R-8257

F-1 ENGINE PRELAUNCH OPERATIONS SUPPORT GUIDELINES APOLLO/SATURN V VEHICLE, S-IC STAGE

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North American Rockwell

6633 Canoga Avenue,
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FOREWORD

This report was prepared under G.O. 09256, Contract NAS8-18734, to fulfill the requirements of R-6531-7, <u>F-1 Engine Operational and Flight Support Program Plan</u>, Task D4-4-1.

ABSTRACT

This document considers all detectable F-1 engine nonconformance conditions which could reasonably be expected to occur during Saturn V vehicle launch preparations. Guidelines are provided for launch support personnel in evaluating a nonconformance condition relative to corrective action and impact on the countdown status.

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REVISIONS

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90

145

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15	47	~~76~~	131
19	48	95	145
21A	60A	103A	167A
22	~~60B~~	103B	167B
23	61	104	168
~~25~~	62	106A	169
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46			182
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INTRODUCTION

INTRODUCTION

In the event an engine operational requirement or condition exceeds defined limits during Saturn V Vehicle launch preparations, an immediate assessment of acceptability, alternatives, and/or additional constraints to be applied to other requirements or conditions is necessary to minimize the impact on the launch schedule.

To aid in this assessment, all detectable F-1 engine nonconformance conditions have been determined and are presented herein together with recommended dispositions. These recommended dispositions are intended as a supplement to aid in timely engineering evaluation and judgment relative to the F-1 engine and potential impact on the Saturn V Vehicle.

The interactions of simultaneous engine nonconformance conditions, stage effects, and stage and engine interactions resulting from engine nonconformance conditions are not considered herein.

To simplify usage of this document, the overall operations conducted during Saturn V Vehicle launch preparations are subdivided into five chronological activities. These activities are defined as:

1. Pre-Wet CDDT: This is the activity during which preparations for Wet CDDT are accomplished. There is no countdown clock time related to this activity. Engine-related functions occurring within this activity are shown in Fig. 1.
2. Wet CDDT: This is the activity during which all launch countdown events are simulated to demonstrate that the vehicle and GSE are ready for launch. The flight crew is not on board the vehicle and inert engine ordnance is used. The activity is initiated at a countdown clock time of T-4 days, 20 hours, 30 minutes, and terminated at T+17 hours. Engine-related functions occurring within this activity including Wet CDDT securing are shown in Fig. 1 .

3. Dry CDDT: This is the activity during which the launch countdown events initiated with a countdown clock setting of T-6 hours and terminated at T-4 minutes are simulated. The flight crew is on board during this activity. Cryogenic propellants are not loaded. Engine-related functions occurring within this activity are shown in Fig. 1.

4. Prelaunch Countdown: This is the activity during which preparations for start of the launch countdown are accomplished. There is no countdown time related to this activity. Engine-related functions occurring within this activity are shown in Fig. 1.

5. Launch Countdown: This is the activity during which the operations required to prepare for launch and launch of the Saturn V Vehicle are accomplished. This activity is initiated with a countdown clock time of T-4 days, 20 hours, 30 minutes, and terminated with vehicle liftoff. Engine-related functions occurring within this activity are shown in Fig. 1.

INSTRUCTIONS FOR USE OF THIS DOCUMENT

Guideline sheets are presented for each of the five preceding activities. Each guideline sheet gives the nominal requirement or condition, the detectable nonconformance conditions, and recommended disposition relative to engine status and pending operations. The applicable engine status and pending operation for each recommended disposition of a nonconformance condition is denoted by a blackened circle. In some cases, the recommended disposition is applicable to more than one engine status condition and pending operation. This is indicated by several blackened circles.

The Nonconformance Condition Index (Table 1) pages 4 through 7 presents a cross reference of applicable guideline sheets for each nonconformance condition relative to each of the five chronological launch activities covered in this document. When more than one guideline sheet is required

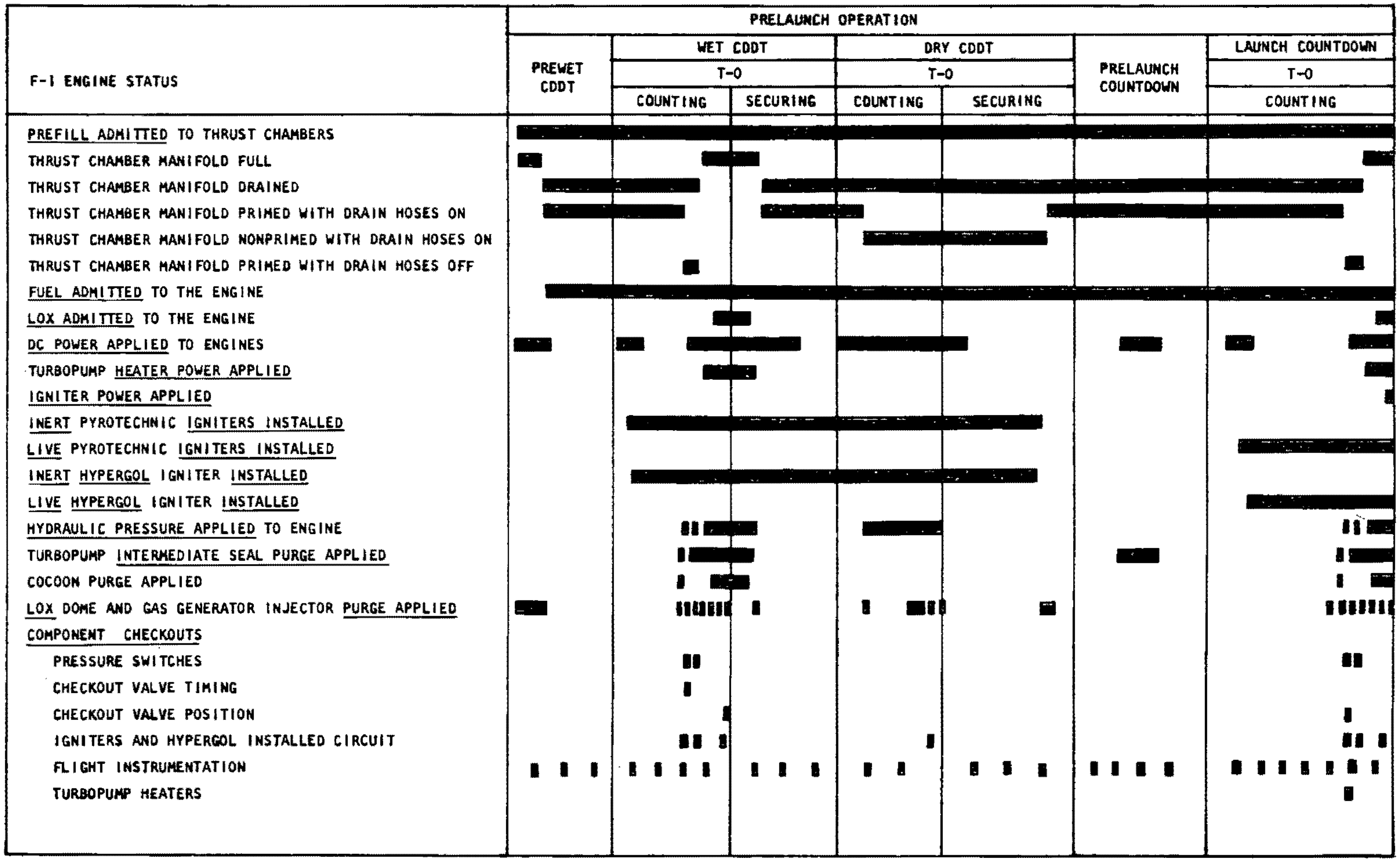

Figure 1. Engine-Related Functions for Launch Countdown

TABLE 1

NONCONFORMANCE CONDITION INDEX

Nonconformance Condition	Page Number				
	Pre-Wet CDDT	Wet CDDT	Dry CDDT	Prelaunch Countdown	Launch Countdown
1. Hydraulic Fluid Requirements					
A. Hydraulic Supply Pressure	10	33 - 36	94	--	137 - 140
Loss of hydraulic pressure or less than 400 psig Hydraulic pressure 400 to 1400 psig Hydraulic pressure 1600 to 1800 psig* Hydraulic pressure 1800 to 2200 psig Hydraulic pressure 2200 to 3000 psig Hydraulic pressure greater than 3000 psig					
B. Hydraulic Supply Temperature	--	37 - 38	--	--	141 - 143
Hydraulic fluid temperature less than 40 F Hydraulic fluid temperature 40 to 60 F Hydraulic fluid temperature 130 to 200 F Hydraulic fluid temperature greater than 200 F					
2. Fuel Propellant Requirements					
A. Turbopump Fuel Inlet Pressure	--	39	--	--	144
Fuel inlet pressure below 43.3 psia Fuel inlet pressure above 110 psia					
B. Fuel Bulk Temperature	--	40	--	--	145
Fuel temperature less than 35 F Fuel temperature greater than 100 F					
C. Fuel Composition/Purity	11 & 12	41 & 42	95 & 96	119 & 120	146 & 147
Fuel specific gravity out of limits Fuel contamination with RJ-1					
3. Fuel System/Hydraulic System Leakage					
A. Fuel Overboard Drain Line Leakage	13	43	97	121	147 - 150
Fuel leakage from drain line exceeds flowrate recorded during hydraulic system checkouts Prefill fluid leakage from drain line					
B. Turbopump Lube Seal Drain Line Leakage	14	44	98	122	151
Liquid leakage from drain line					
C. External Fuel Leakage	15	45 - 48	99	123	152 - 154
External fuel leakage noted from fuel or hydraulic system joint					
D. Fuel Leakage Past Main Fuel Valve Poppet	16 & 17	49 - 52	100 - 101	124	155 - 157
Fuel leakage from thrust chamber manifold drain hoses Fuel leakage from thrust chamber exit					

*Peculiar to Launch Countdown nonconformance condition pp 140A, 140B, 140C, and 140D

TABLE 1

(Continued)

Nonconformance Condition	Page Number				
	Pre-Wet CDDT	Wet CDDT	Dry CDDT	Prelaunch Countdown	Launch Countdown
E. Gas Generator Valve Fuel Leakage Fuel leakage from combustor drain port Fuel leakage from thrust chamber exit	18	51 - 53	102	125	157 - 158
4. LOX Propellant Requirement					
A. Turbopump LOX Inlet Pressure LOX inlet pressure below 78.3 psia LOX inlet pressure above 165 psia	--	54	--	--	159
B. Turbopump LOX Inlet Temperature LOX temperature warmer than -275 F LOX temperature colder than -297.5 F	--	55	--	--	160 - 161
C. LOX Purity LOX purity less than 99.5 percent	--	56	--	--	162
5. LOX System Leakage					
A. Turbopump LOX Seal Drain Line Leakage Liquid leakage in form of droplets Liquid leakage in form of a steady stream Loss of camera monitoring capability	--	57	--	--	163 - 164
B. External LOX Leakage Liquid leakage detected from LOX system joint	--	58	--	--	165
C. Main LOX Valve/Gas Generator Valve LOX Leakage LOX leakage detected from thrust chamber exit	--	59	--	--	166
6. Purge Gas Requirements					
A. LOX Dome/Gas Generator LOX Injector Purge Purge requirement during prefill tapoff or gimbaling Loss of purge or less than 60 psig Purge pressure between 60 and 120 psig Purge pressure between 220 and 1000 psig Purge pressure above 1000 psig	19	60 - 63	103 - 104	--	167 - 169
B. Turbopump Intermediate Seal Purge Loss of purge or purge pressure below 15 psig Purge pressure between 15 and 45 psig Purge pressure between 45 and 59 psig Purge pressure between 101 and 200 psig* Purge pressure between 126 and 200 psig Purge pressure between 200 and 350 psig Purge pressure above 350 psig	--	64 - 65	--	126	170 - 172

*Peculiar to Launch Countdown nonconformance condition

TABLE 1

(Continued)

Nonconformance Condition	Page Number				
	Pre-Wet CDDT	Wet CDDT	Dry CDDT	Prelaunch Countdown	Launch Countdown
C. Cocoon Purge Loss of purge Purge heater inoperative	--	67	--	--	173
D. Purge Gas Purity Moisture content Contamination	20	68	105	127	174
7. <u>Prefill Fluid Requirements</u>					
A. Prefill Composition Solid particles pH level Percent glycol	21	69	106	128	175
B. Thrust Chamber Manifold Drain Hoses	22	70	107	129	176
C. Prefill Level Unable to obtain prefill overflow on one or more engines	23	71 - 73	108	--	177 - 178
D. Engine Attitude Attitude exceeds 2.5 degrees after last prefill tapoff	--	74	--	--	179
8. <u>Prefill Fluid Leakage</u> Internal thrust chamber prefill leakage External thrust chamber prefill leakage	24	75	109	130	180
9. <u>Electrical Power Requirements</u>					
A. d-c Voltage Loss of d-c power or less than 24 volts High d-c voltage level, 32 to 36 volts High d-c voltage level, above 36 volts	25	76	110	131	181 - 182
B. a-c Turbopump Heater Voltage Loss of a-c power or less than 190 volts High a-c voltage level, 220 to 240 volts High a-c voltage level, above 240 volts	--	77	--	--	183 - 184
C. a-c Igniter Firing Voltage Loss of voltage Low a-c voltage level, less than 400 volts Low a-c voltage level, 400 to 500 volts High a-c voltage level, 750 to 1000 volts High a-c voltage level, above 1000 volts	--	78	111	--	185 - 186

TABLE 1

(Concluded)

Nonconformance Condition	Page Number				
	Pre-Wet CDDT	Wet CDDT	Dry CDDT	Prelaunch Countdown	Launch Countdown
10. Electrical Indication Requirements					
A. Propellant Valve Position Indications Main LOX valves (2), main fuel valves (2), or gas generator valve position other than close indicated	26 - 28	79 - 81	112	132	187 - 189
B. Checkout Valve Position Indication Checkout valve indicates other than, or in addition to, ground position Checkout valve indicates stage position prior to auto sequence Checkout valve fails to achieve stage position during auto sequence	29	82 - 84	113	133	190 - 193
C. Hypergol Installed Indication Installed indication not obtained after cartridge insertion Installed indication lost after cartridge insertion Cartridge cap cannot be screwed on using hand torque	--	85	114	--	194
D. Igniter Links Installed Indication Installed indication not obtained after igniter installation Installed indication lost after igniter installation	--	86 - 87	115	--	195 - 197
11. Flight Instrumentation Requirements					
A. Redline Parameter Calibration voltage out of specification limits Turbopump LOX bearing temperature Engine environmental temperature	30	88	116	134	198
B. Nonredline Parameter Calibration voltage out of specification limits	31	89	117	135	199
12. Engine Environmental Temperature Redline Environmental temperature less than 0 F	--	90	--	--	200
13. Turbopump LOX Bearing Temperature Redline Turbopump LOX bearing temperature less than 0 F Turbopump LOX bearing temperature greater than 200 F	--	91	--	--	201 - 203
14. Thrust OK Pressure Switch Requirements High calibration pickup pressure Low calibration pickup pressure Differential pressure out of limits	--	92	--	--	204
15. Thermal Insulation Requirements Thermal insulation panels soaked with flamable fluid Thermal insulation panels soaked with nonflamable fluid	32	93	118	136	205

to present the recommended dispositions for a specific nonconformance condition, a (continued on next page) note has been placed at the bottom edge of the sheet.

An example for use of this document is given below.

A nonconformance condition of loss of hydraulic pressure or less than 400 psig occurs during Wet CDDT. The nonconformance condition is listed under Hydraulic Fluid Requirements in the Nonconformance Condition Index, and the applicable guideline sheet page numbers under Wet CDDT are pages 33 through 36. By turning to the pages and checking for the applicable engine status and pending operation; for example engine status: Prefill Overflowed; LOX Admitted; and pending operation: Start Automatic Sequence (page 35A), the recommended disposition is: HOLD - Turn on the environmental and LOX system purges and leave purges on until oxidizer is removed from the engine or hydraulic pressure is restored.

DEFINITION OF IMMEDIATE ACTION TERMS

The following immediate action terms are used in the recommended disposition

<u>PROCEED</u>: Engine-related functions could be continued through the test without corrective action required. Subsequent problems arising from an underlying or associated condition would require a reassessment of the action to be accomplished. Corrective action would be required to eliminate the nonconformance condition after completion of the test.

<u>HOLD</u>: No additional engine-related functions may be performed until certain specific conditions are met. Upon completion of the corrective action, the test could be continued (with respect to engine-related functions).

BACKOUT: The nonconformance condition is unacceptable and it is necessary to revert to a previous status. Corrective action is mandatory prior to proceeding with engine-related functions.

CONTINUE: The nonconformance condition is acceptable for the current engine status or for a number of specified events during an activity. The nonconformance condition must be corrected prior to changing status or completion of the specified events (as indicated on the guideline sheets). If the nonconformance condition is not corrected as indicated, the recommended dispositions would change to HOLD or BACKOUT.

GUIDELINES FOR PRE-WET CDDT

GUIDELINES FOR PRE-WET CDDT

Pending Operation

○ Admit Prefill ○ Drain Manifold ○ Admit Fuel

Engine Status

○ Prefill Admitted ○ Manifold Primed ● Fuel Admitted

Nominal Condition	Nonconformance Condition	Recommended Disposition
Hydraulic supply pressure of 1400 to 1800 psig required (1510 to 1870) psia umbilical pressure) for hydraulics applied main fuel valve leak check if valve leakage occurs without hydraulic pressure	1. Hydraulic supply pressure less than 400 psig, or loss of hydraulic pressure	1.1 HOLD - Turn LOX system purge ON 1.2 Install drain hoses on the fuel inlet manifold drain quick disconnects and leave installed until after hydraulic pressure is reapplied. Measure total volume of fuel which initially drains. 1.3 If fuel volume noted in step 1.2 exceeds 13 ounces, perform thrust chamber jacket flush. 1.4 Perform thrust chamber LOX dome flush if the LOX dome is suspected to be contaminated.
	2. Hydraulic sypply pressure 400 to 1400 psig	2.1 PROCEED
	3. Hydraulic supply pressure 1800 to 2200 psig	3.1 CONTINUE - <u>DO NOT GIMBAL</u>
	4. Hydraulic supply pressure 2200 to 3000 psig	4.1 CONTINUE - <u>DO NOT GIMBAL</u> 4.1.1 Inspect for external hydraulic system leakage and fuel overboard drain line leakage; see pages covering these problems for disposition.

(Continued on next page)

GUIDELINES FOR PRE-WET CDDT

Pending Operation

○ Admit Prefill ○ Drain Manifold ○ Admit Fuel

Engine Status

○ Prefill Admitted ○ Manifold Primed ● Fuel Admitted

Nominal Condition	Nonconformance Condition	Recommended Disposition
Hydraulic supply pressure of 1400 to 1800 psig required (1510 to 1870) psia umbilical pressure) for hydraulics applied main fuel valve leak check if valve leakage occurs without hydraulic pressure	5. Hydraulic supply pressure greater than 3000 psig	5.1 HOLD - Turn LOX system purge ON. Turn off hydraulic pressure. 5.1.1 Perform action applicable to loss of hydraulic pressure and subsequent to reapplication of hydraulic pressure, and perform 4.1.1. 5.1.2 Evaluate possible requirement to replace components.

GUIDELINES FOR PRE-WET CDDT

Pending Operation		
○ Admit Prefill ○ Drain Manifold ● Admit Fuel		
Engine Status		
● Prefill Admitted ● Manifold Primed ● Fuel Admitted		
Nominal Condition	**Nonconformance Condition**	**Recommended Disposition**
RP-1 fuel specific gravity shall be in the range of 0.801 to 0.815 per MIL-R-25576. Fuel samples are obtained prior to filling the facility storage tank, and prior to vehicle fuel tanking pre-wet CDDT	1. RP-1 specific gravity less than 0.801 or greater than 0.815.	1.1 HOLD - Out-of-tolerance values of RP-1 specific gravity are indicative of a measurement error or contamination of the fuel with another fluid. 1.2 Obtain additional RP-1 samples and conduct laboratory analyses to determine correct specific gravity values. 1.3 If specific gravity is verified to be outside of MIL specification values, BACKOUT. 1.4 Determine the identity of the contaminates responsible for the discrepant specific gravity value. The determination of fuel acceptability is dependent upon the type of comtaminate, its effect on engine performance, and the performance effect on flight trajectory. NOTES 1. RP-1 low specific gravity results in high engine performance, while high specific gravity results in low engine performance. The performance effect is + 1.8 K-lb thrust for each engine per -0.001 units of specific gravity 2. The effect of engine performance level change due to specific gravity upon Saturn V flight trajectory must be assessed by NASA.

GUIDELINES FOR PRE-WET CDDT

Pending Operation

○ Admit Prefill ○ Drain Manifold ○ Admit Fuel

Engine Status

● Prefill Admitted ● Manifold Primed ● Fuel Admitted

Nominal Condition	Nonconformance Condition	Recommended Disposition
RP-1 fuel shall not contain excessive quantities of RJ-1 fuel	1. RP-1 fuel is contaminated with RJ-1 fuel	1. PROCEED 2. Subsequent to completion of current operation, determine the amount of RJ-1 mixed with the RP-1. The effect of RJ-1 mixed with RP-1 is to increase the fuel specific gravity which will decrease engine thrust. 100-percent RJ-1 lowers engine thrust 4 percent, thrust OK pressure switches will pickup; however, the effect of low liftoff thrust and low flight thrust effect on Saturn V flight trajectory must be assessed by NASA. A fuel volume of approximately 475 gallons per engine will be consumed prior to launch liftoff, however, RJ-1 volumes greater than approximately 170 gallons in the inboard and 198 gallons in the outboard engine fuel suction lines will result in mixing in the fuel tank

GUIDELINES FOR PRE-WET CDDT

Pending Operation

○ Admit Prefill ○ Drain Manifold ○ Admit Fuel

Engine Status

● Prefill Admitted ○ Manifold Primed ● Fuel Admitted

Nominal Condition	Nonconformance Condition	Recommended Disposition	
Leakage from fuel overboard drain line shall not exceed that volumetric flowrate recorded during hydraulic system leak and functional test	1. Fuel leakage from fuel overboard drain line exceeds the volumetric flowrate recorded during hydraulic system leak and functional test	1.1	HOLD - Perform the following isolations.
		1.1.1	Pressurize the fuel tank to maximum permissable level. If the leakage rate decreased, depressurize the fuel tank and PROCEED with the launch countdown.
		1.1.1.1	If the leakage rate increases or remains the same, perform the following:
		1.1.1.1.1	Measure the leakage rate. If the leakage rate is less than 158 cc/min., PROCEED.
		1.1.1.1.2	If the leakage rate is greater than 158 cc/min., perform the following:
		1.1.1.1.2.1	Disconnect the 1-inch line from the hydraulic drain system from the Y-fitting on the 1-3/4-inch fuel overboard drain line. Cap the Y-fitting.
		1.1.1.1.2.2	Install the fuel seal drain manifold adapter P/N 9020907.
		1.1.1.1.2.3	Measure the leakage from the inlet port of the adapter (No. 6 seal).

(Continued on next page)

GUIDELINES FOR PRE-WET CDDT

Pending Operation

○ Admit Prefill ○ Drain Manifold ○ Admit Fuel

Engine Status

● Prefill Admitted ○ Manifold Primed ● Fuel Admitted

Nominal Condition	Nonconformance Condition	Recommended Disposition
Leakage from fuel overboard drain line shall not exceed that volumetric flowrate recorded during hydraulic system leak and functional test	1. Fuel leakage from fuel overboard drain line exceeds the volumetric flowrate recorded during hydraulic system leak and functional test	1.1.1.1.2.3.1 If the leakage rate is less than 20 gpm, PROCEED. 1.1.1.1.2.3.2 If the leakage rate is greater than 20 gpm, replace the engine. 1.1.1.1.2.4 Measure the leakage from the primary port of the adpter (No. 5 seal). 1.1.1.1.2.4.1 If the leakage rate is less than 6.5 gpm, PROCEED. 1.1.1.1.2.4.2 If the leakage rate is more than 6.5 gpm, replace the engine. 1.1.1.1.2.5 Measure the leakage rate from the overboard drain line. This leakage is bearing coolant valve leakage. 1.1.1.1.2.5.1 If the leakage rate is less than 158 cc/min., PROCEED. 1.1.1.1.2.5.2 If the leakage rate is more than 158 cc/min., replace bearing coolant valve. 1.1.1.1.3 Measure the leakage rate from the 1-inch hydraulic drain system. If the leakage rate does not exceed 1882 cc/min., PROCEED.

(Continued on next page)

GUIDELINES FOR PRE-WET CDDT

Pending Operation

○ Admit Prefill ○ Drain Manifold ○ Admit Fuel

Engine Status

● Prefill Admitted ○ Manifold Primed ● Fuel Admitted

Nominal Condition	Nonconformance Condition	Recommended Disposition	
Leakage from fuel overboard drain line shall not exceed that volumetric flowrate recorded during hydraulic system leak and functional test	1. Fuel leakage from fuel overboard drain line exceeds the volumetric flowrate recorded during hydraulic system leak and functional test	1.1.1.1.4	If the leakage rate exceeds 1882 cc/min perform the following:
		1.1.1.1.4.1	Isolate the ignition monitor valve vent from the overboard drain system.
		1.1.1.1.4.1.1	If the leakage is less than 1882 cc/min., reinstall flight hardware and PROCEED.
		1.1.1.1.4.1.2	If the leakage is greater than 1882 cc/min., replace the ignition monitor valve.
		1.1.1.1.4.2	Isolate the redundant shutdown drain from overboard drain system.
		1.1.1.1.4.2.1	If the leakage is less than 3764 cc/min., reinstall flight hardware and PROCEED.
		1.1.1.1.4.2.2	If the leakage is greater than 3764 cc/min., perform the following:
		1.1.1.1.4.2.2.1	Isolate the engine control valve drain from the overboard drain system. Measure the leakage rate from the redundant shutdown valve.

(Continued on next page)

GUIDELINES FOR PRE-WET CDDT

Pending Operation

○ Admit Prefill ○ Drain Manifold ○ Admit Fuel

Engine Status

● Prefill Admitted ○ Manifold Primed ● Fuel Admitted

Nominal Condition	Nonconformance Condition	Recommended Disposition	
Leakage from fuel overboard drain line shall not exceed that volumetric flowrate recorded during hydraulic system leak and functional test	1. Fuel leakage from fuel overboard drain line exceeds the volumetric flowrate recorded during hydraulic system leak and functional test	1.1.1.1.4.2.2.2	If the leakage is less than 3764 cc/min., reinstall flight hardware and PROCEED.
		1.1.1.1.4.2.2.3	If the leakage exceeds 3764 cc/min., replace the redundant shutdown valve.
		1.1.1.1.4.3	Isolate the No. 1 main fuel valve potentiometer drain from the overboard drain system.
		1.1.1.1.4.3.1	If the leakage is less than 9410 cc/min., reinstall flight hardware and PROCEED.
		1.1.1.1.4.3.2	If the leakage is greater than 9410 cc/min., replace the main fuel valve potentiometer.
		1.1.1.1.4.4	Isolate the No. 2 main fuel valve potentiometer drain from the overboard drain system.
		1.1.1.1.4.4.1	If the leakage is less than 9410 cc/min., reinstall flight hardware and PROCEED.

(Continued on next page)

GUIDELINES FOR PRE-WET CDDT

Pending Operation

○ Admit Prefill ○ Drain Manifold ○ Admit Fuel

Engine Status

● Prefill Admitted ○ Manifold Primed ● Fuel Admitted

Nominal Condition	Nonconformance Condition	Recommended Disposition	
Leakage from fuel overboard drain line shall not exceed that volumetric flowrate recorded during hydraulic system leak and functional test	1. Fuel leakage from fuel overboard drain line exceeds the volumetric flowrate recorded during hydraulic system leak and functional testing	1.1.1.1.4.4.2	If the leakage is greater than 9410 cc/min., replace the main fuel valve potentiometer.
		1.1.1.1.5	If the source of leakage is not determined by isolating the preceding components, PROCEED.
	2. Prefill leakage from fuel overboard drain line	2.1	HOLD - Replace hypergol manifold assembly.

GUIDELINES FOR PRE-WET CDDT

Pending Operation

○ Admit Prefill ○ Drain Manifold ○ Admit Fuel

Engine Status

○ Prefill Admitted ○ Manifold Primed ● Fuel Admitted

Nominal Condition	Nonconformance Condition	Recommended Disposition
Zero liquid leakage from lube seal drain line	1. Liquid leakage from drain line	1.1 HOLD - Remove fuel from engine. Take investigation action to determine leakage source. Engine replacement may be required.

GUIDELINES FOR PRE-WET CDDT

Pending Operation

○ Admit Prefill ○ Drain Manifold ○ Admit Fuel

Engine Status

○ Prefill Admitted ○ Manifold Primed ● Fuel Admitted

Nominal Condition	Nonconformance Condition	Recommended Disposition
No external fuel leakage allowed.	1. External fuel leakage is noted from engine seal (propellant feed system or hydraulic system).	1.1 HOLD - Isolate leakage source and determine if leakage is greater than surface wetting. 1.1.1 If the leak is from the engine hydraulic control system, turn on LOX dome-gas generator LOX injector purge, and turn off hydraulic pressure to the engine. 1.1.2 Torque joint to maximum allowed value and verify that fuel leakage stops or is reduced to surface wetting. 1.1.3 If fuel leakage exceeds a surface wetting condition at maximum joint torque, remove fuel from engine. Replace discrepant seal per applicable field manual. 1.2 If leak is from engine fuel system joint, torque joint to maximum allowed value and verify that fuel leakage stops. 1.2.1 If fuel leakage continues at maximum joint torque, remove fuel from engine. Replace discrepant seal per applicable field manual. 1.3 Remove residual fuel from engine external surface and replace any fuel wetted thermal insulation panels per applicable field manual.

Revised 1-15-71

GUIDELINES FOR PRE-WET CDDT

Pending Operation

○ Admit Prefill ○ Drain Manifold ○ Admit Fuel

Engine Status

● Prefill Admitted ● Manifold Primed ● Fuel Admitted

Nominal Condition	Nonconformance Condition	Recommended Disposition
Main fuel valve leakage without hydraulic pressure applied shall not exceed 500 cc/min. from each valve.	1. Fuel leakage noted from thrust chamber fuel inlet manifold drain hoses at a flowrate above 500 cc/min. per valve.	1.1 HOLD - Turn LOX system purge on. Remove prefill and fuel from engine. 1.2 Replace discrepant main fuel valve per applicable field manual. 1.3 Reperform negated leak and functional tests. 1.4 Perform thrust chamber jacket flush, and LOX dome flush if LOX dome contamination is suspected. 1.5 Replace any fuel wetted thermal insulation panels per applicable field manual.

GUIDELINES FOR PRE-WET CDDT

Pending Operation

○ Admit Prefill ○ Drain Manifold ○ Admit Fuel

Engine Status

● Prefill Admitted ● Manifold Primed ● Fuel Admitted

Nominal Condition	Nonconformance Condition		Recommended Disposition
No main fuel valve leakage allowed with hydraulic pressure applied to engine.	1. Fuel leakage noted from thrust chamber fuel inlet manifold drain hoses.	1.1	HOLD - Turn ON LOX system purge.
		1.1.1	Remove prefill and fuel from the engine.
		1.1.1.1	Replace discrepant main fuel valve per applicable field manual.
		1.1.1.2	Perform valve timing tests with low LOX dome-gas generator LOX injector purge on.
		1.1.3	Perform a thrust chamber fuel jacket flush if fuel leakage rate exceeds 1000 cc/min. from replaced valve. Perform LOX dome flush if fuel leakage overflowed from the thrust chamber injector and the low LOX dome-gas generator LOX injector purge was not on.
		1.1.4	Perform main fuel valve leak test with and without hydraulic pressure applied to the replacement main fuel valve.
	2. Fuel leakage noted from thrust chamber exit.	2.1	HOLD - Turn ON LOX system purge.
		2.1.1	Remove prefill and fuel from the engine/
		2.1.1.1	Replace discrepant main fuel valve per applicable field manual.

(Continued on next page)

GUIDELINES FOR PRE-WET CDDT

Pending Operation

○ Admit Prefill ○ Drain Manifold ○ Admit Fuel

Engine Status

● Prefill Admitted ● Manifold Primed ● Fuel Admitted

Nominal Condition	Nonconformance Condition	Recommended Disposition
No main fuel valve leakage allowed with hydraulic pressure applied to engine.	2. Fuel leakage noted from thrust chamber exit.	2.1.1.2 Reperform negated leak and functional tests. 2.1.1.3 Perform a thrust chamber fuel jacket flush. Perform LOX dome flush if fuel leakage occurred without the low LOX dome-gas generator purge on. 2.1.1.4 Perform main fuel valve leak test with and without hydraulic pressure applied to the replacement main fuel valve.

GUIDELINES FOR PRE-WET CDDT

Pending Operation

○ Admit Prefill ○ Drain Manifold ○ Admit Fuel

Engine Status

○ Prefill Admitted ● Manifold Primed ● Fuel Admitted

Nominal Condition	Nonconformance Condition	Recommended Disposition
No gas generator valve fuel leakage allowed.	1. Fuel leakage noted from gas generator combustor drain port.	1.1 HOLD - Turn ON LOX system purge. 1.1.1 If hydraulic pressure is not applied to the engine, apply 1400 to 1800 psig (1510 to 1870 psia umbilical pressure) hydraulic pressure. 1.1.1.1 If leakage stops with hydraulic pressure applied, PROCEED with the hydraulic system pressurized. Hydraulic pressure will be required any time fuel is in the engine. 1.1.1.1.1 Perform a gas generator LOX injector flush if gas generator valve leakage occurs without the LOX system purge on. 1.1.1.2 If leakage continues with hydraulic pressure applied, remove prefill and fuel from the engine. 1.1.1.2.1 Replace discrepant gas generator valve per applicable field manual. 1.1.1.2.2 Reperform negated leak and functional tests. 1.1.1.2.3 Perform gas generator LOX injector flush.

GUIDELINES FOR PRE-WET CDDT

Pending Operation

● Admit Prefill ○ Drain Manifold ○ Admit Fuel

Engine Status

○ Prefill Admitted ○ Manifold Primed ○ Fuel Admitted

Nominal Condition	Nonconformance Condition	Recommended Disposition
LOX dome-gas generator LOX injector purge must be on within a pressure range of 120 to 1000 psig during prefill and fuel admittance to engine. Nominal pressure is 220 psig. (Measurement monitored at Lut. System ΔP between measurement and engine interface is 80 psi when interface pressure is 120 psig.)	1. Purge goes off.	1.1 HOLD - Correct problem. Determine where purge went off. If purge went off when prefill was overflowing the injector, flush the LOX dome.
	2. Purge pressure between 0 and 120 psig.	2.1 HOLD - Turn off purge to preclude LOX purge check valve chatter, and correct problem.
	3. Purge pressure above 1000 psig.	3.1 HOLD - Turn purge off and correct problem. 3.2 Subsequent to completion of corrective action, if purge system pressure exceeded 3600 psig, turn purge on and perform purge system leak test to verify wrap-around line bellows integrity. NOTE: High- and low-level LOX system purges are considered interchangeable.

Revised 1-15-71

GUIDELINES FOR PRE-WET CDDT

Pending Operation

○ Admit Prefill ○ Drain Manifold ○ Admit Fuel

Engine Status

● Prefill Admitted ● Manifold Primed ● Fuel Admitted

Nominal Condition	Nonconformance Condition	Recommended Disposition
The purity of gaseous nitrogen shall be equivalent to Type I of MIL-P-27401 specification.	1. The moisture content exceeds 26.3 ppm by volume of water vapor at 70 F.	1.1 HOLD - Correct cause of excessive moisture prior to supplying gaseous nitrogen to engine system.
	2. The purity of the nitrogen is less than 99.5 percent nitrogen by volume. (Total hydrocarbon 25 ppm by weight as carbon, 0.5 percent by volume as oxygen, 58.3 ppm by volume as methane).	2.1 HOLD - Determine extent of nonconformance and evaluate hardware condition on an individual occurrence and application basis.

GUIDELINES FOR PRE-WET CDDT

Pending Operation

● Admit Prefill ○ Drain Manifold ○ Admit Fuel

Engine Status

○ Prefill Admitted ○ Manifold Primed ○ Fuel Admitted

Nominal Condition	Nonconformance Condition	Recommended Disposition
Thrust chamber prefill fluid shall be in conformance with Specification RB0210-017: Solid particles: no sediment; pH value: 6.5 ±1.5; ethylene glycol percentage by weight: 50 ±1 percent	1. The prefill fluid contains solid particles which are smaller than 1350 microns.	1.1 PROCEED
	2. The prefill fluid contains solid particles which are larger than 1350 microns.	2.1 HOLD - Filter the prefill fluid to obtain acceptable particle sizes prior to introducing the prefill fluid into the thrust chamber.
	3. The pH of the prefill fluid is less than 5.0	3.1 HOLD - Exposure of thrust chamber components to this organic acid is acceptable for short time durations only, one week maximum.
	4. The pH of the prefill fluid is larger than 8.0	4.1 PROCEED
	5. The prefill fluid contains from 50 to 60 percent ethylene glycol by weight.	5.1 PROCEED
	6. The prefill fluid contains more than 60 percent ethylene glycol by weight.	6.1 HOLD - Add distilled or deionized water to the prefill fluid to obtain a 50-percent mixture by weight.
	7. The prefill fluid contains from 45 to 50 percent ethylene glycol by weight.	7.1 PROCEED

(Continued on next page)

Revised 1-15-71

GUIDELINES FOR PRE-WET CDDT

Pending Operation

● Admit Prefill ○ Drain Manifold ○ Admit Fuel

Engine Status

○ Prefill Admitted ○ Manifold Primed ○ Fuel Admitted

Nominal Condition	Nonconformance Condition	Recommended Disposition
Thrust chamber prefill fluid shall be in conformance with Specification RB0210-017: Solid particles: no sediment; pH value: 6.5 ±1.5; ethylene glycol percentage by weight: 50 ±1 percent	8. The prefill fluid contains less than 45 percent ethylene gylcol by weight.	8.1 HOLD - Take corrective action to obtain a 50-percent mixture by weight.

GUIDELINES FOR PRE-WET CDDT

Pending Operation

○ Admit Prefill ○ Drain Manifold ○ Admit Fuel

Engine Status

● Prefill Admitted ● Manifold Primed ● Fuel Admitted

Nominal Condition	Nonconformance Condition	Recommended Disposition
Drain hoses must not be removed from the fuel inlet manifold drainage quick disconnects until after the final application of hydraulic supply pressure to the engine if main fuel valve leakage has occurred without hydraulic pressure applied.	1. Drain hoses are removed prior to final application of hydraulic supply pressure.	1.1 HOLD - Turn LOX system purge on. Accomplish either step 1.1.1 or 1.1.2, whichever is faster. 1.1.1 Install drain hoses on the fuel inlet manifold drain quick disconnects and leave installed until after hydraulic pressure is applied. Measure initial volume of fuel which drains. 1.1.2 Apply hydraulic supply pressure. Then install drain hoses on the fuel inlet manifold drain quick disconnect and measure total volume of fuel which drains. 1.1.3 If fuel volume measured in step 1.1.1 or 1.1.2 exceeds 13 ounces, perform thrust chamber fuel jacket flush. Perform a thrust chamber LOX dome flush if the LOX dome is suspected to be contaminated. Then PROCEED. 1.1.3.1 If fuel volume measured in step 1.1.1 or 1.1.2 is less than 13 ounces, PROCEED.

GUIDELINES FOR PRE-WET CDDT

Pending Operation

○ Admit Prefill ○ Drain Manifold ○ Admit Fuel

Engine Status

● Prefill Admitted ○ Manifold Primed ○ Fuel Admitted

Nominal Condition	Nonconformance Condition	Recommended Disposition
Thrust chamber fuel jacket must be pre-filled to injector overflow. Prefill overflow must be visually verified.	1. Thrust chamber is noted not to exhibit overflow on one or more engines.	1.1 HOLD - Correct problem. 1.1.1 If thrust chamber does not prefill due to sticking check valve, replace check valve per per applicable field manual, verify torquing procedure and record torque values. Waive throat plug leak check.

GUIDELINES FOR PRE-WET CDDT

Pending Operation		
○ Admit Prefill ○ Drain Manifold ○ Admit Fuel		
Engine Status		
● Prefill Admitted ● Manifold Primed ● Fuel Admitted		
Nominal Condition	Nonconformance Condition	Recommended Disposition
No internal or external leakage is allowed from thrust chamber.	1. Internal leakage of prefill fluid	1.1 HOLD 1.1.1 Repair the thrust chamber per R-3896-3. 1.1.2 Flush LOX dome at conclusion of weld repair and conduct throat plug leak check after LOX dome flush completion. 2.1 HOLD 2.2 Repair the thrust chamber per R-3896-3, (Vol. II) 2.2.1 Flush LOX dome at conclusion of weld repair and conduct throat plug leak check after completion of dome flush. 2.2.2 Remove external prefill leakage from engine and TIS surfaces, and replace TIS panels, which are internally wet with prefill.

