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SHUTTLE CRITICAL ITEMS LIST - ORBITER NUMBER: 03-1-0436-X

SUBSYSTEM NAME: MAIN PROPULSION

REVISION : 1 02/15/90

	PART NAME VENDOR NAME	PART NUMBER VENDOR NUMBER
■ LRU :	VALVE, RELIEF	MC284-0501-0002
■	PARKER-HANNIFIN	5760074-101

PART DATA

- EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:
VALVE, RELIEF, 1 INCH, LH2 FEEDLINE MANIFOLD RELIEF.
- REFERENCE DESIGNATORS: RV6
- QUANTITY OF LIKE ITEMS: 1
ONE LH2
- FUNCTION:
RELIEVES PRESSURE BUILDUP FROM LH2 MANIFOLD. THE VALVE INLET IS ISOLATED FROM THE FEED SYSTEM UNTIL MECO BY THE UPSTREAM FEEDLINE RELIEF SHUTOFF VALVE (PV8). THE RELIEF VALVE INCORPORATES A SENSE PORT WHICH SENSES THE LH2 MANIFOLD PRESSURE VIA A SENSE LINE. THE CRACKING AND RESEAT PRESSURES ARE BETWEEN 40 & 55 PSIG.

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ASSEMBLY :PARKER-HANNIFIN ABORT: CRIT. FUNC: 3
P/N RI :MC284-0501-0002 RTLS, TAL CRIT. HDW: 3
P/N VENDOR: VEHICLE 102 103 104
QUANTITY :1 EFFECTIVITY: X X X
:ONE LH2 PHASE(S): PL LO X OO DO LS
:

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APPROVED BY: DES NPB REL LA SCOE QE G. Williams

REDUNDANCY SCREEN: A- B- C-
APPROVED BY (NASA): SSM Phillip E. Goff REL Michael D. Bingham QE Scott H. ...

ITEM:

VALVE, RELIEF, 1 INCH, LH2 FEEDLINE MANIFOLD RELIEF. (RV6)

FUNCTION:

RELIEVES PRESSURE BUILDUP FROM LH2 MANIFOLD. REQUIRED TO OPERATE FOR OI-8B ORBITER SOFTWARE - FOR NOMINAL, ATO, AOA, AND TAL MISSIONS LH2 MANIFOLD PRESSURE INCREASES TO RELIEF PRESSURE SETTING PRIOR TO INITIATION OF PROPELLANT DUMP.

FOR OI-8C MISSIONS, APPROVED ORBITER SOFTWARE CHANGE CR89199 EXTENDS RTLS DUMP VALVE OPEN TIME TO MECO + 90 SECONDS FOR ALL MISSIONS EXCEPT RTLS. AS A RESULT OF THIS CHANGE, A MANIFOLD PRESSURE INCREASE TO RELIEF PRESSURE SETTING PRIOR TO INITIATION (MECO + 120 SECONDS FOR NOMINAL, ATO, AND AOA MISSIONS; APPROXIMATELY MECO + 2 TO 3 MINUTES FOR TAL MISSIONS) OF DUMP IS NOT EXPECTED.

THE VALVE INLET IS ISOLATED FROM THE FEED SYSTEM UNTIL MECO BY THE UPSTREAM FEEDLINE RELIEF SHUTOFF VALVE (PV8). THE RELIEF VALVE INCORPORATES A SENSE PORT WHICH SENSES THE LH2 MANIFOLD PRESSURE VIA A SENSE LINE. THE CRACKING AND RESEAT PRESSURES ARE BETWEEN 40 & 55 PSIG.

FAILURE MODE:

FAILS TO RESEAT/INTERNAL LEAKAGE OF MAIN POPPET POST MECO.

CAUSE(S):

PIECE PART STRUCTURAL FAILURE, BINDING, CONTAMINATION.

EFFECT(S) ON:

(A)SUBSYSTEM (B)INTERFACES (C)MISSION (D)CREW/VEHICLE

(A,B) RESULTS IN THE LOSS OF HELIUM OVERBOARD DURING MANIFOLD REPRESSURIZATION THROUGH THE FAILED MANIFOLD RELIEF VALVE (RV6). LOSS OF AFT COMPARTMENT PURGE (RTLS/TAL ABORT CRITICAL).

