



Kismet Hybrid Rocket Engine Cold Flow 3

Cold Flow Test Operations Procedures

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Cold Flow Test Operations Procedures

Contents

This document contains the following procedure:

- The *Cold Flow Test* procedure comprises steps for conducting a carbon dioxide test of the engine and fill system using the electrical control system and motorized ball valves.

Personnel Required

The test operations team consists of nine personnel:

- 1 ☐ The **Operations Director [OPS]** directs operations procedures and communicates with the other test personnel.
- 2 ☐ The **Primary Fill Operator [PRIMARY]** is the main system operator. **PRIMARY** operates all manual valves as well as the test control system.
- 3 ☐ The **Secondary Fill Operator [SECONDARY]** is the backup for **PRIMARY**, and communicates with OPS. If **PRIMARY** becomes incapacitated, **SECONDARY** is responsible for removing them from danger.
- 4 ☐ The **DAQ Technician [DAQ]** monitors and operates the test data acquisition system.
- 5 ☐ the **Control System Operator [CONTROL]** operates the test control system, including actuation of remote valves.
- 6 ☐ The **Heating Technician [HEAT]** operates the valves for the tank heating system.
- 7 ☐ **Perimeter Guard 1 [P1]**, **Perimeter Guard 2 [P2]**, and **Perimeter Guard 3 [P3]** ensure that no unauthorized personnel enter the testing area during test operations.

Sign-Off

To be completed by all test personnel after reading and familiarization with procedures

- | | | | |
|---|---|-------|-------|
| 1 | <input type="checkbox"/> Operations Director [OPS] | _____ | _____ |
| 2 | <input type="checkbox"/> Primary Fill Operator [PRIMARY] | _____ | _____ |
| 3 | <input type="checkbox"/> Secondary Fill Operator [SECONDARY] | _____ | _____ |
| 4 | <input type="checkbox"/> DAQ Technician [DAQ] | _____ | _____ |
| 5 | <input type="checkbox"/> Control System Operator [CONTROL] | _____ | _____ |
| 6 | <input type="checkbox"/> Heating Technician [HEAT] | _____ | _____ |
| 7 | <input type="checkbox"/> Perimeter Guard 1 [P1] | _____ | _____ |
| 8 | <input type="checkbox"/> Perimeter Guard 2 [P2] | _____ | _____ |
| 9 | <input type="checkbox"/> Perimeter Guard 3 [P3] | _____ | _____ |

Prior to Start

- 1 ☐ Ensure that the following procedures are complete:
- 2 ☐ Oxidizer Tank Assembly procedure
- 3 ☐ Plumbing Setup procedure
- 4 ☐ Oxidizer Tank Stand Setup procedure
- 5 ☐ Tank Heating Setup procedure
- 6 ☐ Test Stand Setup procedure
- 7 ☐ Data Acquisition Setup procedure
- 8 ☐ Test Control System Setup procedure
- 9 ☐ Ensure that all technicians as defined above are available and have completed the sign-off.
- 10 ☐ Ensure that all spectators and test personnel are wearing safety glasses.
- 11 ☐ Ensure that **PRIMARY** and **SECONDARY** are wearing face shields and have no exposed skin.
- 12 ☐ Ensure that **PRIMARY** is wearing thermal gloves.
- 13 ☐ Ensure that **OPS** is in possession of the system control key.

Cold Flow Test Procedure

- 1 ☐ **PRIMARY**: Confirm that the following valves are initially closed:
 - 2 ☐ Cylinder Valve
 - 3 ☐ Remote Fill Valve
 - 4 ☐ Parallel Fill Valve
 - 5 ☐ Motorized Vent Valve
 - 6 ☐ Line Vent Valve
 - 7 ☐ Injector Valve
- 8 ☐ **PRIMARY**: Confirm that the following valves are initially open:
 - 9 ☐ Series Fill Valve
 - 10 ☐ Linear Actuator Vent Valve
- 11 ☐ **DAQ**: Confirm that all pressure transducers are reading atmospheric pressure.
- 12 ☐ **DAQ**: Confirm that all load cells are reading the determined zero point.
- 13 ☐ **PAUSE POINT**
- 14 ☐ **P1, P2, and P3**: Close the perimeter and do not allow any further personnel to enter the testing area.
- 15 ☐ **SECONDARY**: Confirm that no personnel are present in the testing area other than **PRIMARY** and **SECONDARY**.
- 16 ☐ **PRIMARY**: Remove the cap from the carbon dioxide supply cylinder.
- 17 ☐ **PRIMARY**: Connect the fill line to the supply cylinder, hand tighten, and then tighten with a wrench. Do not force the connection.
- 18 ☐ **PRIMARY**: Slowly open the Cylinder Valve through $\frac{3}{4}$ of a turn.
 - If leaks are observed:
 - 19 ☐ **PRIMARY**: Close the Cylinder Valve.
 - 20 ☐ **PRIMARY**: Open the Line Vent Valve.
 - 21 ☐ **PRIMARY**: Slowly open the Parallel Fill Valve.
 - 22 ☐ **DAQ**: Confirm that the Fill Pressure Transducer is reading atmospheric pressure.
 - 23 ☐ **OPS**: Abort test procedures and revisit plumbing setup.
- 24 ☐ **PRIMARY**: Communicate the supply cylinder pressure as visible on the Pressure Gauge.
- 25 ☐ **DAQ**: Communicate the supply cylinder pressure as read by the Fill Pressure Transducer.
- 26 ☐ **DAQ**: Confirm that the two pressure measurements are in agreement.
- 27 ☐ **PRIMARY** and **SECONDARY**: Retreat to the test control area, behind the blast shield.
- 28 ☐ **PRIMARY**: Perform the following control system checks:
 - 29 ☐ Confirm that all actuator controls are in the “closed” position:
 - 30 ☐ Remote Fill Valve
 - 31 ☐ Motorized Vent Valve
 - 32 ☐ Injector Valve
- 33 ☐ **PAUSE POINT**