GUIDELINES FOR PRE-WET CDDT

Pending Operation

○ Admit Prefill ○ Drain Manifold ○ Admit Fuel

Engine Status

● Prefill Admitted ● Manifold Primed ● Fuel Admitted

Nominal Condition	Nonconformance Condition	Recommended Disposition
D-C electrical power: 24 to 32 vdc under load conditions.	1. Loss of d-c power or less than 18 volts.	1.1 HOLD - Correct problem. 1.2 Verify that d-c power distribution to engine is normal and that all propellant valves are in the close position.
	2. Low d-c voltage (18 to 24 vdc).	2.1 CONTINUE - Through Wet CDDT, voltage at four-way valve and checkout valve must be greater than 18 vdc when valves are actuating (equivalent no -load buss voltage of approximately 22 vdc). Problems may be encountered with attaining reliable facility relay operation.
	3. High d-c voltage (32 to 36 vdc).	3.1 PROCEED
	4. High d-c voltage (greater than 36 vdc).	4.1 HOLD - Turn off electrical power and effect repair. Verify that all engine electrical indicators illuminate properly. Conduct an electrical functional check of the following components: main LOX valve, main fuel valve and gas generator valves position indicators, hypergol installed switch, checkout valve position switch, igniter circuits, flight instruments (calibration) and turbopump heater htermostats.

GUIDELINES FOR PRE-WET CDDT

Pending Operation

● Admit Prefill ○ Drain Manifold ○ Admit Fuel

Engine Status

○ Prefill Admitted ○ Manifold Primed ○ Fuel Admitted

Nominal Condition	Nonconformance Condition	Recommended Disposition
Main LOX valves (2), main fuel valves (2), gas generator ball valve CLOSE indications are required for start of admitting prefill to engine.	1. One valve CLOSE indication is not received; or one valve OPEN indication is received; or both OPEN and CLOSED indications are received.	1.1 HOLD - If hydraulic pressure is not applied to the engine, apply hydraulic pressure and verify that proper indication is received. 1.1.1 If indication is not received with hydraulic pressure, replace defective part per applicable field manual.

GUIDELINES FOR PRE-WET CDDT

Pending Operation

○ Admit Prefill ○ Drain Manifold ● Admit Fuel

Engine Status

○ Prefill Admitted ● Manifold Primed ○ Fuel Admitted

Nominal Condition	Nonconformance Condition	Recommended Disposition
Main LOX valves (2), main fuel valves (2), gas generator ball valve CLOSE indications are required for start of stage fuel tanking.	1. One valve CLOSE indication is not received; or one valve OPEN indication is received; or both OPEN and CLOSED indications are received.	1.1 HOLD - If hydraulic pressure is not applied to the engine, apply hydraulic pressure and verify that proper indication is received. 1.1.1 If indication is not received with hydraulic pressure, replace defective part per applicable field manual.

GUIDELINES FOR PRE-WET CDDT

Pending Operation

○ Admit Prefill ○ Drain Manifold ○ Admit Fuel

Engine Status

○ Prefill Admitted ○ Manifold Primed ● Fuel Admitted

Nominal Condition	Nonconformance Condition	Recommended Disposition
Main LOX valves (2), main fuel valves (2), gas generator valve CLOSE indications are present when d-c power is applied.	1. One valve CLOSE indication is not received; or one valve OPEN indication is received; or both OPEN and CLOSED indications are received.	1.1 HOLD - if hydraulic pressure is not applied to the engine, apply hydraulic pressure 1.2 If valve closed indication is not received with hydraulic pressure applied, accomplish the following action for the appropriate valve. 1.2.1 Main fuel valve position: correct problem, if main fuel valve position switch is defective, BACKOUT remove fuel and prefill, from engine. Replace position indicater per applicable field manual and accomplish checkout per established procedure. 1.2.2 Main LOX or gas generator valve position: use appropriate "work-around" procedure to provide the interlock indications required to continue through launch, than PROCEED. 1.3 If valve closed indication is received with hydraulic pressure applied, accomplish the following action for the appropriate valve.

(Continued on next page)

GUIDELINES FOR PRE-WET CDDT

Pending Operation

○ Admit Prefill ○ Drain Manifold ○ Admit Fuel

Engine Status

○ Prefill Admitted ○ Manifold Primed ● Fuel Admitted

Nominal Condition	Nonconformance Condition	Recommended Disposition
Main LOX valves (2), main fuel valves (2), gas generator valve CLOSE indications are present when d-c power is applied.	1. One valve CLOSE indication is not received; or one valve OPEN indication is received; or both OPEN and CLOSED indications are received.	1.3.1 Main fuel valve position: drain thrust chamber fuel manifold with hydraulic pressure applied. Inspect prefill fluid for evidence of fuel. If more than 13 ounces of fuel is detected in the prefill fluid, BACKOUT, remove prefill from engine and perform a fuel jacket flush. If LOX dome contamination is suspected, perform a LOX dome flush. 1.3.2 Main LOX valve position: PROCEED 1.3.3 Gas generator valve position: inspect gas generator combustor drain for evidence of fuel. If fuel is detected and the LOX purge was not on, BACKOUT, perform a flush of the gas generator LOX injector.

GUIDELINES FOR PRE-WET CDDT

Pending Operation

○ Admit Prefill ○ Drain Manifold ○ Admit Fuel

Engine Status

● Prefill Admitted ● Manifold Primed ● Fuel Admitted

Nominal Condition	Nonconformance Condition	Recommended Disposition
Checkout valve must be in the ground position, when d-c power or hydraulics are applied to the engine	1. Checkout valve indicates some position other than, or in addition to, the ground position.	1.1 HOLD - Cycle checkout valve to ground position. If ground position is not attained within 4 seconds, BACKOUT - remove power to preclude motor burnout. 1.2 Determine whether the problem is associated with the checkout valve actuator or the ground control system. Take corrective action and verify proper system operation. 1.2.1 If actuator is defective, replace actuator per applicable field manual.

GUIDELINES FOR PRE-WET CDDT

Pending Operation

○ Admit Prefill ○ Drain Manifold ○ Admit Fuel

Engine Status

● Prefill Admitted ● Manifold Primed ● Fuel Admitted

Nominal Condition	Nonconformance Condition	Recommended Disposition
Calibration of flight instrumentation redline parameters (3 steps: ambient, 20 percent, and 80 percent).	1. Calibration voltage output out of specification limits (1 of 3 steps or a zero shift).	1.1 PROCEED (If a zero shift was observed, determine the amount of shift bias for use when reviewing future measurements recorded by the affected transducer).
	2. Calibration voltage output out of specification limits (2 of 3 steps, all 3 steps, or complete failure of output signal).	
	2.1 Turbopump LOX bearing temperature	2.1.1 HOLD - Replace transducer and checkout replacement part.
	2.2 Engine environmental temperature	2.2.1 HOLD - Replace transducer and checkout replacement part.

GUIDELINES FOR PRE-WET CDDT

Pending Operation

○ Admit Prefill ○ Drain Manifold ○ Admit Fuel

Engine Status

● Prefill Admitted ● Manifold Primed ● Fuel Admitted

Nominal Condition	Nonconformance Condition	Recommended Disposition
Calibration of flight instrumentation non-redline parameters pressure transducers (3 steps: ambient, 20 percent, and 80 percent).	1. Calibration voltage output out of specification limits (1 of 3 step)	1.1 PROCEED
	2. Calibration voltage output out of specification limits (2 of 3 steps with backup)	2.1 PROCEED
	3. Calibration voltage output out of specification limits (2 of 3 steps, no backup).	3.1 PROCEED
	4. Calibration voltage output out of specification limits (zero shift).	4.1 PROCEED

GUIDELINES FOR PRE-WET CDDT

Pending Operation

○ Admit Prefill ○ Drain Manifold ○ Admit Fuel

Engine Status

● Prefill Admitted ● Manifold Primed ● Fuel Admitted

Nominal Condition	Nonconformance Condition	Recommended Disposition
Thermal insulation panels shall not be internally wetted	1. Thermal insulation panels are internally wetted with non-flammable fluids (water).	1.0 PROCEED
	2. Thermal insulation panels are internally wetted with flammable fluids (RP-1, RJ-1, etc.)	2.0 HOLD - Replace wetted panels then PROCEED.

GUIDELINES FOR WET CDDT

GUIDELINES FOR WET CDDT

Pending Operation

○ Inert Ordnance Inst. ● Prefill Topoff ○ Admit LOX ○ Start Auto. Sequence ○ Drain LOX ○ Drain Manifold

Engine Status

● Fuel Admitted ● Inert Ordnance Installed ○ Prefill Overflowed ○ LOX Admitted

○ Auto. Sequence ○ LOX Drained ○ Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
Hydraulic supply pressure of 1400 to 1800 psig required (1510- to 1870-psia umbilical pressure) prior to admitting LOX to engine.	1. Hydraulic supply pressure less than 400 psig, or loss of hydraulic pressure.	1.1 CONTINUE to LOX tanking if no main fuel valve leakage has occurred without hydraulic pressure applied to the engine. 1.2 HOLD - If main fuel valve leakage has occurred without hydraulic pressure applied to the engine, turn LOX system purge on and accomplish either step 1.2.1 or 1.2.2 (whichever is faster) then proceed. 1.2.1 Install drain hoses on fuel inlet manifold drain quick disconnects and leave installed until after hydraulic pressure is reapplied. Measure total volume of fuel that drains initially. 1.2.2 Measure the volume of fuel in the thrust chamber prefill fluid post CDDT. Perform drainage with hydraulic pressure applied. 1.3 Post CDDT - Perform thrust chamber LOX dome flush if LOX dome contamination is suspected. 1.4 If fuel volume noted in step 1.2.1 or 1.2.2 exceeds 13 ounces, perform thrust chamber jacket flush post CDDT.

(Continued on next page)

GUIDELINES FOR WET CDDT

Pending Operation

○ Inert Ordnance Inst. ● Prefill Topoff ○ Admit LOX ○ Start Auto. Sequence ○ Drain LOX ○ Drain Manifold

Engine Status

● Fuel Admitted ● Inert Ordnance Installed ○ Prefill Overflowed ○ LOX Admitted
○ Auto. Sequence ○ LOX Drained ○ Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
Hydraulic supply pressure of 1400 to 1800 psig required (1510- to 1870-psia umbilical pressure) prior to admitting LOX to engine.	2. Hydraulic supply pressure, 400 to 1400 psig	2.1 PROCEED
	3. Hydraulic supply pressure, 1800 to 2200 psig	3.1 CONTINUE through CDDT - DO NOT GIMBAL
	4. Hydraulic supply pressure, 2200 to 3000 psig	4.1 CONTINUE through CDDT - DO NOT GIMBAL 4.1.1 Inspect for external hydraulic system leakage and fuel overboard drain line leakage; see pages covering these problems for disposition.
	5. Hydraulic supply pressure greater than 3000 psig	5.1 HOLD - Turn LOX system purge ON. Turn off hydraulic pressure. 5.1.1 Perform action applicable to loss of hydraulic pressure and, subsequent to reapplication of hydraulic pressure, perform 4.1.1. 5.1.2 Evaluate possible requirement to replace components post CDDT.

GUIDELINES FOR WET CDDT

Pending Operation

○ Inert Ordnance Inst. ○ Prefill Topoff ● Admit LOX ○ Start Auto. Sequence ○ Drain LOX ○ Drain Manifold

Engine Status

○ Fuel Admitted ○ Inert Ordnance Installed ● Prefill Overflowed ○ LOX Admitted
○ Auto. Sequence ○ LOX Drained ○ Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
Hydraulic supply pressure of 1400 to 1800 psig required (1510- to 1870- psia umbilical pressure) prior to admitting LOX to engine.	1. Hydraulic supply pressure less than 400 psig, or loss of hydraulic pressure.	1.1 CONTINUE to LOX tanking 1.1.1 If main fuel valve leakage has occurred without hydraulic pressure applied to the engine, accomplish either step 1.1.1.1 or 1.1.1.2 (whichever is faster) then proceed. 1.1.1.1 Install drain hoses on the fuel inlet manifold drain quick disconnects and leave installed until after hydraulic pressure is reapplied. Measure total volume of fuel that drains initially. 1.1.1.2 Measure the volume of fuel in the thrust chamber prefill fluid post CDDT. Perform drainage with hydraulic pressure applied. 1.2 Post CDDT - Perform thrust chamber LOX dome flush if the LOX dome contamination is suspected. 1.3 If fuel volume noted in step 1.1.1.1 or 1.1.1.2 exceeds 13 ounces, perform thrust chamber jacket flush post CDDT.

(Continued on next page)

GUIDELINES FOR WET CDDT

Pending Operation

○ Inert Ordnance Inst. ○ Prefill Topoff ● Admit LOX ○ Start Auto. Sequence ○ Drain LOX ● Drain Manifold

Engine Status

○ Fuel Admitted ○ Inert Ordnance Installed ● Prefill Overflowed ○ LOX Admitted
○ Auto. Sequence ○ LOX Drained ○ Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
Hydraulic supply pressure of 1400 to 1800 psig required (1510- to 1870- psia umbilical pressure) prior to admitting LOX to engine.	2. Hydraulic supply pressure, 400 to 1400 psig	2.1 PROCEED
	3. Hydraulic supply pressure, 1800 to 2200 psig	3.1 CONTINUE through CDDT - <u>DO NOT GIMBAL</u>
	4. Hydraulic supply pressure, 2200 to 3000 psig	4.1 CONTINUE through CDDT - <u>DO NOT GIMBAL</u> 4.1.1 Inspect for external hydraulic system leakage and fuel overboard drain line leakage; see pages covering these problems for disposition.
	5. Hydraulic supply pressure, greater than 3000 psig	5.1 HOLD - Turn LOX system purge ON. Turn off hydraulic pressure. 5.1.1 Perform action applicable to loss of hydraulic pressure and, subsequent to reapplication of hydraulic pressure, perform 4.1.1. 5.1.2 Evaluate possible requirement to replace components post CDDT.

GUIDELINES FOR WET CDDT

Pending Operation

○ Inert Ordnance Inst. ○ Prefill Topoff ○ Admit LOX ● Start Auto. Sequence ○ Drain LOX ○ Drain Manifold

Engine Status

○ Fuel Admitted ○ Inert Ordnance Installed ○ Prefill Overflowed ● LOX Admitted

● Auto. Sequence ○ LOX Drained ○ Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
Hydraulic supply pressure of 1400 to 1800 psig (1510- to 1870-psig umbilical pressure) with LOX in engine.	1. Hydraulic supply pressure, 400 to 1400 psig	1.1 PROCEED
	2. Hydraulic supply pressure, less than 400 psig, or loss of hydraulic pressure	2.1 HOLD - Turn on the environmental and LOX system purges and leave the purges on until oxidizer is removed from the engine or hydraulic pressure is restored. NOTE: All field documentation specifies to start LOX detanking if hydraulic pressure is lost for more than 10 minutes. 2.1.1 If hydraulic pressure is restored within 20 minutes, perform the following. NOTE: Reference Fig. 2 to determine actual time for paragraphs 2.1.1 and 2.1.2. 2.1.1.1 Post CDDT - Drain thrust chamber fuel manifold prefill into a suitable container and inspect for the presence of fuel. Perform drainage with hydraulic supply pressure applied.

(Continued on next page)

GUIDELINES FOR WET CDDT

Pending Operation

○ Inert Ordnance Inst. ○ Prefill Topoff ○ Admit LOX ● Start Auto. Sequence ○ Drain LOX ○ Drain Manifold

Engine Status

○ Fuel Admitted ○ Inert Ordnance Installed ○ Prefill Overflowed ● LOX Admitted

● Auto. Sequence ○ LOX Drained ○ Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
Hydraulic supply pressure of 1400 to 1800 psig (1510- to 1870-psig umbilical pressure) with LOX in engine.	2. Hydraulic supply pressure, less than 400 psig, or loss of hydraulic pressure	2.1.1.2.1 If more than 13 ounces of fuel is detected, conduct main fuel valve leak test with hydraulic pressure applied, and perform thrust chamber jacket flush. Perform thrust chamber LOX dome flush if LOX dome contamination is suspected. 2.1.2 If hydraulic pressure is not restored in 20 minutes, BACKOUT - remove LOX from engine and return engine to ambient temperature. 2.1.2.1 Inspect the gas generator combustor drain for evidence of leakage. If evidence of leakage is detected and the LOX system purge was not on, conduct gas generator LOX system flush post CDDT. 2.1.2.2 With hydraulic supply pressure applied, drain the thrust chamber fuel manifold prefill into a suitable container and inspect for presence of fuel.

(Continued on next page)

FIGURE 2

INSTRUCTIONS FOR USE OF GAS GENERATOR BALL VALVE FUEL SHAFT STEADY-STATE AND TRANSIENT TEMPERATURE CHART

The gas generator ball valve fuel shaft steady-state and transient temperature chart can be used for four purposes.

1. The nomograph located at the bottom center of the chart represents a tradeoff between hydraulic pressure and hydraulic temperature. For any initial gas generator ball valve fuel shaft temperature, numerous hydraulic temperature and hydraulic pressure combinations are possible. This is illustrated with two combinations shown by the diagonal lines at 1 .

2. The primary purpose of the chart is to determine the time interval from a complete loss of hydraulic pressure to the point where fuel will no longer flow when hydraulic pressure is restored. The following four steps should be used in connection with the chart:

   A. First, draw a line on the nomograph between the steady-state hydraulic temperature and hydraulic pressure at the time of the loss of hydraulic pressure. Where this line crosses the centerline at 1 represents the gas generator ball valve fuel shaft temperature at that time.

   B. Secondly, draw a diagonal line from this gas generator ball valve fuel shaft temperature at 2 to the reference point at 3 .

   C. Thirdly, a horizontal line is drawn from 4 where the diagonal crosses the freezing point reference line to the exponential curve at 5 .

   D. Finally, the time interval from the loss of hydraulic pressure to the point where fuel will no longer flow when hydraulic pressure is restored is read directly below the intersection of the exponential curve at 6 .

3. The chart also can be used to determine the gas generator ball valve fuel shaft temperature for various time intervals after a complete hydraulic pressure loss as follows:

   A. First, the initial gas generator ball valve fuel shaft temperature, as found by drawing a diagonal line between the particular hydraulic temperature and hydraulic pressure at 1 is located on the scale at 2 (reference step 2A).

   B. Second, the line is drawn from the temperature at 2 to the reference point at 3 (reference step 2B).

   C. Third, the specific time interval in question is located on the exponential curve at 7 8 .

D. Finally, a horizontal line is drawn from (8) to (9), and the actual gas generator ball valve fuel shaft temperature is read above the intersection at (10).

4. The 60 F O-ring limit can also be used to determine if any action need be taken. If the hydraulic pressure is restored within the time interval as dictated by the intersection of the diagonal from (2) to (3) and the O-ring limit reference line, no action need be taken. If it is not restored within this time interval, but before the time limit imposed by the freezing point reference line, inspection is necessary.

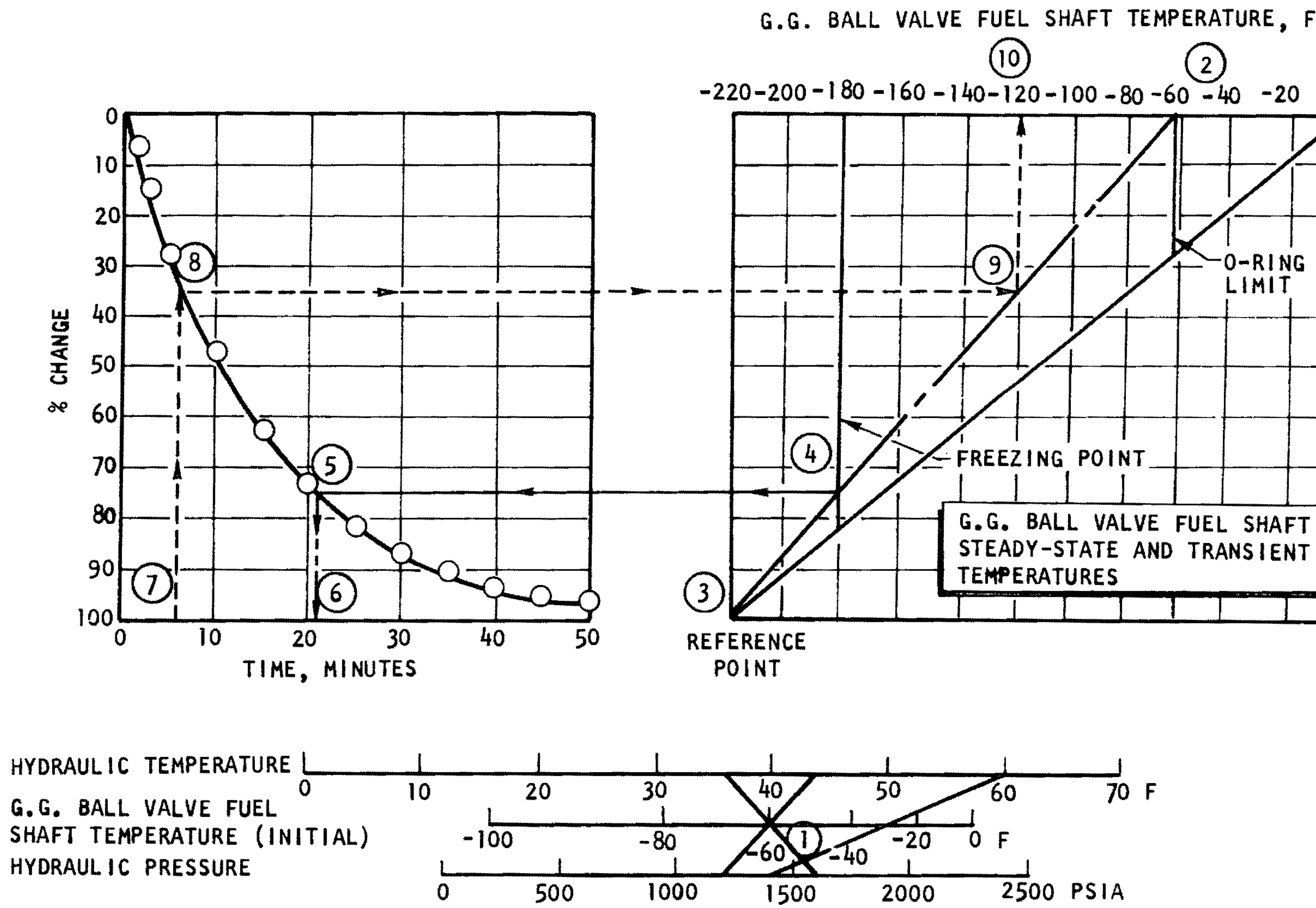

Figure 2. Gas Generator Valve Fuel Shaft Steady-State and Transient Temperatures

GUIDELINES FOR WET CDDT

Pending Operation

○ Inert Ordnance Inst. ○ Prefill Topoff ○ Admit LOX ● Start Auto. Sequence ○ Drain LOX ○ Drain Manifold

Engine Status

○ Fuel Admitted ○ Inert Ordnance Installed ○ Prefill Overflowed ● LOX Admitted

● Auto. Sequence ○ LOX Drained ○ Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
Hydraulic supply pressure of 1400 to 1800 psig (1510- to 1870-psia) umbilical pressure with LOX in engine.	2. Hydraulic supply pressure less than 400 psig, or loss of hydraulic pressure.	2.1.2.2.1 If more than 13 ounches of fuel is detected, post CDDT conduct main fuel valve leak test with hydraulic pressure applied, and perform thrust chamber jacket flush. Perform thrust chamber LOX dome flush if LOX dome contamination is suspected.
		2.1.2.3 With hydraulic pressure applied, inspect for leakage from the fuel overboard drain line, and for external hydraulic system leakage (see pages covering these problems for disposition).
		2.1.2.4 Remove plugs from port "G" on each main fuel valve and inspect (swab check) for evidence of fuel. If fuel is detected, replace the main fuel valve per applicable field manual.
	3. Hydraulic supply pressure, 1800 to 2200 psig	3.1 CONTINUE through CDDT - <u>DO NOT GIMBAL</u>
	4. Hydraulic supply pressure, 2200 to 3000 psig	4.1 CONTINUE through CDDT - <u>DO NOT GIMBAL</u>
		4.1.1 Inspect for external hydraulic leakage and fuel overboard drain line leakage; see pages covering these problems for disposition.

(Continued on next page)

GUIDELINES FOR WET CDDT

Pending Operation

○ Inert Ordnance Inst. ○ Prefill Topoff ○ Admit LOX ● Start Auto. Sequence ○ Drain LOX ○ Drain Manifold

Engine Status

○ Fuel Admitted ○ Inert Ordnance Installed ○ Prefill Overflowed ● LOX Admitted
● Auto. Sequence ○ LOX Drained ○ Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
Hydraulic supply pressure of 1400 to 1800 psig (1510- to 1870-psia) umbilical pressure with LOX in engine.	5. Hydraulic supply pressure greater than 3000 psig	5.1 BACKOUT - Turn on LOX system purge. Reduce hydraulic pressure to value between 400 and 3000 psig. If pressure is above 3600 psig, turn hydraulic pressure off. 5.1.1 With hydraulic pressure applied, inspect for external hydraulic leakage and fuel overboard drain line leakage; see pages covering these problems for disposition. 5.1.2 Perform action applicable to reduced hydraulic pressure per the preceding applicable paragraph. 5.1.3 Evaluate possible requirement to replace components post CDDT.

GUIDELINES FOR WET CDDT

Pending Operation

○ Inert Ordnance Inst. ○ Prefill Topoff ○ Admit LOX ○ Start Auto. Sequence ● Drain LOX ○ Drain Manifold

Engine Status

○ Fuel Admitted ○ Inert Ordnance Installed ○ Prefill Overflowed ○ LOX Admitted
○ Auto. Sequence ○ LOX Drained ○ Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
Hydraulic supply pressure of 1400 to 1800 psig (1510- to 1870-psia umbilical pressure) with LOX in engine.	1. Hydraulic supply pressure 400 to 1400 psig	1.1 PROCEED
	2. Hydraulic supply pressure less than 400 psig, or loss of hydraulic pressure	2.1 HOLD - Turn on the environmental and LOX system purges and leave the purges on until oxidizer is removed from the engine or hydraulic pressure is restored, then PROCEED.
		2.1.1 Post CDDT, inspect the gas generator combustor drain for evidence of leakage. If evidence of leakage is detected and the LOX system purge was not on, conduct gas generator LOX system flush post CDDT.
		2.1.2 Post CDDT, with hydraulic supply pressure applied, drain the thrust chamber fuel manifold prefill into a suitable container and inspect for presence of fuel.
		2.1.2.1 If more than 13 ounces of fuel is detected, post CDDT, conduct main fuel valve leak test with hydraulic pressure applied, and perform thrust jacket flush. Perform thrust chamber LOX dome flush if LOX dome contamination is suspected.

(Continued on next page)

GUIDELINES FOR WET CDDT

Pending Operation

○ Inert Ordnance Inst. ○ Prefill Topoff ○ Admit LOX ○ Start Auto. Sequence ● Drain LOX ○ Drain Manifold

Engine Status

○ Fuel Admitted ○ Inert Ordnance Installed ○ Prefill Overflowed ○ LOX Admitted
○ Auto. Sequence ○ LOX Drained ○ Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition	
Hydraulic supply pressure of 1400 to 1800 psig (1510- to 1870-psia umbilical pressure) with LOX in engine.	2. Hydraulic supply pressure less than 400 psig, or loss of hydraulic pressure	2.1.3	If hydraulic pressure is not restored in 20 minutes, inspect for leakage from the fuel overboard drain line, and for external hydraulic system leakage with hydraulic pressure applied post CDDT. See pages covering these problems for disposition.
		2.1.3.1	Remove plugs from Port "G" on each main LOX valve and inspect (Swab check) for evidence of fuel if hydraulic pressure is not restored in 20 minutes. If fuel is detected, replace the main LOX valve per applicable field manual.
	3. Hydraulic supply pressure, 1800 to 2200 psig	3.1	CONTINUE through CDDT - DO NOT GIMBAL
	4. Hydraulic supply pressure, 2200 to 3000 psig	4.1	CONTINUE through CDDT - DO NOT GIMBAL
		4.1.1	Inspect for external hydraulic leakage and fuel overboard drain line leakage; see pages covering these problems for disposition.
	5. Hydraulic supply pressure greater than 3000 psig	5.1	HOLD - Turn on LOX system purge. Reduce hydraulic pressure to value between 400 and 3000 psig. If pressure is above 3600 psig, turn hydraulic pressure off, then PROCEED.

(Continued on next page)

GUIDELINES FOR WET CDDT

Pending Operation

○ Inert Ordnance Inst. ○ Prefill Topoff ○ Admit LOX ○ Start Auto. Sequence ● Drain LOX ○ Drain Manifold

Engine Status

○ Fuel Admitted ○ Inert Ordnance Installed ○ Prefill Overflowed ○ LOX Admitted

○ Auto. Sequence ○ LOX Drained ○ Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
Hydraulic supply pressure of 1400 to 1800 psig (1510- to 1870-psia umbilical pressure) with LOX in engine.	5. Hydraulic supply pressure greater than 3000 psig	5.1.1 With hydraulic pressure applied post CDDT, inspect for external hydraulic leakage and fuel overboard drain line leakage; see pages covering these problems for disposition. 5.1.2 Perform action applicable to reduced hydraulic pressure per the preceding applicable paragraphs post CDDT. 5.1.3 Evaluate possible requirement to replace components post CDDT.

GUIDELINES FOR WET CDDT

Pending Operation

○ Inert Ordnance Inst. ○ Prefill Topoff ● Admit LOX ○ Start Auto. Sequence ○ Drain LOX ○ Drain Manifold

Engine Status

○ Fuel Admitted ○ Inert Ordnance Installed ○ Prefill Overflowed ○ LOX Admitted

○ Auto. Sequence ○ LOX Drained ○ Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
Hydraulic fluid temperature of 60 to 130 F required with LOX in engine.	1. Hydraulic fluid temperature, 130 to 200 F	1. PROCEED
	2. Hydraulic fluid temperature, 40 to 60 F	2.1 HOLD - Check engine hydraulic supply pressure. 2.1.1 If hydraulic temperature is 50 to 60 F, raise hydraulic pressure to 1800 psig and PROCEED. 2.1.2 If hydraulic temperature is 40 to 50 F, raise hydraulic pressure to 2200 psig and CONTINUE through CDDT, - <u>DO NOT GIMBAL</u>
	3. Hydraulic fluid temperature less than 40 F	3.1 HOLD - Investigate and correct problem. 3.1.1 Obtain a hydraulic temperature in excess of 40 F and raise hydraulic pressure to attain a temperature-pressure relationship in accordance with 2.1.1 or 2.1.2. 3.1.1.1 Inspect the fuel overboard drain line for leakage; see page covering this condition for disposition. 3.1.2 If problem cannot be corrected, BACKOUT.

(Continued on next page)

GUIDELINES FOR WET CDDT

Pending Operation

○ Inert Ordnance Inst. ○ Prefill Topoff ● Admit LOX ○ Start Auto. Sequence ○ Drain LOX ○ Drain Manifold

Engine Status

○ Fuel Admitted ○ Inert Ordnance Installed ○ Prefill Overflowed ○ LOX Admitted ○ Auto. Sequence ○ LOX Drained ○ Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
Hydraulic fluid temperature of 60 to 130 F required with LOX in engine.	3. Hydraulic fluid temperature less than 40 F	3.1.2.1 When hydraulic temperature is restored, inspect for external hydraulic system leakage and overboard fuel drain line leakage; see pages covering these conditions for disposition.
	4. Hydraulic fluid temperature greater than 200 F	4.1 HOLD - Reduce hydraulic pressure to the minimum value at which the hydraulic unit will satisfactorily operate, but not less than 400 psig.
		4.1.1 If hydraulic pressure reduction is not effective in reducing hydraulic temperature, BACKOUT. Turn on LOX system purge and turn off hydraulic pressure.
		4.1.1.1 With hydraulic supply pressure reapplied post CDDT, inspect for fuel in thrust chamber fuel manifold prefill.
		4.1.1.2 If more than 13 ounces of fuel is detected, perform thrust chamber jacket flush. Perform a LOX dome flush if LOX dome contamination is suspected.
		4.1.1.3 Post CDDT, inspect the combustor drain for evidence of fuel leakage. If evidence of leakage is detected and the LOX system purge was not on, flush gas generator LOX injector.

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GUIDELINES FOR WET CDDT

Pending Operation

○ Inert Ordnance Inst. ○ Prefill Topoff ● Admit LOX ○ Start Auto. Sequence ○ Drain LOX ○ Drain Manifold

Engine Status

○ Fuel Admitted ○ Inert Ordnance Installed ○ Prefill Overflowed ○ LOX Admitted
○ Auto. Sequence ○ LOX Drained ○ Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
Hydraulic fluid temperature of 60 to 130 F required with LOX in engine.	4. Hydraulic fluid temperature greater than 200 F	4.1.2 Inspect for leakage from fuel overboard drain line after correcting problem; see page covering this condition for disposition.

GUIDELINES FOR WET CDDT

Pending Operation

○ Inert Ordnance Inst. ○ Prefill Topoff ○ Admit LOX ● Start Auto. Sequence ● Drain LOX ○ Drain Manifold

Engine Status

○ Fuel Admitted ○ Inert Ordnance Installed ○ Prefill Overflowed ● LOX Admitted

● Auto. Sequence ○ LOX Drained ○ Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
Hydraulic fluid temperature of 60 to 130 F required with LOX in engine.	1. Hydraulic fluid temperature, 130 to 200 F	1.1 PROCEED
	2. Hydraulic fluid temperature, 40 to 60 F	2.1 HOLD - Check engine hydraulic supply pressure.
		2.1.1 If hydraulic temperature is 50 to 60 F, raise hydraulic pressure to 1800 psig and PROCEED.
		2.1.2 If hydraulic temperature is 40 to 50 F, raise hydraulic pressure to 2200 psig and CONTINUE through CDDT, - DO NOT GIMBAL.
	3. Hydraulic Fluid temperature less than 40 F	3.1 HOLD - Investigate and correct problem.
		3.1.1 Obtain a hydraulic temperature in excess of 40 F, and raise hydraulic pressure to attain a temperature-pressure relationship in accordance with 2.1.1 or 2.1.2.
		3.1.1.1 Inspect the fuel overboard drain line for leakage; see page covering this condition for disposition.
		3.1.2. If problem cannot be corrected, BACKOUT - remove LOX from engine.

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GUIDELINES FOR WET CDDT

Pending Operation

○ Inert Ordnance Inst. ○ Prefill Topoff ○ Admit LOX ● Start Auto. Sequence ● Drain LOX ○ Drain Manifold

Engine Status

○ Fuel Admitted ○ Inert Ordnance Installed ○ Prefill Overflowed ● LOX Admitted

● Auto. Sequence ○ LOX Drained ○ Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition	
Hydraulic fluid temperature of 60 to 130 F required with LOX in engine.	3. Hydraulic fluid temperature less than 40 F	3.1.2.1	When hydraulic temperature is restored, inspect for external hydraulic system leakage and overboard fuel drain line leakage. Post CDDT, inspect gas generator combustor drain line for evidence of gas generator seal leakage; see page covering these conditions for disposition.
	4. Hydraulic fluid temperature greater than 200 F	4.1	HOLD - Reduce hydraulic pressure to the minimum value at which the hydraulic unit will satisfactorily operate, but not less than 400 psig.
		4.1.1	If hydraulic pressure reduction is not effective in reducing hydraulic temperature, BACKOUT - remove LOX from engine. Turn on LOX system purge, consider cycling hydraulic pressure on and off in 2-minute intervals until LOX is removed from the engine, then remove hydraulic pressure.
		4.1.1.1	With hydraulic supply pressure applied, inspect for fuel in thrust chamber fuel manifold prefill.
		4.1.1.2	If more than 13 ounces of fuel is detected, perform thrust chamber jacket flush. Perform a LOX dome flush if LOX dome contamination is suspected.

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GUIDELINES FOR WET CDDT

Pending Operation

○ Inert Ordnance Inst. ○ Prefill Topoff ○ Admit LOX ● Start Auto. Sequence ● Drain LOX ○ Drain Manifold

Engine Status

○ Fuel Admitted ○ Inert Ordnance Installed ○ Prefill Overflowed ● LOX Admitted
● Auto. Sequence ○ LOX Drained ○ Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
Hydraulic fluid temperature of 60 to 130 F required with LOX in engine.	4. Hydraulic fluid temperature greater than 200F	4.1.1.3 Post CDDT, inspect the combustor drain for evidence of fuel leakage. If evidence of leakage is detected and the LOX system purge was not on, flush gas generator LOX injector. 4.1.2 Inspect for leakage from fuel overboard drain line after correcting problem; see page covering this condition for disposition.

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GUIDELINES FOR WET CDDT

Pending Operation

○ Inert Ordnance Inst. ○ Prefill Topoff ○ Admit LOX ○ Start Auto. Sequence ○ Drain LOX ○ Drain Manifold

Engine Status

○ Fuel Admitted ○ Inert Ordnance Installed ○ Prefill Overflowed ○ LOX Admitted

● Auto. Sequence ○ LOX Drained ○ Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
Fuel pump inlet pressure shall be within the range of 43.3 to 110 psiat from tank pressurization to T-19 seconds (monitored as fuel tank ullage pressure)	1. Fuel pump inlet pressure less than 43.3 psiat	1.1 CONTINUE THROUGH AUTOMATIC SEQUENCE, verify fuel prevalves are open, then PROCEED with securing. 1.2 Post CDDT, verify value of fuel tank ullage pressure during AUTOMATIC SEQUENCE (minimum ullage pressure redline is 27.0 psia) and verify fuel prevalves were open. Check out instrumentation system to define reading error. 1.3 Verify gross fuel system leakage does not exist. NOTE: An ullage pressure redline (27.0 psia) in conjunction with a flight mass load redline (99.8 percent) will yield a fuel pump inlet pressure of 43.3 psiat. Fuel pump inlet pressure is not a redline, and is not real-time monitored during the AUTOMATIC SEQUENCE.
	2. Fuel pump inlet pressure greater than 110 psiat	2.1 PROCEED 2.2 Post CDDT, verify value of fuel tank ullage pressure during AUTOMATIC SEQUENCE (maximum ullage pressure redline in 30.2 psia) and verify fuel prevalves were open. Check out instrunentation to define reading error.

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GUIDELINES FOR WET CDDT

Pending Operation

○ Inert Ordnance Inst. ○ Prefill Topoff ○ Admit LOX ○ Start Auto. Sequence ○ Drain LOX ○ Drain Manifold

Engine Status

○ Fuel Admitted ○ Inert Ordnance Installed ○ Prefill Overflowed ○ LOX Admitted

● Auto. Sequence ○ LOX Drained ○ Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
Fuel pump inlet pressure shall be within the range of 43.3 to 110 psiat from tank pressurization to T-19 seconds (monitored as fuel tank ullage pressure)	2. Fuel pump inlet pressure greater than 110 psiat	NOTE: An ullage pressure redline of 30.2 psia maximum is equivalent to approximately 48-psiat fuel pump inlet pressure. The fuel tank vent and relief valve is actuated at approximately 31.5 psia, either mechanically by the pressure or automatically by the high fuel tank pressure switch. Fuel pump inlet pressure is not a redline and is not real-time monitored during the AUTOMATIC SEQUENCE.

GUIDELINES FOR WET CDDT

Pending Operation

○ Inert Ordnance Inst. ○ Prefill Topoff ○ Admit LOX ○ Start Auto. Sequence ○ Drain LOX ○ Drain Manifold

Engine Status

● Fuel Admitted ● Inert Ordnance Installed ● Prefill Overflowed ● LOX Admitted

● Auto. Sequence ● LOX Drained ● Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
Fuel bulk temperature shall be within the range of 35 to 100 F during engine operation	1. Fuel bulk temperature is greater than 100 F	1.1 PROCEED 1.2 Subsequent to completion of CDDT, verify instrumentation systems
	2. Fuel bulk temperature is less than 35 F	2.1 PROCEED 2.2 Subsequent to completion of CDDT, verify instrumentation system 2.3 If temperature was less than 0 F; inspect engine for external fuel and fuel overboard drain line leakage, post CDDT.

GUIDELINES FOR WET CDDT

Pending Operation

○ Inert Ordnance Inst. ○ Prefill Topoff ○ Admit LOX ○ Start Auto. Sequence ○ Drain LOX ○ Drain Manifold

Engine Status

● Fuel Admitted ● Inert Ordnance Installed ● Prefill Overflowed ● LOX Admitted

● Auto. Sequence ● LOX Drained ● Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
RP-1 fuel specific gravity shall be in the range of 0.801 to 0.815 per MIL-R-25576.	1. RP-1 specific gravity less than 0.801 or greater than 0.815	1.1 CONTINUE through CDDT 1.2 Out-of-tolerance values of RP-1 specific gravity are indicative of a measurement error or contamination of the fuel with another fluid. 1.3 Obtain additional RP-1 samples and conduct laboratory analyses to determine correct specific gravity values. 1.4 If specific gravity is verified to be outside of MIL specification values, BACKOUT. 1.5 Determine the identity of the contaminates responsible for the discrepant specific gravity value. The determination of fuel acceptability is dependent upon the type of contaminant, its effect on engine performance, and the performance effect on flight trajectory. NOTES: 1. RP-1 low specific gravity results in high engine performance, while high specific gravity results in low engine performance. The performance effect is +1.8K-lb thrust for each engine per -0.001 units of specific gravity.