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(C,D) NO EFFECT FOR NOMINAL MISSION. POSSIBLE LOSS OF CREW/VEHICLE DURING RTLS/TAL ABORT.

DISPOSITION & RATIONALE:

(A) DESIGN (B) TEST (C) INSPECTION (D) FAILURE HISTORY (E) OPERATIONAL USE

(A) DESIGN

THE RELIEF VALVE CONSISTS OF TWO SECTIONS: A PRESSURE ACTUATED MAIN POPPET SECTION AND A PILOT SECTION WHICH SENSES MANIFOLD PRESSURE BY MEANS OF A SENSING LINE.

THE PILOT SECTION CONTROLS THE OPENING AND CLOSING OF THE MAIN POPPET BY ALLOWING THE MANIFOLD PRESSURE TO ENTER OR EXIT A CONTROL CHAMBER. WHEN THE MANIFOLD PRESSURE REACHES A PREDETERMINED PILOT SETTING, THE PILOT VENTS THE CHAMBER PRESSURE OVERBOARD ALLOWING THE PRESSURE DIFFERENTIAL ACROSS THE MAIN POPPET TO PUSH THE MAIN POPPET OPEN. ONCE THE MANIFOLD PRESSURE DROPS BELOW THE PILOT CONTROL SETTING, THE PILOT POPPET CLOSES, THE MANIFOLD PRESSURE ENTERS THE CONTROL CHAMBER, AND THE MAIN POPPET CLOSES.

THE FOLLOWING COMPONENTS MAY CAUSE A FAILURE TO RESEAT/REMAIN CLOSED OR LEAKAGE DUE TO STRUCTURAL FAILURE: MACHINED SPRING, STOP SPRING, STOP, PUSH ROD, PILOT POPPET SPRING, PILOT POPPET, PILOT SEAT, PILOT SEAT RETAINER, MAIN BELLOWS, MAIN SEAL, MAIN SEAT, PILOT SEAT ASSEMBLY SEAL, AND PILOT SEAT ASSEMBLY SEAL SPRING.

THE MACHINED SPRING CONTROLS THE CRACKING PRESSURE. IT IS OF INCONEL 718, HEAT TREATED AND PASSIVATED.

THE STOP SPRING PRELOADS THE PILOT STOP. IT IS A BELLEVILLE SPRING OF HEAT TREATED INCONEL 718.

THE STOP PRELOADS THE INSIDE DIAMETER OF THE STOP SPRING. THE STOP IS CRES PH 15-5, HEAT TREATED AND PASSIVATED.

THE PUSH ROD PRELOADS THE PILOT POPPET SPRING. THE PUSH ROD IS A286 CRES, HEAT TEATED AND PASSIVATED.

THE PILOT POPPET SPRING IS THE RETURN SPRING FOR THE PILOT POPPET. THE SPRING IS OF ELGILOY 54-71A AND HEAT TREATED.

THE PILOT POPPET IS THE FLOW CONTROL DEVICE FOR THE PILOT VALVE, IT IS CRES PH 13-8 MO, HEAT TREATED AND PASSIVATED.

THE PILOT SEAT IS TEFLON (TFE).

THE PILOT SEAT RETAINER RETAINS THE PILOT SEAT IN THE PILOT SEAT ASSEMBLY. IT IS OF 6051-T651 ALUMINIUM ALLOY. THE PILOT SEAT RETAINER IS TORQUED, STRESS RELIEVED, AND RETORQUED.

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THE PILOT BELLOWS (2 PLY) AND MAIN BELLOWS (3 PLY) ARE SIMILAR IN CONSTRUCTION AND OF THE SAME MATERIAL. BOTH BELLOWS ASSEMBLIES CONSIST OF 3 PARTS; THE FLANGE, A BELLOWS, AND A CAP; ALL OF INCONEL 625 AND PASSIVATED. THE SEAMS OF THE BELLOWS ARE FUSION WELDED (FULL PENETRATION). THE FLANGE AND CAP ARE FUSION WELDED TO THE BELLOWS. EACH BELLOWS ASSEMBLY IS TESTED FOR PROOF PRESSURE AND LEAKAGE BEFORE BEING ASSEMBLED INTO A RELIEF VALVE. THE MAIN BELLOWS ASSEMBLY IS THEN ELECTRON BEAM WELDED TO THE MIDDLE HOUSING ASSEMBLY. THE WELD IS DYE PENETRANT INSPECTED, PROOF PRESSURE TESTED, AND LEAK TESTED.

