEM MANAGER	:	:	<i>[Signature]</i>
NASA QUALITY ASSURANCE	:	:	<i>[Signature]</i>