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GUIDELINES FOR WET CDDT

Pending Operation

○ Inert Ordnance Inst. ○ Prefill Topoff ○ Admit LOX ○ Start Auto. Sequence ○ Drain LOX ○ Drain Manifold

Engine Status

● Fuel Admitted ● Inert Ordnance Installed ● Prefill Overflowed ● LOX Admitted

● Auto. Sequence ● LOX Drained ● Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
RP-1 fuel specific gravity shall be in the range of 0.801 to 0.815 per MIL-R-25576.	1. RP-1 specific gravity less than 0.801 or greater than 0.815	NOTES: 2. The effect of engine performance level change due to specific gravity upon Saturn V flight trajectory must be assessed by NASA.

GUIDELINES FOR WET CDDT

Pending Operation

○ Inert Ordnance Inst. ○ Prefill Topoff ○ Admit LOX ○ Start Auto. Sequence ○ Drain LOX ○ Drain Manifold

Engine Status

● Fuel Admitted ● Inert Ordnance Installed ● Prefill Overflowed ● LOX Admitted

● Auto. Sequence ● LOX Drained ● Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
RP-1 fuel shall not contain excessive quantities of RJ-1 fuel.	1. RP-1 fuel is contaminated with RJ-1 fuel.	1.1 PROCEED 2.1 Subsequent to CDDT completion, determine the amount of RJ-1 mixed with the RP-1. The effect of RJ-1 mixed with RP-1 is to increase the fuel specific gravity, which will decrease engine thrust. 100 percent RJ-1 lowers engine thrust 4 percent, thrust OK pressure switches will pick up; however, the effect of low liftoff thrust and low flight thrust on Saturn V flight trajectory must be assessed by NASA. A fuel volume of approximately 475 gallons per engine will be consumed prior to launch liftoff; however, RJ-1 volumes greater than approximately 170 gallons in the inboard and 198 gallons in the outboard engine fuel suction lines will result in mixing in the fuel tank.

GUIDELINES FOR WET CDDT

Pending Operation

○ Inert Ordnance Inst. ○ Prefill Topoff ○ Admit LOX ○ Start Auto. Sequence ○ Drain LOX ○ Drain Manifold

Engine Status

● Fuel Admitted ● Inert Ordnance Installed ● Prefill Overflowed ● LOX Admitted

● Auto. Sequence ● LOX Drained ● Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
Leakage from fuel overboard drain line shall not exceed that volumetric flowrate recorded during hydraulic system leak and functional test.	1. Fuel leakage from fuel overboard drain line exceeds the volumetric flowrate recorded during hydraulic system leak and functional test.	1.1 CONTINUE through CDDT - Attempt to define leakage rate and type of fuel. Post CDDT, investigate the source of leakage by use of an isolation procedure.
	2. Prefill leakage from fuel overboard drain line	2.1 CONTINUE through CDDT - Replace hypergol manifold assembly post CDDT.

GUIDELINES FOR WET CDDT

Pending Operation

○ Inert Ordnance Inst. ○ Prefill Topoff ○ Admit LOX ○ Start Auto. Sequence ○ Drain LOX ○ Drain Manifold

Engine Status

● Fuel Admitted ● Inert Ordnance Installed ● Prefill Overflowed ● LOX Admitted

● Auto. Sequence ● LOX Drained ● Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
Zero liquid leakage from turbopump lube seal drain line	1. Liquid leakage from drain line	1.1 BACKOUT - Remove propellants from engine. Take investigative action to determine leakage source. Engine replacement may be required.

GUIDELINES FOR WET CDDT

Pending Operation

○ Inert Ordnance Inst. ○ Prefill Topoff ○ Admit LOX ○ Start Auto. Sequence ○ Drain LOX ○ Drain Manifold

Engine Status

● Fuel Admitted ● Inert Ordnance Installed ● Prefill Overflowed ○ LOX Admitted

○ Auto. Sequence ○ LOX Drained ○ Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
No external fuel leakage allowed	1. External fuel leakage is noted from engine seal (propellant feed system or hydraulic system).	1.1 CONTINUE to LOX tanking - Isolate leakage source and determine if leakage is greater than surface wetting. 1.1.1 If the leak is from the engine hydraulic control system, turn on LOX dome-gas generator LOX injector purge and turn off hydraulic pressure to the engine. 1.1.2 Torque joint to maximum allowed value and verify that fuel leakage stops or is reduced to surface wetting. 1.1.3 BACKOUT - If fuel leakage exceeds a surface wetting condition at maximum joint torque, remove fuel from engine. Replace discrepant seal per applicable field manual. 1.2 If leak is from engine fuel system joint, torque joint to maximum allowed value and verify that fuel leakage stops. 1.2.1 BACKOUT - If fuel leakage continues at maximum joint torque, remove fuel from engine. Replace discrepant seal per applicable field manual.

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GUIDELINES FOR WET CDDT

Pending Operation

○ Inert Ordnance Inst. ○ Prefill Topoff ○ Admit LOX ○ Start Auto. Sequence ○ Drain LOX ○ Drain Manifold

Engine Status

● Fuel Admitted ● Inert Ordnance Installed ● Prefill Overflowed ○ LOX Admitted

○ Auto. Sequence ○ LOX Drained ○ Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
No external fuel leakage allowed	1. External fuel leakage is noted from engine seal (propellant feed system or hydraulic system).	1.3 Remove residual fuel from engine external surfaces and replace any fuel-wetted thermal insulation panels per applicable field manual.

GUIDELINES FOR WET CDDT

Pending Operation

○ Inert Ordnance Inst. ○ Prefill Topoff ● Admit LOX ○ Start Auto. Sequence ○ Drain LOX ○ Drain Manifold

Engine Status

○ Fuel Admitted ○ Inert Ordnance Installed ○ Prefill Overflowed ○ LOX Admitted
○ Auto. Sequence ○ LOX Drained ○ Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
No external fuel leakage allowed	1. External fuel leakage is noted from engine seal (propellant feed system or hydraulic system).	1.1 HOLD - Isolate leakage source and take actions to prevent external contamination of engine and thermal insulation. 1.1.1 If the leak is from the engine hydraulic control system, turn on LOX dome-gas generator LOX injector purge and turn off hydraulic pressure to the engine. 1.1.2 Torque joint to maximum allowed value and verify that fuel leakage stops or is reduced to surface wetting. 1.1.3 BACKOUT - If fuel leakage exceeds a surface wetting condition at maximum joint torque, remove fuel from engine. Replace discrepant seal per applicable field manual. 1.2 If leak is from engine fuel system joint, torque joint to maximum allowed value and verify that fuel leakage stops. 1.2.1 BACKOUT - If fuel leakage continues at maximum joint torque, remove fuel from engine. Replace discrepant seal per applicable field manual. 1.3 Remove residual fuel from engine external surface and replace any fuel-wetted thermal insulation panels per applicable field manual.

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GUIDELINES FOR WET CDDT

Pending Operation

○ Inert Ordnance Inst. ○ Prefill Topoff ○ Admit LOX ● Start Auto. Sequence ● Drain LOX ○ Drain Manifold

Engine Status

○ Fuel Admitted ○ Inert Ordnance Installed ○ Prefill Overflowed ● LOX Admitted
● Auto. Sequence ○ LOX Drained ○ Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
No external fuel leakage allowed	1. External fuel leakage noted from engine.	1.1 BACKOUT - Remove LOX from engine and isolate leakage source. Take actions to prevent external contamination of engine and thermal insulation. 1.1.1 If the leak is from the engine hydraulic control system, turn on LOX dome-gas generator LOX injector purge and turn off hydraulic pressure to the engine. 1.1.2 Torque joint to maximum allowed value and verify that fuel leakage stops or is reduced to surface wetting. 1.1.3 BACKOUT - If fuel leakage exceeds a surface wetting condition at maximum joint torque, remove fuel from engine and replace discrepant seal per applicable field manual. 1.2 If leak is from engine fuel system joint, torque joint to maximum allowed value and verify that fuel leakage stops. 1.2.1 BACKOUT - If fuel leakage continues at maximum joint torque, remove fuel from engine. Replace discrepant seal per applicable field manual. 1.3 Remove residual fuel from engine external surfaces and replace any fuel-wetted thermal insulation panels per applicable field manual.

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GUIDELINES FOR WET CDDT

Pending Operation

○ Inert Ordnance Inst. ○ Prefill Topoff ○ Admit LOX ○ Start Auto. Sequence ○ Drain LOX ○ Drain Manifold

Engine Status

○ Fuel Admitted ○ Inert Ordnance Installed ○ Prefill Overflowed ○ LOX Admitted

○ Auto. Sequence ● LOX Drained ● Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition	
No external fuel leakage allowed	1. External fuel leakage is noted from engine seal (propellant feed system or hydraulic system).	1.1	Isolate leakage source and take actions to prevent external contamination of engine and thermal insulation.
		1.1.1	If the leak is from the engine hydraulic control system, turn on LOX dome-gas generator LOX injector purge and turn off hydraulic pressure to the engine.
		1.1.2	Torque joint to maximum allowed value and verify that fuel leakage stops or is reduced to surface wetting.
		1.1.3	If fuel leakage exceeds a surface wetting condition at maximum joint torque, remove fuel from engine. Replace discrepant seal per applicable field manual.
		1.2	If leak is from engine fuel system joint, torque joint to maximum allowed value and verify that fuel leakage stops.
		1.2.1	If fuel leakage continues at maximum joint torque, remove fuel from engine. Replace discrepant seal per applicable field manual.
		1.3	Remove residual fuel from engine external surfaces and replace any fuel-wetted thermal insulation panels per applicable field manual.

GUIDELINES FOR WET CDDT

Pending Operation

○ Inert Ordnance Inst. ● Prefill Topoff ○ Admit LOX ○ Start Auto. Sequence ○ Drain LOX ○ Drain Manifold

Engine Status

● Fuel Admitted ● Inert Ordnance Installed ○ Prefill Overflowed ○ LOX Admitted
○ Auto. Sequence ○ LOX Drained ● Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
Main fuel valve leakage without hydraulic pressure applied shall not exceed 500 cc/min. from each valve.	1. Fuel leakage noted from thrust chamber fuel inlet manifold drain hoses in excess of 500 cc/min. per fuel valve.	1.1 HOLD - Turn on LOX system purge. 1.1.1 Apply 1400 to 1800 psig (1510- to 1870-psia umbilical pressure) hydraulic pressure. 1.1.1.1 Proceed through CDDT with LOX system purge on, hydraulic pressure applied to the engine, and drain hoses installed on the fuel inlet manifold drain quick disconnects. 1.1.1.1.1 Post CDDT, replace discrepant main fuel valve per applicable field manual. 1.1.1.1.2 Perform valve timing tests with low LOX dome-gas generator LOX injector purge on. 1.1.1.1.3 Perform a thrust chamber fuel jacket flush. Perform LOX dome flush if fuel leakage overflows from the thrust chamber injector and the low LOX dome-gas generator LOX injector purge was not on. 1.1.1.1.4 Perform main fuel valve leak test with and without hydraulic pressure applied to the replacement main fuel valve.

GUIDELINES FOR WET CDDT

Pending Operation

○ Inert Ordnance Inst. ○ Prefill Topoff ● Admit LOX ○ Start Auto. Sequence ○ Drain LOX ○ Drain Manifold

Engine Status

● Fuel Admitted ● Inert Ordnance Installed ● Prefill Overflowed ○ LOX Admitted
○ Auto. Sequence ● LOX Drained ● Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
No main fuel valve leakage allowed with hydraulic pressure applied to engine	1. Fuel leakage noted from thrust chamber fuel inlet manifold drain hoses	1.1 HOLD - Turn on LOX system purge. PROCEED through CDDT with LOX system purge on, hydraulic pressure applied to the engine, and drain hoses installed on the fuel inlet manifold drain quick disconnects.
		1.1.1 Post CDDT, replace discrepant main fuel valve per applicable field manual.
		1.1.2 Perform valve timing tests with low LOX dome-gas generator LOX injector purge on.
		1.1.3 Perform a thrust chamber fuel jacket flush if fuel leakage rate exceeds 1000 cc/min. from valve. Perform LOX dome flush if fuel leakage overflows from the thrust chamber injector and the low LOX dome-gas generator LOX injector purge was not on.
		1.1.4 Perform main fuel valve leak test with and without hydraulic pressure applied to the replacement main fuel valve.
	2. Fuel leakage noted from thrust chamber exit	2.1 HOLD - Turn on LOX system purge.
		2.1.1 Attach drain hoses to thrust chamber fuel inlet manifold drain quick disconnects and allow prefill fluid to drain.

(Continued on next page)

GUIDELINES FOR WET CDDT

Pending Operation

○ Inert Ordnance Inst. ○ Prefill Topoff ● Admit LOX ○ Start Auto. Sequence ○ Drain LOX ○ Drain Manifold

Engine Status

● Fuel Admitted ● Inert Ordnance Installed ○ Prefill Overflowed ○ LOX Admitted

○ Auto. Sequence ● LOX Drained ● Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
No main fuel valve leakage allowed with hydraulic pressure applied to engine	2. Fuel leakage noted from thrust chamber exit	2.1.1.1 PROCEED through CDDT with LOX system purge on and drain hoses installed on the fuel inlet manifold drain quick disconnects. 2.1.1.2 Post CDDT, replace discrepant main fuel valve per applicable field manual. 2.1.1.3 Perform valve timing tests with low LOX dome-gas generator LOX injector purge on. 2.1.1.4 Perform a thrust chamber fuel jacket flush. Perform LOX dome flush if fuel leakage occurred without the low LOX dome-gas generator LOX injector purge on. 2.1.1.5 Perform main fuel valve leak test with and without hydraulic pressure applied to the replacement main fuel valve

GUIDELINES FOR WET CDDT

Pending Operation

○ Inert Ordnance Inst. ○ Prefill Topoff ● Admit LOX ○ Start Auto. Sequence ○ Drain LOX ○ Drain Manifold

Engine Status

○ Fuel Admitted ○ Inert Ordnance Installed ○ Prefill Overflowed ○ LOX Admitted
○ Auto. Sequence ○ LOX Drained ○ Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
No fuel leakage allowed from thrust chamber exit (main fuel valves or gas generator valve)	1. Fuel leakage noted from thrust chamber exit	1.1 HOLD - Turn on LOX system servicing purge. Investigate and determine if the leakage is from the gas generator valve or the main fuel valves.
		1.1.1 If the gas generator valve is NOT leaking and the main fuel valve IS LEAKING, drain the thrust chamber fuel inlet manifold. PROCEED through CDDT with LOX system purge on and drain hoses installed on the fuel inlet manifold quick disconnects.
		1.1.1.1 Post CDDT, replace discrepant main fuel valve per applicable field manual.
		1.1.1.1.1 Perform valve timing tests with LOX dome-gas generator LOX injector purge on.
		1.1.1.1.2 Perform main fuel valve leak test with and without hydraulic pressure applied.
		1.1.1.1.3 Perform thrust chamber fuel jacket flush. Perform LOX dome flush if LOX dome contamination is suspected.
		1.1.2 If the gas generator valve IS LEAKING, BACKOUT. Remove prefill and propellant from engine.

(Continued on next page)

GUIDELINES FOR WET CDDT

Pending Operation

○ Inert Ordnance Inst. ○ Prefill Topoff ● Admit LOX ○ Start Auto. Sequence ○ Drain LOX ○ Drain Manifold

Engine Status

○ Fuel Admitted ○ Inert Ordnance Installed ○ Prefill Overflowed ○ LOX Admitted

○ Auto. Sequence ○ LOX Drained ○ Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
No fuel leakage allowed from thrust chamber exit (main fuel valves or gas generator valve)	1. Fuel leakage noted from thrust chamber exit	1.1.2.1 Replace discrepant gas generator valve per applicable field manual. 1.1.2.2 Perform engine valve timing test with low LOX dome-gas generator LOX injector purge on. 1.1.2.3 Perform gas generator LOX injector flush. 1.1.3 Replace any fuel-wetted thermal insulation panel per applicable field manual.

GUIDELINES FOR WET CDDT

Pending Operation

○ Inert Ordnance Inst. ○ Prefill Topoff ○ Admit LOX ● Start Auto. Sequence ● Drain LOX ○ Drain Manifold

Engine Status

○ Fuel Admitted ○ Inert Ordnance Installed ○ Prefill Overflowed ● LOX Admitted

● Auto. Sequence ○ LOX Drained ○ Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition	
No fuel leakage allowed from thrust chamber exit (main fuel valves or gas generator valve)	1. Fuel leakage noted from thrust chamber exit	1.1	BACKOUT - Turn on LOX system servicing purge. Remove LOX from engine. Investigate and determine if the leakage is from the gas generator valve or the main fuel valves.
		1.1.1	If the gas generator valve is NOT leaking and the main fuel valve IS LEAKING, drain the thrust chamber fuel inlet manifold. PROCEED through CDDT with LOX system purge on and drain hoses installed on the fuel inlet manifold quick disconnects.
		1.1.1.1	Post CDDT, replace discrepant main fuel valve per applicable field manual.
		1.1.1.1.1	Perform valve timing tests with low LOX dome-gas generator LOX injector purge on.
		1.1.1.1.2	Perform main fuel valve leak test with and without hydraulic pressure applied.
		1.1.1.1.3	Perform thrust chamber fuel jacket flush. Perform LOX dome flush if LOX dome contamination is suspected.

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GUIDELINES FOR WET CDDT

Pending Operation
○ Inert Ordnance Inst. ○ Prefill Topoff ○ Admit LOX ● Start Auto. Sequence ● Drain LOX ○ Drain Manifold
Engine Status
○ Fuel Admitted ○ Inert Ordnance Installed ○ Prefill Overflowed ● LOX Admitted ● Auto. Sequence ○ LOX Drained ○ Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
No fuel leakage allowed from thrust chamber exit (main fuel valves or gas generator valve)	1. Fuel leakage noted from thrust chamber exit	1.1.2 If the gas generator valve IS LEAKING, BACKOUT. Remove prefill and propellant from engine. 1.1.2.1 Replace discrepant gas generator valve per applicable field manual. 1.1.2.2 Perform engine valve timing test with low LOX dome-gas generator LOX injector purge on. 1.1.2.3 Perform gas generator LOX injector flush. 1.1.3 Replace any fuel-wetted thermal insulation panels per applicable field manual.

GUIDELINES FOR WET CDDT

Pending Operation
○ Inert Ordnance Inst. ○ Prefill Topoff ● Admit LOX ○ Start Auto. Sequence ○ Drain LOX ○ Drain Manifold
Engine Status
● Fuel Admitted ● Inert Ordnance Installed ● Prefill Overflowed ○ LOX Admitted ○ Auto. Sequence ● LOX Drained ● Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition	
No gas generator valve fuel leakage allowed	1. Fuel leakage noted from gas generator combustor drain port	1.1	HOLD - Turn ON LOX system purge.
		1.1.1	If hydraulic pressure is not applied to the engine, apply 1400 to 1800 psig (1510- to 1870-psia umbilical pressure) hydraulic pressure.
		1.1.1.1	If leakage stops with hydraulic pressure applied, PROCEED through CDDT with the hydraulic system pressurized. Hydraulic pressure will be required any time fuel is in the engine.
		1.1.1.1.1	Post CDDT, remove fuel from the gas generator combustor. Perform a gas generator LOX injector flush if gas generator valve leakage occurs without the LOX system purge on.
		1.1.1.2	If leakage continues with hydraulic pressure applied, BACKOUT. Remove prefill and propellant from engine.
		1.1.1.2.1	Replace discrepant gas generator valve per applicable field manual.

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GUIDELINES FOR WET CDDT

Pending Operation		
○ Inert Ordnance Inst. ○ Prefill Topoff ● Admit LOX ○ Start Auto. Sequence ○ Drain LOX ○ Drain Manifold		
Engine Status		
● Fuel Admitted ● Inert Ordnance Installed ● Prefill Overflowed ○ LOX Admitted ○ Auto. Sequence ● LOX Drained ● Manifold Primed		
Nominal Condition	**Nonconformance Condition**	**Recommended Disposition**
No gas generator valve fuel leakage allowed	1. Fuel leakage noted from gas generator combustor drain port	1.1.1.2.2 Perform engine valve timing test with low LOX dome-gas generator LOX injector purge on. 1.1.1.2.3 Perform gas generator LOX injector flush.

GUIDELINES FOR WET CDDT

Pending Operation

○ Inert Ordnance Inst. ○ Prefill Topoff ○ Admit LOX ○ Start Auto. Sequence ○ Drain LOX ○ Drain Manifold

Engine Status

○ Fuel Admitted ○ Inert Ordnance Installed ○ Prefill Overflowed ○ LOX Admitted

● Auto. Sequence ○ LOX Drained ○ Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
LOX pump inlet pressure shall be within the range of 78.3 to 165 psia from LOX tank pressurization complete to T-19 seconds (monitored as LOX tank ullage pressure).	1. LOX pump inlet pressure is below 78.3 psia, as indicated by an outboard LOX suction line pressure below 76.7 psia.	1.1 CONTINUE through AUTOMATIC SEQUENCE.
		1.2 Failure to meet indicated suction line pressures is indicative of gross LOX leakage, a closed LOX prevalve, or instrumentation out of tolerance.
		1.3 If gross LOX leakage is observed drain LOX as soon as possible.
		1.4 If LOX prevalves are open and there is no gross lOX leakage, PROCEED.
		1.5 Post CDDT, verify value for LOX tank ullage pressure during AUTOMATIC SEQUENCE (minimum ullage pressure redline is 23.7 psia) and check out LOX suction line pressure instrumentation system.
		<u>NOTE</u>: LOX suction line pressures are not redlines and are not real-time monitored during AUTOMATIC SEQUENCE. An ullage pressure minimum redline of 23.7 psia with a flight mass load redline of 99.8 percent are relied upon to provide sufficient LOX pump inlet pressure.

(Continued on next page)

GUIDELINES FOR WET CDDT

Pending Operation

○ Inert Ordnance Inst. ○ Prefill Topoff ○ Admit LOX ○ Start Auto. Sequence ○ Drain LOX ○ Drain Manifold

Engine Status

○ Fuel Admitted ○ Inert Ordnance Installed ○ Prefill Overflowed ○ LOX Admitted

● Auto. Sequence ○ LOX Drained ○ Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
LOX pump inlet pressure shall be within the range of 78.3 to 165 psia from LOX tank pressurization complete to T-19 seconds (monitored as LOX tank ullage pressure).	2. LOX pump inlet pressure is over 165 psia, as indicated by an outboard LOX suction line pressure exceeding 161.7 psia on the inboard LOX suction line pressure exceeding 163.4 psia	2.1 PROCEED 2.2 Exceeding maximum LOX pump inlet pressure is indicative of out-of-tolerance instrumentation. Post CDDT, verify value for LOX tank ullage pressure during AUTOMATIC SEQUENCE (maximum ullage pressure redline is 30.2 psia) and check out LOX suction line pressure instrumentation system. NOTE: LOX suction line pressures are not redlines and are not real-time monitored during AUTOMATIC SEQUENCE. An ullage pressure maximum redline of 30.2 psia with a maximum flight mass load of 100.2 percent provides a LOX pump inlet pressure of 85.6 psia.

GUIDELINES FOR WET CDDT

Pending Operation

○ Inert Ordnance Inst. ○ Prefill Topoff ○ Admit LOX ● Start Auto. Sequence ○ Drain LOX ○ Drain Manifold

Engine Status

○ Fuel Admitted ○ Inert Ordnance Installed ○ Prefill Overflowed ● LOX Admitted
○ Auto. Sequence ○ LOX Drained ○ Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
LOX pump inlet temperature shall be within the range of -275 to -297.5 from temperature stabilization after initiation of bubbling until initiation of AUTOMATIC SEQUENCE.	1. LOX pump inlet temperature in excess of -275 F, as indicated by LOX suction line temperature in excess of -275 F.	1.1 PROCEED 1.2 LOX temperature warmer than -275 F is not possible if the LOX recirculation (helium bubbling) system is operative. 1.3 Post CDDT, check LOX suction line temperature instrumentation system and bubbling system. <u>NOTE</u>: The normal helium bubbling system flows LOX from No. 2 duct to No. 1 duct, and LOX from ducts No. 5 and No. 4 to No. 3 duct.
	2. LOX pump inlet temperature less than -297.5 F, as indicated by LOX suction line temperature less than -297.5 F.	2.1 PROCEED 2.2 LOX temperature colder than -297.5 F is indicative of out-of-tolerance instrumentation systems. Post CDDT, check LOX suction line temperature instrumentation system.

GUIDELINES FOR WET CDDT

Pending Operation

○ Inert Ordnance Inst. ○ Prefill Topoff ● Admit LOX ○ Start Auto. Sequence ○ Drain LOX ○ Drain Manifold

Engine Status

○ Fuel Admitted ○ Inert Ordnance Installed ○ Prefill Overflowed ○ LOX Admitted

○ Auto. Sequence ○ LOX Drained ○ Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
LOX purity shall be equal to or exceed 99.5 percent oxygen per MIL-P-25508C. Oxidizer purity is normally determined prior to facility storage tank filling and prior to vehicle tanking.	1. Oxidizer purity is less than 99.5 percent by volume when gasified.	1.1 HOLD 1.2 Failure to meet oxygen purity is indicative of a purity determination error or contamination of the oxygen. 1.3 Obtain additional oxygen samples, and conduct laboratory analyses to determine correct purity of oxygen and identity of the contamination. 1.4 If purity is satisfactory, PROCEED. 1.5 If purity is below 99.5 percent as a result of an inert dilutant (nitrogen, argon), PROCEED. NOTES: 1. Engine performance is degraded by inert dilutants. Oxygen dilution of 1 percent (by weight) with nitrogen will lower thrust 35K, lower engine mixture ratio 0.0058 units, and lower engine specific impulse 2.0 seconds. 2. The final disposition of this oxygen must be determined by NASA.

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GUIDELINES FOR WET CDDT

Pending Operation

○ Inert Ordnance Inst. ○ Prefill Topoff ● Admit LOX ○ Start Auto. Sequence ○ Drain LOX ○ Drain Manifold

Engine Status

○ Fuel Admitted ○ Inert Ordnance Installed ○ Prefill Overflowed ○ LOX Admitted
○ Auto. Sequence ○ LOX Drained ○ Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
LOX purity shall be equal to or exceed 99.5 percent oxygen per MIL-P-25508C. Oxidizer purity is normally determined prior to facility storage tank filling and prior to vehicle tanking.	1. Oxidizer purity is less than 99.5 percent by volume when gasified.	1.6 If purity is below 99.5 percent with unsatisfactory hydrocarbon or particulate contamination, HOLD pending availability of satisfactory oxygen.

GUIDELINES FOR WET CDDT

Pending Operation

○ Inert Ordnance Inst. ○ Prefill Topoff ○ Admit LOX ○ Start Auto. Sequence ● Drain LOX ○ Drain Manifold

Engine Status

○ Fuel Admitted ○ Inert Ordnance Installed ○ Prefill Overflowed ● LOX Admitted

● Auto. Sequence ○ LOX Drained ○ Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
No LOX leakage allowed from primary LOX seal drain line.	1. Liquid leakage is emitting from the LOX seal drain line.	1.1 CONTINUE through CDDT. Minor leakage from the drain line is not uncommon during turbopump childown.

GUIDELINES FOR WET CDDT

Pending Operation

○ Inert Ordnance Inst. ○ Prefill Topoff ○ Admit LOX ○ Start Auto. Sequence ● Drain LOX ○ Drain Manifold

Engine Status

○ Fuel Admitted ○ Inert Ordnance Installed ○ Prefill Overflowed ● LOX Admitted

● Auto. Sequence ○ LOX Drained ○ Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
No external LOX leakage allowed	1. External LOX leakage noted from engine	1.1 BACKOUT - Turn on the environmental purge and leave on until LOX is removed from the engine. 1.1.1 Remove LOX from engine and isolate leakage source. 1.1.2 Torque joint to maximum allowed value and verify that leakage stops. 1.1.2.1 If leakage continues at maximum joint torque, replace discrepant seal per applicable field manual. 1.2 Evaluate possible requirement to replace or test components exposed to the external LOX leakage.

GUIDELINES FOR WET CDDT

Pending Operation

○ Inert Ordnance Inst. ○ Prefill Topoff ○ Admit LOX ○ Start Auto. Sequence ● Drain LOX ○ Drain Manifold

Engine Status

○ Fuel Admitted ○ Inert Ordnance Installed ○ Prefill Overflowed ● LOX Admitted

● Auto. Sequence ○ LOX Drained ○ Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
No LOX leakage allowed from thrust chamber exit (main LOX valves or gas generator ball valve)	1. LOX leakage is detected from the thrust chamber exit.	1.1 HOLD - If leakage continues, BACKOUT. Remove propellants, and prefill from engine. 1.1.1 Determine if leakage is past main LOX valve or gas generator ball valve. 1.1.1.1 Replace discrepant valve per applicable field manual. 1.1.1.2 Perform valve timing tests with low LOX system purge ON. 1.1.1.3 If gas generator ball valve is replaced, perform gas generator LOX injector flush per applicable field manual. If main LOX valve is replaced and LOX dome contamination is suspected, perform LOX dome flush.

GUIDELINES FOR WET CDDT

Pending Operation

○ Inert Ordnance Inst. ○ Prefill Topoff ○ Admit LOX ○ Start Auto. Sequence ○ Drain LOX ○ Drain Manifold

Engine Status

● Fuel Admitted ● Inert Ordnance Installed ● Prefill Overflowed ● LOX Admitted

○ Auto. Sequence ○ LOX Drained ○ Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
LOX dome-gas generator LOX injector purge must be on with a pressure range of 120 to 1000 psig during prefill admittance to the engine, during prefill tapoff of the injector, and during engine gimbaling with prefill in the thrust chamber. Nominal pressure is 220 psig. (Measurement monitored at Lut. System ΔP between measurement and engine interface is 80 psi when interface pressure is 120 psig.)	1. Purge below 60 psig or goes off during thrust chamber prefill, prefill topoff, or engine gimbaling.	1.1 HOLD - Turn purge off, then CONTINUE through WET CDDT. Perform LOX dome flush post CDDT.
	2. Purge pressure between 60 and 120 psig during thrust chamber prefill, prefill topoff, or engine gimbaling.	2.1 HOLD - Turn off prefill system or stop gimbaling, then turn off purge to preclude LOX purge check valve chatter. Correct problem, then PROCEED. 2.2 If problem cannot be corrected, CONTINUE through WET CDDT without purge, and perform a LOX dome flush post CDDT.
	3. Purge pressure above 1000 psig during thrust chamber prefill, prefill topoff, or engine gimbaling.	3.1 HOLD - Turn prefill system off or stop gimbaling, then turn purge off. Correct problem.

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GUIDELINES FOR WET CDDT

Pending Operation
○ Inert Ordnance Inst. ○ Prefill Topoff ○ Admit LOX ○ Start Auto. Sequence ○ Drain LOX ○ Drain Manifold
Engine Status
● Fuel Admitted ● Inert Ordnance Installed ● Prefill Overflowed ● LOX Admitted ○ Auto. Sequence ○ LOX Drained ○ Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
Low LOX dome-gas generator LOX injector purge must be on with a pressure range of 120 to 1000 psig during prefill admittance to the engine, during prefill topoff of the injector, and during engine gimbaling with prefill in the thrust chamber. (Measurement monitored at Lut. System ΔP between measurement and engine interface is 80 psi when interface pressure is 120 psig.)	4. Purge pressure above 1000 psig during thrust chamber prefill, prefill topoff, or engine gimbaling.	4.2 Readjust pressure within range. If purge system pressure exceeded 3600 psig, turn purge on and perform purge system leak test to verify wraparound line bellows integrity, then PROCEED. If problem cannot be corrected, CONTINUE through WET CDDT without purge, and perform a LOX dome flush post CDDT.
	5. Purge system pressure less than 120 psig or greater than 1000 psig prior to initiating engine gimbal or prefill operation.	5.1 HOLD - Turn off purge. Repair system prior to performing gimbal or prefill operations, and PROCEED. 5.2 If problem cannot be corrected, CONTINUE through CDDT without purge, and perform a LOX dome flush post CDDT.
	6. Engine gimbals after last prefill of thrust chamber with low LOX dome-gas generator LOX injector purge ON.	6.1 PROCEED
	7. Engine gimbals after last prefill of thrust chamber with low LOX dome-gas generator LOX injector purge OFF.	7.1 CONTINUE through WET CDDT. Perform LOX dome flush post CDDT.

Revised 6-30-71

GUIDELINES FOR WET CDDT

Pending Operation

○ Inert Ordnance Inst. ○ Prefill Topoff ○ Admit LOX ● Start Auto. Sequence ○ Drain LOX ○ Drain Manifold

Engine Status

○ Fuel Admitted ○ Inert Ordnance Installed ○ Prefill Overflowed ○ LOX Admitted
○ Auto. Sequence ○ LOX Drained ○ Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
LOX dome-gas generator LOX injector purge must be on within a pressure range of 120 to 1000 psig for start of AUTOMATIC SEQUENCE. Nominal pressure is 220 psig. (Measurement monitored at Lut. System ΔP between measurement and engine interface is 80 psi when interface pressure is 120 psi.)	1. Purge pressure in range of 0 to 120 psig prior to initiation of AUTOMATIC SEQUENCE.	1.1 HOLD - Turn off purge to preclude check valve chatter, then PROCEED.
	2. Purge pressure above 1000 psig prior to initiation of AUTOMATIC SEQUENCE.	2.1 HOLD - Turn off purge, then PROCEED. Post CDDT, if purge system pressure exceeded 3600 psig, perform purge system leak test to verify wraparound line bellows integrity.

Revised 1-15-71

GUIDELINES FOR WET CDDT

Pending Operation

○ Inert Ordnance Inst. ○ Prefill Topoff ○ Admit LOX ○ Start Auto. Sequence ○ Drain LOX ● Drain Manifold

Engine Status

○ Fuel Admitted ○ Inert Ordnance Installed ○ Prefill Overflowed ○ LOX Admitted
○ Auto. Sequence ● LOX Drained ● Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
LOX dome-gas generator LOX injector purge must be on with a pressure range of 120 to 1000 psig when hydraulics are shut off with the thrust chamber manifold full during securing operations. Nominal pressure is 220 psig. (Measurement monitored at Lut. System ΔP between measurement and engine interface is 80 psi when interface pressure is 120 psi.)	1. Purge pressure goes off, or is less than 120 psig prior to hydraulic shutoff.	1.1 HOLD - Turn off purge to preclude LOX purge check valve chatter. Correct problem, then PROCEED. 1.2 If problem cannot be corrected, attach thrust chamber manifold drain hoses and drain manifolds prior to hydraulics shutoff. Reprime thrust chamber manifolds after hydraulics are shut down.
	2. Purge pressure is greater than 1000 psig prior to hydraulics shutoff.	2.1 HOLD - Turn purge off. Correct problem. 2.2 If problem cannot be corrected, attach thrust chamber manifold drain hoses and drain manifolds prior to hydraulics shutoff. Reprime thrust chamber manifolds after hydraulics are shut down. 2.3 If purge system pressure exceeded 3600 psig, perform purge system leak test to verify wraparound line bellows integrity.

GUIDELINES FOR WET CDDT

Pending Operation

○ Inert Ordnance Inst. ○ Prefill Topoff ○ Admit LOX ○ Start Auto. Sequence ○ Drain LOX ○ Drain Manifold

Engine Status

○ Fuel Admitted ○ Inert Ordnance Installed ○ Prefill Overflowed ○ LOX Admitted

● Auto. Sequence ○ LOX Drained ○ Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
LOX system purge pressure range of 120 to 1000 psig during AUTOMATIC SEQUENCE. Nominal pressure is 220 psig. (Measurement monitored at Lut. System ΔP between measurement and engine interface is 80 psi when interface pressure is 120 psig.)	1. Purge inoperative 2. Purge pressure below 120 psig 3. Purge pressure above 1000 psig	1.1 CONTINUE through CDDT. 2.1 HOLD - Turn off purge to preclude check valve chatter, then CONTINUE through CDDT. 3.1 HOLD - Turn off purge. CONTINUE through CDDT. Post CDDT, if purge system pressure exceeded 3600 psig, perform purge system leak test to verify structural integrity of purge line bellows.

GUIDELINES FOR WET CDDT

Pending Operation

○ Inert Ordnance Inst. ○ Prefill Topoff ● Admit LOX ○ Start Auto. Sequence ○ Drain LOX ○ Drain Manifold

Engine Status

○ Fuel Admitted ○ Inert Ordnance Installed ○ Prefill Overflowed ○ LOX Admitted ○ Auto. Sequence ○ LOX Drained ○ Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
Turbopump intermediate seal purge of 60 to 125 psig is required for start of LOX loading.	1. Low supply pressure, 0 to 15 psig	1.1 HOLD - Turn off purge. Correct purge system problem.
	2. Low supply pressure, 15 to 59 psig	2.1 PROCEED
	3. High supply pressure, 126 to 200 psig	3.1 PROCEED
	4. High supply pressure, 201 to 350 psig	4.1 HOLD - Turn off purge. Correct problem. 4.2 Post CDDT, verify seal integrity by conducting a quantitative flow test.
	5. High supply pressure, greater than 350 psig	5.1 BACKOUT - Turn off purge immediately. Replace turbopump intermediate seal per applicable field manual.

GUIDELINES FOR WET CDDT

Pending Operation

○ Inert Ordnance Inst. ○ Prefill Topoff ○ Admit LOX ○ Start Auto. Sequence ○ Drain LOX ○ Drain Manifold

Engine Status

○ Fuel Admitted ○ Inert Ordnance Installed ○ Prefill Overflowed ● LOX Admitted

● Auto. Sequence ○ LOX Drained ○ Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
Turbopump intermediate seal purge of 60 to 125 psig	1. Low supply pressure, less than 15 psig or loss of supply pressure	1.1 BACKOUT - Remove LOX from engine. Correct problem and verify proper seal purge operation.
	2. Low supply pressure, 15 to 59 psig	2.1 PROCEED
	3. High supply pressure, 126 to 200 psig	3.1 PROCEED
	4. High supply pressure, 201 to 350 psig	4.1 BACKOUT - Remove LOX from engine, then turn off purge. Correct problem. 4.2 Post CDDT, verify seal integrity by conducting a quantitative flow test.
	5. High supply pressure, greater than 350 psig	5.1 BACKOUT - Turn off purge immediately. Remove LOX from engine. Replace turbopump intermediate seal per applicable field manual.

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GUIDELINES FOR WET CDDT

Pending Operation

○ Inert Ordnance Inst. ● Prefill Topoff ○ Admit LOX ○ Start Auto. Sequence ● Drain LOX ○ Drain Manifold

Engine Status

○ Fuel Admitted ○ Inert Ordnance Installed ○ Prefill Overflowed ○ LOX Admitted
○ Auto. Sequence ○ LOX Drained ○ Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
Cocoon purge on and purge heater on required 15 to 30 minutes after start of LOX load and at all subsequent times LOX is in engine.	1. Cocoon purge or purge heater inoperative	1.1 CONTINUE until engine environmental temperature decreases to 0 F. Reference disposition on sheet for temperature less than 0 F if this condition occurs.

GUIDELINES FOR WET CDDT

Pending Operation

○ Inert Ordnance Inst. ○ Prefill Topoff ○ Admit LOX ○ Start Auto. Sequence ○ Drain LOX ○ Drain Manifold

Engine Status

● Fuel Admitted ● Inert Ordnance Installed ● Prefill Overflowed ● LOX Admitted

● Auto. Sequence ● LOX Drained ● Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
The purity of gaseous nitrogen shall be equivalent to Type I of MIL-P-27401 specification.	1. The moisture content exceeds 26.3 ppm by volume of water vapor at 70 F.	1.1 HOLD - Correct cause of excessive moisture prior to supplying gaseous nitrogen to engine system.
	2. The purity of the nitrogen is less than 99.5 percent nitrogen by volume. (Total hydrocarbon 25 ppm by weight as carbon, 0.5 percent by volume as oxygen, 58.3 ppm by volume as methane.)	2.1 HOLD - Determine extent of nonconformance and evaluate hardware condition on an individual occurrence and application basis.