THE MAIN SEAL IS RULON-A, LAPPED TO A TWO MICROINCH SURFACE FINISH, AND COMPLETELY RETAINED BETWEEN THE MAIN POPPET SEAL RETAINER AND THE MAIN POPPET CAP.

THE MAIN SEAT IS CRES (PH 13-8 MO) PASSIVATED. THE SEALING SURFACE IS LAPPED TO A FOUR MICROINCH SURFACE FINISH.

THE PILOT SEAT ASSEMBLY SEAL PREVENTS INTERNAL LEAKAGE FROM THE PILOT CAVITY BETWEEN THE PILOT SEAT ASSEMBLY AND THE HOUSING. THE "V" SEAL IS A TEFLON JACKETED INCONEL 718 SPRING.

THE PILOT SEAT ASSEMBLY SEAL SPRING PRELOADS THE PILOT SEAT ASSEMBLY AGAINST THE PILOT SEAT ASSEMBLY SEAL. IT IS A BELLEVILLE SPRING OF 302 CRES AND PASSIVATED.

TWO COMPONENTS MAY CAUSE A FAILURE TO RESEAT DUE TO BINDING: THE MAIN POPPET ACTUATING ROD AND THE PILOT SPRING-SEAT. THE MAIN POPPET ACTUATING ROD TRANSFERS FORCE FROM THE MAIN BELLOWS TO THE MAIN POPPET. THE SPRING-SEAT PULLS THE PILOT POPPET COMPLETELY OPEN (WHICH DUMPS PILOT PRESSURE TO ALLOW FULL FLOW THROUGH THE VALVE) BY EQUALIZING THE PRESSURE WITHIN THE MAIN BELLOWS WITH THAT OF THE FEEDLINE, AS SENSED BY THE PILOT BELLOWS. FAILURE OF THE SPRING SEAT TO RETURN WILL PREVENT THE PILOT POPPET FROM SEATING CAUSING FAILURE OF THE MAIN POPPET TO RESEAT.

THE MAIN POPPET ACTUATING ROD PASSES THROUGH A HOLE IN THE THERMAL ISOLATOR. THE THERMAL ISOLATOR IS VESPEL SP-21. THE HOLE IS OVER SEVEN DIAMETERS IN LENGTH, PRECLUDING COCKING. THE ROD IS INCONEL 718 AND PASSIVATED. THE CENTER SECTION IS SMALLER IN DIAMETER THAN THE ENDS TO REDUCE CONTACT AREA, PRECLUDING BINDING DUE TO CONTAMINANT PARTICLES TRAPPED BETWEEN THE ROD AND ISOLATOR. THE CONTACT SURFACE HAS A 16 MICROINCH FINISH WHICH MATES SMOOTHLY WITH THE THERMAL ISOLATOR.

THE SEAT-SPRING SLIDES SMOOTHLY AND FREELY WITHIN THE BORE OF THE RETAINER. THE RETAINER IS CRES (PH 13-8 MO), HEAT TREATED AND PASSIVATED. ITS BORE IS APPROXIMATELY ONE DIAMETER IN LENGTH AND HAS A 16 MICROINCH SURFACE FINISH. THE SPRING-SEAT IS 304 CRES AND PASSIVATED. THE UPPER AND LOWER CIRCUMFERENTIAL CONTACT SURFACES ARE POLISHED TO A 16 MICROINCH FINISH.

SYSTEM CONTAMINATION IS MINIMIZED DUE TO THE PRESENCE OF AN ET SCREEN, A GSE DEBRIS PLATE, AND A GSE FILTER.

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STRUCTURAL ANALYSIS INDICATES POSITIVE MARGINS OF SAFETY FOR ALL
CONDITIONS OF VALVE OPERATIONS.