- 34 ☐ **OPS**: Poll the following personnel for GO/NO GO status:
- 35 ☐ **HEAT**
- 36 ☐ **CONTROL**
- 37 ☐ **DAQ**
- 38 ☐ **PRIMARY**
- 39 ☐ **SECONDARY**
- 40 ☐ **OPS**: Give the system control key to **CONTROL**.
- 41 ☐ **CONTROL**: Engage the key switch and power on the control boxes.
- 42 ☐ **CONTROL**: Open the Motorized Vent Valve.
- 43 ☐ **CONTROL**: Open the Remote Fill Valve.
- If leaks are observed:

44 ☐ **CONTROL**: Close the Remote Fill Valve.

45 ☐ **CONTROL**: Open the Injector Valve.

46 ☐ **OPS**: Proceed only when the oxidizer tank has fully vented.

47 ☐ **PRIMARY** and **SECONDARY**: Approach the test plumbing.

48 ☐ **PRIMARY**: Close the Cylinder Valve.

49 ☐ **CONTROL**: Open the Remote Fill Valve.

50 ☐ **DAQ**: Confirm that the Fill Pressure Transducer is reading atmospheric pressure.

51 ☐ **OPS**: Abort test procedures and revisit plumbing setup.
 - If the Remote Fill Valve fails to open:

52 ☐ **OPS**: Abort test procedures and revisit control system setup.
- 53 ☐ **OPS**: Proceed only when a white plume is visible from the vent plug.
- 54 ☐ **CONTROL**: Close the Motorized Vent Valve.
- 55 ☐ **CONTROL**: Close the Remote Fill Valve.
- If the Remote Fill Valve fails to close:

56 ☐ **PRIMARY** and **SECONDARY**: Approach the test plumbing.

57 ☐ **PRIMARY**: Close the Series Fill Valve.

58 ☐ **PRIMARY** and **SECONDARY**: Retreat to the test control area.
- 59 ☐ **HEAT**: Open the Tank Heating Valve.
- 60 ☐ **DAQ**: Proceed only when the oxidizer tank pressure is at least 750 psi.
- If the oxidizer tank pressure does not reach 750 psi:

61 ☐ **HEAT**: Close the Tank Heating Valve.

62 ☐ **CONTROL**: Open the Injector Valve.

63 ☐ **OPS**: Proceed only when the oxidizer tank has fully vented.

64 ☐ **PRIMARY** and **SECONDARY**: Approach the test plumbing.

65 ☐ **PRIMARY**: Close the Cylinder Valve.

66 ☐ **CONTROL**: Open the Remote Fill Valve.

67 ☐ **DAQ**: Confirm that the Oxidizer Tank Pressure Transducer is reading atmospheric pressure.

68 ☐ **OPS**: Abort test procedures and revisit plumbing setup.
- 69 ☐ **HEAT**: Close the Tank Heating Valve.

- 70 ☐ **CONTROL**: Open the Motorized Vent Valve.
- 71 ☐ **CONTROL**: Close the Linear Actuator Vent Valve.
- If leaks are observed or the Linear Actuator Vent Valve fails to close:
- 72 ☐ **CONTROL**: Close the Motorized Vent Valve.
- 73 ☐ **OPS**: Proceed with the cold flow test.
- Otherwise:
- 74 ☐ **CONTROL**: Open the Linear Actuator Vent Valve.
- 75 ☐ **OPS**: Proceed with the cold flow test.
- 76 ☐ **CONTROL**: Close the Motorized Vent Valve.
- 77 ☐ **PAUSE POINT**
- 78 ☐ **CONTROL**: Conduct the cold flow test by opening the Injector Valve.
- 79 ☐ **PAUSE POINT**
- 80 ☐ **DAQ**: Confirm that the Oxidizer Tank Pressure Transducer is reading atmospheric pressure.
- 81 ☐ **PRIMARY**: Open the Line Vent Valve using the ropes.
- 82 ☐ **CONTROL**: Open the Motorized Vent Valve.
- 83 ☐ **OPS**: Proceed only when the oxidizer tank has fully vented.
- 84 ☐ **PRIMARY** and **SECONDARY**: Approach the test plumbing.
- 85 ☐ **PRIMARY**: Close the Cylinder Valve.
- 86 ☐ **CONTROL**: Open the Remote Fill Valve.
- 87 ☐ **PRIMARY**: Slowly open the Parallel Fill Valve.
- 88 ☐ **PRIMARY**: Disconnect the fill line from the supply cylinder.
- 89 ☐ **PRIMARY**: Replace the cap on the carbon dioxide supply cylinder.
- 90 ☐ **DAQ**: Confirm that the Fill Pressure Transducer is reading atmospheric pressure.
- 91 ☐ **OPS**: Wait for at least 3 minutes before proceeding.
- 92 ☐ **P1, P2, and P3**: Open the perimeter.
- 93 ☐ **OPS**: Proceed with teardown and disassembly.