GUIDELINES FOR WET CDDT

Pending Operation

○ Inert Ordnance Inst. ● Prefill Topoff ○ Admit LOX ○ Start Auto. Sequence ○ Drain LOX ● Drain Manifold

Engine Status

○ Fuel Admitted ○ Inert Ordnance Installed ○ Prefill Overflowed ○ LOX Admitted
○ Auto. Sequence ○ LOX Drained ○ Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
Thrust chamber prefill fluid shall be in conformance with specification RB0210-017: Solid particles; no sedement pH value; 6.5 ±1.5 Ethylene glycol percentage by weight; 50 ±1 per percent.	1. The prefill fluid contains solid particles which are smaller than 1350 microns.	1.1 PROCEED
	2. The prefill fluid contains solid particles which are larger than 1350 microns.	2.1 HOLD - Do not topoff, then CONTINUE through CDDT. 2.2 Post CDDT, filter the prefill fluid to obtain acceptable particle sizes prior to introducing the prefill fluid into the thrust chamber.
	3. The pH of the prefill fluid is less than 5.0.	3.1 HOLD - Do not topoff, the CONTINUE through CDDT. Exposure of thrust chamber components to this organic acid is acceptable for short time durations only, 1 week maximum.
	4. The pH of the prefill fluid is larger than 8.0.	4.1 PROCEED.
	5. The prefill fluid contains from 50 to 60 percent ethylene glycol by weight.	5.1 PROCEED.
	6. The prefill fluid contains more than 60 percent ethylene glycol by weight.	6.1 HOLD - Do not topoff, CONTINUE through CDDT, post CDDT add distilled or deionized water to the prefill fluid to obtain a 50 percent mixture by weight.

(Continued on next page)

GUIDELINES FOR WET CDDT

Pending Operation

○ Inert Ordnance Inst. ● Prefill Topoff ○ Admit LOX ○ Start Auto. Sequence ○ Drain LOX ● Drain Manifold

Engine Status

○ Fuel Admitted ○ Inert Ordnance Installed ○ Prefill Overflowed ○ LOX Admitted
○ Auto. Sequence ○ LOX Drained ○ Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
Thrust chamber prefill fluid shall be in conformance with specification RB0210-017; Solid particles; no sedement pH value; 6.5 ±1.5 Ethylene glycol percentage by weight; 50 ±1 per percent.	7. The prefill fluid contains from 45 to 50 percent ethylene glycol by weight.	7.1 PROCEED.
	8. The prefill fluid contains less than 45 percent ethylene glycol by weight.	8.1 HOLD - Do not topoff, CONTINUE through CDDT, post CDDT. Take corrective action to obtain a 50 percent mixture by weight.

GUIDELINES FOR WET CDDT

Pending Operation

○ Inert Ordnance Inst. ● Prefill Topoff ○ Admit LOX ○ Start Auto. Sequence ○ Drain LOX ○ Drain Manifold

Engine Status

● Fuel Admitted ● Inert Ordnance Installed ○ Prefill Overflowed ○ LOX Admitted

○ Auto. Sequence ○ LOX Drained ● Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
Drain hoses must not be removed from the fuel inlet manifold drainage quick disconnects until after the final application of hydraulic supply pressure to the engine if main fuel valve leakage has occurred without hydraulic pressure applied.	1. Drain hoses are removed prior to final application of hydraulic supply pressure.	1.1 HOLD - Turn LOX system purge on. Accomplish either step 1.1.1, 1.1.2, or 1.1.3, whichever is faster. 1.1.1 Apply hydraulic supply pressure. Install drain hoses on the fuel inlet manifold drain quick disconnects and measure total volume of fuel which drains, then PROCEED. 1.1.2 Reinstall drain hoses on the fuel inlet manifold drain quick disconnects and measure initial volume of fuel which drains, then PROCEED. 1.1.3 Measure the volume of fuel in the thrust chamber prefill fluid post CDDT. Perform drainage with hydraulic supply pressure applied. 1.1.4 Post CDDT, perform a thrust chamber LOX dome flush if LOX dome contamination is suspected. Perform a thrust chamber fuel jacket flush, post CDDT, if more than 13 ounces of fuel is detected in steps 1.1.1, 1.1.2, or 1.1.3.

GUIDELINES FOR WET CDDT

Pending Operation

○ Inert Ordnance Inst. ● Prefill Topoff ○ Admit LOX ○ Start Auto. Sequence ○ Drain LOX ○ Drain Manifold

Engine Status

○ Fuel Admitted ○ Inert Ordnance Installed ○ Prefill Overflowed ● LOX Admitted

○ Auto. Sequence ○ LOX Drained ○ Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
Thrust chamber fuel jacket must be prefilled to injector overflow. Prefill overflow must be visually verified.	1. Thrust chamber does not exhibit overflow on one or more engines.	1.1 CONTINUE through CDDT - Correct problem after completion of CDDT.

GUIDELINES FOR WET CDDT

Pending Operation

○ Inert Ordnance Inst. ● Prefill Topoff ○ Admit LOX ○ Start Auto. Sequence ○ Drain LOX ○ Drain Manifold

Engine Status

○ Fuel Admitted ○ Inert Ordnance Installed ○ Prefill Overflowed ○ LOX Admitted

○ Auto. Sequence ○ LOX Drained ○ Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
Thrust chamber fuel inlet manifold must be refilled to injector overflow after drain hose removal.	1. Thrust chamber does not exhibit prefill overflow on one or more engines.	1.1 PROCEED

GUIDELINES FOR WET CDDT

Pending Operation		
○ Inert Ordnance Inst. ○ Prefill Topoff ○ Admit LOX ● Start Auto. Sequence ○ Drain LOX ○ Drain Manifold		
Engine Status		
○ Fuel Admitted ○ Inert Ordnance Installed ● Prefill Overflowed ● LOX Admitted ○ Auto. Sequence ○ LOX Drained ○ Manifold Primed		
Nominal Condition	**Nonconformance Condition**	**Recommended Disposition**
Thrust chamber prefill must be topped off after last engine gimbal test.	1. Thrust chamber prefill topoff on all or any engine does not occur.	1.1 PROCEED

GUIDELINES FOR WET CDDT

Pending Operation		
○ Inert Ordnance Inst. ● Prefill Topoff ○ Admit LOX ○ Start Auto. Sequence ○ Drain LOX ● Drain Manifold		
Engine Status		
○ Fuel Admitted ○ Inert Ordnance Installed ● Prefill Overflowed ● LOX Admitted ● Auto. Sequence ● LOX Drained ○ Manifold Primed		
Nominal Condition	Nonconformance Condition	Recommended Disposition
F-1 engine thrust chamber attitude must not exceed 2 degrees 30 minutes during and after last prefill topoff.	1. Engine attitude exceeds 2 degrees 30 minutes during or after prefill topoff.	1.1 PROCEED 1.2 If low LOX purge was not on when engine attitude change occurred, perform LOX dome flush post CDDT.

GUIDELINES FOR WET CDDT

Pending Operation

○ Inert Ordnance Inst. ○ Prefill Topoff ○ Admit LOX ○ Start Auto. Sequence ○ Drain LOX ○ Drain Manifold

Engine Status

● Fuel Admitted ● Inert Ordnance Installed ● Prefill Overflowed ● LOX Admitted ● Auto. Sequence ● LOX Drained ● Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
No internal or external prefill leakage is allowed from thrust chamber.	1. Internal leakage of prefill fluid.	1.1 CONTINUE through CDDT - Turn on low LOX system purge and leave on through CDDT. 1.1.1 Post CDDT, repair the thrust chamber per R-3896-3. 1.1.2 Flush LOX dome at conclusion of weld repair and conduct throat plug leak check after LOX dome flush completion.
	2. External leakage of prefill.	2.1 HOLD - Drain prefill from thrust chamber, then PROCEED. 2.2 Post CDDT, repair the thrust chamber pre R-3896-3, (Vol. II). 2.2.1 Flush LOX dome at conclusion of weld repair and conduct throat plug leak check after completion of dome flush. 2.2.2 Remove external prefill leakage from engine and TIS surfaces, and replace TIS panels, which are internally wet with prefill.

GUIDELINES FOR WET CDDT

Pending Operation

○ Inert Ordnance Inst. ○ Prefill Topoff ○ Admit LOX ○ Start Auto. Sequence ○ Drain LOX ○ Drain Manifold

Engine Status

● Fuel Admitted ● Inert Ordnance Installed ● Prefill Overflowed ● LOX Admitted
● Auto. Sequence ● LOX Drained ● Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
d-c electrical power: 24 to 32 vdc under load conditions.	1. Loss of d-c power or less than 18 volts.	1.1 HOLD - Correct problem. 1.2 Verify that d-c power distribution to engine is normal and that all propellant valves are in the closed position.
	2. Low d-c voltage (18 to 24)	2.1 CONTINUE - Through Wet CDDT, voltage at four-way valve and checkout valve must be greater than 18 vdc when valves are actuating (equivalent no-load buss voltage of approximately 22 vdc). Problems may be encountered with attaining reliable facility relay operation.
	3. High d-c voltage (32 to 36 vdc).	3.1 PROCEED.
	4. High d-c voltage (greater than 36 vdc).	4.1 HOLD - Turn off electrical power and effect repair. Verify that all engine electrical indicators illuminate propertly for CDDT completion. Post CDDT, conduct an electrical functional check of the following components: main LOX valve, main fuel valve, and gas generator valves position indicators, hypergol installed switch, checkout valve position switch, igniter circuits, flight instruments (calibration), and turbopump heater thermostats.

GUIDELINES FOR WET CDDT

Pending Operation

○ Inert Ordnance Inst. ○ Prefill Topoff ● Admit LOX ○ Start Auto. Sequence ○ Drain LOX ○ Drain Manifold

Engine Status

○ Fuel Admitted ○ Inert Ordnance Installed ○ Prefill Overflowed ● LOX Admitted

● Auto. Sequence ● LOX Drained ○ Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
Turbopump heater a-c electrical power: 190 to 220 vac under load conditions (Heater power turned on when LOX is admitted to engine).	1. Loss of a-c power or low voltage less than 190 vac.	1.1 PROCEED
	2. High voltage (200 to 240 vac)	2.1 PROCEED
	3. High voltage (greater than 240 vac)	3.1 HOLD - Turn off a-c power to turbopump heaters and PROCEED. Post CDDT, verify proper operation of the turbopump heater system.

GUIDELINES FOR WET CDDT

Pending Operation

● Inert Ordnance Inst. ○ Prefill Topoff ○ Admit LOX ● Start Auto. Sequence ○ Drain LOX ○ Drain Manifold

Engine Status

● Fuel Admitted ○ Inert Ordnance Installed ● Prefill Overflowed ● LOX Admitted

● Auto. Sequence ● LOX Drained ● Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
Pyrotechnic igniter a-c electrical power; 500 to 750 vac under load conditions	1. Low voltage (less than 500 vac)	1.1 PROCEED
	2. High voltage (750 to 1000 vac)	2.1 PROCEED
	3. High voltage (greater than 1000 vac)	3.1 HOLD - Turn off igniter power supply, then PROCEED through CDDT.

GUIDELINES FOR WET CDDT

Pending Operation

○ Inert Ordnance Inst. ● Prefill Topoff ○ Admit LOX ○ Start Auto. Sequence ○ Drain LOX ○ Drain Manifold

Engine Status

● Fuel Admitted ● Inert Ordnance Installed ○ Prefill Overflowed ○ LOX Admitted

○ Auto. Sequence ○ LOX Drained ● Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
Main LOX valves (2) main fuel valves (2), gas generator valve CLOSE indications are required at all times d-c power is applied.	1. One valve CLOSE indication is not received, or one valve OPEN indication is received, or both OPEN and CLOSE indications are received.	1.1 HOLD - If hydraulic pressure is not applied to the engine, apply hydraulic pressure and verify that proper indication is received. 1.2 If valve CLOSE indication is not received with hydraulic pressure applied, use appropriate "work-around" procedures to provide the interlock indications which are required to continue through CDDT, then PROCEED. 1.3 If valve CLOSE indication is received with hydraulic pressure applied, perform the following action to the appropriate valve. 1.3.1 Main LOX valve position - PROCEED 1.3.2 Main fuel valve position - CONTINUE through CDDT - post CDDT, drain thrust chamber fuel manifold with hydraulic pressure applied. Inspect prefill fluid for evidence of fuel. If more than 13 ounces of fuel is detected, perform fuel jacket flush. If LOX dome contamination is suspected, perform LOX dome flush.

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GUIDELINES FOR WET CDDT

Pending Operation

○ Inert Ordnance Inst. ● Prefill Topoff ○ Admit LOX ○ Start Auto. Sequence ○ Drain LOX ○ Drain Manifold

Engine Status

● Fuel Admitted ● Inert Ordnance Installed ○ Prefill Overflowed ○ LOX Admitted

○ Auto. Sequence ○ LOX Drained ● Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
Main LOX valves (2) main fuel valves (2), gas generator valve CLOSE indications are required at all times d-c power is applied.	1. One valve CLOSE indication is not received, or one valve OPEN indication is received, or both OPEN and CLOSE indications are received.	1.3.3 Gas generator valve position-Inspect gas generator combustor drain for evidence of fuel then CONTINUE through CDDT. If fuel is noted and the gas generator LOX purge was not on, perform a flush of the gas generator LOX injector subsequent to CDDT completion.

GUIDELINES FOR WET CDDT

Pending Operation

○ Inert Ordnance Inst. ○ Prefill Topoff ● Admit LOX ○ Start Auto. Sequence ○ Drain LOX ● Drain Manifold

Engine Status

○ Fuel Admitted ○ Inert Ordnance Installed ● Prefill Overflowed ○ LOX Admitted
○ Auto. Sequence ● LOX Drained ○ Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
Main LOX valves (2), main fuel valves (2), gas generator valve CLOSE indications are required at all times d-c power is applied	1. One valve CLOSE indication is not received; or one valve OPEN indication is received; or both OPEN and CLOSE indications are received.	1.1 If hydraulic pressure was not lost, HOLD - Use appropriate "work-around" procedure to provide valve position interlocks required to continue through CDDT, then PROCEED.
		1.2 If hydraulic pressure was lost and the gas generator valve did leave the CLOSED position and returns CLOSED or remains off the CLOSED position, HOLD.
		1.2.1 Inspect gas generator combustor drain for evidence of fuel. If fuel noted and the gas generator LOX system purge was not on when the leakage occurred, perform a flush of the gas generator LOX injector post CDDT.
		1.3 If hydraulic pressure was lost and if the main fuel valve position indicated the valve left CLOSE, CONTINUE through CDDT. Post CDDT drain thrust chamber fuel manifold with hydraulic pressure applied. Inspect prefill fluid for evidence of fuel. If more than 13 ounces of fuel is detected, perform fuel jacket flush. If LOX dome contamination is suspected, perform LOX dome flush.
		1.4 If hydraulic pressure was lost and the main LOX valve momentarily left the CLOSE position, PROCEED.

GUIDELINES FOR WET CDDT

Pending Operation

○ Inert Ordnance Inst. ○ Prefill Topoff ○ Admit LOX ● Start Auto. Sequence ● Drain LOX ○ Drain Manifold

Engine Status

○ Fuel Admitted ○ Inert Ordnance Installed ○ Prefill Overflowed ● LOX Admitted

● Auto. Sequence ○ LOX Drained ○ Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
Main LOX valves (2), main fuel valves (2), gas generator valve CLOSE indications are required for start of stage LOX admittance to the engine, and for start of automatic sequence.	1. One valve CLOSE indication is not received; or one valve OPEN indication is received; or both OPEN and CLOSE indications are received.	1.1 If hydraulic pressure was not lost, HOLD - Use appropriate "work-around" procedure to provide valve position interlocks required to continue through CDDT, then PROCEED. 1.2 If hydraulic pressure was lost and the gas generator valve did leave the CLOSED position and returns CLOSED or remains off the CLOSED position, BACKOUT - Remove propellants from engine and correct problem. CAUTION: Explosive gel may have formed, - DO NOT DISTURB. If LOX system purge is ON, leave ON, but do NOT turn purge on if it is off. DO NOT GIMBAL. 1.2.1 Inspect gas generator combustor drain for evidence of fuel. If fuel noted and the gas generator LOX system purge was not on when the leakage occurred, perform a flush of the gas generator LOX injector post CDDT.

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GUIDELINES FOR WET CDDT

Pending Operation

○ Inert Ordnance Inst. ○ Prefill Topoff ○ Admit LOX ● Start Auto. Sequence ● Drain LOX ○ Drain Manifold

Engine Status

○ Fuel Admitted ○ Inert Ordnance Installed ○ Prefill Overflowed ● LOX Admitted
● Auto. Sequence ○ LOX Drained ○ Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
Main LOX valves (2), main fuel valves (2), gas generator valve CLOSE indications are required for start of stage, LOX admittance to the engine, and for start of automatic sequence.	1. One valve CLOSE indication is not received; or one valve OPEN indication is received; or both OPEN and CLOSE indications are received.	1.3 If hydraulic pressure was lost and the main fuel valve position indicated the valve left CLOSE, CONTINUE through CDDT. Post CDDT drain thrust chamber fuel manifold with hydraulic pressure applied. Inspect prefill fluid for evidence of fuel. If more than 13 ounces of fuel is detected, perform fuel jacket flush. If LOX dome contamination is suspected, perform LOX dome flush. 1.4 If hydraulic pressure was lost and the main LOX valve momentarily left the CLOSE position, PROCEED.

GUIDELINES FOR WET CDDT

Pending Operation

● Inert Ordnance Inst. ○ Prefill Topoff ● Admit LOX ○ Start Auto. Sequence ○ Drain LOX ○ Drain Manifold

Engine Status

● Fuel Admitted ○ Inert Ordnance Installed ● Prefill Overflowed ○ LOX Admitted
○ Auto. Sequence ○ LOX Drained ○ Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
Checkout valve must be in the ground position when hydraulic pressure is applied to the engine.	1. Checkout valve indicates some position other than, or in addition to, the ground position.	1.1 HOLD - Cycle checkout valve to ground position. If ground position is not attained in 4 seconds, remove power to preclude motor burnout. 1.1.1 Determine if problem is associated with the checkout valve actuator or the ground control system. 1.1.2 If the problem is associated with the ground control system, conduct cycling tests as required to verify that the checkout valve will attain the desired position at the proper time and that the correct indication will be received at that time. Then PROCEED. 1.1.3 If the actuator is defective, and the checkout valve is not in the ground position, replace actuator per applicable field manual.

GUIDELINES FOR WET CDDT

Pending Operation

○ Inert Ordnance Inst. ○ Prefill Topoff ○ Admit LOX ● Start Auto. Sequence ○ Drain LOX ○ Drain Manifold

Engine Status

○ Fuel Admitted ○ Inert Ordnance Installed ○ Prefill Overflowed ● LOX Admitted

○ Auto. Sequence ○ LOX Drained ○ Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
Checkout valve must be in the ground position for start of automatic sequence.	1. Checkout valve indicates some position other than, or in addition to, the ground position.	1.1 HOLD - Cycle checkout valve to ground position. If ground position is not attained in 4 seconds, BACKOUT - Remove power to preclude motor burnout. 1.1.1 Turn cocoon purge on and leave on until oxidizer is removed from the engine. Reduce hydraulic pressure to minimum value at which the hydraulic pumping unit will satisfactorily operate, but not less than 400 psig. 1.1.2 Remove LOX from engine and turn off hydraulic pressure. See sheets on hydraulic pressure loss for further disposition. 1.1.3 Determine if problem is associated with the checkout valve actuator or the ground control system. 1.1.4 If the problem is associated with the ground control system, conduct cycling tests as required to verify that the checkout valve will attain the desired position at the proper time and that the correct indication will be received at that time. Then PROCEED.

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GUIDELINES FOR WET CDDT

<u>Pending Operation</u>

○ Inert Ordnance Inst. ○ Prefill Topoff ○ Admit LOX ● Start Auto. Sequence ○ Drain LOX ○ Drain Manifold

<u>Engine Status</u>

○ Fuel Admitted ○ Inert Ordnance Installed ○ Prefill Overflowed ● LOX Admitted
○ Auto. Sequence ○ LOX Drained ○ Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
Checkout valve must be in the ground position for start of automatic sequence.	1. Checkout valve indicates some position other than, or in addition to, the ground position.	1.1.5 If the actuator is defective and the checkout valve is not in the ground position, replace actuator per applicable field manual. 1.2 If the checkout valve is in the ground position and cannot be cycled to the engine position, use appropriate "work-around" procedure to provide interlock indications which are required to continue through CDDT, then PROCEED. Perform step 1.1.5 post CDDT. Cycle checkout valve to engine position post CDDT with fuel in the engine and the ground hydraulic supply pressure set at 1500 ±100 psig at the four-way valve for at least 20 seconds. NOTE: The checkout valve motor will burn out if power is applied to a stalled motor in excess of approximately 30 seconds. (Position switches turn off power to the motor.) If the checkout valve remains in the engine position for 20 minutes, the ground hydraulic pumping unit reservoir will become depleted with automatic shutdown of the hydraulic pumping unit. See sheet on RP-1 contaminated with RJ-1 for further disposition.

GUIDELINES FOR WET CDDT

Pending Operation

◯ Inert Ordnance Inst. ◯ Prefill Topoff ◯ Admit LOX ◯ Start Auto. Sequence ◯ Drain LOX ◯ Drain Manifold

Engine Status

◯ Fuel Admitted ◯ Inert Ordnance Installed ◯ Prefill Overflowed ◯ LOX Admitted

● Auto. Sequence ◯ LOX Drained ◯ Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
Checkout valve must be in the stage position prior to initiation of forward umbilical disconnect signal.	1. Checkout valve fails to attain the stage position during the AUTOMATIC SEQUENCE resulting in automatic cutoff.	1.1 HOLD - If high LOX system purge is on, turn it off. 1.2 Verify that checkout valve returned to the ground position. 1.2.1 Determine if problem is associated with the checkout valve actuator or the ground control system. 1.2.2 If the problem is associated with the ground control system, conduct cycling tests as required to verify that the checkout valve will attain the engine position at the proper time and that the correct indication will be received at that time. Then PROCEED. 1.2.3 If the checkout valve is in the ground position and cannot be cycled to the engine position, use appropriate "work-around" procedure to provide interlock indications which are required to continue through CDDT, then PROCEED. Perform step 1.2.4 post CDDT. Cycle checkout valve to engine position post CDDT with fuel in the engine and the ground hydraulic supply pressure set at 1500 ±100 psig at the four-way valve for at least 20 seconds.

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GUIDELINES FOR WET CDDT

Pending Operation

○ Inert Ordnance Inst. ○ Prefill Topoff ○ Admit LOX ○ Start Auto. Sequence ○ Drain LOX ○ Drain Manifold

Engine Status

○ Fuel Admitted ○ Inert Ordnance Installed ○ Prefill Overflowed ○ LOX Admitted

● Auto. Sequence ○ LOX Drained ○ Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
Checkout valve must be in the stage position prior to initiation of forward umbilical disconnect signal.	1. Checkout valve fails to attain the stage position during the AUTOMATIC SEQUENCE resulting in automatic cutoff.	1.2.4 If actuator is defective, replace actuator per applicable field manual post CDDT. 1.3 If the checkout valve is not in the ground position, cycle checkout valve to ground position. If ground position is not attained in 4 seconds, BACKOUT - Remove power to preclude motor burnout. 1.3.1 Turn cocoon purge on and leave on until oxidizer is removed from the engine. Reduce hydraulic pressure to minimum value at which the hydraulic pumping unit will satisfactorily operate, but not less than 400 psig. 1.3.2 Remove LOX from engine and turn off hydraulic pressure. See sheets on hydraulic pressure loss for further disposition. 1.3.3 Correct problem per steps 1.2.1 and 1.2.2.

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Revised 6-30-71

GUIDELINES FOR WET CDDT

Pending Operation		
○ Inert Ordnance Inst. ○ Prefill Topoff ○ Admit LOX ○ Start Auto. Sequence ○ Drain LOX ○ Drain Manifold		
Engine Status		
○ Fuel Admitted ○ Inert Ordnance Installed ○ Prefill Overflowed ○ LOX Admitted ● Auto. Sequence ○ LOX Drained ○ Manifold Primed		
Nominal Condition	**Nonconformance Condition**	**Recommended Disposition**
Checkout valve must be in the stage position prior to initiation of forward umbilical disconnect signal.	1. Checkout valve fails to attain the stage position during the AUTOMATIC SEQUENCE resulting in automatic cutoff.	1.3.4 If the actuator is defective, replace actuator per applicable field manual. NOTE: The checkout valve motor will burn out if power is applied to a stalled motor in excess of approximately 30 seconds (position switches turn off power to motor). NOTE: If the checkout valve remains in the engine position for 20 minutes the ground hydraulic pumping unit reservoir will become depleted with automatic shutdown of the hydraulic pumping unit. See sheet on RP-1 contaminated with RJ-1 for further disposition.

GUIDELINES FOR WET CDDT

Pending Operation

● Inert Ordnance Inst. ○ Prefill Topoff ○ Admit LOX ○ Start Auto. Sequence ○ Drain LOX ○ Drain Manifold

Engine Status

○ Fuel Admitted ○ Inert Ordnance Installed ● Prefill Overflowed ● LOX Admitted

● Auto. Sequence ● LOX Drained ● Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
Hypergol cartridge installed light must actuate when inert cartridge is installed and remain actuated to serve as an interlock. Cartridge cap must be screwed on by hand torque only.	1. Light does not go on when cartridge is installed or light goes off after cartridge installation.	1.1 CONTINUE through CDDT - Use appropriate "work-around" procedures to provide the interlock indications which are required to CONTINUE through CDDT. Correct problem post CDDT.
	2. Cartridge cap cannot be screwed on by hand torque.	2.1 HOLD - Verify proper operation of hypergol diaphragm follower by use of a GSE tool. If possible, correct problem. If problem cannot be corrected, use appropriate "work-around" procedures to provide interlock indications which are required to CONTINUE through CDDT, then PROCEED. Effect system repair post CDDT.

GUIDELINES FOR WET CDDT

Pending Operation

● Inert Ordnance Inst. ○ Prefill Topoff ○ Admit LOX ○ Start Auto. Sequence ○ Drain LOX ○ Drain Manifold

Engine Status

○ Fuel Admitted ○ Inert Ordnance Installed ● Prefill Overflowed ● LOX Admitted
○ Auto. Sequence ○ LOX Drained ○ Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
Pyrotechnic igniters (4) installed indication is required to start AUTOMATIC SEQUENCE (Inert ordnance installed for CDDT.)	1. Pyrotechnic igniter installed signal not received when circuit is completed or is subsequently lost	1.1 CONTINUE to start AUTOMATIC SEQUENCE - Simulate igniter installed signal prior to start of AUTOMATIC SEQUENCE. 1.1.1 Correct problem after CDDT.

GUIDELINES FOR WET CDDT

Pending Operation

○ Inert Ordnance Inst. ○ Prefill Topoff ○ Admit LOX ● Start Auto. Sequence ○ Drain LOX ○ Drain Manifold

Engine Status

○ Fuel Admitted ○ Inert Ordnance Installed ○ Prefill Overflowed ○ LOX Admitted
○ Auto. Sequence ○ LOX Drained ○ Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
Pyrotechnic igniters (4) installed indication is required to start AUTOMATIC SEQUENCE (Inert ordnance installed for CDDT)	1. Pyrotechnic igniter installed signal is lost	1.1 HOLD - Simulate igniter installed signal, then PROCEED. 1.1.1 Correct problem after CDDT.

GUIDELINES FOR WET CDDT

Pending Operation

● Inert Ordnance Inst. ○ Prefill Topoff ○ Admit LOX ○ Start Auto. Sequence ○ Drain LOX ○ Drain Manifold

Engine Status

● Fuel Admitted ○ Inert Ordnance Installed ● Prefill Overflowed ● LOX Admitted

● Auto. Sequence ● LOX Drained ● Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
Calibration of flight instrumentation redline parameters (3 steps; ambient, 20 percent, and 80 percent).	1. Calibration voltage output of specification limits (1 of 3 steps or a zero shift).	1.1 PROCEED. (If a zero shift was observed determine the amount of shift bias for use when receiving future measurements recorded by the effected transducer).
	2. Calibration voltage output out of specification limits (2 of 3 steps, all 3 steps, or complete failure of output signal).	
	2.1 Turbopump LOX bearing temperature	2.1.1 PROCEED - (During effective period of redline monitoring, use alternates which are S-IC engine heater panel temperature OK and temperature high light indications).
	2.2 Engine environmental temperature	2.2.1 CONTINUE through CDDT - Utilize measurement on another engine for redline monitoring.

GUIDELINES FOR WET CDDT

Pending Operation

○ Inert Ordnance Inst. ○ Prefill Topoff ○ Admit LOX ○ Start Auto. Sequence ○ Drain LOX ○ Drain Manifold

Engine Status

● Fuel Admitted ● Inert Ordnance Installed ● Prefill Overflowed ● LOX Admitted

● Auto. Sequence ● LOX Drained ● Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
Calibration of flight instrumentation nonredline parameters pressure transducers (three steps: ambient, 20 percent, and 80 percent)	1. Calibration voltage output out of specification limits (1 of 3 steps)	1.1 PROCEED
	2. Calibration voltage output out of specification limits (2 of 3 steps with backup)	2.1 PROCEED
	3. Calibration voltage output out of specification limits (2 of 3 steps no backups)	3.1 PROCEED
	4. Calibration voltage output out of specification limits (zero shift)	4.1 PROCEED

GUIDELINES FOR WET CDDT

Pending Operation

○ Inert Ordnance Inst. ○ Prefill Topoff ○ Admit LOX ● Start Auto. Sequence ○ Drain LOX ○ Drain Manifold

Engine Status

○ Fuel Admitted ○ Inert Ordnance Installed ○ Prefill Overflowed ● LOX Admitted

○ Auto. Sequence ○ LOX Drained ○ Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
Engine environmental temperature shall be greater than 0 F from LOX admittance to engine until start of AUTOMATIC SEQUENCE	1. Engine environmental temperature less than 0 F	1.1 CONTINUE - Until temperature reaches -20 F. Correct problem. 1.1.1 When temperature reaches -20 F, HOLD. Inspect for leakage from cocoon. If LOX leakage is detected-BACKOUT. 1.1.2 Inspect for leakage from fuel overboard drain system. Reference fuel drain line leakage sheet for disposition. 1.1.3 If neither LOX leakage nor fuel drain system leakage are detected, PROCEED. 1.2 Post CDDT, inspect for external fuel leakage and drain fluid from thrust chamber manifold, with hydraulic pressure applied, and measure volume of fuel in prefill fluid. If more than 13 ounces of fuel is present in the prefill fluid, perform a fuel jacket flush.

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GUIDELINES FOR WET CDDT

Pending Operation		
○ Inert Ordnance Inst. ○ Prefill Topoff ○ Admit LOX ● Start Auto. Sequence ○ Drain LOX ○ Drain Manifold		
Engine Status		
○ Fuel Admitted ○ Inert Ordnance Installed ○ Prefill Overflowed ● LOX Admitted ○ Auto. Sequence ○ LOX Drained ○ Manifold Primed		
Nominal Condition	**Nonconformance Condition**	**Recommended Disposition**
Turbopump LOX bearing temperature above 0 F from LOX loading to start of AUTOMATIC SEQUENCE	1. Turbopump LOX bearing temperature less than 0 F	1.1 PROCEED
	2. Turbopump LOX bearing temperature greater than 200 F	2.1 HOLD - Turn heater power off. Then PROCEED. Turn power ON and OFF as required to maintain bearing temperature in a range of 0 to 200 F (80 to 130 F is normal).

GUIDELINES FOR WET CDDT

Pending Operation		
○ Inert Ordnance Inst. ○ Prefill Topoff ○ Admit LOX ○ Start Auto. Sequence ○ Drain LOX ○ Drain Manifold		
Engine Status		
● Fuel Admitted ● Inert Ordnance Installed ● Prefill Overflowed ● LOX Admitted ● Auto. Sequence ● LOX Drained ● Manifold Primed		
Nominal Condition	**Nonconformance Condition**	**Recommended Disposition**
Thrust OK pressure switch calibration Pickup pressure 1060 $^{+65}_{-65}$ psig Dropout pressure 50 to 100 psig below pickup pressure	1. High calibration pickup pressure (greater than 1125 psig)	1.1 PROCEED - (Replace pressure switch per applicable field manual post CDDT).
	2. Low calibration pickup pressure (less than 994 psig)	2.1 PROCEED - (Replace pressure switch per applicable field manual post CDDT).
	3. Differential pressure less than or greater than specified	3.1 PROCEED - (Replace pressure switch per applicable field manual post CDDT).

GUIDELINES FOR WET CDDT

Pending Operation

○ Inert Ordnance Inst. ○ Prefill Topoff ○ Admit LOX ○ Start Auto. Sequence ○ Drain LOX ○ Drain Manifold

Engine Status

● Fuel Admitted ● Inert Ordnance Installed ● Prefill Overflowed ● LOX Admitted
● Auto. Sequence ● LOX Drained ● Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
Thermal insulation panels shall not be internally wetted.	1. Thermal insulation panels are internally wetted with nonflammable fluid (water).	1.1 PROCEED
	2. Thermal insulation panels are internally wetted with flammable fluids (RP-1, RJ-1, etc.).	2.1 PROCEED. Replace wetted panels post CDDT.

GUIDELINES FOR DRY CDDT

Pending Operation

○ Prep for Gimbaling ○ Remove Inert Ordnance ● Prime Manifold

Engine Status

● Fuel Admitted ● Engines Gimbaled ● Inert Ordnance Removed ○ Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
Hydraulic supply pressure of 1400 to 1800 psig required (1510 to 1870 psia umbilical pressure) for engine gimbaling.	1. Hydraulic supply pressure less than 400 psig, or loss of hydraulic pressure	1.1 CONTINUE Through CDDT - If main fuel valve leakage has occurred without hydraulic pressure applied, allow all fuel to drain from the fuel inlet manifold drain hoses after restoring hydraulic pressure prior to initiation of engine gimbaling. NOTE: If the engine is gimbaled with drain hoses installed with the fuel inlet manifold cavities primed with fuel (100 ounces), the thrust chamber fuel jacket must be flushed.
	2. Hydraulic supply pressure 400 to 1400 psig	2.1 PROCEED
	3. Hydraulic supply pressure 1800 to 2200 psig	3.1 CONTINUE Through CDDT - DO NOT GIMBAL
	4. Hydraulic supply pressure 2200 to 3000 psig	4.1 CONTINUE Through CDDT - DO NOT GIMBAL 4.1.1 Inspect for external hydraulic system leakage and fuel overboard drain line leakage; see pages covering these problems for disposition.
	5. Hydraulic supply pressure greater than 3000 psig	5.1 HOLD - Turn LOX system purge ON. Turn off hydraulic pressure.

(Continued on next page)

GUIDELINES FOR DRY CDDT

Pending Operation

○ Prep for Gimbaling ○ Remove Inert Ordnance ● Prime Manifold

Engine Status

● Fuel Admitted ● Engines Gimbaled ● Inert Ordnance Removed ○ Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
Hydraulic supply pressure of 1400 to 1800 psig required (1510 to 1870 psia umbilical pressure) for engine gimbaling (continued).	5. Hydraulic supply pressure less than 400 psig, or loss of hydraulic pressure (continued)	5.1.1 Perform action applicable to loss of hydraulic pressure per paragraph 1, and subsequent to reapplication of hydraulic pressure, perform 4.1.1. 5.1.2 Evaluate possible requirement to replace components post CDDT.

GUIDELINES FOR DRY CDDT

Pending Operation

○ Prep for Gimbaling ○ Remove Inert Ordnance ○ Prime Manifold

Engine Status

● Fuel Admitted ● Engines Gimbaled ● Inert Ordnance Removed ● Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
RP-1 fuel specific gravity shall be in the range of 0.801 to 0.815 per MIL-R-25576.	1. RP-1 specific gravity less than 0.801 or greater than 0.815	1.1 CONTINUE through Dry CDDT 1.2 Out of tolerance values of RP-1 specific gravity are indicative of a measurement error or contamination of the fuel with another fluid. 1.3 Obtain additional RP-1 samples and conduct laboratory analyses to determine correct specific gravity values. 1.4 If specific gravity is verified to be outside of specification values, BACKOUT - Determine the identity of the contaminates responsible for the discrepant specific gravity value. The determination of fuel acceptability is dependent upon the type of contaminants, its effect on engine performance, and the performance effect on flight trajectory. NOTES: 1. RP-1 low specific gravity results in high engine performance, while high specific gravity results in low engine performance. The performance effect is +1.8 K-lb thrust for each engine per -0.001 units of specific gravity. 2. The effect of engine performance level change due to specific gravity upon Saturn V flight trajectory must be assessed by NASA.

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GUIDELINES FOR DRY CDDT

Pending Operation

○ Prep for Gimbaling ○ Remove Inert Ordnance ○ Prime Manifold

Engine Status

● Fuel Admitted ● Engines Gimbaled ● Inert Ordnance Removed ● Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
RP-1 fuel shall not contain excessive quantities of RJ-1 fuel	1. RP-1 fuel is contaminated with RJ-1 fuel	1.1 PROCEED 1.2 Subsequent to DRY CDDT completion determine the amount of RJ-1 mixed with the RP-1. The effect of RJ-1 mixed with RP-1 is to increase the fuel specific gravity which will decrease engine thrust. 100 percent RJ-1 lowers engine thrust 4 percent, thrust OK pressure switches will pick up; however the effect of low liftoff thrust and low flight thrust effect on Saturn V flight trajectory must be assessed by NASA. A fuel volume of approximately 475 gallons per engine will be consumed prior to launch liftoff; however RJ-1 volumes greater than approximately 170 gallons in the inboard and 198 gallons in the outboard engine fuel suction lines will result in mixing in the fuel tank.

GUIDELINES FOR DRY CDDT

Pending Operation

○ Prep for Gimbaling ○ Remove Inert Ordnance ○ Prime Manifold

Engine Status

● Fuel Admitted ● Engines Gimbaled ● Inert Ordnance Removed ● Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
Leakage from fuel overboard drain line shall not exceed that volumetric flowrate recorded during hydraulic system leak and functional test.	1. Fuel leakage from fuel overboard drain line exceeds the volumetric flowrate recorded during hydraulic system leak and functional test.	1.1 CONTINUE Through DRY CDDT - Attempt to define leakage rate and type fuel (RP-1 or RJ-1). Post CDDT; investigate the source of leakage by use of an isolation procedure.
	2. Prefill leakage from fuel overboard drain line	2.1 CONTINUE Through DRY CDDT - Replace hypergol manifold assembly post CDDT.

GUIDELINES FOR DRY CDDT

Pending Operation

○ Prep for Gimbaling ○ Remove Inert Ordnance ○ Prime Manifold

Engine Status

● Fuel Admitted ● Engines Gimbaled ● Inert Ordnance Removed ● Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
Zero liquid leakage from lube seal drain line.	1. Liquid leakage from drain line	1.1 BACKOUT - Remove propellants from engine. Take investigative action to determine leakage source. Engine replacement may be required.

GUIDELINES FOR DRY CDDT

Pending Operation

○ Prep for Gimbaling ○ Remove Inert Ordnance ○ Prime Manifold

Engine Status

● Fuel Admitted ● Engines Gimbaled ● Inert Ordnance Removed ● Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition	
No external fuel leakage allowed.	1. External fuel leakage is noted from engine seal (propellant feed system or hydraulic system).	1.1	HOLD - Isolate leakage source.
		1.1.1	If the leak is from the engine hydraulic control system, turn on low LOX dome-gas generator LOX injector purge and turn off hydraulic pressure to the engine, then PROCEED through CDDT. Perform post CDDT inspections as defined on sheets covering loss of hydraulic pressure.
		1.1.2	Post CDDT, torque joint to maximum allowed value and verify that fuel leakage stops.
		1.1.2.1	If fuel leakage continues at maximum joint torque, remove fuel from engine. Replace discrepant seal per applicable field manual.
		1.2	If leak is from engine fuel system joint, torque joint to maximum allowed value and PROCEED through CDDT.
		1.2.1	POST-CDDT - If fuel leakage continues at maximum joint torque, remove fuel from engine. Replace discrepant seal per applicable field manual.
		1.3	Remove residual fuel from engine external surfaces and replace any fuel wetted thermal insulation panels per applicable field manual.

GUIDELINES FOR DRY CDDT

Pending Operation

● Prep for Gimbaling ● Remove Inert Ordnance ○ Prime Manifold

Engine Status

● Fuel Admitted ○ Engines Gimbaled ● Inert Ordnance Removed ● Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
Main fuel valve leakage without hydraulic pressure applied shall not exceed 500 cc/min. from each valve.	1. Fuel leakage noted from thrust chamber fuel inlet manifold drain hoses in excess of 500 cc/min. per fuel valve.	1.1 HOLD - Turn ON LOX system purge. 1.1.1 Apply 1400 to 1800 psig (1510 to 1870 psia umbical pressure) hydraulic pressure. 1.1.1.1 Proceed through CDDT with LOX system purge on, hydraulic pressure applied to the engine and drain hoses installed on the fuel inlet manifold drain quick disconnects. 1.1.1.1.1 Post CDDT, replace discrepant main fuel valve per applicable field manual. 1.1.1.1.2 Perform valve timing tests with low LOX dome-gas generator LOX injector purge on. 1.1.1.1.3 Perform a thrust chamber fuel jacket flush. Perform LOX dome flush if fuel leakage overflows from the thrust chamber injector and the low LOX dome-gas generator LOX injector purge was not on. 1.1.1.1.4 Perform main fuel valve leak test with and without hydraulic pressure applied to the replacement main fuel valve.