(B) TEST

ATP

VISUAL INSPECTION

STROKE VERIFICATION OF MAIN POPPET (0.225 +/- 0.002 INCH)

AMBIENT TEST

PROOF PRESS: VALVE BODY, 110 PSIG INLET & SENSE PORT, 300 PSIG OUTLET

INTERNAL LEAKAGE:

1 TO 35 PSIG GHe AT INLET AND SENSE PORT
10 SCIM MAX AT OUTLET PORT

EXTERNAL LEAKAGE: 55 PSIG GHe; 5 SCIM MAX

CRACK/RESEAT: 40 TO 55 PSIG

REVERSE FLOW LEAKAGE:

10 PSID GHe OUTLET TO INLET
MAIN SEAT LEAKAGE 50 SCIM MAX
PILOT REVERSE LEAKAGE 1700 SCIM MAX.

CRYOGENIC TEST (GHe AT -300 DEG F):

CRACK/RESEAT: 40 TO 55 PSIG, VALVE BODY AMBIENT

EXTERNAL LEAKAGE: 55 PSIG, 10 SCIM MAX, VALVE BODY -100 DEG F

INTERNAL LEAKAGE: 35 PSIG, 10 SCIM MAX, VALVE BODY -100 DEG F

CERTIFICATION

LIFE TEST

CRYO - 4500 CYCLES OPEN AND CLOSED USING LN2, VALVE CHECKED FOR
INTERNAL LEAKAGE AFTER EACH 500 CYCLES, VALVE CHECKED FOR CRYO
INTERNAL LEAKAGE AFTER EACH 1500 CYCLES.

AMBIENT - 500 CYCLES, VALVE INTERNAL LEAK CHECK EACH 50 CYCLES.

CRYO STEADY STATE FLOW TEST

SENSES PORT PRESS AT 65 PSIG GHe AT -412 DEG F
FLOW RATE OF 272 GPM LH2 AT 23 PSID

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CRYO RESPONSE TEST

1.5 SEC TO INDICATE STEADY FLOW AFTER CRACKING WITH LH2

CRYO FUNCTIONAL TEST USING LH2

CRACKED AT 51 PSIG; RESEAT AT 44 PSIG

RANDOM VIBRATION 13.3 HOURS IN EACH OF THE THREE AXES

FIRST 4 HOUR AND 26 MINUTE PERIOD

ENVIRONMENT: AMBIENT

SENSE PORT: 35 PSIG GHe AT -425 DEG F

MAIN INLET: AMBIENT

SECOND 4 HOUR AND 26 MINUTE PERIOD

ENVIRONMENT: AMBIENT TO +100 TO -100 TO AMBIENT

SENSE PORT: 35 PSIG GHe AT -425 DEG F

MAIN INLET: 35 PSIG GHe AT -425 DEG F

THIRD 4 HOUR AND 26 MINUTE PERIOD

ENVIRONMENT: AMBIENT

SENSE PORT: 35 PSIG GHe AT -425 DEG F

MAIN INLET: 35 PSIG LN2

CRACK/RESEAT AND INTERNAL LEAKAGE PERFORMED AT COMPLETION OF EACH AXIS OF VIBRATION.

BENCH HANDLING AND DESIGN SHOCK PER MIL-STD-810

FOLLOWED BY AMBIENT CRACK/RESEAT AND INTERNAL LEAKAGE TESTS.

THERMAL CYCLE TEST (3 CYCLES)

VALVE AT 70 DEG F; SHOCKED WITH -300 DEG F FLUID FOR 20 MINUTES MIN;
VALVE ALLOWED TO WARM UP TO 70 DEG F; VALVE HEATED TO 275 DEG F FOR 15
MINUTES. DURING THE 15 MINUTES THE VALVE WAS TESTED FOR AMBIENT
CRACK/RESEAT PRESSURE.

ELECTRICAL BONDING

BURST TEST

220 PSIG ON SENSE AND INLET PORTS, 600 PSIG ON OUTLET PORT

CMRSD

V41AYO.140 LH2 PROP SYS DECAY CHECK (EVERY FLIGHT)

V41BEO.030 RV6 LH2 MANIFOLD RELIEF VALVE INTERNAL LEAK TEST (I5)

V41BHO.120 RV6 LH2 MANIFOLD RELIEF VALVE FUNCTIONAL (PRIOR TO FIRST
REFLIGHT OF EACH VEHICLE)

V41BUO.161 LH2 FEEDLINE SCREEN INSPECTION (I5)

V41BUO.163 LH2 FEEDLINE SCREEN INSPECTION - VERTICAL (I25)

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(C) INSPECTION

RECEIVING INSPECTION

RAW MATERIALS ARE VERIFIED BY INSPECTION FOR MATERIAL AND PROCESS CERTIFICATION. PART PROTECTION COATING AND PLATING REQUIREMENTS ARE VERIFIED BY INSPECTION.

CONTAMINATION CONTROL

CONTAMINATION CONTROL PROCESS AND CORROSION PROTECTION PROVISIONS ARE VERIFIED. CLEANLINESS TO LEVEL 400A (PROCUREMENT SPECIFICATION REQUIREMENT IS 400) VERIFIED BY INSPECTION.

ASSEMBLY/INSTALLATION

ALL CRITICAL DIMENSIONS ARE VERIFIED BY INSPECTION. LOG OF CLEAN ROOM AND TOOL CALIBRATION IS VERIFIED BY INSPECTION. TORQUE PER DRAWING REQUIREMENTS AND SURFACE FINISH ARE VERIFIED BY INSPECTION. SURFACES REQUIRING CORROSION PROTECTION ARE VERIFIED BY INSPECTION. ALL SEALING SURFACES AND SEALS ARE VISUALLY EXAMINED BEFORE INSTALLATION USING 10X MAGNIFICATION. MANDATORY INSPECTION POINTS ARE INCLUDED IN THE MANUFACTURING PROCEDURE.

CRITICAL PROCESSES

HEAT TREATMENT, WELDING, PARTS PASSIVATION, AND ANODIZING ARE VERIFIED. DRY FILM LUBRICANT APPLICATIONS ARE VERIFIED BY INSPECTION.

NONDESTRUCTIVE EVALUATION

ALL WELDS ARE VISUALLY EXAMINED AND VERIFIED BY DYE PENETRANT. IN ADDITION, HELLOWS WELDS (EXCLUDING END FITTING WELDS) ARE X-RAYED.

TESTING

ATF VERIFIED BY INSPECTION.

HANDLING/PACKAGING

PACKAGING FOR SHIPPING IS VERIFIED BY INSPECTION.

(D) FAILURE HISTORY

GENERAL SYSTEM CONTAMINATION

THIS FAILURE MODE HAS NOT OCCURRED ON THIS COMPONENT DUE TO CONTAMINATION. HOWEVER, GENERAL MPS SYSTEM CONTAMINATION HAS OCCURRED WHICH MAY LODGE ANYWHERE IN THE SYSTEM CAUSING THIS FAILURE MODE (REFERENCE THE FOLLOWING PARAGRAPHS).

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CONTAMINATION FAILURES HAVE OCCURRED AT ALL PHASES OF MANUFACTURING AND PARTS REPLACEMENT. IN ALL CASES, STRICT ADHERENCE TO CLEANLINESS CONTROL PROCEDURES IS THE PRIMARY METHOD OF CONTAMINATION PREVENTION.

NUMEROUS LARGE PARTICLES OF BLACK RUBBER MATERIAL WERE FOUND DURING A POST FLIGHT EXAMINATION OF THE LH2 17 INCH DISCONNECT OF OV099 (FLIGHT 7, REFERENCE CAR AC9800). THE LO2 AND LH2 SYSTEMS OF ALL VEHICLES WERE EXAMINED. NO RUBBER WAS FOUND IN ANY OTHER VEHICLES. AFTER EXTENSIVE INVESTIGATION THE ORIGIN WAS NOT DETERMINED.