GUIDELINES FOR DRY CDDT

Pending Operation

● Prep for Gimbaling ○ Remove Inert Ordnance ○ Prime Manifold

Engine Status

● Fuel Admitted ● Engines Gimbaled ○ Inert Ordnance Removed ○ Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
No main fuel valve leakage allowed with hydraulic pressure applied to engine.	1. Fuel leakage noted from thrust chamber fuel inlet manifold drain hoses.	1.1 HOLD - Turn ON LOX system purge. PROCEED through CDDT with LOX system purge on, hydraulic pressure applied to the engine and drain hoses installed on the fuel inlet manifold drain quick disconnects. 1.1.1 Post CDDT, replace discrepant main fuel valve per applicable field manual. 1.1.2 Perform valve timing tests with low LOX dome-gas generator LOX injector purge on. 1.1.3 Perform a thrust chamber fuel jacket flush if fuel leakage rate exceeds 1000 cc/min. from discrepant valve. Perform LOX dome flush if fuel leakage overflows from the thrust chamber injector and the low LOX dome-gas generator LOX injector purge was not on. 1.1.4 Perform main fuel valve leak test with and without hydraulic pressure applied to the replacement main fuel valve.

GUIDELINES FOR DRY CDDT

Pending Operation

○ Prep for Gimbaling ○ Remove Inert Ordnance ○ Prime Manifold

Engine Status

● Fuel Admitted ● Engines Gimbaled ● Inert Ordnance Removed ● Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition	
No gas generator valve fuel leakage allowed	1. Fuel leakage noted from gas generator combustor drain port.	1.1	HOLD - Turn ON LOX system purge.
		1.1.1	If hydraulic pressure is not applied to the engine, apply 1400 to 1800 psig (1510 to 1870 psia umbilical pressure) hydraulic pressure.
		1.1.1.1	If leakage stops with hydraulic pressure applied, PROCEED through CDDT with the hydraulic system pressurized. Hydraulic pressure will be required any time fuel is in the engine.
		1.1.1.1.1	Post CDDT perform a gas generator LOX injector flush if gas generator valve fuel leakage occurs without the LOX system purge on.
		1.1.1.2	If leakage continues with hydraulic pressure applied, PROCEED through CDDT. Post CDDT, remove prefill and fuel from the engine.
		1.1.1.2.1	Replace discrepant gas generator valve per applicable field manual.
		1.1.1.2.2	Perform engine valve timing test with low LOX dome-gas generator LOX injector purge on.
		1.1.1.2.3	Perform gas generator LOX injector flush.

GUIDELINES FOR DRY CDDT

Pending Operation

● Prep for Gimbaling ○ Remove Inert Ordnance ○ Prime Manifold

Engine Status

● Fuel Admitted ● Engines Gimbaled ○ Inert Ordnance Removed ○ Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
LOX dome-gas generator LOX injector purge must be on with a pressure range of 120 to 1000 psig during engine gimbaling with prefill in the thrust chamber. Nominal pressure is 220 psig.	1. Purge system pressure less than 120 psig or greater than 1000 psig <u>prior</u> to initiating engine gimbal operation.	1.1 HOLD - Turn purge off. Repair system prior to performing gimbal operations, and PROCEED. 1.2 If problem cannot be corrected, CONTINUE through CDDT without purge, and perform a LOX dome flush post DRY CDDT.
	2. Purge pressure below 60 psig or goes off during engine gimbaling.	2.1 HOLD - Turn purge off to preclude check valve chatter, then CONTINUE through DRY CDDT, perform LOX dome flush post DRY CDDT.
(Measurement monitored at Lut. System ΔP between measurement and engine interface is 80 psi when interface pressure is 120 psig)	3. Purge pressure between 60 and 120 psig during engine gimbaling.	3.1 HOLD - Stop gimbaling turn off purge to preclude LOX purge check valve chatter. Correct problem, then PROCEED. 3.2 If problem cannot be corrected, CONTINUE through DRY CDDT without purge, and perform a LOX dome flush post DRY CDDT or do not gimbal during DRY CDDT.
	4. Purge pressure above 1000 psig during engine gimbaling.	4.1 HOLD - Stop gimbaling. Turn purge off. Correct problem.

(Continued on next page)

GUIDELINES FOR DRY CDDT

Pending Operation		
● Prep for Gimbaling ○ Remove Inert Ordnance ○ Prime Manifold		
Engine Status		
● Fuel Admitted ● Engines Gimbaled ○ Inert Ordnance Removed ○ Manifold Primed		
Nominal Condition	**Nonconformance Condition**	**Recommended Disposition**
LOX dome-gas generator LOX injector purge must be on with a pressure range of 120 to 1000 psig during engine gimbaling with prefill in the thrust chamber. Nominal pressure is 220 psig. (Measurement monitored at Lut. System ΔP between measurement and engine interface is 80 psi when interface pressure is 120 psig)	4. Purge pressure above 1000 psig during engine gimbaling. (Continued)	4.2 Readjust pressure within range. If purge system pressure exceeded 3600 psig, turn purge on and perform purge system leak test to verify wrap around line bellows integrity. Then PROCEED. 4.3 If problem cannot be corrected, CONTINUE through DRY CDDT without purge, and perform a LOX dome flush post DRY CDDT or do not gimbal during DRY CDDT.

GUIDELINES FOR DRY CDDT

Pending Operation

○ Prep for Gimbaling ○ Remove Inert Ordnance ● Prime Manifold

Engine Status

○ Fuel Admitted ○ Engines Gimbaled ○ Inert Ordnance Removed ○ Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
LOX dome-gas generator LOX injector purge must be on with a pressure range of 120 to 1000 psig when prefill is admitted to prime the thrust chamber manifold. Nominal pressure is 220 psig. (Measurement monitored at Lut. System ΔP between measurement and engine interface is 80 psi when interface pressure is 120 psig)	1. Purge pressure goes off, or is less than 120 psig during prefill admittance. 2. Purge pressure greater than 1000 psig during prefill admittance.	1.1 HOLD - Turn off prefill system, then turn off purge to preclude LOX check valve chatter. Correct problem. Then PROCEED. 2.1 HOLD - Turn off prefill system, then turn off purge. Correct problem. 2.2 If purge system pressure exceeded 3600 psig, perform purge system leak check to verify wrap-around line bellows integrity.

GUIDELINES FOR DRY CDDT

Pending Operation

○ Prep for Gimbaling ○ Remove Inert Ordnance ○ Prime Manifold

Engine Status

● Fuel Admitted ● Engines Gimbaled ● Inert Ordnance Removed ● Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
The purity of gaseous nitrogen shall be equivalent to Type I of MIL-P-27401 specification.	1. The moisture content exceeds 26.3 ppm by volume of water vapor at 70 F.	1.1 HOLD - Correct cause of excessive moisture prior to supplying gaseous nitrogen to the engine system.
	2. The purity of the nitrogen is less than 99.5 percent nitrogen by volume (total hydrocarbon 25 ppm by weight as carbon, 0.5 percent by volume as oxygen, 58.3 ppm by volume as methane).	2.1 HOLD - Determine extent of nonconformance and evaluate hardware condition on an individual occurrence and application basis.

GUIDELINES FOR DRY CDDT

Pending Operation

○ Prep for Gimbaling ○ Remove Inert Ordnance ● Prime Manifold

Engine Status

○ Fuel Admitted ○ Engines Gimbaled ○ Inert Ordnance Removed ○ Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
Thrust chamber prefill fluid shall be in conformance with specification RB0210-017. Solid particles: no sedement; pH value: 6.5 ±1.5; ethylene glycol percentage by weight: 50 ±1 percent.	1. The prefill fluid contains solid particles which are smaller than 1350 microns.	1.1 PROCEED
	2. The prefill fluid contains solid particles which are larger than 1350 microns.	2.1 HOLD - Filter the prefill fluid to obtain acceptable particle sizes prior to introducing the prefill fluid into the thrust chamber.
	3. The pH of the prefill fluid is less than 5.0.	3.1 HOLD - Exposure of thrust chamber components to this organic acid is acceptable for short time durations only, 1 week maximum.
	4. The pH of the prefill fluid is larger than 8.0.	4.1 PROCEED
	5. The prefill fluid contains from 50 to 60 percent ethylene glycol by weight.	5.1 PROCEED
	6. The prefill fluid contains more than 60 percent ethylene glycol by weight.	6.1 HOLD - Add distilled or deionized water to the prefill fluid to obtain a 50 percent mixture by weight.
	7. The prefill fluid contains from 45 to 50 percent ethylene glycol by weight.	7.1 PROCEED

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GUIDELINES FOR DRY CDDT

Pending Operation		
○ Prep for Gimbaling ○ Remove Inert Ordnance ● Prime Manifold		
Engine Status		
○ Fuel Admitted ○ Engines Gimbaled ○ Inert Ordnance Removed ○ Manifold Primed		
Nominal Condition	Nonconformance Condition	Recommended Disposition
Thrust chamber prefill fluid shall be in conformance with specification RB0210-017. Solid particles: no sedement; pH value: 6.5 ±1.5; ethylene glycol percentage by weight: 50 ±1 percent.	8. The prefill fluid contains less than 45 percent ethylene glycol by weight.	8.1 HOLD - Take corrective action to obtain a 50 percent mixture by weight.

GUIDELINES FOR DRY CDDT

Pending Operation

● Prep for Gimbaling ● Remove Inert Ordnance ○ Prime Manifold

Engine Status

● Fuel Admitted ○ Engines Gimbaled ● Inert Ordnance Removed ● Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
Drain hoses must not be removed from the fuel inlet manifold drainage quick disconnects until after the final application of hydraulic supply pressure to the engine if main fuel valve leakage has occurred without hydraulic pressure applied.	1. Drain hoses are removed prior to final application of hydraulic sypply pressure.	1.1 HOLD - Turn LOX system purge on. Accomplish either step 1.1.1 or 1.1.2, whichever is faster. 1.1.1 Apply hydraulic supply pressure. Then install drain hoses on the fuel inlet manifold drain quick disconnects and measure total volume of fuel which drains. The PROCEED. 1.1.2 Reinstall drain hoses on the fuel inlet manifold drain quick disconnects and measure initial volume of fuel which drains. Then PROCEED. 1.1.3 Post CDDT, perform a thrust chamber LOX dome flush if the LOX dome is suspected to be contaminated. Perform a thrust chamber fuel jacket flush, post CDDT, if more than 13 ounces of fuel is detected in steps 1.1.1 or 1.1.2.

GUIDELINES FOR DRY CDDT

Pending Operation

○ Prep for Gimbaling ○ Remove Inert Ordnance ● Prime Manifold

Engine Status

○ Fuel Admitted ○ Engines Gimbaled ○ Inert Ordnance Removed ○ Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
Thrust chamber fuel jacket must be re-primed with prefill.	1. Thrust chamber is noted not to exhibit drain hose drainage on one or more engines.	1.1 HOLD - Correct problem. 1.1.1 If thrust chamber does not prefill due to sticking check valve, replace check valve per applicable field manual, verify torqueing procedure and record torque values. Waive throat plug leak check.

GUIDELINES FOR DRY CDDT

Pending Operation

○ Prep for Gimbaling ○ Remove Inert Ordnance ○ Prime Manifold

Engine Status

● Fuel Admitted ● Engines Gimbaled ● Inert Ordnance Removed ● Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
No internal or external prefill leakage is allowed from thrust chamber.	1. Internal leakage of prefill fluid.	1.1 CONTINUE through CDDT - Turn on low LOX system purge and leave on through CDDT. 1.1.1 Post CDDT repair the thrust chamber per R-3896-3. 1.1.2 Flush LOX dome at conclusion of weld repair and conduct throat plug leak check after LOX dome flush completion.
	2. External leakage of prefill.	2.1 HOLD - Drain prefill from thrust chamber. Then PROCEED. 2.2 Post CDDT, repair the thrust chamber per R-3896-3, (Vol. II). 2.2.1 Flush LOX dome at conclusion of weld repair and conduct throat plug leak check after completion of dome flush. 2.2.2 Remove external prefill leakage from engine and TIS surfaces, and replace TIS panels, which are internally wet with prefill.

GUIDELINES FOR DRY CDDT

Pending Operation		
○ Prep for Gimbaling ○ Remove Inert Ordnance ○ Prime Manifold		
Engine Status		
● Fuel Admitted ● Engines Gimbaled ● Inert Ordnance Removed ○ Manifold Primed		
Nominal Condition	**Nonconformance Condition**	**Recommended Disposition**
d-c electrical power: 24 to 32 vdc under load conditions.	1. Loss of d-c power or less than 18 volts.	1.1 CONTINUE through DRY CDDT 1.2 Post DRY CDDT, verify d-c power distribution to engine is normal and all propellant valves are in the closed position.
	2. Low d-c voltage (18 to 24).	2.1 PROCEED
	3. High d-c voltage 32 to 36 vdc.	3.1 PROCEED
	4. High d-c voltage, greater than 36 vdc.	4.1 HOLD - Turn off electrical power and CONTINUE through DRY CDDT, post DRY CDDT. Effect system repair. Verify that all engine electrical indicators illuminate properly. Post DRY CDDT completion conduct an electrical functional check of the following components: main LOX valve, main fuel valve, and gas generator valve position indicators, hypergol installed switch, checkout valve position switches, igniter circuits, flight instruments (calibration) and turbopump heater thermostats.

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GUIDELINES FOR DRY CDDT

Pending Operation		
○ Prep for Gimbaling ○ Remove Inert Ordnance ○ Prime Manifold		
Engine Status		
● Fuel Admitted ● Engines Gimbaled ○ Inert Ordnance Removed ○ Manifold Primed		
Nominal Condition	Nonconformance Condition	Recommended Disposition
Pyrotechnic igniter a-c electrical power 500 to 750 vac under load conditions	1. Low voltage, less than 500 vac.	1.1 PROCEED
	2. High voltage, 750 vac to 1000 vac.	2.1 PROCEED
	3. High voltage, greater than 1000 vac.	3.1 HOLD - Turn off igniter power supply and PROCEED through DRY CDDT.

GUIDELINES FOR DRY CDDT

Pending Operation

○ Prep for Gimbaling ○ Remove Inert Ordnance ○ Prime Manifold

Engine Status

● Fuel Admitted ● Engines Gimbaled ● Inert Ordnance Removed ● Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
Main LOX valves (2), main fuel valves (2) gas generator valve CLOSE indications are required at all times d-c power is applied.	1. One valve CLOSE indication is not received; or one valve OPEN indication is received; or both OPEN and CLOSED indications are received.	1.1 HOLD - If hydraulic pressure is not applied to the engine, apply hydraulic pressure and verify that proper indication is received. 1.2 If valve CLOSED indication is not received with hydraulic pressure applied, use appropriate "work-around" procedures to provide the interlock indications which are required to CONTINUE through CDDT, then PROCEED. 1.3 If valve closed indication is received with hydraulic pressure applied, perform the following actions for the appropiate valve. 1.3.1 Main LOX valve position - PROCEED 1.3.2 Main fuel valve position - CONTINUE through CDDT. Post CDDT, drain thrust chamber fuel manifold with hydraulic pressure applied. Inspect prefill fluid for evidence of fuel. If more than 13 ounces of fuel is detected, perform fuel jacket flush. If LOX dome contamination is suspected, perform LOX dome flush.

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GUIDELINES FOR DRY CDDT

Pending Operation

○ Prep for Gimbaling ○ Remove Inert Ordnance ○ Prime Manifold

Engine Status

● Fuel Admitted ● Engines Gimbaled ● Inert Ordnance Removed ● Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
Main LOX valves (2), main fuel valve (2) gas generator valve CLOSE indications are required at all times d-c power is applied.	1. One valve CLOS indication is not received; or one valve OPEN indication is received; or both OPEN and CLOSED indications are received.	1.3.3 Gas generator valve position - Inspect gas generator combustor drain for evidence of fuel, then CONTINUE through CDDT. If fuel is noted and the gas generator LOX purge was not on, perform a flush of the gas generator LOX injector subsequent to CDDT completion.

GUIDELINES FOR DRY CDDT

Pending Operation

○ Prep for Gimbaling ○ Remove Inert Ordnance ○ Prime Manifold

Engine Status

● Fuel Admitted ● Engines Gimbaled ○ Inert Ordnance Removed ○ Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
Checkout valve must be in the ground position when hydraulic pressure is applied to the engine.	1. Checkout valve indicates some position other than, or in addition to, the ground position.	1.1 HOLD - Cycle checkout valve to ground position. If ground position is not attained in 4 seconds, BACKOUT - remove power to preclude motor burnout. 1.2 Turn off hydraulic pressure, then PROCEED. 1.3 Post DRY CDDT - Determine if problem is associated with the checkout valve actuator or the ground control system. 1.3.1 If the problem is associated with the ground control system, conduct cycling tests as required to verify that the checkout valve will attain the desired position at the proper time and that the correct indication will be received at that time. 1.3.2 If the actuator is defective and the checkout valve is not in the ground position, replace actuator per applicable field manual.

GUIDELINES FOR DRY CDDT

Pending Operation		
○ Prep for Gimbaling ○ Remove Inert Ordnance ○ Prime Manifold		
Engine Status		
● Fuel Admitted ○ Engines Gimbaled ○ Inert Ordnance Removed ○ Manifold Primed		
Nominal Condition	Nonconformance Condition	Recommended Disposition
Hypergol cartridge installed must remain actuated to serve as an interlock.	1. Light goes off after cartridge installation	1.1 CONTINUE through CDDT - Use appropriate "work-around" procedures to provide the interlock indications which are required to CONTINUE through CDDT. Correct problem post CDDT.

GUIDELINES FOR DRY CDDT

Pending Operation

○ Prep for Gimbaling ○ Remove Inert Ordnance ○ Prime Manifold

Engine Status

● Fuel Admitted ● Engines Gimbaled ○ Inert Ordnance Removed ○ Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
Pyrotechnic igniters (4) installed indication is required to obtain engine armed indication. (Inert ordance installed for DRY CDDT)	1. Pyrotechnic igniter installed signal not received when circuit is completed or is subsequently lost	1.1 CONTINUE through DRY CDDT - Simulate igniter installed signal to obtain engine armed indication. 1.1.1 Correct problem after DRY CDDT completion.

GUIDELINES FOR DRY CDDT

Pending Operation		
○ Prep for Gimbaling ○ Remove Inert Ordnance ○ Prime Manifold		
Engine Status		
● Fuel Admitted ● Engines Gimbaled ● Inert Ordnance Removed ● Manifold Primed		
Nominal Condition	**Nonconformance Condition**	**Recommended Disposition**
Calibration of flight instrumentation redline parameters (3 steps: ambient, 20 percent, and 80 percent).	1. Calibration voltage output out of specification limits (1 of 3 steps or a zero shift).	1.1 PROCEED - (If a zero shift was observed determine the amount of shift bias for use when reviewing future measurements recorded by the affected transducer).
	2. Calibration voltage output out of specification limits (2 of 3 steps, all 3 steps, or complete failure of output signal).	
	2.1 Turbopump LOX bearing temperature.	2.1.1 PROCEED
	2.2 Engine environmental	2.2.1 PROCEED

GUIDELINES FOR DRY CDDT

Pending Operation

○ Prep for Gimbaling ○ Remove Inert Ordnance ○ Prime Manifold

Engine Status

● Fuel Admitted ● Engines Gimbaled ● Inert Ordnance Removed ● Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
Calibration of flight instrumentation non-redline parameter pressure transducers (3 steps: ambient, 20 percent and 80 percent).	1. Calibration voltage output out of specification limits (1 of 3 steps).	1.1 PROCEED
	2. Calibration voltage output out of specification limits (2 of 3 steps with backup).	2.1 PROCEED
	3. Calibration voltage output out of specification limits (2 of 3 steps no backup).	3.1 PROCEED
	4. Calibration voltage output out of specification limits (zero shift).	4.1 PROCEED

GUIDELINES FOR DRY CDDT

Pending Operation		
○ Prep for Gimbaling ○ Remove Inert Ordnance ○ Prime Manifold		
Engine Status		
● Fuel Admitted ● Engines Gimbaled ● Inert Ordnance Removed ● Manifold Primed		
Nominal Condition	**Nonconformance Condition**	**Recommended Disposition**
Thermal insulation panels shall not be internally wetted.	1. Thermal insulation panels are internally wetted with nonflammable fluid (water).	1.1 PROCEED
	2. Thermal insulation panels are internally wetted with flammable fluids (RP-1, RJ-1, etc.).	2.1 PROCEED - Replace wetted panels post DRY CDDT.

GUIDELINES FOR
PRELAUNCH COUNTDOWN

GUIDELINES FOR PRELAUNCH COUNTDOWN

Pending Operation

Engine Status

● Prefill Admitted ● Fuel Admitted ● Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
RP-1 fuel specific gravity shall be in the range of 0.801 to 0.815 per MIL-2-25576.	1. RP-1 specific gravity less than 0.801 or greater than 0.815.	1.1 HOLD - Out of tolerance values of RP-1 specific gravity are indicative of a measurement error or contamination of the fuel with another fluid. 1.2 Obtain additional RP-1 samples and conduct laboratory analyses to determine correct specific gravity values 1.3 If specific gravity is verified to be outside of MIL specification values, BACKOUT 1.4 Determine the identity of the contaminates responsible for the discrepant specific gravity value. The determination of fuel acceptability is dependent upon the type of contaminate, its effect on engine performance, and the performance effect on flight trajectory. NOTES 1. RP-1 low specific gravity results in high engine performance, while high specific gravity results in low engine performance. The performance affect is + 1.8 K-lb thrust for each engine per -0.001 units of specific gravity. 2. The effect of engine performance level change due to specific gravity upon Saturn V flight trajectory must be assessed by NASA.

GUIDELINES FOR PRELAUNCH COUNTDOWN

Pending Operation

Engine Status

● Prefill Admitted ● Fuel Admitted ● Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
RP-1 fuel shall not contain excessive quantities of RJ-1 fuel.	1. RP-1 fuel is contaminated with RJ-1 fuel.	1.1 HOLD 1.2 Determine the amount of RJ-1 mixed with the RP-1. The effect of RJ-1 mixed with RP-1 is to increase the fuel specific gravity which will decrease engine thrust. 100 percent RJ-1 lowers engine thrust 4 percent, thrust OK pressure switches will pick up; however, the effect of low liftoff thrust and low flight thrust effect on Saturn V flight trajectory must be assessed by NASA. A fuel volume of approximately 475 gallons per engine will be consumed prior to launch liftoff; however, RJ-1 volumes greater than approximately 170 gallons in the inboard and 198 gallons in the outboard engine fuel suction lines will result in mixing in the fuel tank.

GUIDELINES FOR PRELAUNCH COUNTDOWN

Pending Operation

Engine Status

● Prefill Admitted ● Fuel Admitted ○ Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition	
Leakage from fuel overboard drain line shall not exceed that volumetric flowrate recorded during hydraulic system leak and functional test.	1. Fuel leakage from fuel overboard drain line exceeds the volumetric flowrate recorded during hydraulic system leak and functional test.	1.1	HOLD - Perform the following isolations:
		1.1.1	Pressurize the fuel tank to maximum permissable level. If the leakage rate decreases, depressurize the fuel tank and PROCEED with the launch countdown.
		1.1.1.1	If the leakage rate increases or remains the same, perform the following:
		1.1.1.1.1	Measure the leakage rate. If the leakage rate is less than 158 cc/min., PROCEED.
		1.1.1.1.2	If the leakage rate is greater than 158 cc/min., perform the following:
		1.1.1.1.2.1	Disconnect the 1-inch line from the hydraulic drain system from the Y-fitting on the 1-3/4-inch fuel overboard drain line. Cap the Y-fitting.
		1.1.1.1.2.2	Install the fuel seal drain manifold adapter P/N 9020907
		1.1.1.1.2.3	Measure the leakage from the inlet port of the adapter (No. 6 seal).

(Continued on next page)

Pending Operation

Engine Status

● Prefill Admitted ● Fuel Admitted ○ Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition	
Leakage from fuel overboard drain line shall not exceed that volumetric flowrate recorded during hydraulic system leak and functional test.	1. Fuel leakage from fuel overboard drain line exceeds the volumetric flowrate recorded during hydraulic system leak and functional test.	1.1.1.1.2.3.1	If the leakage rate is less than 20 gpm, PROCEED.
		1.1.1.1.2.3.2	If the leakage rate is greater than 20 gpm, replace the engine.
		1.1.1.1.2.4	Measure the leakage from the primary port of the adapter (No. 5 seal).
		1.1.1.1.2.4.1	If the leakage rate is less than 6.5 gpm, PROCEED.
		1.1.1.1.2.4.2	If the leakage rate is more than 6.5 gpm, replace the engine.
		1.1.1.1.2.5	Measure the leakage rate from the overboard drain line. This leakage is bearing coolant valve leakage.
		1.1.1.1.2.5.1	If the leakage rate is less than 158 cc/min., PROCEED
		1.1.1.1.2.5.2	If the leakage rate is more than 158 cc/min., replace bearing coolant valve.
		1.1.1.1.3	Measure the leakage rate from the 1-inch hydraulic drain system. If the leakage rate does not exceed 1882 cc/min., PROCEED.

(Continued on next page)

Pending Operation

Engine Status

● Prefill Admitted ● Fuel Admitted ○ Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition	
Leakage from fuel overboard drain line shall not exceed that volumetric flowrate recorded during hydraulic system leak and functional test.	1. Fuel leakage from fuel overboard drain line exceeds the volumetric flowrate recorded during hydraulic system leak and functional test.	1.1.1.1.4	If the leakage rate exceeds 1882 cc/min., perform the following:
		1.1.1.1.4.1	Isolate the ignition monitor valve vent from the overboard drain system.
		1.1.1.1.4.1.1	If the leakage is less than 1882 cc/min., reinstall flight hardware and PROCEED.
		1.1.1.1.4.1.2	If the leakage is greater than 1882 cc/min., replace the ignition monitor valve.
		1.1.1.1.4.2	Isolate the redundant shutdown drain from overboard drain system.
		1.1.1.1.4.2.1	If the leakage is less than 3764 cc/min., reinstall flight hardware and PROCEED.
		1.1.1.1.4.2.2	If the leakage is greater than 3764 cc/min., perform the following:
		1.1.1.1.4.2.2.1	Isolate the engine control valve drain from the overboard drain system. Measure the leakage rate from the redundant shutdown valve.

(Continued on next page)

GUIDELINES FOR PRELAUNCH COUNTDOWN

Pending Operation

Engine Status

● Prefill Admitted ● Fuel Admitted ○ Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition	
Leakage from fuel overboard drain line shall not exceed that volumetric flowrate recorded during hydraulic system leak and functional test.	1. Fuel leakage from fuel overboard drain line exceeds the volumetric flowrate recorded during hydraulic system leak and functional test.	1.1.1.1.4.2.2.2	If the leakage is less than 3764 cc/min., reinstall flight hardware and PROCEED.
		1.1.1.1.4.2.2.3	If the leakage exceeds 3764 cc/min., replace the redundant shutdown valve.
		1.1.1.1.4.3	Isolate the No. 1 main fuel valve potentiometer drain from the overboard drain system.
		1.1.1.1.4.3.1	If the leakage is less than 9410 cc/min., reinstall flight hardware and PROCEED.
		1.1.1.1.4.3.2	If the leakage is greater than 9410 cc/min., replace the main fuel valve potentiometer.
		1.1.1.1.4.4	Isolate the No. 2 main fuel valve potentiometer drain from the overboard drain system.
		1.1.1.1.4.4.1	If the leakage is less than 9410 cc/min., reinstall flight hardware and PROCEED.

(Continued on next page)

Pending Operation

Engine Status

● Prefill Admitted ● Fuel Admitted ○ Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition	
Leakage from fuel overboard drain line shall not exceed that volumetric flowrate recorded during hydraulic system leak and functional test.	1. Fuel leakage from fuel overboard drain line exceeds the volumetric flowrate recorded during hydraulic system leak and functional test.	1.1.1.1.4.4.2	If the leakage is greater than 9410 cc/min., replace the main fuel valve potentiometer.
		1.1.1.1.5	If the source of leakage is not determined by isolating the preceding components, PROCEED.
	2. Prefill leakage from fuel overboard drain line.	2.1	HOLD - Replace hypergol manifold assembly

GUIDELINES FOR PRELAUNCH COUNTDOWN

Pending Operation

Engine Status

○ Prefill Admitted ● Fuel Admitted ○ Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
Zero liquid leakage from lube seal drain line.	1. Liquid leakage from drain line.	1.1 HOLD - Remove propellants from engine. Take investigative action to determine leakage source. Engine replacement may be required.

GUIDELINES FOR PRELAUNCH COUNTDOWN

Pending Operation

Engine Status

○ Prefill Admitted ● Fuel Admitted ○ Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
No external fuel leakage allowed.	1. External fuel leakage is noted from engine seal (propellant feed system or hydraulic system).	1.1 HOLD - Isolate leakage source. 1.1.1 If the leak is from the engine hydraulic control system and if the system is pressurized, turn on low LOX dome-gas generator LOX injector purge and turn off hydraulic pressure to the engine. Perform inspections as defined on sheets covering loss of hydraulic pressure. 1.1.2 Torque joint to maximum allowed value and verify that fuel leakage stops. 1.1.3 If fuel leakage continues at maximum joint torque, remove fuel from engine. Replace discrepant seal per applicable field manual. 1.2 If leak is from engine fuel system joint, torque joint to maximum allowed value and verify that fuel leakage stops. 1.2.1 If fuel leakage continues at maximum joint torque, remove fuel from engine. Replace discrepant seal per applicable field manual. 1.3 Remove residual fuel from engine external surfaces and replace any fuel wetted thermal insulation panels per applicable field manual.

GUIDELINES FOR PRELAUNCH COUNTDOWN

Pending Operation		
Engine Status ● Prefill Admitted ● Fuel Admitted ● Manifold Primed		
Nominal Condition	**Nonconformance Condition**	**Recommended Disposition**
Main fuel valve leakage without hydraulic pressure applied shall not exceed 500 cc/min. from each valve.	1. Fuel leakage noted from thrust chamber fuel inlet manifold drain hoses at a flowrate above 500 cc/min. per valve.	1.1 HOLD - Turn LOX system purge on. Remove prefill and fuel from engine. 1.2 Replace discrepant main fuel valve per applicable field manual. 1.3 Perform engine valve timing test with low LOX dome-gas generator LOX injector purge on. 1.4 Perform main fuel valve leak test with hydraulic pressure applied. 1.5 Perform thrust chamber jacket flush, and LOX dome flush if LOX dome contamination is suspected. 1.6 Replace any fuel wetted thermal insulation panels per applicable field manual.

GUIDELINES FOR PRELAUNCH COUNTDOWN

Pending Operation

Engine Status

● Prefill Admitted ● Fuel Admitted ● Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition	
No gas generator valve fuel leakage allowed.	1. Fuel leakage noted from gas generator combustor drain port.	1.1	HOLD - Turn on LOX system purge.
		1.1.1	If hydraulic pressure is not applied to the engine, apply 1400 to 1800 psig (1510 to 1870 psia umbilical pressure) hydraulic pressure.
		1.1.1.1	If leakage stops with hydraulic pressure applied, PROCEED with the hydraulic system pressurized. Hydraulic pressure will be required any time fuel is in the engine.
		1.1.1.1.1	Perform a gas generator LOX injector flush if gas generator valve leakage occurs without the LOX system purge on.
		1.1.1.2	If leakage continues with hydraulic pressure applied, remove prefill and fuel from the engine.
		1.1.1.2.1	Replace discrepant gas generator valve per applicable field manual.
		1.1.1.2.2	Perform engine valve timing test with low LOX dome-gas generator LOX injector purge on.
		1.1.1.2.3	Perform gas generator LOX injector flush.

GUIDELINES FOR PRELAUNCH COUNTDOWN

Pending Operation

Engine Status

● Prefill Admitted ● Fuel Admitted ● Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
Turbopump intermediate seal purge 60 to 125 psig. (Purge not required during prelaunch countdown operations but will be ON due to gaseous nitrogen pressurization of the vehicle gas bottles for vehicle system checkouts).	1. Purge pressure less than 60 psig.	1.1 HOLD - Turn purge OFF, correct problem, then PROCEED.
	2. Purge pressure between 126 and 200 psig	2.1 PROCEED.
	3. Purge Pressure greater than 201 psig.	3.1 HOLD - Turn purge off immediately. Correct problem.
		3.2 Verify seal integrity by conduting a quantitative flow test.
		3.3 If purge pressure was greater than 350 psig, replace intermediate seal per applicable field manual.

GUIDELINES FOR PRELAUNCH COUNTDOWN

Pending Operation

Engine Status

● Prefill Admitted ● Fuel Admitted ● Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
The purity of gaseous nitrogen shall be equivalent to Type I of MIL-P-27401 specification.	1. The moisture content exceeds 26.3 ppm by volume of water vapor at 70 F.	1.1 HOLD - Correct cause of excessive moisture prior to supplying gaseous nitrogen to the engine system.
	2. The purity of the nitrogen is less than 99.5 percent nitrogen by volume. (Total hydrocarbon 25 ppm by weight as carbon, 0.5 percent by volume as oxygen, 58.3 ppm by volume as methane).	2.1 HOLD - Determine extent of nonconformance and evaluate hardware condition on an individual occurrence and application basis.

Pending Operation

Engine Status

● Prefill Admitted ● Fuel Admitted ● Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
Thrust chamber prefill fluid shall be in conformance with specification RB0210-017: Solid Particles: no sediment; pH Value: 6.5 ±1.5; Ethylene Glycol percentage by weight: 50 ±1 percent.	1. The prefill fluid contains solid particles which are smaller than 1350 microns.	1.1 PROCEED.
	2. The prefill fluid contains solid particles which are larger than 1350 microns.	2.1 HOLD - Filter the prefill fluid to obtain acceptable particle sizes prior to introducing the prefill fluid into the thrust chamber.
	3. The pH of the prefill fluid is less than 5.0	3.1 HOLD - Exposure of thrust chamber components to this organic acid is acceptable for short time durations only, one week maximum.
	4. The pH of the prefill fluid is larger than 8.0	4.1 PROCEED.
	5. The prefill fluid contains from 50 to 60 percent ethylene glycol by weight.	5.1 PROCEED.
	6. The prefill fluid contains more than 60 percent ethylene glycol by weight.	6.1 HOLD - Add distilled or deionized water to the prefill fluid to obtain a 50 percent mixture by weight.
	7. The prefill fluid contains from 45 to 50 percent ethylene glycol by weight.	7.1 PROCEED.
	8. The prefill fluid contains less than 45 percent ethylene glycol by weight.	8.1 HOLD - Take corrective action to obtain a 50 percent mixture by weight.

Pending Operation

Engine Status

● Prefill Admitted ● Fuel Admitted ● Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
Drain hoses must not be removed from the fuel inlet manifold drainage quick disconnects until after the final application of hydraulic supply pressure to the engine if main fuel valve leakage has occurred without hydraulic pressure applied.	1. Drain hoses are removed prior to final application of hydraulic supply pressure.	1.1 HOLD - Turn LOX system purge on. Accomplish either step 1.1.1 or 1.1.2, whichever is faster.
		1.1.1 Install drain hoses on the fuel inlet manifold drain quick disconnects and leave installed until after hydraulic pressure is applied. Measure initial volume of fuel which drains.
		1.1.2 Apply hydraulic supply pressure. Then install drain hoses on the fuel inlet manifold drain quick disconnects and measure total volume of fuel which drains.
		1.1.3 If fuel volume measured in step 1.1.1 or 1.1.2 exceeds 13 ounces, perform a thrust chamber fuel jacket flush. Perform a thrust chamber LOX dome flush if the LOX dome is suspected to be contaminated. Then PROCEED.
		1.1.3.1 If fuel volume measured in step 1.1.1 or 1.1.2 is less than 13 ounces, PROCEED.

GUIDELINES FOR PRELAUNCH COUNTDOWN

Pending Operation

Engine Status

● Prefill Admitted ● Fuel Admitted ● Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
No internal or external prefill leakage is allowed from thrust chamber.	1. Internal leakage of prefill fluid, not breaking from wall (seeper leak).	1.1 HOLD - Drain prefill below level of leak. 1.2 Clean area around leak. 1.3 Repair with silicone adhesive sealant RTV-102 (General Electric) or aluminum tape. 1.4 Refill chamber and PROCEED.
	2. Internal leakage of prefill fluid breaking from wall.	2.1 HOLD - Drain prefill from thrust chamber. 2.2 Repair the thrust chamber per R-3896-3 (Vol. II). 2.3 Flush LOX dome at conclusion of weld repair and conduct throat plug leak check after completion of dome flush.
	3. External leakage of prefill	3.1 HOLD - Drain prefill from thrust chamber. 3.2 Repair the thrust chamber per R-3896-3 (Vol. II). 3.3 Flush LOX dome at conclusion of weld repair and conduct throat plug leak check after completion of dome flush. 3.4 Remove external prefill leakage from engine and TIS surfaces, and replace TIS panels, which are internally wet with prefill.

(Continued on next page)

GUIDELINES FOR PRELAUNCH COUNTDOWN

Pending Operation		
Engine Status: ● Prefill Admitted ● Fuel Admitted ● Manifold Primed		
Nominal Condition	Nonconformance Condition	Recommended Disposition
No internal or external prefill leakage is allowed from thrust chamber.	4. Prefill leakage from any thrust chamber fitting.	4.1 HOLD - Torque fitting to maximum value. 4.2 If leakage continues, remove prefill from thrust chamber. Replace fitting and/or seal to correct leakage. 4.3 If leakage cannot be stopped per 4.2, consider welding fitting to stop leak. 4.4 Remove external prefill leakage from engine and TIS surfaces, and replace TIS panels, which are internally wet with prefill.

GUIDELINES FOR PRELAUNCH COUNTDOWN

Pending Operation

Engine Status

● Prefill Admitted ● Fuel Admitted ● Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
d-c electrical power - 24 to 32 vdc under load conditions.	1. Loss of d-c power or less than 18 volts	1.1 HOLD - Correct problem. 1.2 Verify that d-c power distribution to engine is normal and that all propellant valves are in the close position.
	2. Low d-c voltage (18 to 24)	2.1 PROCEED.
	3. High d-c voltage, 32 to 36 vdc	3.1 PROCEED.
	4. High d-c voltage, greater than 36 vdc.	4.1 HOLD - Turn off electrical power and effect repair. Post repair, verify that all engine electrical indicators illuminate properly. Conduct an electrical functional check of the following components: main LOX valve, main fuel valve, and gas generator valves position indicators, hypergol installed switch, checkout valve position switch, igniter circuits, flight instruments (calibration) and turbopump heater thermostats.

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Pending Operation

Engine Status

● Prefill Admitted ● Fuel Admitted ● Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
Main LOX valves (2), main fuel valves (2), gas generator valve CLOSE indications are present when d-c power is applied.	1. One valve CLOSE indication is not received; or one valve OPEN indication is received; or both OPEN and CLOSE indications are received.	1.1 HOLD - If hydraulic pressure is not applied to the engine, apply hydraulic pressure. 1.2 If valve closed indication is not received with hydraulic pressure applied, accomplish the following action for the appropriate valve: 1.2.1 Main fuel valve position: correct problem, if main fuel valve position switch is defective, BACKOUT, remove propellant, prefill, from engine. Replace position indicator per applicable field manual and accomplish checkout per established procedure. 1.2.2 Main LOX or gas generator valve position: use appropriate "work-around" procedure to provide the interlock indications required to continue through launch, then PROCEED. 1.3 If valve closed indication is received with hydraulic pressure applied, accomplish the following action for the appropriate valve:

(Continued on next page)

GUIDELINES FOR PRELAUNCH COUNTDOWN

Pending Operation

Engine Status

● Prefill Admitted ● Fuel Admitted ● Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
Main LOX valves (2), main fuel valves (2), gas generator valve CLOSE indications are present when d-c power is applied.	1. One valve CLOSE indication is not received; or one valve OPEN indication is received; or both OPEN and CLOSE indications are received.	1.3.1 Main fuel valve position: drain thrust chamber fuel manifold with hydraulic pressure applied. Inspect prefill fluid for evidence of fuel. If more than 13 ounces of fuel is detected in the prefill fluid, BACKOUT, remove prefill from engine and perform a fuel jacket flush. If LOX dome contamination is suspected, perform a LOX dome flush. 1.3.2 Main LOX valve position: PROCEED. 1.3.3 Gas generator valve position: inspect gas generator combustor drain for evidence of fuel. If fuel is detected and the LOX purge was not on, perform a flush of the gas generator LOX injector.