METAL SHAVINGS HAVE BEEN DISCOVERED IN LINES AND COMPONENTS, WHICH WAS MOST LIKELY GENERATED WHEN THEY WERE CUT OUT AND/OR REPLACED (REFERENCE CARS AC9868, A9654, AC2210, AB1706; DR AD2226). METHODS ARE BEING REVISED TO MINIMIZE PARTICLE GENERATION WHEN INSTALLING/REPLACING COMPONENTS, LINES, AND FITTINGS REQUIRING WELDED OR BRAZED JOINTS (PRODUCT QUALITY IMPROVEMENT COUNCIL). PERSONNEL HAVE BEEN CAUTIONED. ROCKWELL PROBLEM ACTION CENTER WILL CONTINUE TO MONITOR BRAZING/WELDING REWORK CONTAMINATION. PROCEDURES ARE BEING REVISED TO IMPROVE CLEANLINESS MAINTENANCE DURING COMPONENT BUILD UP AND REWORK (REFERENCE MCR 12512). SUPPLIER DOCUMENTS/PROCEDURES HAVE BEEN REVIEWED AND CLEANLINESS MAINTENANCE PROCEDURES HAVE BEEN IMPROVED.

A PIECE OF A BRAZING PREFORM LODGED IN A 2-WAY SOLENOID VALVE ON OV-099 AT PALMDALE CAUSING A LEAKAGE FAILURE (REFERENCE CARS AC2111, AB2538). STEEL AND ALUMINUM PARTICLES CAUSED EXCESSIVE LEAKAGE ON THE 850 PSIG HELIUM RELIEF VALVE (REF CAR AC2229). FOR BOTH FAILURES CORRECTIVE ACTION WAS TO ADD SPECIAL PURGE PORTS TO THE MPS HELIUM PANEL ASSEMBLIES TO IMPROVE THE QUALITY OF FINAL CLOSEOUT BRAZES.

SEVERAL FOREIGN MATERIALS WERE INTRODUCED INTO THE MPS SYSTEM DURING MANUFACTURE AND PARTS REPLACEMENT. EXAMPLES ARE: GLASS CLOTH IN LINE TO PREVENT TRAVEL OF CHIPS DOWN LINE; POLYSTYRENE OBJECT TO HOLD VALVE POPPET OPEN WHILE PURGING; COTTON SWAB MATERIAL AND GLASS BEADS FROM CLEANING OPERATION; MISCELLANEOUS PLASTIC; FOAM; AND TAPE (REFERENCE CARS AB4751, AC2217, AC6768, AC9868, MPS3A0005, AC7912, AB0530). MATERIALS WERE REMOVED AND PERSONNEL WERE CAUTIONED. A HIGH FLOW DELTA P TEST AT PALMDALE WAS ADDED TO VERIFY THAT LINES WERE NOT PLUGGED. GRIT BLASTING (GLASS BEADS AND SAND USED TO CLEAN A LINE) IS NO LONGER PERFORMED. PROCEDURES ARE BEING REVISED TO IMPROVE CLEANLINESS MAINTENANCE DURING COMPONENT BUILD UP AND REWORK (REFERENCE MCR 12512). SUPPLIER DOCUMENTS/PROCEDURES HAVE BEEN REVIEWED AND CLEANLINESS MAINTENANCE PROCEDURES HAVE BEEN IMPROVED.

ONE PIECE OF WIRE WAS FOUND IN THE INTERNAL RELIEF VALVE OF THE LO2 PREVALVE ON OV103 (REFERENCE CAR AC9101). THE SOURCE OF THE CONTAMINATION WAS NEVER FOUND, BUT IT WAS BELIEVED TO BE FROM THE ET. OTHER CONTAMINATION HAS BEEN FOUND ON THE FEEDLINE SCREENS, SUCH AS AN UNIDENTIFIED ROUND OBJECT AND VARIOUS METALLIC PARTICLES (REFERENCE CARS AB0529 AND AB0530). SOURCE OF CONTAMINATION WAS UNDETERMINED. BORESCOPE EXAMINATIONS ARE CONDUCTED ON ALL FEEDLINE SCREENS EVERY FIFTH FLIGHT TO VERIFY CLEANLINESS. CONTAMINATION WAS REMOVED WHEN POSSIBLE.

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(E) OPERATIONAL USE

NO CREW ACTION CAN BE TAKEN.