Pending Operation

Engine Status

● Prefill Admitted ● Fuel Admitted ● Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
Checkout valve must be in the ground position if hydraulic pressure is applied to the engine, and when d-c power is applied.	1. Checkout valve indicates some position other than, or in addition to, the ground position.	1.1 HOLD - Cycle checkout valve to ground position. If ground position is not attained in 4 seconds, BACKOUT, remove power to preclude motor burnout. 1.2 Determine if problem is associated with the checkout valve actuator or the ground control system. 1.2.1 If the problem is associated with the ground control system, conduct cycling tests as required to verify that the checkout valve will attain the desired position at the proper time and that the correct indication will be received at that time. 1.2.2 If the actuator is defective and the checkout valve is not in the ground position, replace actuator per applicable field manual.

GUIDELINES FOR PRELAUNCH COUNTDOWN

Pending Operation

Engine Status

● Prefill Admitted ● Fuel Admitted ● Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
Calibration of flight instrumentation redline parameters (3 steps: ambient, 20 percent, and 80 percent).	1. Calibration voltage output out of specification limits (1 of 3 steps or a zero shift).	1.1 PROCEED. (If a zero shift was observed, determine the amount of shift bias for use when reviewing future measurements recorded by the affected transducer)
	2. Calibration voltage output out of specification limits (2 of 3 steps, all 3 steps, or complete failure of output signal).	
	2.1 Turbopump LOX bearing temperature.	2.1.1 CONTINUE through launch countdown - Utilize alternates - S-IC engine heater panel TEMPERATURE OK and TEMPERATURE HIGH light indications for redline during countdown.
	2.2 Engine environmental temperature.	2.2.1 CONTINUE through launch countdown - Utilize measurement on another engine for redline monitoring.

GUIDELINES FOR PRELAUNCH COUNTDOWN

Pending Operation		
Engine Status: ● Prefill Admitted ● Fuel Admitted ● Manifold Primed		
Nominal Condition	Nonconformance Condition	Recommended Disposition
Calibration of flight instrumentation non-redline parameters pressure transducers (3 steps: ambient, 20 percent, and 80 percent).	1. Calibration voltage output out of specification limits (1 of 3 steps).	1.1 PROCEED.
	2. Calibration voltage output out of specification limits (2 of 3 steps with backup)	2.1 PROCEED.
	3. Calibration voltage output out of specification limits (2 of 3 steps no backup).	3.1 PROCEED.
	4. Calibration voltage output out of specification limits (zero shift).	4.1 PROCEED.

GUIDELINES FOR PRELAUNCH COUNTDOWN

Pending Operation

Engine Status

● Prefill Admitted ● Fuel Admitted ● Manifold Primed

Nominal Condition	Nonconformance Condition	Recommended Disposition
Thermal insulation panels shall not be internally wetted.	1. Thermal insulation panels are internally wetted with nonflammable fluid (water).	1.1 PROCEED.
	2. Thermal insulation panels are internally wetted with flammable fluid (RP-1, RJ-1, etc.).	2.1 HOLD - Replace wetted panels, then PROCEED.

GUIDELINES FOR
LAUNCH COUNTDOWN

GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation

○ Install Live Ordnance ● Prefill Topoff ○ Admit LOX ○ Start Auto Sequence

Engine Status

● Fuel Admitted ● Live Ordnance Installed ○ Prefill Overflowed ○ LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
Hydraulic supply pressure of 1400 to 1800 psig required (1570 to 1870 psia umbilical pressure) prior to admitting LOX to engine.	1. Hydraulic supply pressure less than 400 psig, or loss of hydraulic pressure.	1.1 CONTINUE to LOX tanking if no main fuel valve leakage has occurred without hydraulic pressure applied to the engine.
		1.2 HOLD - If main fuel valve leakage has occurred without hydraulic pressure applied to the engine, turn LOX system purge on.
		1.2.1 Install drain hoses on the fuel inlet manifold drain quick disconnects and leave installed until after hydraulic pressure is reapplied. Measure total volume of fuel which initially drains. If fuel volume exceeds 13 ounces, perform thrust chamber fuel jacket flush. Perform thrust chamber LOX-dome flush after removing hypergol cartridge if the LOX dome is suspected to be contaminated.
	2. Hydraulic supply pressure 400 to 1400 psig.	2.1 CONTINUE to start automatic sequence. Correct problem.
		<u>NOTE</u>: Do not admit LOX to engine if it will be necessary to shut down hydraulic pumping unit.
	3. Hydraulic supply pressure 1800 to 2200 psig.	3.1 CONTINUE to start automatic sequence - <u>DO NOT GIMBAL.</u>
		<u>NOTE</u>: Do not admit LOX if the hydraulic pumping unit must be shut down.

(Continued on next page)

GUIDELINES FOR LAUNCH COUNTDOWN

<u>Pending Operation</u>

○ Install Live Ordnance ● Prefill Topoff ○ Admit LOX ○ Start Auto Sequence

<u>Engine Status</u>

● Fuel Admitted ● Live Ordnance Installed ○ Prefill Overflowed ○ LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
Hydraulic supply pressure of 1400 to 1800 psig required (1570 to 1870 psia umbilical pressure) prior to admitting LOX to engine.	4. Hydraulic supply pressure 2200 to 3000 psig	4.1 <u>DO NOT GIMBAL</u> 4.1.1 Inspect for external hydraulic system leakage and fuel overboard drain line leakage; see pages covering these problems for disposition.
	5. Hydraulic supply pressure greater than 3000 psig.	5.1 HOLD - Turn on LOX system purge. Turn off hydraulic pressure. Correct problem. 5.1.1 Perform action applicable to loss of hydraulic pressure. 5.1.2 Perform action per 4.1.1 subsequent to reapplication of hydraulic pressure. 5.1.3 Evaluate possible requirement to replace components.

GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ● Admit LOX ○ Start Auto Sequence

Engine Status

○ Fuel Admitted ○ Live Ordnance Installed ● Prefill Overflowed ○ LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
Hydraulic supply pressure of 1400 to 1800 psig required (1570 to 1870 psia umbilical pressure) prior to admitting LOX to engine.	1. Hydraulic supply pressure less than 400 psig, or loss of hydraulic pressure.	1.1 HOLD - Turn LOX system purge on. 1.1.1 If main fuel valve leakage has occurred without hydraulic pressure applied to the engine, install drain hoses on the fuel inlet manifold drain quick disconnects, and leave installed until after hydraulic pressure is reapplied. Measure total volume of fuel which initially drains. If fuel volume exceeds 13 ounces, perform thrust chamber fuel jacket flush. Perform thrust chamber LOX-dome flush after removing hypergol cartridge if the LOX dome is suspected to be contaminated.
	2. Hydraulic supply pressure 400 to 1400 psig.	2.1 CONTINUE to start automatic sequence. Correct problem. NOTE: Do not admit LOX to engine if it will be necessary to shut down hydraulic pumping unit.
	3. Hydraulic supply pressure 1800 to 2200 psig	3.1 CONTINUE to start automatic sequence - DO NOT GIMBAL NOTE: Do not admit LOX if the hydraulic pumping unit must be shut down.

(Continued on next page)

GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ● Admit LOX ○ Start Auto Sequence

Engine Status

○ Fuel Admitted ○ Live Ordnance Installed ● Prefill Overflowed ○ LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
Hydraulic supply pressure of 1400 to 1800 psig required (1570 to 1870 psia umbilical pressure) prior to admitting LOX to engine.	4. Hydraulic supply pressure 2200 to 3000 psig.	4.1 <u>DO NOT GIMBAL</u> 4.1.1 Inspect for external hydraulic system leakage and fuel overboard drain line leakage; see pages covering these problems for disposition.
	5. Hydraulic supply pressure greater than 3000 psig.	5.1 HOLD - Turn on LOX system purge. Turn off hydraulic pressure. Correct problem. 5.1.1 Perform action applicable to loss of hydraulic pressure. 5.1.2 Perform action per 4.1.1 subsequent to reapplication of hydraulic pressure. 5.1.3 Evaluate possible requirement to replace components.

GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ○ Admit LOX ○ Start Auto Sequence

Engine Status

○ Fuel Admitted ○ Live Ordnance Installed ○ Prefill Overflowed ● LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition	
Hydraulic supply pressure of 1400 to 1800 psig (1510 to 1870 psia umbilical pressure) with LOX in engine.	1. Hydraulic supply pressure 400 to 1400 psig.	1.1	CONTINUE to start automatic sequence. Correct problem.
	2. Hydraulic supply pressure less than 400 psig, or loss of hydraulic pressure.	2.1	HOLD - Turn on the environmental and LOX system purges and leave the purges on until oxidizer is removed from the engine or hydraulic pressure is restored.
		<u>NOTE</u>:	All field documentation specifies to start LOX detanking if hydraulic pressure is lost for more than 10 minutes.
		2.1.1	If hydraulic pressure is restored within 20 minutes, perform the following:
		<u>NOTE</u>:	Reference Fig. 3 (next page) to determine actual time for paragraphs 2.1.1 and 2.1.2.
		2.1.1.1	Drain the gas generator combustor of any fuel accumulated.
		2.1.1.2	Verify that no leakage is emitting from fuel overboard drain line.
		2.1.1.3	With hydraulic supply pressure applied, drain thrust chamber fuel manifold prefill into a suitable container and inspect for the presence of fuel.

(Continued on next page)

FIGURE 3

INSTRUCTIONS FOR USE OF GAS GENERATOR BALL VALVE FUEL SHAFT STEADY-STATE AND TRANSIENT TEMPERATURE CHART

The gas generator ball valve fuel shaft steady-state and transient temperature chart can be used for four purposes.

1. The nomograph located at the bottom center of the chart represents a tradeoff between hydraulic pressure and hydraulic temperature. For any initial gas generator ball valve fuel shaft temperature, there are numerous hydraulic temperature and hydraulic pressure combinations possible. This is illustrated with two combination shown by the diagonal lines at (1) .

2. The primary purpose of the chart is to determine the time interval from a complete loss of hydraulic pressure to the point where fuel will no longer flow when hydraulic pressure is restored. The following four steps should be used in connection with the chart:

   A. First, draw a line on the nomograph between the steady-state hydraulic temperature and hydraulic pressure at the time of the loss of hydraulic pressure. Where this line crosses the centerline at (1) represents the gas generator ball valve fuel shaft temperature at that time.

   B. Second, draw a diagonal line from this gas generator ball valve fuel shaft temperature at (2) to the reference point at (3) .

   C. Third, a horizontal line is drawn from (4) where the diagonal crosses the freezing point reference line to the exponential curve at (5) .

   D. Fourth, the time interval from the loss of hydraulic pressure to the point where fuel will no longer flow when hydraulic pressure is restored is read directly below the intersection of the exponential curve at (6) .

3. The chart can also be used to determine the gas generator ball valve fuel shaft temperature for various time intervals after a complete hydraulic pressure loss as follows:

   A. First, the initial gas generator ball valve fuel shaft temperature as found by drawing a diagonal line between the particular hydraulic temperature and hydraulic pressure at (1) is located on the scale at (2) (reference step 2A).

   B. Second, the line is drawn from the temperature at (2) to the reference point at (3) (reference step 2B).

FIGURE 3 (CONTINUED)

C. Third, the specific time interval in question is located on the exponential curve at (7) (8) .

D. Fourth, a horizontal line is drawn from (8) to (9) , and the actual gas generator ball valve fuel shaft temperature is read above the intersection at (10) .

4. The -60 F O-ring limit can also be used to determine whether any action need be taken. If the hydraulic pressure is restored within the time interval as dictated by the intersection of the diagonal from (2) to (3) and the O-ring limit reference line, then no action need be taken. If it is not restored within this time interval, but before the time limit imposed by the freezing point reference line, inspection is necessary.

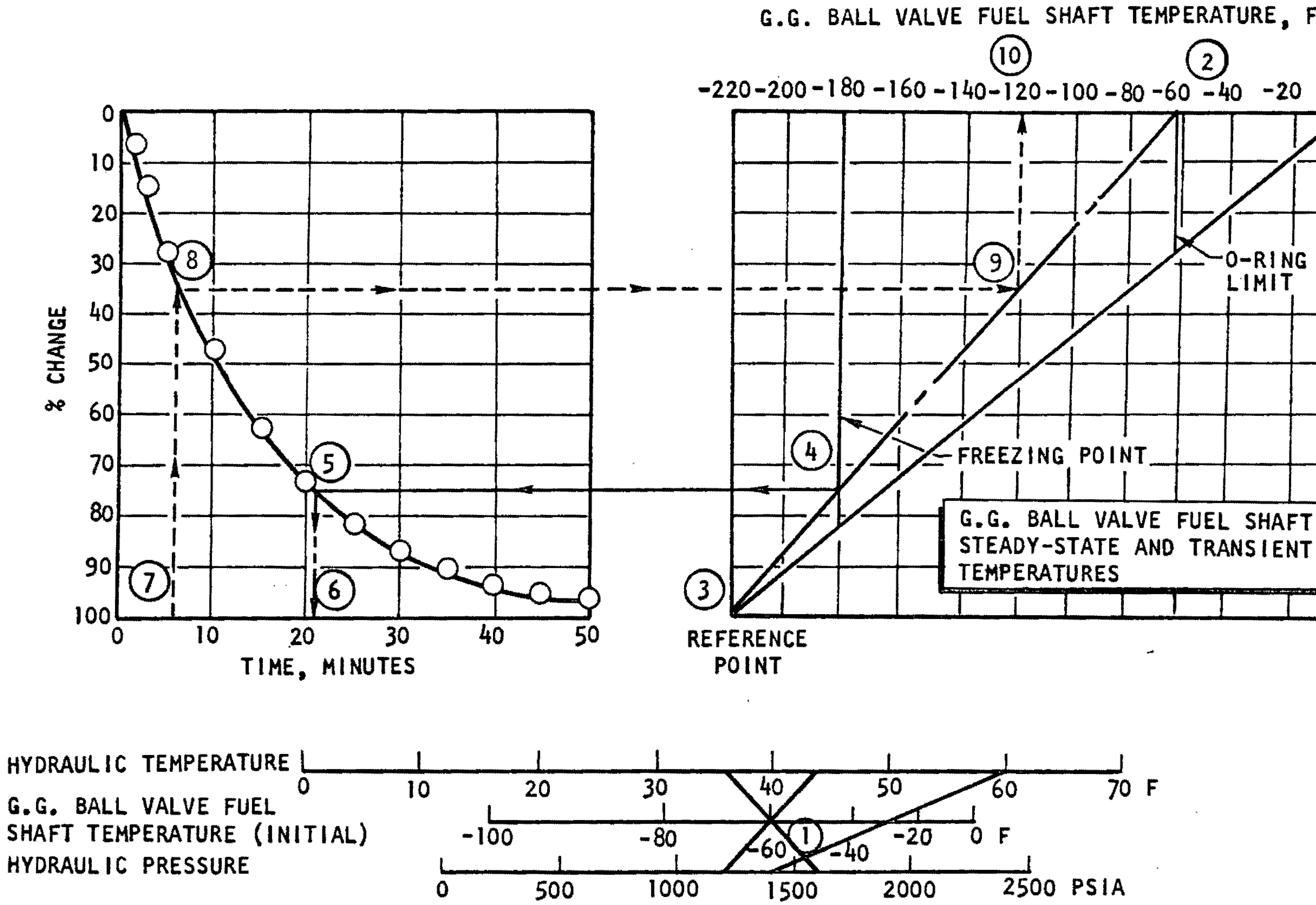

Figure 3. (Concluded)

GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ○ Admit LOX ○ Start Auto Sequence

Engine Status

○ Fuel Admitted ○ Live Ordnance Installed ○ Prefill Overflowed ● LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
Hydraulic supply pressure of 1400 to 1800 psig (1510 to 1870 psia umbilical pressure) with LOX in engine.	2. Hydraulic supply pressure less than 400 psig, or loss of hydraulic pressure.	2.1.1.3.1 If more than 13 ounces of fuel is detected, BACKOUT, drain prefill, conduct main fuel valve leak test with hydraulic pressure applied, and perform thrust chamber jacket flush after removing propellants from engine. Perform thrust chamber LOX dome flush after removing hypergol cartridge if LOX dome contamination is suspected.
		2.1.2 If hydraulic pressure is not restored in 20 minutes, BACKOUT, remove LOX from engine and return engine to ambient temperature.
		2.1.2.1 Inspect the gas generator combustor drain for evidence of leakage. If evidence of leakage is detected and the LOX system purge was not on, conduct gas generator LOX system flush after removing igniters and propellants from engine.
		2.1.2.2 With hydraulic supply pressure applied, drain the thrust chamber fuel manifold prefill into a suitable container and inspect for presence of fuel.

(Continued on next page)

GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ○ Admit LOX ○ Start Auto Sequence

Engine Status

○ Fuel Admitted ○ Live Ordnance Installed ○ Prefill Overflowed ● LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
Hydraulic supply pressure of 1400 to 1800 psig (1510 to 1870 psia umbilical pressure) with LOX in engine.	2. Hydraulic supply pressure less than 400 psig, or loss of hydraulic pressure.	2.1.2.2.1 If more than 13 ounces of fuel is detected, drain prefill, conduct main fuel valve leak test with hydraulic pressure applied, and perform thrust chamber jacket flush after removing propellants from engine. Perform thrust chamber LOX dome flush after removing hypergol cartridge if LOX dome contamination is suspected.
		2.1.2.3 With hydraulic pressure applied, inspect for leakage from the fuel overboard drain line, and for external hydraulic system leakage, see pages covering these problems for disposition.
		2.1.2.4 Remove plugs from Port "G" on each main LOX valve and inspect (swab check) for evidence of fuel. If fuel is detected, replace the main LOX valve per applicable field manual.
	3. Hydraulic supply pressure 1800 to 2200 psig.	3.1 CONTINUE to start automatic sequence - <u>DO NOT GIMBAL</u>

(Continued on next page)

GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ○ Admit LOX ○ Start Auto Sequence

Engine Status

○ Fuel Admitted ○ Live Ordnance Installed ○ Prefill Overflowed ● LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition	
Hydraulic supply pressure of 1400 to 1800 psig (1510 to 1870 psia umbilical pressure) with LOX in engine.	4. Hydraulic supply pressure 2200 to 3000 psig.	4.1	HOLD - Correct problem - <u>DO NOT GIMBAL</u>.
		4.1.1	Inspect for external hydraulic leakage and fuel overboard drain line leakage; see pages covering these problems for disposition.
	5. Hydraulic supply pressure greater than 3000 psig.	5.1	BACKOUT - Turn on LOX system purge. Reduce hydraulic pressure to value between 400 and 3000 psig. If pressure is above 3600 psig, turn hydraulic pressure off.
		5.1.1	With hydraulic pressure applied, inspect for external hydraulic leakage and fuel overboard drain line leakage; see pages covering these problems for disposition.
		5.1.2	Perform action application to reduced hydraulic pressure per the preceding applicable paragraph.
		5.1.3	Evaluate possible requirement to replace components.

GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ○ Admit LOX ● Start Auto Sequence

Engine Status

○ Fuel Admitted ○ Live Ordnance Installed ○ Prefill Overflowed ○ LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
Hydraulic supply pressure of 1400 to 1600 psig (1510 to 1670 psia umbilical pressure) with LOX in engine.	1. Hydraulic supply pressure 400 to 1400 psig. 2. Hydraulic supply pressure less than 400 psig, or loss of hydraulic pressure.	1.1 HOLD - Until problem is corrected. Then PROCEED. 2.1 HOLD - Turn on the environmental and LOX system purges and leave the purges on until oxidizer is removed from the engine or hydraulic pressure is restored. NOTE: All field documentation specifies to start LOX detanking if hydraulic pressure is lost for more than 10 minutes. 2.1.1 If hydraulic pressure is restored within 20 minutes, perform the following: NOTE: Reference Fig. 1 to determine actual time for paragraphs 2.1.1 and 2.1.2. 2.1.1.1 Drain the gas generator combustor of any fuel accumulated. 2.1.1.2 Verify no leakage is emitting from fuel overboard drain line. 2.1.1.3 With hydraulic supply pressure applied, drain thrust chamber fuel manifold prefill into a suitable container and inspect for the presence of fuel.

(Continued on next page)

GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ○ Admit LOX ● Start Auto Sequence

Engine Status

○ Fuel Admitted ○ Live Ordnance Installed ○ Prefill Overflowed ○ LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
Hydraulic supply pressure of 1400 to 1600 psig (1510 to 1670 psia umbilical pressure) with LOX in engine.	2. Hydraulic supply pressure less than 400 psig, or loss of hydraulic pressure.	2.1.1.3.1 If more than 13 ounces of fuel is detected, BACKOUT, drain prefill, conduct main fuel valve leak test with hydraulic pressure applied, and perform thrust chamber jacket flush after removing propellants from engine. Perform thrust chamber LOX dome flush if LOX dome contamination is suspected. 2.1.2 If hydraulic pressure is not restored in 20 minutes, BACKOUT, remove LOX from engine and return engine to ambient temperature. 2.1.2.1 Inspect the gas generator combustor drain for evidence of leakage. If evidence of leakage is detected and the LOX system purge was not on, conduct gas generator LOX system flush after removing igniters and propellants from engine. 2.1.2.2 With hydraulic supply pressure applied, drain the thrust chamber fuel manifold prefill into a suitable container and inspect for presence of fuel.

GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ○ Admit LOX ● Start Auto Sequence

Engine Status

○ Fuel Admitted ○ Live Ordnance Installed ○ Prefill Overflowed ○ LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition	
Hydraulic supply pressure of 1400 to 1600 psig (1510 to 1670 psia umbilical pressure) with LOX in engine.	2. Hydraulic supply pressure less than 400 psig, or loss of hydraulic pressure.	2.1.2.2.1	If more than 13 ounces of fuel is detected, drain prefill, conduct main fuel valve leak test with hydraulic pressure applied, and perform thrust chamber flush after removing propellant from engine. Perform thrust chamber LOX dome flush after removing hypergol cartridge if LOX dome contamination is suspected.
		2.1.2.3	With hydraulic pressure applied, inspect for leakage from the fuel overboard drain line, and for external hydraulic system leakage, see pages covering these problems for disposition.
		2.1.2.4	Remove plugs from Port "G" on each main LOX valve and inspect (swab check) for evidence of fuel. If fuel is detected, replace the main LOX valve per applicable field manual.
	3. Hydraulic supply pressure 1600 to 1800 psig.	3.1	PROCEED.
	4. Hydraulic supply pressure 1800 to 3000 psig.	4.1	HOLD - Investigate and correct problem - DO NOT GIMBAL.
		4.1.1	Inspect for external hydraulic leakage and fuel overboard drain line leakage; see pages covering these problems for disposition.

(Continued on next page)

Pending Operation		
○ Install Live Ordnance ○ Prefill Topoff ○ Admit LOX ● Start Auto Sequence		
Engine Status		
○ Fuel Admitted ○ Live Ordnance Installed ○ Prefill Overflowed ○ LOX Admitted ○ Auto Sequence		
Nominal Condition	**Nonconformance Condition**	**Recommended Disposition**
Hydraulic supply pressure of 1400 to 1600 psig (1510 to 1670 psia umbilical pressure) with LOX in engine.	5. Hydraulic supply pressure greater than 3000 psig.	5.1 BACKOUT - Turn on LOX system purge. Reduce hydraulic pressure to value between 400 and 3000 psig. If pressure is above 3600 psig, turn hydraulic pressure off. 5.1.1 With hydraulic pressure applied, inspect for external hydraulic leakage and fuel overboard drain line leakage; see pages covering these problems for disposition. 5.1.2 Perform action applicable to reduced hydraulic pressure per the preceding applicable paragraph. 5.1.3 Evaluate possible requirement to replace components.

GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ● Admit LOX ○ Start Auto Sequence

Engine Status

○ Fuel Admitted ○ Live Ordnance Installed ○ Prefill Overflowed ○ LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
Hydraulic fluid temperature of 60 to 130 F required with LOX in engine.	1. Hydraulic fluid temperature 130 to 200 F.	1.1 PROCEED.
	2. Hydraulic fluid temperature 40 to 60 F.	2.1 HOLD - Check engine hydraulic supply pressure.
		2.1.1 If hydraulic temperature is 50 to 60 F, raise hydraulic pressure to 1800 psig, and CONTINUE to start of automatic sequence
		2.1.2 If hydraulic temperature is 40 to 50 F, raise hydraulic pressure to 2200 psig and CONTINUE to start of automatic sequence - DO NOT GIMBAL.
	3. Hydraulic fluid temperature less than 40 F.	3.1 HOLD - Investigate and correct problem.
		3.1.1 Obtain a hydraulic temperature in excess of 40 F and raise hydraulic pressure to obtain a temperature-pressure relationship in accordance with 2.1.1 or 2.1.2.
		3.1.1.1 Inspect fuel overboard drain line for leakage; see pages covering this condition for disposition.
		3.1.2 If problem cannot be corrected, BACKOUT.

(Continued on next page)

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ● Admit LOX ○ Start Auto Sequence

Engine Status

○ Fuel Admitted ○ Live Ordnance Installed ○ Prefill Overflowed ○ LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
Hydraulic fluid temperature of 60 to 130 F required with LOX in engine.	3. Hydraulic fluid temperature less than 40 F.	3.1.2.1 When hydraulic temperature is restored, inspect for external hydraulic system leakage and overboard fuel drain line leakage; see pages covering these conditions for disposition.
	4. Hydraulic fluid temperature greater than 200 F.	4.1 HOLD - Reduce hydraulic pressure to the minimum value at which the hydraulic pumping unit will satisfactorily operate, but not less than 400 psig. Correct problem.
		4.1.1 If hydraulic pressure reduction is not effective in reducing hydraulic temperature, BACKOUT. Turn on LOX system purge and turn off hydraulic pressure.
		4.1.2 Inspect for leakage from fuel overboard drain line after restoring hydraulic pressure; see page covering this condition for disposition.
		4.1.3 Inspect for fuel leakage from thrust chamber fuel inlet manifold disconnect valves after restoring hydraulic pressure.

(Continued on next page)

GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ● Admit LOX ○ Start Auto Sequence

Engine Status

○ Fuel Admitted ○ Live Ordnance Installed ○ Prefill Overflowed ○ LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
Hydraulic fluid temperature of 60 to 130 F required with LOX in engine.	4. Hydraulic fluid temperature greater than 200 F.	4.1.3.1 If more than 13 ounces of fuel is detected in the manifold, perform the thrust chamber flush procedure, after removing igniters, hypergol, and prefill from engine. Perform a LOX dome flush after removing hypergol if LOX dome contamination is suspected. 4.1.4 Inspect the combustor drain for evidence of fuel leakage. If evidence of leakage is detected and the LOX system purge was not on, BACKOUT, remove igniters and flush gas generator LOX injector.

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ○ Admit LOX ○ Start Auto Sequence

Engine Status

○ Fuel Admitted ○ Live Ordnance Installed ○ Prefill Overflowed ● LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
Hydraulic fluid temperature of 60 to 130 F required with LOX in engine.	1. Hydraulic fluid temperature 130 to 200 F.	1.1 PROCEED.
	2. Hydraulic fluid temperature 40 to 60 F.	2.1 HOLD - Check engine hydraulic supply pressure.
		2.1.1 If hydraulic temperature is 50 to 60 F, raise hydraulic pressure to 1800 psig, and CONTINUE to start of automatic sequence.
		2.1.2 If hydraulic temperature is 40 to 50 F, raise hydraulic pressure to 2200 psig and CONTINUE to start of automatic sequence - <u>DO NOT GIMBAL</u>.
	3. Hydraulic fluid temperature less than 40 F.	3.1 HOLD - Investigate and correct problem.
		3.1.1 Obtain a hydraulic temperature in excess of 40 F and raise hydraulic pressure to obtain a temperature-pressure relationship in accordance with 2.1.1 or 2.1.2.
		3.1.1.1 Inspect fuel overboard drain line for leakage; see page covering this condition for disposition.
		3.1.2 If problem cannot be corrected, BACKOUT, remove LOX from engine.

(Continued on next page)

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ○ Admit LOX ○ Start Auto Sequence

Engine Status

○ Fuel Admitted ○ Live Ordnance Installed ○ Prefill Overflowed ● LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
Hydraulic fluid temperature of 60 to 130 F required with LOX in engine.	3. Hydraulic fluid temperature less than 40 F.	3.1.2.1 When hydraulic temperature is restored, inspect for external hydraulic system leakage and overboard fuel drain line leakage; see pages covering these conditions for disposition.
	4. Hydraulic fluid temperature greater than 200 F.	4.1 HOLD - Reduce hydraulic pressure to the minimum value at which the hydraulic pumping unit will satisfactorily operate, but not less than 400 psig. Correct problem.
		4.1.1 If hydraulic pressure reduction is not effective in reducing hydraulic temperature, BACKOUT, remove LOX from engine. Turn on LOX system purge, consider cycling hydraulic pressure on and off in 2-minute intervals until LOX is removed from the engine, then remove hydraulic pressure. Correct problem.
		4.1.2 Inspect for leakage from fuel overboard drain line after restoring hydraulic pressure; see page covering this condition for disposition.
		4.1.3 Inspect for fuel leakage from thrust chamber fuel inlet manifold disconnect valves while cycling hydraulic pressure per 4.1.1, and after restoring hydraulic pressure.

(Continued on next page)

GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ○ Admit LOX ○ Start Auto Sequence

Engine Status

○ Fuel Admitted ○ Live Ordnance Installed ○ Prefill Overflowed ● LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
Hydraulic fluid temperature of 60 to 130 F required with LOX in engine.	4. Hydraulic fluid temperature greater than 200 F.	4.1.3.1 If more than 13 ounces of fuel is detected in the manifold, perform the thrust chamber flush procedure, after removing igniters, hypergol, and prefill from engine. Perform a LOX dome flush if LOX dome contamination is suspected. 4.1.4 Inspect the combustor drain for evidence of fuel leakage. If evidence of leakage is detected and the LOX system purge was not on, BACKOUT, remove igniters and flush gas generator LOX injector.

GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ○ Admit LOX ● Start Auto Sequence

Engine Status

○ Fuel Admitted ○ Live Ordnance Installed ○ Prefill Overflowed ○ LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
Hydraulic fluid temperature of 60 to 130 F required with LOX in engine.	1. Hydraulic fluid temperature 130 to 200 F.	1.1 PROCEED.
	2. Hydraulic fluid temperature 40 to 60 F.	2.1 HOLD - Check engine hydraulic supply pressure. If pressure is 1400 to 1600 psig, PROCEED.
	3. Hydraulic fluid temperature less than 40 F.	3.1 HOLD - Investigate and correct problem.
		3.1.1 Obtain a hydraulic temperature in excess of 40 F.
		3.1.1.1 Inspect fuel overboard drain line for leakage; see page covering this condition for disposition.
		3.1.2 If problem cannot be corrected, BACKOUT, remove LOX from engine.
		3.1.2.1 When hydraulic temperature is restored, inspect for external hydraulic system leakage and overboard fuel drain line leakage; see pages covering these conditions for disposition.
	4. Hydraulic fluid temperature greater than 200 F.	4.1 HOLD - Reduce hydraulic pressure to the minimum value at which the hydraulic pumping unit will satisfactorily operate, but not less than 400 psig. Correct problem.

(Continued on next page)

GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ○ Admit LOX ● Start Auto Sequence

Engine Status

○ Fuel Admitted ○ Live Ordnance Installed ○ Prefill Overflowed ○ LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
Hydraulic fluid temperature of 60 to 130 F required with LOX in engine.	4. Hydraulic fluid temperature greater than 200 F.	4.1.1 If hydraulic pressure reduction is not effective in reducing hydraulic temperature, BACKOUT, remove LOX from engine. Turn on LOX system purge, consider cycling hydraulic pressure on and off in 2-minute intervals until LOX is removed from the engine, then remove hydraulic pressure. Correct problem. 4.1.2 Inspect for leakage from fuel overboard drain line after restoring hydraulic pressure; see page covering this condition for disposition. 4.1.3 Inspect for fuel leakage from thrust chamber fuel inlet manifold disconnect valves while cycling hydraulic pressure per 4.1.1, and after restoring hydraulic pressure. 4.1.3.1 If more than 13 ounces of fuel is detected in the manifold, perform the thrust chamber flush procedure, after removing igniters, hypergol, and prefill from engine. Perform a LOX dome flush if LOX dome contamination is suspected.

(Continued on next page)

GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ○ Admit LOX ● Start Auto Sequence

Engine Status

○ Fuel Admitted ○ Live Ordnance Installed ○ Prefill Overflowed ○ LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
Hydraulic fluid temperature of 60 to 130 F required with LOX in engine.	4. Hydraulic fluid temperature greater than 200 F.	4.1.4 Inspect the combustor drain for evidence of fuel leakage. If evidence of leakage is detected and the LOX system purge was not on, BACKOUT, remove igniters and flush gas generator LOX injector.

GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ○ Admit LOX ○ Start Auto Sequence

Engine Status

○ Fuel Admitted ○ Live Ordnance Installed ○ Prefill Overflowed ○ LOX Admitted ● Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
Fuel pump inlet pressure shall be within the range of 43.3 to 110 psia from tank pressurization to T-19 seconds (Monitored as fuel tank ullage pressure).	1. Fuel pump inlet pressure less than 43.3 psia.	1.1 HOLD - Verify that gross fuel system leakage does not exist. 1.2 Fuel pump inlet pressure is not monitored in real time during the automatic sequence. Fuel tank ullage pressure is monitored from completion of fuel tank pressurization (approximately T-70 seconds) to T-19 seconds. Minimum ullage pressure redline of 27.0 psia corresponds to a fuel pump inlet pressure of 43.3 psia. Fuel prevalve open position switches are interlocked to start of automatic sequence and ignition command. 1.3 If ullage pressure is within redline, prevalves are in open position, and there is no indication of gross fuel system leakage, PROCEED.
	2. Fuel pump inlet pressure greater than 110 psia.	2.1 PROCEED.

(Continued on next page)

GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ○ Admit LOX ○ Start Auto Sequence

Engine Status

○ Fuel Admitted ○ Live Ordnance Installed ○ Prefill Overflowed ○ LOX Admitted ● Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
Fuel pump inlet pressure shall be within the range of 43.3 to 110 psia from tank pressurization to T-19 seconds (Monitored as fuel tank ullage pressure).	2. Fuel pump inlet pressure greater than 110 psia.	2.2 Fuel pump inlet pressure is not monitored in real time during the automatic sequence. Fuel tank ullage pressure is monitored from completion of fuel tank pressurization (approximately T-70 seconds) to T-19 seconds. Maximum ullage pressure redline of 30.2 psia corresponds to a fuel pump inlet pressure of approximately 48 psia. Fuel prevalve open position switches are interlocked to start of automatic sequence and ignition command. The fuel tank vent and relief valve is actuated at approximately 31.5 psia either mechanically by ullage pressure or automatically by the high fuel tank ullage pressure switch.

GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ○ Admit LOX ● Start Auto Sequence

Engine Status

● Fuel Admitted ● Live Ordnance Installed ● Prefill Overflowed ● LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
Fuel bulk temperature shall be within the range of 35 to 100 F during engine operation.	1. Fuel bulk temperature is greater than 100 F.	1.1 PROCEED. 1.2 Fuel temperature greater than 100 F would be in excess of ambient temperature, and there is no facility fuel system heater. The indication of temperature is probably instrumentation. Check fuel suction line internal temperature C192, C194, and C196, and fuel bulk temperature C300, C301, and C302.
	2. Fuel bulk temperature less than 35 F, but greater than 30 F.	2.1 PROCEED. 2.2 Mean ambient temperature should never be less than 30 F, therefore fuel bulk temperature should never be less than 30 F.
	3. Fuel bulk temperature less than 30 F, but greater than zero.	3.1 HOLD - Verify all fuel temperatures measurements noted in 1.2. 3.2 Cold fuel temperature reduces engine thrust 1.13 K-lb per engine per degree F fuel temperature. Effect of Saturn V flight trajectory must be assessed by NASA.
	4. Fuel bulk temperature less than zero.	4.1 BACKOUT - Ensure that the cocoon purge is ON. 4.2 Inspect engine for external fuel and fuel overboard drain line leakage.

Revised 1-29-71

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ○ Admit LOX ● Start Auto Sequence

Engine Status

● Fuel Admitted ● Live Ordnance Installed ● Prefill Overflowed ● LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
RP-1 fuel shall not contain excessive quantities of RJ-1 fuel.	1. RP-1 fuel is contaminated with RJ-1 fuel.	1.1 HOLD - Determine the amount of RJ-1 mixed with the RP-1. The effect of RJ-1 mixed with RP-1 is to increase the fuel specific gravity which will decrease engine thrust. 100 percent RJ-1 lowers engine thrust 4 percent, thrust OK pressure switches will pick up; however, the effect of low liftoff thrust and low flight thrust effect on Saturn V flight trajectory must be assessed by NASA. A fuel volume of approximately 475 gallons per engine will be consumed prior to launch liftoff; however RJ-1 volumes greater than approximately 170 gallons in the inboard and 198 gallons in the outboard engine fuel suction lines will result in mixing in the fuel tank.

GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ○ Admit LOX ● Start Auto Sequence

Engine Status

● Fuel Admitted ● Live Ordnance Installed ● Prefill Overflowed ● LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
RP-1 fuel specific gravity shall be in the range of 0.801 to 0.815 per MIL-R-25576.	1. RP-1 specific gravity less than 0.801 or greater than 0.815	1.1 HOLD - Out of tolerance values of RP-1 specific gravity are indicative of a measurement error or contamination of the fuel with another fluid. 1.2 Obtain additional RP-1 samples and conduct laboratory analyses to determine correct specific gravity values. 1.3 If specific gravity is verified to be outside of MIL specification values, BACKOUT. 1.4 Determine the identity of the contaminates responsible for the discrepant specific gravity value. The determination of fuel acceptability is dependent upon the type of contaminate, its effect on engine performance and the performance effect on flight trajectory. NOTES 1. RP-1 low specific gravity results in high engine performance, while high specfic gravity results in low engine performance. The performance effect is + 1.8 K-lb thrust for each engine per -0.001 units of specific gravity. 2. The effect of engine performance level change due to specific gravity upon Saturn V flight trajectory must be assessed by NASA.

GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ○ Admit LOX ○ Start Auto Sequence

Engine Status

● Fuel Admitted ● Live Ordnance Installed ● Prefill Overflowed ○ LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition	
Leakage from fuel overboard drain line shall not exceed that volumetric flowrate recorded during hydraulic system leak and functional test.	1. Fuel leakage from fuel overboard drain line exceeds the volumetric flowrate recorded during hydraulic system leak and functional test.	1.1	CONTINUE to start of LOX tanking.
		1.1.1	Pressurize the fuel tank to maximum permissable level. If the leakage rate decreases, depressurize the fuel tank and PROCEED with the launch countdown.
		1.1.1.1	If the leakage rate increases or remains the same, perform the following
		1.1.1.1.1	Measure the leakage rate. If the leakage rate is less than 158 cc/min., PROCEED.
		1.1.1.1.2	If the leakage rate is greater than 158 cc/min., perform the following:
		1.1.1.1.2.1	Disconnect the 1-inch line from the hydraulic drain system from the Y-fitting on the 1-3/4-inch fuel overboard drain line. Cap the Y-fitting.
		1.1.1.1.2.2	Install the fuel seal drain manifold adapter P/N 9020907.
		1.1.1.1.2.3	Measure the leakage from the inlet port of the adapter (No. 6 seal).

(Continued on next page)

GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ○ Admit LOX ○ Start Auto Sequence

Engine Status

● Fuel Admitted ● Live Ordnance Installed ● Prefill Overflowed ○ LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition	
Leakage from fuel overboard drain line shall not exceed that volumetric flowrate recorded during hydraulic system leak and functional test.	1. Fuel leakage from fuel overboard drain line exceeds the volumetric flowrate recorded during hydraulic system leak and functional test.	1.1.1.1.2.3.1	If the leakage rate is less than 20 gpm, PROCEED.
		1.1.1.1.2.3.2	If the leakage rate is greater than 20 gpm, BACKOUT, replace the engine.
		1.1.1.1.2.4	Measure the leakage from the primary port of the adapter (No. 5 seal).
		1.1.1.1.2.4.1	If the leakage rate is less than 6.5 gpm, PROCEED.
		1.1.1.1.2.4.2	If the leakage rate is more than 6.5 gpm, BACKOUT, replace the engine.
		1.1.1.1.2.5	Measure the leakage rate from the overboard drain line. This leakage is bearing coolant valve leakage.
		1.1.1.1.2.5.1	If the leakage rate is less than 158 cc/min., PROCEED
		1.1.1.1.2.5.2	If the leakage rate is more than 158 cc/min., BACKOUT, replace bearing coolant valve.

(Continued on next page)

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ○ Admit LOX ○ Start Auto Sequence

Engine Status

● Fuel Admitted ● Live Ordnance Installed ● Prefill Overflowed ○ LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition	
Leakage from fuel overboard drain line shall not exceed that volumetric flowrate recorded during hydraulic system leak and functional test.	1. Fuel leakage from fuel overboard drain line exceeds the volumetric flowrate recorded during hydraulic system leak and functional test.	1.1.1.1.3	Measure the leakage rate from the 1-inch hydraulic drain system. If the leakage rate does not exceed 1882 cc/min., PROCEED.
		1.1.1.1.4	If the leakage rate exceeds 1882 cc/min., perform the following:
		1.1.1.1.4.1	Isolate the ignition monitor valve vent from the overboard drain system.
		1.1.1.1.4.1.1	If the leakage is less than 1882 cc/min., reinstall flight hardware and PROCEED.
		1.1.1.1.4.1.2	If the leakage is greater than 1882 cc/min., BACKOUT, replace the ignition monitor valve.
		1.1.1.1.4.2	Isolate the redundant shutdown drain from overboard drain system.
		1.1.1.1.4.2.1	If the leakage is less than 3764 cc/min., reinstall flight hardware and PROCEED.
		1.1.1.1.4.2.2	If the leakage is greater than 3764 cc/min., perform the following:

(Continued on next page)

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ○ Admit LOX ○ Start Auto Sequence

Engine Status

● Fuel Admitted ● Live Ordnance Installed ● Prefill Overflowed ○ LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition	
Leakage from fuel overboard drain line shall not exceed that volumetric flowrate recorded during hydraulic system leak and functional test.	1. Fuel leakage from fuel overboard drain line exceeds the volumetric flowrate recorded during hydraulic system leak and functional test.	1.1.1.1.4.2.2.1	Isolate the engine control valve drain from the overboard drain system. Measure the leakage rate from the redundant shutdown valve.
		1.1.1.1.4.2.2.2	If the leakage is less than 3764 cc/min., reinstall flight hardware and PROCEED.
		1.1.1.1.4.2.2.3	If the leakage exceeds 3764 cc/min., BACKOUT, replace the redundant shutdown valve.
		1.1.1.1.4.3	Isolate the No. 1 main fuel valve potentiometer drain from the overboard drain system.
		1.1.1.1.4.3.1	If the leakage is less than 9410 cc/min., reinstall flight hardware and PROCEED.
		1.1.1.1.4.3.2	If the leakage is greater than 9410 cc/min., BACKOUT, replace the main fuel valve potentiometer.
		1.1.1.1.4.4	Isolate the No. 2 main fuel valve potentiometer drain from the overboard drain system.

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GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ○ Admit LOX ○ Start Auto Sequence

Engine Status

● Fuel Admitted ● Live Ordnance Installed ● Prefill Overflowed ○ LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition	
Leakage from fuel overboard drain line shall not exceed that volumetric flowrate recorded during hydraulic system leak and functional test.	1. Fuel leakage from fuel overboard drain line exceeds the volumatric flowrate recorded during hydraulic system leak and functional test.	1.1.1.1.4.4.1	If the leakage is less than 9410 cc/min., reinstall flight hardware and PROCEED.
		1.1.1.1.4.4.2	If the leakage is greater than 9410 cc/min., BACKOUT, replace the main fuel valve potentiometer.
		1.1.1.1.5	If the source of leakage is not determined by isolating the preceding components, PROCEED.
	2. Prefill leakage from fuel overboard drain line.	2.1	BACKOUT - Remove fuel, prefill, and hypergol. Replace hypergol manifold assembly

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ● Admit LOX ○ Start Auto Sequence

Engine Status

○ Fuel Admitted ○ Live Ordnance Installed ○ Prefill Overflowed ○ LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition	
Leakage from fuel overboard drain line shall not exceed that volumetric flowrate recorded during hydraulic system leak and functional test.	1. Fuel leakage from fuel overboard drain line exceeds the volumetric flowrate recorded during hydraulic system leak and functional test.	1.1	HOLD - Accomplish the following isolations:
		1.1.1	Pressurize the fuel tank to maximum permissable level. If the leakage rate decreases, depressurize the fuel tank and PROCEED with the launch countdown.
		1.1.1.1	If the leakage rate increases or remains the same, perform the following:
		1.1.1.1.1	Measure the leakage rate. If the leakage rate is less than 158 cc/min., PROCEED.
		1.1.1.1.2	If the leakage rate is greater than 158 cc/min., perform the following:
		1.1.1.1.2.1	Disconnect the 1-inch line from the hydraulic drain system from the Y-fitting on the 1-3/4-inch fuel overboard drain line. Cap the Y-fitting.
		1.1.1.1.2.2	Install the fuel seal drain manifold adapter P/N 9020907.

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Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ● Admit LOX ○ Start Auto Sequence

Engine Status

○ Fuel Admitted ○ Live Ordnance Installed ○ Prefill Overflowed ○ LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition	
Leakage from fuel overboard drain line shall not exceed that volumetric flowrate recorded during hydraulic system leak and functional test.	1. Fuel leakage from fuel overboard drain line exceeds the volumetric flowrate recorded during hydraulic system leak and functional test.	1.1.1.1.2.3	Measure the leakage from the inlet port of the adapter (No. 6 seal).
		1.1.1.1.2.3.1	If the leakage rate is less than 20 gpm, PROCEED.
		1.1.1.1.2.3.2	If the leakage rate is greater than 20 gpm, BACKOUT, replace the engine.
		1.1.1.1.2.4	Measure the leakage from the primary port of the adapter (No. 5 seal).
		1.1.1.1.2.4.1	If the leakage rate is less than 6.5 gpm, PROCEED.
		1.1.1.1.2.4.2	If the leakage rate is more than 6.5 gpm, BACKOUT, replace the engine.
		1.1.1.1.2.5	Measure the leakage rate from the overboard drain line. This leakage is bearing coolant valve leakage.
		1.1.1.1.2.5.1	If the leakage rate is less than 158 cc/min., PROCEED.
		1.1.1.1.2.5.2	If the leakage rate is more than 158 cc/min., BACKOUT, replace bearing coolant valve.

(Continued on next page)

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ● Admit LOX ○ Start Auto Sequence

Engine Status

○ Fuel Admitted ○ Live Ordnance Installed ○ Prefill Overflowed ○ LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition	
Leakage from fuel overboard drain line shall not exceed that volumetric flowrate recorded during hydraulic system leak and functional test.	1. Fuel leakage from fuel overboard drain line exceeds the volumetric flowrate recorded during hydraulic system leak and functional test.	1.1.1.1.3	Measure the leakage rate from the 1-inch hydraulic drain system. If the leakage rate does not exceed 1882 cc/min., PROCEED.
		1.1.1.1.4	If the leakage rate exceeds 1882 cc/min., perform the following:
		1.1.1.1.4.1	Isolate the ignition monitor valve vent from the overboard drain system.
		1.1.1.1.4.1.1	If the leakage is less than 1882 cc/min., reinstall flight hardware and PROCEED.
		1.1.1.1.4.1.2	If the leakage is greater than 1882 cc/min., BACKOUT, replace the ignition monitor valve.
		1.1.1.1.4.2	Isolate the redundant shutdown drain from overboard drain system.
		1.1.1.1.4.2.1	If the leakage is less than 3764 cc/min., reinstall flight hardware and PROCEED.
		1.1.1.1.4.2.2	If the leakage is greater than 3764 cc/min., perform the following:

(Continued on next page)

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ● Admit LOX ○ Start Auto Sequence

Engine Status

○ Fuel Admitted ○ Live Ordnance Installed ○ Prefill Overflowed ○ LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition	
Leakage from fuel overboard drain line shall not exceed that volumetric flowrate recorded during hydraulic system leak and functional test.	1. Fuel leakage from fuel overboard drain line exceeds the volumetric flowrate recorded during hydraulic system leak and functional test.	1.1.1.1.4.2.2.1	Isolate the engine control valve drain from the overboard drain system Measure the leakage rate from the redundant shutdown valve.
		1.1.1.1.4.2.2.2	If the leakage is less than 3764 cc/min., reinstall flight hardware and PROCEED.
		1.1.1.1.4.2.2.3	If the leakage exceeds 3764 cc/min., BACKOUT, replace the redundant shutdown valve.
		1.1.1.1.4.3	Isolate the No. 1 main fuel valve potentiometer drain from the overboard drain system.
		1.1.1.1.4.3.1	If the leakage is less than 9410 cc/min., reinstall flight hardware and PROCEED.
		1.1.1.1.4.3.2	If the leakage is greater than 9410 cc/min., BACKOUT, replace the main fuel valve potentiometer.
		1.1.1.1.4.4	Isolate the No. 2 main fuel valve potentiometer drain from the overboard drain system.

GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ● Admit LOX ○ Start Auto Sequence

Engine Status

○ Fuel Admitted ○ Live Ordnance Installed ○ Prefill Overflowed ○ LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition	
Leakage from fuel overboard drain line shall not exceed that volumetric flowrate recorded during hydraulic system leak and functional test.	1. Fuel leakage from fuel overboard drain line exceeds the volumetric flowrate recorded during hydraulic system leak and functional test.	1.1.1.1.4.4.1	If the leakage is less than 9410 cc/min., reinstall flight hardware and PROCEED.
		1.1.1.1.4.4.2	If the leakage is greater than 9410 cc/min., BACKOUT, replace the main fuel valve potentiometer.
		1.1.1.1.5	If the source of leakage is not determined by isolating the preceding components, PROCEED.
	2. Prefill leakage from fuel overboard drain line.	2.1	BACKOUT - Remove fuel, prefill, and hypergol. Replace hypergol manifold assembly.

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ○ Admit LOX ● Start Auto Sequence

Engine Status

○ Fuel Admitted ○ Live Ordnance Installed ○ Prefill Overflowed ● LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition	
Leakage from fuel overboard drain line shall not exceed that volumetric flowrate recorded during hydraulic system leak and functional test.	1. Fuel leakage from fuel overboard drain line exceeds the volumetric flowrate recorded during hydraulic system leak and functional test.	1.1	HOLD - Pressurize the fuel tank to maximum permissable level.
		1.1.1	If the leakage rate decreases, depressurize the fuel tank and PROCEED with the launch countdown.
		1.1.1.1	If the leakage rate increases or remains the same, BACKOUT, remove LOX from engine.
		1.1.1.1.1	Measure the leakage rate.
		1.1.1.1.1.1	If the leakage rate is less than 158 cc/min., PROCEED.
		1.1.1.1.1.2	If the leakage rate is greater than 158 cc/min., perform the following:
		1.1.1.1.1.2.1	Disconnect the 1-inch line from the hydraulic drain system from the Y-fitting on the 1-3/4-inch fuel overboard drain line. Cap the Y-fitting.
		1.1.1.1.1.2.2	Install the fuel seal drain manifold adapter P/N 9020907.

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GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ○ Admit LOX ● Start Auto Sequence

Engine Status

○ Fuel Admitted ○ Live Ordnance Installed ○ Prefill Overflowed ● LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition	
Leakage from fuel overboard drain line shall not exceed that volumetric flowrate recorded during hydraulic system leak and functional test.	1. Fuel leakage from fuel overboard drain line exceeds the volumetric flowrate recorded during hydraulic system leak and functional test.	1.1.1.1.1.2.3	Measure the leakage from the inlet port of the adapter (No. 6 seal).
		1.1.1.1.1.2.3.1	If the leakage rate is less than 20 gpm, PROCEED.
		1.1.1.1.1.2.3.2	If the leakage rate is greater than 20 gpm, BACKOUT, replace the engine.
		1.1.1.1.1.2.4	Measure the leakage from the primary port of the adapter (No. 5 seal).
		1.1.1.1.1.2.4.1	If the leakage rate is less than 6.5 gpm, PROCEED.
		1.1.1.1.1.2.4.2	If the leakage rate is more than 6.5 gpm, BACKOUT, replace the engine.
		1.1.1.1.1.2.5	Measure the leakage rate from the overboard drain line. This leakage is bearing coolant valve leakage.
		1.1.1.1.1.2.5.1	If the leakage rate is less than 158 cc/min., PROCEED.
		1.1.1.1.1.2.5.2	If the leakage rate is more than 158 cc/min., BACKOUT, replace bearing coolant valve.

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ○ Admit LOX ● Start Auto Sequence

Engine Status

○ Fuel Admitted ○ Live Ordnance Installed ○ Prefill Overflowed ● LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition	
Leakage from fuel overboard drain line shall not exceed that volumetric flowrate recorded during hydraulic system leak and functional test.	1. Fuel leakage from fuel overboard drain line exceeds the volumetric flowrate recorded during hydraulic system leak and functional test.	1.1.1.1.1.2.6	Measure the leakage rate from the 1-inch hydraulic drain system. If the leakage rate does not exceed 1882 cc/min., PROCEED.
		1.1.1.1.1.2.7	If the leakage rate exceeds 1882 cc/min., perform the following:
		1.1.1.1.1.2.7.1	Isolate the ignition monitor valve vent from the overboard drain system.
		1.1.1.1.1.2.7.1.1	If the leakage is less than 1882 cc/min., reinstall flight hardware and PROCEED.
		1.1.1.1.1.2.7.1.2	If the leakage is greater than 1882 cc/min., BACKOUT, replace the ignition monitor valve.
		1.1.1.1.1.2.7.2	Isolate the redundant shutdown drain from overboard drain system.
		1.1.1.1.1.2.7.2.1	If the leakage is less than 3764 cc/min., reinstall flight hardware and PROCEED.

(Continued on next page)

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ○ Admit LOX ● Start Auto Sequence

Engine Status

○ Fuel Admitted ○ Live Ordnance Installed ○ Prefill Overflowed ● LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition	
Leakage from fuel overboard drain line shall not exceed that volumetric flowrate recorded during hydraulic system leak and functional test.	1. Fuel leakage from fuel overboard drain line exceeds the volumetric flowrate recorded during hydraulic system leak and functional test.	1.1.1.1.1.2.7.2.2	If the leakage is greater than 3764 cc/min., perform the following:
		1.1.1.1.1.2.7.2.2.1	Isolate the engine control valve drain from the overboard drain system. Measure the leakage rate from the redundant shutdown valve.
		1.1.1.1.1.2.7.2.2.1.1	If the leakage is less than 3764 cc/min., reinstall flight hardware and PROCEED.
		1.1.1.1.1.2.7.2.2.1.2	If the leakage exceeds 3764 cc/min., BACKOUT, replace the redundant shutdown valve.
		1.1.1.1.1.2.7.3	Isolate the No. 1 main fuel valve potentiometer drain from the overboard drain system.
		1.1.1.1.1.2.7.3.1	If the leakage is less than 9410 cc/min., reinstall flight hardware and PROCEED.

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GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ○ Admit LOX ● Start Auto Sequence

Engine Status

○ Fuel Admitted ○ Live Ordnance Installed ○ Prefill Overflowed ● LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition	
Leakage from fuel overboard drain line shall not exceed that volumetric flowrate recorded during hydraulic system leak and functional test.	1. Fuel leakage from fuel overboard drain line exceeds the volumetric flowrate recorded during hydraulic system leak and functional test.	1.1.1.1.1.2.7.3.2	If the leakage is greater than 9410 cc/min., BACKOUT, replace the main fuel valve potentiometer.
		1.1.1.1.1.2.7.4	Isolate the No. 2 main fuel valve potentiometer drain from the overboard drain system.
		1.1.1.1.1.2.7.4.1	If the leakage is less than 9410 cc/min., reinstall flight hardware and PROCEED.
		1.1.1.1.1.2.7.4.2	If the leakage is greater than 9410 cc/min., BACKOUT, replace the main fuel valve potentiometer.
		1.1.1.1.1.2.8	If the source of leakage is not determined by isolating the preceding components, PROCEED
	2. Prefill leakage from fuel overboard drain line.	2.1	BACKOUT - Remove fuel, prefill, and hypergol. Replace hypergol manifold assembly.

GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ○ Admit LOX ○ Start Auto Sequence

Engine Status

● Fuel Admitted ● Live Ordnance Installed ● Prefill Overflowed ● LOX Admitted ● Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
Zero liquid leakage from turbopump lube seal drain line.	1. Liquid leakage from drain line	1.1 BACKOUT - Remove propellants, prefill, igniters, and hypergol cartridge from engine. Take investigative action to determine leakage source. Engine replacement may be required.

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ○ Admit LOX ○ Start Auto Sequence

Engine Status

○ Fuel Admitted ● Live Ordnance Installed ● Prefill Overflowed ○ LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
No external fuel leakage allowed.	1. External fuel leakage is noted from engine seal (propellant feed system or hydraulic system).	1.1 CONTINUE to LOX tanking - Isolate leaking source. 1.1.1 If the leak is from the engine hydraulic control system, remove prefill from thrust chamber fuel manifold. Install thrust chamber fuel inlet manifold drain hoses, remove the gas generator combustor drain plug and turn on the low LOX dome-gas generator LOX injector purge. Turn off hydraulic pressure to the engine and monitor for main fuel valve and gas generator ball valve leakage. Reference sheets on leakage past these valves for disposition if leakage occurs. 1.1.1.1 Torque leaking joint to maximum allowed value and verify that fuel leakage stops. 1.1.1.2 BACKOUT - If fuel leakage continues at maximum joint torque, remove fuel from engine. Replace discrepant seal per applicable field manual. 1.1.2 If leak is from engine fuel system joint, torque joint to maximum allowed value and verify that fuel leakage stops.

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GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ○ Admit LOX ○ Start Auto Sequence

Engine Status

○ Fuel Admitted ● Live Ordnance Installed ● Prefill Overflowed ○ LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
No external fuel leakage allowed.	1. External fuel leakage is noted from engine seal (propellant feed system or hydraulic system).	1.1.2.1 BACKOUT - If fuel leakage continues at maximum joint torque remove fuel from engine. Replace discrepant seal per applicable field manual. 1.2 Remove residual fuel from engine external surfaces and replace any fuel wetted thermal insulation panels per applicable field manual.

GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ● Admit LOX ○ Start Auto Sequence

Engine Status

○ Fuel Admitted ○ Live Ordnance Installed ○ Prefill Overflowed ○ LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
No external fuel leakage allowed.	1. External fuel leakage is noted from engine seal (propellant feed system or hydraulic system).	1.1 HOLD - Isolate leakage source. 1.1.1 If the leak is from the engine hydraulic control system, remove prefill from thrust chamber fuel manifold. Install thrust chamber fuel inlet manifold drain hoses, remove the gas generator combustor drain plug and turn on the low LOX dome-gas generator LOX injector purge. Turn off hydraulic pressure to the engine and monitor for main fuel valve and gas generator ball valve leakage. Reference sheets on leakage past these valves for disposition if leakage occurs. 1.1.1.1 Torque joint to maximum allowed value and verify that fuel leakage stops. 1.1.1.2 BACKOUT - If fuel leakage continues at maximum joint torque, remove fuel from engine. Replace discrepant seal per applicable field manual. 1.1.2 If leak is from engine fuel system joint, torque joint to maximum allowed value and verify that fuel leakage stops.

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GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ● Admit LOX ○ Start Auto Sequence

Engine Status

○ Fuel Admitted ○ Live Ordnance Installed ○ Prefill Overflowed ○ LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
No external fuel leakage allowed.	1. External fuel leakage is noted from engine seal (propellant feed system or hydraulic system).	1.1.2.1 BACKOUT - If fuel leakage continues at maximum joint torque remove fuel from engine. Replace discrepant seal per applicable field manual. 1.2 Remove residual fuel from engine external surfaces and replace any fuel wetted thermal insulation panels per applicable field manual.

GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ○ Admit LOX ● Start Auto Sequence

Engine Status

○ Fuel Admitted ○ Live Ordnance Installed ○ Prefill Overflowed ○ LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition	
No external fuel leakage allowed.	1. External fuel leakage noted from engine.	1.1	BACKOUT - Remove LOX from engine, and isolate leakage source.
		1.1.1	If the leak is from the engine hydraulic control system, drain prefill from the thrust chamber fuel inlet manifold. Install thrust chamber fuel inlet manifold drain hoses, remove the gas generator combustor drain plug and turn on the low LOX dome-gas generator LOX injector purge. Turn off hydraulic pressure to the engine and monitor for main fuel valve and gas generator ball valve leakage. Reference sheets on leakage past these valves for disposition if leakage occurs.
		1.1.1.1	Torque joint to maximum allowed value and verify that fuel leakage stops.
		1.1.1.2	BACKOUT - If fuel leakage continues at maximum joint torque, remove fuel from engine and replace discrepant seal per applicable field manual.
		1.1.2	If leak is from engine fuel system joint, torque joint to maximum allowed value and verify that fuel leakage stops.

(Continued on next page)

GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ○ Admit LOX ● Start Auto Sequence

Engine Status

○ Fuel Admitted ○ Live Ordnance Installed ○ Prefill Overflowed ○ LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
No external fuel leakage allowed.	1. External fuel leakage noted from engine.	1.1.2.1 BACKOUT - If fuel leakage continues at maximum joint torque, remove fuel from engine. Replace discrepant seal per applicable field manual. 1.2 Replace any fuel wetted thermal insulation panels per applicable field manual.

GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation

○ Install Live Ordnance ● Prefill Topoff ○ Admit LOX ○ Start Auto Sequence

Engine Status

● Fuel Admitted ● Live Ordnance Installed ○ Prefill Overflowed ○ LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
Main fuel valve leakage without hydraulic pressure applied shall not exceed 500 cc/min. from each valve.	1. Fuel leakage noted from thrust chamber fuel inlet manifold drain hoses at a flowrate above 500 cc/min. per valve.	1.1 BACKOUT - Turn LOX system purge on. Remove prefill, fuel, igniters, and hypergol cartridge from engine. 1.2 Replace discrepant main fuel valve per applicable field manual. 1.3 Reperform all negated leak and functional tests. 1.4 Perform thrust chamber jacket flush, and LOX dome flush if LOX dome contamination is suspected. 1.5 Replace any fuel wetted thermal insulation panels per applicable field manual.

GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ● Admit LOX ○ Start Auto Sequence

Engine Status

● Fuel Admitted ● Live Ordnance Installed ● Prefill Overflowed ○ LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
No main fuel valve leakage allowed with hydraulic pressure applied to engine.	1. Fuel leakage noted from thrust chamber fuel inlet manifold drain hoses.	1.1 BACKOUT - Turn LOX system purge on. Remove prefill, propellants, igniters, and hypergol cartridge from engine. 1.2 Replace discrepant main fuel valve per applicable field manual. 1.3 Reperform all negated leak and functional tests. 1.4 Perform thrust chamber jacket flush if fuel leakage rate exceeded 500 cc/min. Perform LOX dome flush if fuel leakage overflowed injector and LOX system purge was not on. 1.5 Replace any fuel wetted thermal insulation panels per applicable field manual.
	2. Fuel leakage noted from thrust chamber exit.	2.1 BACKOUT - Turn LOX system purge on. Remove prefill, propellants, igniters, and hypergol cartridge from engine. 2.2 Replace discrepant main fuel valve per applicable field manual. 2.3 Reperform all negated leak and functional tests. 2.4 Perform thrust chamber jacket flush, and LOX dome flush if LOX dome contamination is suspected.

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GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ● Admit LOX ○ Start Auto Sequence

Engine Status

● Fuel Admitted ● Live Ordnance Installed ● Prefill Overflowed ○ LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
No main fuel valve leakage allowed with hydraulic pressure applied to engine.	2. Fuel leakage noted from thrust chamber exit.	2.5 Replace any fuel wetted thermal insulation panels per applicable field manual.

GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation ○ Install Live Ordnance ○ Prefill Topoff ○ Admit LOX ● Start Auto Sequence		
Engine Status ○ Fuel Admitted ○ Live Ordnance Installed ○ Prefill Overflowed ● LOX Admitted ○ Auto Sequence		
Nominal Condition	**Nonconformance Condition**	**Recommended Disposition**
No fuel leakage allowed from thrust chamber exit (main fuel valve or gas generator valve).	1. Fuel leakage noted from thrust chamber exit.	1.1 BACKOUT - Turn LOX system purge on. Remove prefill, propellants, igniters, and hypergol cartridge from engine. Determine if leakage is from gas generator valve or main fuel valve. 1.2 Replace discrepant valve per applicable field manual. 1.3 Reperform negated leak and functional tests. 1.4 If main fuel valve is replaced, accomplish the following. 1.4.1 Perform thrust chamber jacket flush, and LOX dome flush if LOX dome contamination is suspected. 1.5 If gas generator valve is replaced, perform gas generator LOX injector flush. 1.6 Replace any fuel wetted thermal insulation panels per applicable field manual.

GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ● Admit LOX ○ Start Auto Sequence

Engine Status

● Fuel Admitted ● Live Ordnance Installed ● Prefill Overflowed ○ LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
No gas generator valve fuel leakage allowed.	1. Fuel leakage noted from gas generator combustor drain port.	1.1 HOLD - Turn ON LOX system purge. 1.1.1 If hydraulic pressure is not applied to the engine, apply 1400 to 1800 psig (1510 to 1870 psia umbilical pressure) hydraulic pressure 1.1.1.1 If leakage stops with hydraulic pressure applied, CONTINUE with the hydraulic system pressurized. 1.1.1.1.1 Perform a gas generator LOX injector flush if gas generator ball valve leakage occurs without the LOX system purge on. 1.1.1.2 If leakage continues with hydraulic pressure applied, BACKOUT. Remove prefill and propellants from engine. 1.1.1.2.1 Replace discrepant gas generator valve per applicable field manual. 1.1.1.2.2 Reperform negated leak and functional tests. 1.1.1.2.3 Perform gas generator LOX injector flush.

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ○ Admit LOX ○ Start Auto Sequence

Engine Status

○ Fuel Admitted ○ Live Ordnance Installed ○ Prefill Overflowed ○ LOX Admitted ● Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
LOX pump inlet pressure shall be within the range of 78.3 to 165 psia from LOX tank pressurization complete to T-19 seconds (monitored as LOX tank ullage pressure).	1. LOX pump inlet pressure is below 78.3 psia as indicated by an outboard LOX suction line pressure below 75.0 psia or the inboard LOX suction line pressure below 76.7 psia.	1.1 HOLD - Verify that gross LOX system leakage does not exist. 1.2 Failure to meet indicated suction line pressures is indicative of gross LOX leakage, a closed LOX prevalve, or instrumentation out of tolerance. 1.3 If gross LOX leakage is observed - BACKOUT. 1.4 If LOX prevalves are closed - BACKOUT. 1.5 If ullage pressure is within redline, LOX prevalves are open, and there is no gross LOX leakage - PROCEED NOTE: LOX suction line pressures are not redlines and are not real time monitored during automatic sequence. An ullage pressure minimum redline of 23.7 psia with a flight mass load redline of 99.8 percent are relied upon to provide sufficient LOX pump inlet pressure.

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GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ○ Admit LOX ○ Start Auto Sequence

Engine Status

○ Fuel Admitted ○ Live Ordnance Installed ○ Prefill Overflowed ○ LOX Admitted ● Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
LOX pump inlet pressure shall be within the range of 78.3 to 165 psia from LOX tank pressurization complete to T-19 seconds (monitored as LOX tank ullage pressure).	2. LOX pump inlet pressure is over 165 psia as indicated by an outboard LOX suction line pressure exceeding 161.7 psia or the inboard LOX suction line pressure exceeding 163.4 psia.	2.1 PROCEED 2.2 Exceeding maximum LOX pump inlet pressure is indicative of out of tolerance instrumentation. NOTE: LOX suction line pressures are not redlines and are not real time monitored during automatic sequence. An ullage pressure maximum redline of 30.2 psia with a maximum flight mass load of 100.2 percent provides a LOX pump inlet pressure of 85.6 psia.

GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ○ Admit LOX ○ Start Auto Sequence

Engine Status

○ Fuel Admitted ○ Live Ordnance Installed ○ Prefill Overflowed ● LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
LOX pump inlet temperature shall be within the range of -275 to -297.5 F from temperature stabilization after initiation of bubbling until initiation of automatic sequence.	1. LOX pump inlet temperature in excess of -275 F as indicated by LOX suction line temperature in excess of -275 F.	1.1 CONTINUE to start of AUTOMATIC SEQUENCE. 1.2 LOX temperature must be stabilized at a value colder than -275 F prior to initiating the automatic sequence. Verify that LOX suction system interconnect valves and prevalves are open, bubbling system is operative, and LOX suction line temperature instrumentation calibration. Thermal pumping is down ducts 2, 4, and 5, and up ducts 1 and 3; therefore temperatures in ducts 2, 4, and 5, and ducts 1 and 3 may be assumed to be equal if all LOX system valves are in the proper position.
	2. LOX pump inlet temperature less than -297.5 F as indicated by LOX suction line temperature less than -297.5.	2.1 PROCEED 2.2 LOX temperature colder than -297.5 F is not detrimental and connot be sustained. Substantially lower temperatures or lower temperatures that appear stablized are indicative of out of tolerance instrumentation systems.

GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ○ Admit LOX ● Start Auto Sequence

Engine Status

○ Fuel Admitted ○ Live Ordnance Installed ○ Prefill Overflowed ○ LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
LOX pump inlet temperature shall be within the range of -275 to -297.5 F from temperature stabilization after initiation of bubbling until initiation of automatic sequence.	1. LOX pump inlet temperature in excess of -275 F as indicated by LOX suction line temperature in excess of -275 F.	1.1 HOLD - LOX temperature must be stablized at a value colder than -275 F prior to starting the engine. Verify LOX suction system interconnect valves and prevalves are open, LOX bubbling system is operative, and flight instrument calibration. Thermal pumping is down ducts No. 2, 4, and 5, and up ducts No. 1 and 3, therefore, temperatures in ducts No. 2, 4, and 5, or 1 and 3 may be assumed to be equal. BACKOUT - If it cannot be verified by other instrumentation or stage functions that the LOX temperature will be colder than -275 F at engine start.
	2. LOX pump inlet temperature less than -297.5 F as indicated by LOX suction line temperature less than -297.5.	2.1 PROCEED 2.2 LOX temperature colder than -297.5 F is not detrimental and cannot be sustained. Substantially lower temperatures or lower temperatures that appear stabilized are indicative of out of tolerance instrumentation systems.

GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ● Admit LOX ○ Start Auto Sequence

Engine Status

○ Fuel Admitted ○ Live Ordnance Installed ○ Prefill Overflowed ○ LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
LOX purity shall be equal to or exceed 99.5 percent oxygen per MIL-P-25508C. Oxidizer purity is normally determined prior to facility storage tank filling and prior to vehicle tanking.	1. Oxidizer purity is less than 99.5 percent by volume when gassified.	1.1 HOLD 1.2 Failure to meet oxygen purity is indicative of a purity determination error or contamination of the oxygen. 1.3 Obtain additional oxygen samples and conduct laboratory analyses to determine correct purity of oxygen and idenity of the contaminates. 1.4 If purity is satisfactory - PROCEED. 1.5 If purity is below 99.5 percent as a result of an inert dilutent (nitrogen, aragon) HOLD - pending special trajectory analysis. NOTES: 1. Engine performance is degraded by inert dilutents. Oxygen dilution of 1 percent (by weight) with nitrogen will lower thrust 35 K, lower engine mixture ratio 0.0058 units, and lower engine specific impulse 2.0 seconds. 2. The effect of returning this oxygen to storage must be assessed by NASA.

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GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ● Admit LOX ○ Start Auto Sequence

Engine Status

○ Fuel Admitted ○ Live Ordnance Installed ○ Prefill Overflowed ○ LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
LOX purity shall be equal to or exceed 99.5 percent oxygen per MIL-P-25508C. Oxidizer purity is normally determined prior to facility storage tank filling and prior to vehicle tanking.	1. Oxidizer purity is less than 99.5 percent by volume when gassified.	1.6 If purity is below 99.5 percent with unsatisfactory hydrocarbon or particulate contamination, HOLD - pending availability of satisfactory oxygen.

GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ○ Admit LOX ○ Start Auto Sequence

Engine Status

○ Fuel Admitted ○ Live Ordnance Installed ○ Prefill Overflowed ● LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
No LOX leakage allowed from primary LOX seal drain line.	1. Liquid leakage is emitting from the LOX seal drain line.	1.1 CONTINUE - To start of AUTOMATIC SEQUENCE. Minor leakage from the drain line is not uncommon during turbopump chilldown. If leakage stops after system is chilled down PROCEED to launch.
	2. Camera monitoring capability is lost.	2.1 CONTINUE to start of AUTOMATIC SEQUENCE. A visual verification of liquid leakage in the form of droplets or less must be made with the seal in a chill condition for launch.

GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ○ Admit LOX ● Start Auto Sequence

Engine Status

○ Fuel Admitted ○ Live Ordnance Installed ○ Prefill Overflowed ○ LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
No LOX leakage allowed from primary LOX seal drain line.	1. Liquid leakage in the form of drops is emitting from the LOX seal drain line.	1.1 PROCEED
	2. Liquid leakage in the form of a steady stream of fluid is emitting from the LOX seal drain line.	2.1 BACKOUT - Remove propellants, prefill, igniters and hypergol cartridge from engine. 2.1.1 Replace turbopump primary LOX seal per applicable field manual.

GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ○ Admit LOX ● Start Auto Sequence

Engine Status

○ Fuel Admitted ○ Live Ordnance Installed ○ Prefill Overflowed ● LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
No external LOX leakage allowed.	1. External LOX leakage noted from engine.	1.1 BACKOUT - Turn on the environmental purge and leave on until LOX is removed from the engine. 1.1.1 Remove LOX from engine and isolate leakage source. 1.1.2 Torque joint to maximum allowed value and verify that leakage stops. 1.1.2.1 If leakage continues at maximum joint torque, replace discrepant seal per applicable field manual. 1.2 Evaluate possible requirement to replace or test components exposed to the external LOX leakage.

GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ○ Admit LOX ● Start Auto Sequence

Engine Status

○ Fuel Admitted ○ Live Ordnance Installed ○ Prefill Overflowed ● LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
No LOX leakage allowed from thrust chamber exit. (Main LOX valves or gas generator ball	1. LOX leakage is detected from the thrust chamber exit.	1.1 BACKOUT - Remove propellants, prefill, igniters, and hypergol from engine. 1.2 Determine if leakage is past main LOX valve or gas generator ball valve. 1.3 Replace discrepant valve per applicable field manual. 1.4 Reperform negated leak and functional tests. 1.5 If gas generator ball valve is replaced, perform gas generator LOX injector flush per applicable field manual, if main LOX valve replaced and LOX dome contamination is suspected, flush LOX dome.

GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ○ Admit LOX ○ Start Auto Sequence

Engine Status

● Fuel Admitted ● Live Ordnance Installed ● Prefill Overflowed ● LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
LOX dome-gas generator LOX injector purge must be on within a pressure range of 120 to 1000 psig any time the engine is gimbaled with prefill in the thrust chamber and when thrust chamber prefill is topped off. Nominal pressure is 220 psig. (Measurement monitored at Lut. System ΔP between measurement and engine interface is 80 psi when interface pressure is 120 psig)	1. Purge goes off during gimbaling or prefill topoff.	1.1 BACKOUT - Remove prefill, LOX, hypergol and igniters from engine. 1.2 Perform LOX dome flush.
	2. Purge pressure between 0 and 120 psig during gimbaling or prefill topoff.	2.1 HOLD - Stop gimbal or prefill topoff operations. Turn off purge pressure to preclude LOX purge check valve chatter. 2.2 If purge pressure dropped below 60 psig, BACKOUT - Remove LOX, prefill, hypergol, and igniters from engine. 2.2.1 Perform LOX dome flush. 2.3 If purge pressure did not drop below 60 psig, adjust purge pressure to be within desired range and PROCEED.
	3. Purge pressure above 1000 psig during gimbaling or prefill topoff.	3.1 HOLD - Stop gimbal or prefill operation, then turn purge off.

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GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ○ Admit LOX ○ Start Auto Sequence

Engine Status

● Fuel Admitted ● Live Ordnance Installed ● Prefill Overflowed ● LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
LOX dome-gas generator LOX injector purge must be on within a pressure range of 120 to 1000 psig any time the engine is gimbaled with prefill in the thrust chamber and when thrust chamber prefill is topped off. Nominal pressure is 220 psig. (Measurement monitored at Lut. System ΔP between measurement and engine interface is 80 psi when interface pressure is 120 psig)	3. Purge pressure above 1000 psig during gimbaling or prefill topoff.	3.2 Readjust pressure within range. If purge system pressure exceeded 3600 psig, turn purge on and perform purge system leak test to verify wrap-around line bellows integrity.
	4. Purge system pressure less than 120 psig or greater than 1000 psig prior to initiating engine gimbal or prefill operation.	4.1 HOLD - Turn purge off. Repair system prior to performing gimbal or prefill operations.
	5. Engine gimbals after last prefill of thrust chamber with low LOX dome-gas generator LOX injector purge ON.	5.1 HOLD - Retop thrust chamber prefill with low dome-gas generator LOX injector purge ON.
	6. Engine gimbals after last prefill of thrust chamber with low LOX dome-gas generator LOX injector purge OFF.	6.1 BACKOUT - Remove LOX, prefill hypergol, and igniters from engine. 6.2 Perform LOX dome flush.

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GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ○ Admit LOX ● Start Auto Sequence

Engine Status

○ Fuel Admitted ○ Live Ordnance Installed ○ Prefill Overflowed ○ LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
LOX dome-gas generator LOX injector purge must be on within a pressure range of 120 to 1000 psig for start of automatic sequence. Nominal pressure is 220 psig. (Measurement monitored at Lut. System ΔP between measurement and engine interface is 80 psi when interface pressure is 120 psig)	1. Purge pressure in range of 0 to 120 psig prior to initiation of or during automatic sequence. 2. Purge pressure above 1000 psig prior to initiation of or during automatic sequence.	1.1 HOLD - Turn purge manual override switch on and verify that purge pressure is within the 120- to 1000-psig range. Then PROCEED. 1.1.1 If the pressure is not within the 120- to 1000-psig range, HOLD - Turn purge off to preclude check valve chatter and correct problem. 2.1 HOLD - Turn purge off. If purge system pressure exceeded 3600 psig, perform purge system leak test to verify wrap-around line bellows integrity.

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GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ● Admit LOX ○ Start Auto Sequence

Engine Status

○ Fuel Admitted ○ Live Ordnance Installed ○ Prefill Overflowed ○ LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
Turbopump intermediate seal purge 60 to 100 psig.	1. Low supply pressure, less than 15 psig or loss of supply pressure.	1.1 HOLD - Correct problem prior to admitting LOX to engine. Verify no fuel leakage emitting from the turbopump lube seal drain line.
	2. Low supply pressure, 15 to 59 psig.	2.1 CONTINUE to start of AUTOMATIC SEQUENCE.
	3. High supply pressure, 101 to 200 psig.	3.1 CONTINUE to start of AUTOMATIC SEQUENCE.
	4. High supply pressure, 200 350 psig.	4.1 HOLD - Turn off purge. Correct problem prior to admitting LOX to engine. 4.2 Verify seal integrity by conducting a quantitative flow test.
	5. High supply pressure, greater than 350 psig.	5.1 BACKOUT - Turn off purge. Replace turbopump intermediate seal per applicable field manual. NOTE: Stage purge system relief valve will relieve at 105 to 115 psig, which will vent down stage purge bottles.

GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ○ Admit LOX ○ Start Auto Sequence

Engine Status

○ Fuel Admitted ○ Live Ordnance Installed ○ Prefill Overflowed ● LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
Turbopump intermediate seal purge 60 to 100 psig.	1. Low supply pressure, less than 15 psig or loss of supply pressure.	1.1 BACKOUT - Remove LOX from engine. 1.2 Correct problem and verify proper seal purge operation.
	2. Low supply pressure, 15 to 59 psig.	2.1 CONTINUE to start of AUTOMATIC SEQUENCE.
	3. High supply pressure, 101 to 200 psig.	3.1 CONTINUE to start of AUTOMATIC SEQUENCE.
	4. High supply pressure 200 to 350 psig.	4.1 BACKOUT - Remove LOX from engine, then turn off purge. Correct problem. 4.2 Verify seal integrity by conducting a quantitative flow test.
	5. High supply pressure, greater than 350 psig.	5.1 BACKOUT - Turn off purge; remove LOX from engine. Replace turbopump intermediate seal. NOTE: Stage purge system relief valve will relieve at 105 to 115 psig which will vent down stage purge bottles.

GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation		
○ Install Live Ordnance ○ Prefill Topoff ○ Admit LOX ● Start Auto Sequence		
Engine Status		
○ Fuel Admitted ○ Live Ordnance Installed ○ Prefill Overflowed ○ LOX Admitted ○ Auto Sequence		
Nominal Condition	Nonconformance Condition	Recommended Disposition
Turbopump intermediate seal purge 60 to 100 psig.	1. Loss of supply pressure or low supply pressure less than 15 psig.	1.1 BACKOUT - Remove LOX from engine. 1.2 Correct problem and verify proper seal purge operation.
	2. Low supply pressure, 15 to 45 psig.	2.1 HOLD - Correct problem.
	3. Low supply pressure, 45 to 59 psig.	3.1 HOLD - Verify no LOX leakage is emitting from the turbopump LOX primary seal drain line and, if so, PROCEED.
	4. High supply pressure, 101 to 200 psig.	4.1 HOLD - Correct problem.
	5. High supply pressure, 200 to 350 psig.	5.1 BACKOUT - Remove LOX from engine, then turn off purge. Correct problem. 5.2 Verify seal integrity by conducting a quantitative flow test.
	6. High supply pressure greater than 350 psig.	6.1 BACKOUT - Turn off purge immediately. Remove LOX from engine, replace turbopump intermediate seal per applicable field manual.

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GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ○ Admit LOX ● Start Auto Sequence

Engine Status

○ Fuel Admitted ○ Live Ordnance Installed ○ Prefill Overflowed ○ LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
Turbopump intermediate seal purge 60 to 100 psig.	6. High supply pressure greater than 350 psig.	NOTE: Stage purge system relief valve will relieve at 105 to 115 psig. This will vent down the stage purge bottles, which would result in insufficient purge gas for the flight. Stage purge bottle pressure is a prelaunch vehicle redline.

GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ○ Admit LOX ● Start Auto Sequence

Engine Status

○ Fuel Admitted ○ Live Ordnance Installed ○ Prefill Overflowed ● LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
Cocoon purge on and purge heater on required 15 to 30 minutes after start of LOX load and at all subsequent times LOX is in engine.	1. Cocoon purge or purge heater inoperative.	1.1 CONTINUE - until engine environmental temperature decreases to 0 F. HOLD - when temperature reaches 0 F and effect cocoon purge system repair. Reference disposition on sheet for engine environmental temperature less than 0 F for additional requirements.

GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation

● Install Live Ordnance ● Prefill Topoff ● Admit LOX ● Start Auto Sequence

Engine Status

● Fuel Admitted ● Live Ordnance Installed ● Prefill Overflowed ● LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
The purity of gaseous nitrogen shall be equivalent to Type I of MIL-P-27401 specification.	1. The moisture content exceeds 26.3 ppm by volume of water vapor at 70 F.	1.1 HOLD - Correct cause of excessive moisture prior to supplying gaseous nitrogen to engine system.
	2. The purity of the nitrogen is less than 99.5 percent nitrogen by volume. (Total hydrocarbon 25 ppm by weight as carbon, 0.5 percent by volume as oxygen, 58.3 ppm by volume as methane.)	2.1 HOLD - Determine extent of nonconformance and evaluate hardware condition on an individual occurrence and application basis.

GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation

○ Install Live Ordnance ● Prefill Topoff ○ Admit LOX ○ Start Auto Sequence

Engine Status

○ Fuel Admitted ○ Live Ordnance Installed ○ Prefill Overflowed ○ LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
Thrust chamber prefill fluid shall be in conformance with specification RB0210-017. Solid particles: no sedament; pH value: 6.5 ±1.5; ethylene glycol percentage by weight: 50 ±1 percent.	1. The prefill fluid contains solid particles which are smaller than 1350 microns.	1.1 PROCEED
	2. The prefill fluid contains solid particles which are larger than 1350 microns.	2.1 HOLD - Filter the prefill fluid to obtain acceptable particle sizes prior to introducing the prefill fluid into the thrust chamber.
	3. The pH of the prefill fluid is less than 5.0.	3.1 PROCEED
	4. The pH of the prefill fluid is greater than 8.0.	4.1 PROCEED
	5. The prefill fluid contains from 50 to 60 percent ethylene glycol by weight.	5.1 PROCEED
	6. The prefill fluid contains more than 60 percent ethylene glycol by weight.	6.1 HOLD - Add distilled or deionized water to the prefill fluid to obtain an acceptable polution by weight.
	7. The prefill fluid contains from 45 to 50 percent ethylene glycol by weight.	7.1 PROCEED
	8. The prefill fluid contains less than 45 percent ethylene glycol by weight.	8.1 HOLD - Obtain prefill fluid that meets the specification requirement.

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GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation

○ Install Live Ordnance ● Prefill Topoff ○ Admit LOX ○ Start Auto Sequence

Engine Status

● Fuel Admitted ● Live Ordnance Installed ○ Prefill Overflowed ○ LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
Drain hoses must not be removed from the fuel inlet manifold drainage quick disconnects until after the final application of hydraulic supply pressure to the engine if main fuel valve leakage has occurred without hydraulic pressure applied.	1. Drain hoses are removed prior to final application of hydraulic supply pressure.	1.1 HOLD - Turn LOX system purge on. Accomplish either step 1.1.1 or 1.1.2, whichever is faster. 1.1.1 Install drain hoses on the fuel inlet manifold drain quick disconnects and leave installed until after hydraulic pressure is applied. Measure initial volume of fuel which drains. 1.1.2 Apply hydraulic supply pressure. Then install drain hoses on the fuel inlet manifold drain quick disconnects and measure total volume of fuel which drains. 1.1.3 If fuel volume measured in step 1.1.1 or 1.1.2 exceeds 13 ounces, perform a thrust chamber fuel jacket flush. Perform a thrust chamber LOX dome flush after removing the hypergol cartridge if the LOX dome is suspected to be contaminated. Then PROCEED. 1.1.3.1 If fuel volume measured in step 1.1.1 or 1.1.2 is less than 13 ounces, PROCEED.

GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation

○ Install Live Ordnance ● Prefill Topoff ○ Admit LOX ○ Start Auto Sequence

Engine Status

○ Fuel Admitted ○ Live Ordnance Installed ○ Prefill Overflowed ○ LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
Thrust chamber fuel jacket must be prefilled to injector overflow. Prefill overflow must be visually verified.	1. Thrust chamber is noted not to exhibit overflow on one or more engines.	1.1 HOLD - Correct problem. PROCEED after visually verifying prefill overflow. 1.1.1 If thrust chamber does not prefill due to sticking check valve, replace check valve per applicable field manual, verify torqueing procedure and record torque values. Waive throat plug leak check.

GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ○ Admit LOX ● Start Auto Sequence

Engine Status

○ Fuel Admitted ○ Live Ordnance Installed ○ Prefill Overflowed ● LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
Thrust chamber pre-fill must be topped off post last engine gimbal test.	1. Thrust chamber prefill topoff system inoperative.	1.1 PROCEED

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ○ Admit LOX ○ Start Auto Sequence

Engine Status

○ Fuel Admitted ○ Live Ordnance Installed ● Prefill Overflowed ● LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
Engine attitude.	1. Engine attitude exceeds 2.5 degrees from true horizontal after last topoff.	1.1 HOLD - Correct gimbal system problem to restore engine attitude within limits. If low LOX dome purge was on when engine attitude change occurred, topoff prefill in thrust chamber post attitude correction. 1.2 If low LOX dome purge was not on when engine attitude change occurred, BACKOUT - Drain LOX from engine and prefill from thrust chamber. 1.2.1 Remove hypergol and igniters from engine. 1.2.2 Perform LOX dome flush.

GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ○ Admit LOX ● Start Auto Sequence

Engine Status

● Fuel Admitted ● Live Ordnance Installed ● Prefill Overflowed ● LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
No internal or external prefill leakage is allowed from thrust chamber	1. Internal leakage of prefill fluid, not breaking from wall (seeper leak).	1.1 HOLD - Drain prefill below level of leak.
		1.2 Clean area around leak.
		1.3 Repair with silicon adhesive sealant RTV-102 (General Electric) or aluminum tape.
		1.4 Refill chamber and PROCEED.
	2. Internal leakage or prefill fluid breaking from wall.	2.1 BACKOUT - Drain prefill from thrust chamber, remove hypergol, igniters, and LOX from engine.
		2.2 Repair the thrust chamber per R-3896-3, (Vol II).
		2.3 Flush LOX dome at conclusion of weld repair and conduct throat plug leak check after completion of dome flush.
	3. External leakage of prefill.	3.1 BACKOUT - Drain prefill from thrust chamber. Remove hypergol, igniters, and LOX from engine.
		3.2 Repair the thrust chamber per R-3896-3, (Vol II).
		3.3 Flush LOX dome at conclusion of weld repair and conduct throat plug leak check after completion of dome flush.

(Continued on next page)

GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ○ Admit LOX ● Start Auto Sequence

Engine Status

● Fuel Admitted ● Live Ordnance Installed ● Prefill Overflowed ● LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
No internal or external prefill leakage is allowed from thrust chamber.	3. External leakage of prefill.	3.4 Remove external prefill leakage from engine and TIS surfaces, and replace TIS panels, which are internally wet with prefill.
	4. Prefill leakage from any thrust chamber fitting.	4.1 HOLD - Torque fitting to maximum value. 4.2 If leakage continues, BACKOUT - remove prefill from thrust chamber. Replace fitting and/or seal to correct leakage. 4.3 If leakage cannot be stopped per 4.2, consider welding fitting to stop leak. (Requires removal of LOX and ordnance from engine). 4.4 Remove external prefill leakage from engine and TIS surfaces, and replace TIS panels, which are internally wet with prefill.

GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ○ Admit LOX ○ Start Auto Sequence

Engine Status

● Fuel Admitted ● Live Ordnance Installed ● Prefill Overflowed ● LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
d-c electrical power 24 to 32 vdc under load conditions.	1. Loss of d-c power or less than 18 volts.	1.1 HOLD - Correct problem.
		1.1.1 Verify that d-c power distribution to engine is normal and that all propellant valves are in the close position. Then PROCEED after correcting problem.
	2. Low d-c voltage (18 to 24)	2.1 CONTINUE to start AUTOMATIC SEQUENCE. Voltage at four-way valve and checkout valve must be greater than 18 vdc when valves are actuating. (equivalent no-load buss voltage of approximately 22 vdc). Problems may be encountered with reliable facility relay operation.
	3. High d-c voltage (32 to 36 vdc).	3.1 CONTINUE to start AUTOMATIC SEQUENCE.
	4. High d-c voltage (greater than 36 vdc).	4.1 BACKOUT - Turn off electrical power and effect repair. Conduct an electrical functional check of the following components: main LOX valves, main fuel valves and gas generator valve position indicators, hypergol installed switch, checkout valve position switch, igniter circuits, flight instruments (calibration) and turbopump heater thermostats.

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GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ○ Admit LOX ● Start Auto Sequence

Engine Status

○ Fuel Admitted ○ Live Ordnance Installed ○ Prefill Overflowed ○ LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
d-c electrical power, 24 to 32 vdc under load conditions.	1. Loss of d-c power or less than 18 volts.	1.1 HOLD - Correct problem. 1.1.1 Verify that d-c power distribution to engine is normal and that all propellant valves are in the close position. Then PROCEED after correcting problem.
	2. Low d-c voltage (18 to 24).	2.1 HOLD - Cycle checkout valve to determine buss voltage during valve actuation. If load voltage is greater than 18 vdc equivalent at engine CCP, PROCEED. Problems may be encountered with attaining reliable facility relay operation.
	3. High d-c voltage (32 to 36 vdc).	3.1 PROCEED.
	4. High d-c voltage (greater than 36 vdc).	4.1 BACKOUT - Turn off electrical power and effect repair. Ensure that no engine damage was sustained which would present a hazard. Conduct an electrical functional check of the following components: main LOX valves, main fuel valves, and gas generator valve position indicators, hypergol installed switch, checkout valve position switch, igniter circuits, flight instruments (calibration) and turbopump heater thermostats.

GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ● Admit LOX ○ Start Auto Sequence

Engine Status

○ Fuel Admitted ○ Live Ordnance Installed ○ Prefill Overflowed ● LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
Turbopump heater a-c electrical power 190 to 220 vac under load conditions (heater power is turned on when LOX is admitted to engine).	1. Loss of a-c power or low voltage less than 190 vac.	1.1 CONTINUE to start AUTOMATIC SEQUENCE - Correct problem. Consider turbopump bearing temperature requirements. Turn cocoon purge on to assist in maintaining the minimum required turbopump bearing temperature.
	2. High voltage (220 to 240 vac).	2.1 PROCEED
	3. High voltage (greater than 240 vac).	3.1 HOLD - Turn off a-c power to turbopump heaters. Correct problem. Turn cocoon purge on to assist in maintaining the minimum required turbopump bearing temperature, then PROCEED.

GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ○ Admit LOX ● Start Auto Sequence

Engine Status

○ Fuel Admitted ○ Live Ordnance Installed ○ Prefill Overflowed ○ LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
Turbopump heater a-c electrical power 190 to 220 vac under load condition	1. Loss of a-c power or low voltage, less than 190 vac.	1.1 HOLD - Verify that LOX pump bearing temperature is 0 F or greater prior to proceeding. If less than 0 F, see page covering turbopump bearing temperature requirements for disposition.
	2. High voltage (220 to 240 vac).	2.1 PROCEED.
	3. High voltage (greater than 240 vac).	3.1 HOLD - Turn off a-c power to turbopump heaters. If LOX pump bearing temperature is greater than 0 F, PROCEED.

GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ○ Admit LOX ○ Start Auto Sequence

Engine Status

● Fuel Admitted ● Live Ordnance Installed ● Prefill Overflowed ● LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
Pyrotechnic igniter a-c electrical power 500 to 750 vac under load conditions.	1. Low voltage, less than 400 vac.	1.1 CONTINUE to start AUTOMATIC SEQUENCE - Must be corrected prior to igniter firing.
	2. Low voltage 400 to 500 vac.	2.1 PROCEED
	3. High voltage, 750 to 1000 vac.	3.1 PROCEED
	4. High voltage, greater than 1000 vac.	4.1 CONTINUE to start AUTOMATIC SEQUENCE - Must be corrected prior to igniter firing.

GUIDELINES FOR LAUNCH COUNTDOWN

<u>Pending Operation</u>

○ Install Live Ordnance ○ Prefill Topoff ○ Admit LOX ● Start Auto Sequence

<u>Engine Status</u>

○ Fuel Admitted ○ Live Ordnance Installed ○ Prefill Overflowed ○ LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
Pyrotechnic igniter a-c electrical power 500 to 750 vac under load conditions.	1. Low voltage, less than 400 vac.	1.1 HOLD - Correct problem. <u>NOTE</u>: Proceeding with less than 400 vac may result in a cutoff due to failure of the igniters to fire.
	2. Low voltage, 400 to 500 vac.	2.1 PROCEED.
	3. High voltage, 750 to 1000 vac.	3.1 PROCEED.
	4. High voltage, greater than 1000 vac.	4.1 HOLD - Correct problem. <u>NOTE</u>: Proceeding with greater than 1000 vac may result in failure of an igniter harness or igniter which would result in a cutoff due to a failure of the igniters to fire.

GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation

○ Install Live Ordnance ● Prefill Topoff ○ Admit LOX ○ Start Auto Sequence

Engine Status

● Fuel Admitted ● Live Ordnance Installed ○ Prefill Overflowed ○ LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
Main LOX valves (2), main fuel valves (2) gas generator valve CLOSE indications are required any time d-c power is applied to the engine.	1. One valve CLOSE indication is not received; or one valve OPEN indication is received; or both OPEN and CLOSED indications are received.	1.1 HOLD - If hydraulic pressure is not applied to the engine, apply hydraulic pressure. 1.2 If valve closed indication is not received with hydraulic pressure applied, accomplished the following action for the approximate valve. 1.2.1 Main fuel valve position - correct problem, if main fuel valve position switch is defective, BACKOUT - remove the prefill, hypergol, and ignition from engine. Replace position indicator per applicable field manual and accomplish checkout per established procedure. 1.2.2 Main LOX or gas generator valve position - use appropriate "work-around" procedures to provide the interlock indications required to CONTINUE through launch, then PROCEED. 1.3 If valve closed indication is received with hydraulic pressure applied, accomplish the following action for the appropriate valve.

(Continued on next page)

GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ● Admit LOX ○ Start Auto Sequence

Engine Status

○ Fuel Admitted ○ Live Ordnance Installed ● Prefill Overflowed ○ LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
Main LOX valves (2), main fuel valves (2) gas generator valve CLOSE indications are required any time d-c power is applied to the engine.	1. One valve CLOSE indication is not received; or one valve OPEN indication is received; or both OPEN and CLOSED indications are received.	1.3.1 Main fuel valve position - drain thrust chamber fuel manifold with hydraulic pressure applied. Inspect prefill fluid for evidence of fuel. If more than 13 ounces of fuel is detected in the prefill fluid, BACKOUT - remove prefill, hypergol and igniters from engine and perform a fuel jacket flush. If LOX dome contamination is suspected, perform a LOX dome flush. 1.3.2 Main LOX valve position - PROCEED. 1.3.3 Gas generator valve position - Inspect gas generator combustor drain for evidence of fuel. If fuel is detected and the LOX purge was not on, BACKOUT - remove igniters from engine and perform a flush of the gas generator LOX injector.

GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ● Admit LOX ○ Start Auto Sequence

Engine Status

○ Fuel Admitted ○ Live Ordnance Installed ● Prefill Overflowed ○ LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
Main LOX valves (2), main fuel valves (2), gas generator valve CLOSE indications are required for stage LOX tanking.	1. One valve CLOSE indication is not received; or one valve OPEN indication is received; or both OPEN and CLOSED indications are received.	1.1 If hydraulic pressure was not lost, HOLD. 1.1.1 If main fuel valve indicator, correct problem. If indicator is defective, BACKOUT - remove propellants, prefill, hypergol, and igniters, replace position indicator per field manual, and accomplish checkout per established procedure. 1.1.2 If main LOX valve or gas generator valve, use appropriate "work-around" procedure to provide valve position interlocks required to CONTINUE through launch, then PROCEED. 1.2 Hydraulic pressure was lost, and if the gas generator valve did leave the closed position and returns closed or remains off the closed position, HOLD. 1.2.1 Inspect gas generator combustor drain for evidence of fuel. If fuel noted and the gas generator LOX system purge was not on when the leakage occurred, perform a flush of the gas generator LOX injector after removing igniter.

(Continued on next page)

GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ● Admit LOX ○ Start Auto Sequence

Engine Status

○ Fuel Admitted ○ Live Ordnance Installed ● Prefill Overflowed ○ LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
Main LOX valves (2), main fuel valves (2), gas generator valve CLOSE indications are required for stage LOX tanking.	1. One valve CLOSE indication is not received; or one valve OPEN indication is received; or both OPEN and CLOSED indications are received.	1.3 If hydraulic pressure was lost and if the main fuel valve position indicated the valve left close, HOLD - drain thrust chamber fuel manifold with hydraulic pressure applied and inspect prefill fluid for evidence of fuel. If more than 13 ounces of fuel is detected, BACK-OUT - remove prefill, hypergol, and igniters and perform fuel jacket flush. If LOX dome contamination is suspected perform LOX dome flush. 1.4 If hydraulic pressure was lost and if the main LOX valve momentarily left the closed position, PROCEED.

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ○ Admit LOX ● Start Auto Sequence

Engine Status

○ Fuel Admitted ○ Live Ordnance Installed ○ Prefill Overflowed ● LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
Main LOX valves (2), main fuel valves (2), gas generator valve CLOSE indications are required for start of AUTOMATIC SEQUENCE.	1. One valve CLOSE indication is not received; or one valve OPEN indication is received; or both OPEN and CLOSED indications are received.	1.1 If hydraulic pressure was not lost, HOLD. 1.1.1 If main fuel valve indicator, correct problem. If indicator is defective, BACKOUT - remove propellants, prefill, hypergol, and igniters, replace position indicator per established field manual, and accomplish checkout per established procedure. 1.1.2 If main LOX valve or gas generator valve, use appropriate "work-around" procedure to provide valve position interlocks required to CONTINUE through launch, then PROCEED. 1.2 If hydraulic pressure was lost and if the gas generator valve did leave the closed position and returns closed or remains off the closed position, BACKOUT - Remove propellants from engine and correct problem. CAUTION: Explosive gel may have formed, DO NOT DISTURB. If LOX system purge is ON, leave ON, but do NOT turn purge on if it is off. DO NOT GIMBAL.

(Continued on next page)

GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ○ Admit LOX ● Start Auto Sequence

Engine Status

○ Fuel Admitted ○ Live Ordnance Installed ○ Prefill Overflowed ● LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
Main LOX valves (2), main fuel valves (2), gas generator valve CLOSE indications are required for start of AUTOMATIC SEQUENCE.	1. One valve CLOSE indication is not received; or one valve OPEN indication is received; or both OPEN and CLOSED indications are received.	1.3 If hydraulic pressure was lost and if the main fuel valve position indicated the valve left close, HOLD - drain thrust chamber fuel manifold with hydraulic pressure applied and inspect prefill fluid for evidence of fuel. If more than 13 ounces of fuel is detected, BACKOUT - Remove LOX, prefill, hypergol, and igniters, and perform fuel jacket flush. If LOX dome contamination is suspected, perform LOX dome flush. 1.4 If hydraulic pressure was lost and if the main LOX valve momentarily left the closed position, PROCEED.

GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ● Admit LOX ○ Start Auto Sequence

Engine Status

● Fuel Admitted ● Live Ordnance Installed ● Prefill Overflowed ○ LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
Checkout valve must be in the ground position when hydraulic pressure is applied to the engine.	1. Checkout valve indicates some position other than, or in addition to, the ground position.	1.1 HOLD - Cycle checkout valve to ground position. If ground position is not attained in 4 seconds, remove power to preclude motor burnout. 1.1.1 Determine if problem is associated with the checkout valve actuator or the ground control system. 1.1.2 If the problem is associated with the ground control system, conduct cycling tests as required to verify that the checkout valve will attain the desired position at the proper time and that the correct indication will be received at that time. Then PROCEED. 1.1.3 If the actuator is defective, replace actuator per applicable field manual.

GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ○ Admit LOX ● Start Auto Sequence

Engine Status

● Fuel Admitted ● Live Ordnance Installed ● Prefill Overflowed ● LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
Checkout valve stage position switch must not be picked up prior to AUTOMATIC SEQUENCE.	1. Checkout valve stage position switch is picked up prior to AUTOMATIC SEQUENCE.	1.1 BACKOUT - Remove LOX from engine. Replace actuator per applicable field manual.

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ○ Admit LOX ● Start Auto Sequence

Engine Status

○ Fuel Admitted ○ Live Ordnance Installed ○ Prefill Overflowed ● LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
Checkout valve must be in the ground position for start of AUTOMATIC SEQUENCE.	1. Checkout valve indicates some position other than, or in addition to, the ground position.	1.1 HOLD - Cycle checkout valve to ground position. If ground position is not attained in 4 seconds. BACKOUT - Remove power to preclude motor burnout 1.1.1 Turn cocoon purge on and leave on until oxidizer is removed from the engine. Reduce hydraulic pressure to minimum value at which the hydraulic pumping unit will satisfactorily operate, but not less than 400 psig. 1.1.2 Remove LOX from engine and turn off hydraulic pressure. See sheets on hydraulic pressure loss for further disposition. 1.1.3 Determine if the problem is associated with the checkout valve actuator or the ground control system. 1.1.4 If the problem is associated with the ground control system, conduct cycling tests as required to verify that the checkout valve will attain the desired position at the proper time and that the correct indication will be received at that time. Then PROCEED.

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GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ○ Admit LOX ● Start Auto Sequence

Engine Status

○ Fuel Admitted ○ Live Ordnance Installed ○ Prefill Overflowed ● LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
Checkout valve must be in the ground position for start of AUTOMATIC SEQUENCE.	1. Checkout valve indicates some position other than, or in addition to, the ground position.	1.1.5 If the actuator is defective replace actuator per applicable field manual. NOTE: The checkout valve motor will burn out if power is applied to a stalled motor in excess of approximately 30 seconds (position switches turn off power to the motor). If the checkout valve remains in the engine position for 20 minutes, the ground hydraulic pumping unit reservoir low level switch will pickup with automatic shutdown of the hydraulic pumping unit. See sheet on RP-1 contaminated with RJ-1 for further disposition.

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ○ Admit LOX ○ Start Auto Sequence

Engine Status

○ Fuel Admitted ○ Live Ordnance Installed ○ Prefill Overflowed ○ LOX Admitted ● Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
Checkout valve must be in the stage position prior to initiation of forward umbilical disconnect signal and igniter firing signal.	1. Checkout valve fails to attain the stage position during the AUTOMATIC SEQUENCE resulting in automatic cutoff.	1.1 HOLD - Verify that checkout valve returned to the ground position.
		1.2 Determine if the problem is associated with the checkout valve actuator or the ground control system.
		1.2.1 If the problem is associated with the ground control system, conduct cycling tests as required to verify that the checkout valve will attain the engine position at the proper time and that the correct indication will be received at that time. Then PROCEED.
		1.2.2 If the actuator is defective, replace the actuator per applicable field manual.
		1.3 If the checkout valve is not in the ground position, cycle checkout valve to ground position. If ground position is not attained in 4 seconds, BACKOUT - Remove power to preclude motor burnout.
		1.3.1 Turn cocoon purge on and leave on until oxidizer is removed from the engine. Reduce hydraulic pressure to minimum value at which the hydraulic pumping unit will satisfactorily operate, but not less than 400 psig.

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GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ○ Admit LOX ○ Start Auto Sequence

Engine Status

○ Fuel Admitted ○ Live Ordnance Installed ○ Prefill Overflowed ○ LOX Admitted ● Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
Checkout valve must be in the stage position prior to initiation of forward umbilical disconnect signal and igniter firing signal.	1. Checkout valve fails to attain the stage position during the AUTOMATIC SEQUENCE resulting in automatic cutoff.	1.3.2 Remove LOX from engine and turn off hydraulic pressure. See sheets on hydraulic pressure loss for further disposition. 1.3.3 Correct problem per steps 1.2.1. 1.3.4 If the actuator is defective, replace actuator per applicable field manual. NOTE: If the checkout valve remains in the engine position for 20 minutes the ground hydraulic pumping unit reservoir low level switch will pickup with automatic shutdown of the hydraulic pumping unit. See sheet on RP-1 contaminated with RJ-1 for further disposition.

GUIDELINES FOR LAUNCH COUNTDOWN

<u>Pending Operation</u>

● Install Live Ordnance ○ Prefill Topoff ○ Admit LOX ● Start Auto Sequence

<u>Engine Status</u>

○ Fuel Admitted ● Live Ordnance Installed ● Prefill Overflowed ● LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
Hypergol cartridge installed switch must actuate when cartridge is installed and remained actuated to serve as an interlock. Cartridge cap must be screwed on by hand torque only.	1. Light does not go on when cartridge is installed or light goes off after cartridge installation, prior to engine start.	1.1 HOLD - Perform an electrical continuity check of the switch. 1.1.1 If switch is determined to be picked up, PROCEED. Switch must be dropped out prior to main fuel valve opening or a cutoff will result. Take necessary action in facility circuit to ensure that the switch pick-up signal can <u>NOT</u> be received. <u>NOTE</u>: Switch installed indication may be interlocked for start of AUTOMATIC SEQUENCE. If this condition exists, additional facility circuit modifications must be made. 1.1.2 If switch is determined to be not picked up, BACKOUT - Replace switch. 1.1.3 When switch is removed from the hypergol manifold, determine position of diaphragm follower by taking measurements from the manifold switch attach surface to the diaphragm follower inside the manifold. 1.1.3.1 If dimension is 1.340 ±0.006 inches, the diaphragm follower is retracted, indicating the cartridge is safe to remove. Install new switch after cartridge removal.

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GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation

● Install Live Ordnance ○ Prefill Topoff ○ Admit LOX ● Start Auto Sequence

Engine Status

○ Fuel Admitted ● Live Ordnance Installed ● Prefill Overflowed ● LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
Hypergol cartridge installed switch must actuate when cartridge is installed and remained actuated to serve an an interlock. Cartridge cap must be screwed on by hand torque only.	1. Light does not go on when cartridge is installed or light goes off after cartridge installation, prior to engine start.	1.1.3.1.1 Verify proper switch and follower operation by use of the GSE tool prior to reinstalling the cartridge. 1.1.3.2 If dimension is 1.440 ±0.009 inches, the diaphragm follower is extended, indicating the cartridge diaphragm is ruptured. Remove the cartridge by use of the live cartridge removal procedure. Correct problem. 1.1.3.2.1 Verify proper operation of hypergol diaphragm follower by use of a GSE tool.
	2. Cartridge cap cannot be screwed on by hand torque.	2.1 HOLD - Verify proper operation of hypergol diaphragm follower by use of a GSE tool. Correct problem.

GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation

● Install Live Ordnance ○ Prefill Topoff ○ Admit LOX ○ Start Auto Sequence

Engine Status

○ Fuel Admitted ● Live Ordnance Installed ○ Prefill Overflowed ○ LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
Pyrotechnic igniters (4) installed indication is present after electrical connection of the igniters.	1. Pyrotechnic igniter installed signal not received when circuit is completed.	1.1 HOLD - Correct problem.

GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ○ Admit LOX ○ Start Auto Sequence

Engine Status

○ Fuel Admitted ● Live Ordnance Installed ● Prefill Overflowed ● LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
Pyrotechnic igniters (4) installed indication is present after electrical connection of the igniters.	1. Pyrotechnic igniter installed signal lost after igniter installation.	1.1 CONTINUE to start AUTOMATIC SEQUENCE. Correct problem. 1.2 If it is determined that a gas generator igniter has accidently fired and LOX system purge was off, BACKOUT - Remove LOX and igniters and flush gas generator LOX injector. Take appropriate action to correct condition responsible for the igniter firing. 1.3 If it is determined that a gas generator igniter has accidently fired and the LOX system purge was ON, PROCEED after replacing the igniter and eliminating the condition responsible for firing the igniter. 1.4 If it is determined that a nozzle extension igniter has accidently fired, replace igniter and PROCEED after eliminating the condition responsible for firing the igniter.

GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ○ Admit LOX ● Start Auto Sequence

Engine Status

○ Fuel Admitted ○ Live Ordnance Installed ○ Prefill Overflowed ○ LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
Pyrotechnic igniters (4) installed indication is required to start AUTOMATIC SEQUENCE.	1. Pyrotechnic igniter installed signal lost after igniter installation.	1.1 HOLD - Correct problem. 1.2 If it is determined that a gas generator igniter has accidently fired and LOX system purge was OFF, BACKOUT - Remove LOX, and igniters and flush gas generator LOX injector. Take appropriate action to correct condition responsible for the igniter firing. 1.3 If it is determined that a gas generator igniter has accidently fired and the LOX system purge was ON, PROCEED after replacing the igniter and eliminating the condition responsible for firing the igniter. 1.4 If it is determined that a nozzle extension igniter has accidently fired, replace igniter and PROCEED after eliminating the condition responsible for firing the igniter.

GUIDELINES FOR LAUNCH COUNTDOWN

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Engine Status

● Fuel Admitted ● Live Ordnance Installed ● Prefill Overflowed ● LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
Calibration of flight instrumentation. Redline parameters (3 steps: ambient, 20 percent, and 80 percent).	1. Calibration voltage output out of specification limits (1 of 3 steps or a zero shift).	1.1 PROCEED - (If a zero shift was observed determine the amount of shift bias for use when reviewing future measurements recorded by the affected transducers).
	2. Calibration voltage output out of specification limits (2 of 3 steps, all 3 steps, or complete failure of output signal).	
	2.1 Turbopump LOX bearing temperature.	2.1.1 HOLD - Switch to alternate redline, verify heater normal light is ON, if ON, PROCEED. Monitor the normal light until T-187 seconds. NOTE: If the facility circuit utilizes the heater thermostat low- and high-temperature indication as interlocks from LOX admittance to start of AUTOMATIC SEQUENCE, this redline temperature measurement can be deleted.
	2.2 Engine environmental temperature.	2.2.1 PROCEED - Utilize measurement on another engine for redline monitoring.

GUIDELINES FOR LAUNCH COUNTDOWN

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Engine Status

● Fuel Admitted ● Live Ordnance Installed ● Prefill Overflowed ● LOX Admitted ● Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
Calibration of flight instrumentation non-redline parameter pressure transducers (3 steps: ambient, 20 percent, and 80 percent).	1. Calibration voltage output out of specification limits (1 of 3 steps)	1.1 PROCEED
	2. Calibration voltage output out of specification limits (2 of 3 steps with backup).	2.1 PROCEED
	3. Calibration voltage output out of specification limits (2 of 3 steps no backup).	3.1 PROCEED
	4. Calibration voltage output out of specification limits (zero shift).	4.1 PROCEED

GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation
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Engine Status
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Nominal Condition	Nonconformance Condition	Recommended Disposition
Engine environmental temperature above 0 F required (inside cocoon) from LOX admittance to engine until start of AUTOMATIC SEQUENCE.	1. Engine environmental temperature less than 0 F.	1.1 CONTINUE until temperature reaches -10 F. 1.1.1 When temperature reaches -10 F, HOLD - If corrected temperature is above -10 F, PROCEED. 1.1.2 If corrected temperature is less than -10 F, BACKOUT - Inspect for LOX leakage from cocoon. Remove LOX from engine. 1.1.3 Inspect for external fuel leakage and leakage from fuel overboard drain line, reference fuel drain line and external fuel leakage sheets. 1.1.4 With hydraulic supply pressure applied, drain the prefill fluid from the thrust chamber manifold and measure the volume of fuel in the prefill fluid. If more than 13 ounces of fuel is present, BACKOUT - Perform a thrust chamber jacket flush after LOX, prefill, hypergol, have been removed from the engine.

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GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ○ Admit LOX ○ Start Auto Sequence

Engine Status

○ Fuel Admitted ○ Live Ordnance Installed ○ Prefill Overflowed ● LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
Turbopump LOX bearing temperature above 0 F from LOX loading to start of AUTOMATIC SEQUENCE.	1. Turbopump LOX bearing temperature less than 0 F.	1.1 CONTINUE to start AUTOMATIC SEQUENCE - Correct problem.
	2. Turbopump LOX bearing temperature greater than 200 F.	2.1 HOLD - Turn heater power off, then PROCEED. Turn ON and OFF as required. To maintain bearing temperature in a range of 0 to 200 F (80 to 130 F is normal).

GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ○ Admit LOX ● Start Auto Sequence

Engine Status

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Nominal Condition	Nonconformance Condition	Recommended Disposition
Turbopump LOX bearing temperature above 0 F from LOX loading to start of AUTOMATIC SEQUENCE	1. Turbopump LOX bearing temperature less than 0 F.	1.1 HOLD - Determine predicted bearing temperature at engine start based on bearing temperature decay rate vs engine environmental temperature. If bearing temperature is predicted to be greater than -10 F at engine start PROCEED. NOTE: Reference Figure 4 to determine predicted bearing temperature.
	2. Turbopump LOX bearing temperature greater than 200 F.	2.1 HOLD - Turn heater power OFF, then PROCEED.

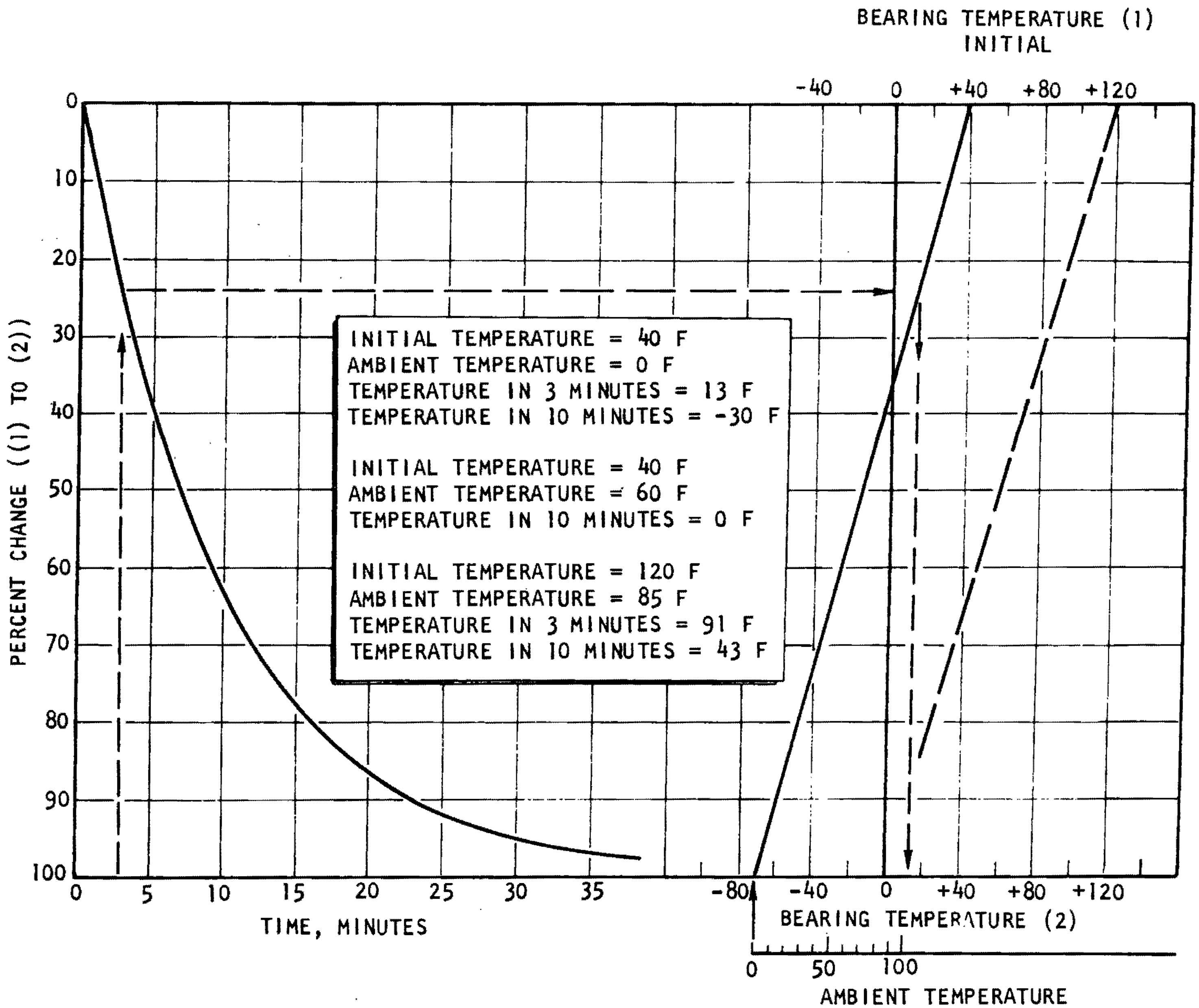

Figure 4. Engine Environmental Temperature vs Turbopump Bearing Temperature

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GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation

○ Install Live Ordnance ○ Prefill Topoff ○ Admit LOX ● Start Auto Sequence

Engine Status

● Fuel Admitted ● Live Ordnance Installed ● Prefill Overflowed ● LOX Admitted ○ Auto Sequence

Nominal Condition	Nonconformance Condition	Recommended Disposition
Thrust OK pressure switch calibration. Pickup pressure $1060 \begin{matrix} +65 \\ -65 \end{matrix}$ Dropout pressure 50 to 100 psig below pickup pressure.	1. High calibration pickup pressure (greater than 1125 psig).	1.1 BACKOUT - Replace pressure switch per applicable field manual, record fastener torques, waive throat plug leak check.
		1.2 Conduct a pressure switch calibration.
	2. Low calibration pickup pressure (less than 995 psig).	2.1 HOLD
		2.2 Determine that other 2 switches on engine are within acceptable limits.
		2.3 PROCEED - If pressures of other 2 switches are within acceptable limits.
		2.4 BACKOUT - If pressure of another switch on same engine is outside acceptable limits. Replace both pressure switches per applicable field manual, record fastener torques, waive throat plug leak check.
		2.4.1 Conduct a pressure switch calibration.
	3. Differential pressure less than or greater than specified	3.1 HOLD
		3.2 Determine that other 2 switches on engine are within acceptable limits.
		3.3 PROCEED - If pressures of other 2 switches are within acceptable limits.

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GUIDELINES FOR LAUNCH COUNTDOWN

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Nominal Condition	Nonconformance Condition	Recommended Disposition
Thrust OK pressure switch calibration. Pickup pressure 1060 $^{+65}_{-65}$ Dropout pressure 50 to 100 psig below pickup pressure.	3. Differential pressure less than or greater than specified	3.4 BACKOUT - If pressure of another switch on same engine is outside acceptable limits. Replace both pressure switches per applicable field manual, record fastener torque, waive throat plug leak check. 3.4.1 Conduct a pressure switch calibration. NOTE: For problem 2 and 3 pressure switch malfunctions, the switch checkout values must be evaluated for preclusion of engine starting with a switch which will not pick up or vehicle flight with a pressure switch in the dropped out position. For these conditions, consideration should be given to installing a jumper in the stage which would provide a continuous switch "pickup" indication without possibility of a switch "dropout" indication.

GUIDELINES FOR LAUNCH COUNTDOWN

Pending Operation		
○ Install Live Ordnance ○ Prefill Topoff ○ Admit LOX ○ Start Auto Sequence		
Engine Status		
● Fuel Admitted ● Live Ordnance Installed ● Prefill Overflowed ● LOX Admitted ● Auto Sequence		
Nominal Condition	Nonconformance Condition	Recommended Disposition
Thermal insulation panels shall not be internally wetted.	1. Thermal insulation panels are internally wetted with non-flammable fluid (water)	1.1 PROCEED.
	2. Thermal insulation panels are internally wetted with flammable fluid (RJ-1, RP-1).	2.1 HOLD - Replace wetted panels, then PROCEED.

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13. ABSTRACT

This document considers all detectable F-1 engine nonconformance conditions which could reasonably be expected to occur during Saturn V vehicle launch preparations. Guidelines are provided for launch support personnel in evaluating a nonconformance condition relative to corrective action and impact on the countdown status.

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