Heated Promoted Combustion Testing

(ASTM G 124-95)

! This Instruction Contains Descriptions of **HAZARDOUS OPERATIONS** !

Materials, Processes, and Manufacturing Department
Materials Combustion Research Facility, Building 4623

National Aeronautics and Space Administration
George C. Marshall Space Flight Center
Marshall Space Flight Center, AL 35812

Release Authority	Name	Title	Organization	Date
Office of Primary Responsibility	_____	Materials Test Branch Chief	EM10	_____
	_____	Industrial Safety	QD50	_____

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Revision	Date	Originator	Description	Affected Pages
Baseline	x/xx/05	Eddie Davis		

This document constitutes the Organizational Work Instruction (OWI) for heated promoted combustion testing in the Materials Combustion Research Facility (MCRF). Any deviation to this OWI must be approved by the test engineer via an approved test plan. Any changes to the test equipment shall be noted on the tester maintenance log and approved by the test engineer. It is the responsibility of the test engineer to obtain NASA Contracting Officer's Technical Representative (COTR) approval where necessary for changes to the test equipment.

Any change to this OWI must be submitted to and approved by the Materials Test Branch Chief, EM10. Revisions may be also be submitted to the concurring organizations listed below for review and concurrence by memo. The original OWI and all changes shall be maintained by EM10. Any change to materials used requires a change to mechanical drawings, in addition to EM10B team lead approval. All documentation must be approved by the appropriate persons mentioned above and incorporated into the OWI before operation of the reconfigured test equipment can resume.

Concurring organizations:
MCRF Test Operations Contractor
EM10B Team Leader
Environmental Health, AD02M

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1.0 Scope

1.1 Scope

The scope of this OWI is Heated Promoted Combustion Testing in accordance with ASTM G124-95, *Standard Test Method for Determining the Combustion Behavior of Metallic Materials in Oxygen-Enriched Atmospheres*, as performed in Marshall Space Flight Center's (MSFC's) Materials Combustion Research Facility (MCRF).

1.2 Purpose

The purpose of the Heated Promoted Combustion Test is to determine the flammability of materials in 50- to 10,000-psig gaseous oxygen (GOX) under elevated temperature conditions. This document covers the determination of the ability of a material to resist ignition or to self-extinguish once ignited when subjected to an atmosphere of GOX at a selected pressure and temperature.

1.3 Applicability

This instruction applies to the Chemistry Team, Materials Test Branch, of the Materials and Processes Laboratory.

2.0 Applicable Documents

ASTM G 124-95. *Standard Test Method for Determining the Combustion Behavior of Metallic Materials in Oxygen-Enriched Environments.*

ED10-OWI-CHM-050. *Materials Combustion Research Facility Guidelines for Test Operations.*

ED10-OWI-CHM-051. *Receipt, Handling, Prioritizing, and Data Requirements of Samples Submitted for Testing in the Materials Combustion Research Facility of the Materials, Processes, and Manufacturing Department, Building 4623.*

ED10-OWI-CHM-058. *Chemical Handling Plan for Building 4623.*

MCRF Mechanical Systems Manual for the Portable Promoted Combustion Test System.

MPD 1840.3. *MSFC Respiratory Protection Program*.

MPR 1040.3. *MSFC Emergency Plan*.

MPR 1840.2. *MSFC Hazard Communications Program*.

MPR 8715.1. *MSFC Safety, Health, and Environmental (SHE) Program*.

MPR 8823.2. *Pressure Systems Guidelines and Certification Requirements*.

MWI 3410.1. *Personnel Certification Program*.

MWI 8621.1. *Close Call and Mishap Reporting and Investigation Program*.

NASA-STD-6001. *Flammability, Odor, Offgassing, and Compatibility Requirements and Test Procedures for Materials in Environments That Support Combustion*.

Note: Always refer to the current version of each applicable document.

3.0 Definitions

3.1 Definitions

Batch test. Test material for 100% GOX compatibility (for promoted combustion) at 10,000 psi. Material shall pass NASA-STD-6001 Test 13B or have a Materials Usage Agreement (MUA) written and approved by MSFC EM03 for use.

Burn length. The length of the sample that has been consumed by combustion. The burn length is determined by subtracting the post-test sample length from the pretest sample length.

Full access. Anyone may enter the test cell at anytime.

Ignitor wire. The palladium-coated aluminum wire (Pyrofuze®) that, when energized with a certain amount of energy, reacts exothermically, providing heat energy to the promoter.

Limited access. Only the test operator shall enter the test cell with the appropriate PPE. The back gates shall be locked, the *No Unauthorized Personnel-See Test Engineer* sign placed over the door to the cells and the facility warning beacons activated to indicate that personnel are preparing to test.

NASA. Marshall Space Flight Center EM10 responsible personnel.

No access. No one shall enter the test cell at any time. The back gates shall be locked, the *Danger-High Pressure-Do Not Enter* sign placed over the door to the cells, and the test cell red facility warning beacon activated to indicate that a test is in progress or that part or all of the test system is pressurized.

Oxygen deficient. Oxygen level in air is less than 19.5%.

Oxygen enriched. Oxygen level in air is greater than 23.5%.

Pressure threshold. The highest pressure at which each standard sample in a set of 10 burns less than 6 in. Tests conducted at the next higher pressure shall produce at least 1 sample that burns 6 in. or more.

Promoter. An aluminum or magnesium cylinder that is pressed onto the sample rod providing at least 3.0 kJ to the sample.

Propagation rate. The rate at which the sample burns, generally calculated by dividing the total burn length by the total burn time.

Standard sample. The standard rod for the promoted combustion test is a cylindrical rod, 1/8 in. in diameter and 12 in. in length.

Tag out. The placement of a tag-out-device on an energy isolating device according to procedure to indicate that the energy isolating device and equipment being controlled must not be operated until the tag-out device is removed by the person who placed it there.

Test area. The portion of Building 4623 and fenced area south of the north wall of Room 108 and the corresponding test console located in Room 106.

Test cell. Room 108 of Building 4623, which contains the testing equipment for HPC.

Test engineer. The person responsible for correctly following the approved test plan for a specific test from sample receipt to test data evaluation.

Test operator. The person responsible for conducting the test under the guidance of the test engineer.

Total burn time. The difference in the time at which burning/dripping stopped and the time of ignition.

3.2 Acronyms

GN_2	Gaseous nitrogen
GOX	Gaseous oxygen
MCRF	Materials Combustion Research Facility
MSDS	Materials Safety Data Sheet
MUA	Materials Usage Agreement
OWI	Organizational Work Instruction
PCC	Promoted Combustion Chamber
PPE	Personal Protective Equipment
VCR	Video Cassette Recorder

4.0 Instructions

The Heated Promoted Combustion (HPC) Test, ASTM G 124-95, provides a standard test method for evaluating metals and alloys being considered for high-temperature, pressurized oxygen service. Metal rods are tested at various pressures and temperatures. Ignition energy is provided by a Pyrofuze® wire wrapped around an aluminum or magnesium promoter.

All operations of this equipment shall be conducted using the applicable documents referenced above (section 2). All critical measuring devices, *e.g.*, pressure gauges, shall be in current calibration (section 9.5). All data and test results shall be recorded on form EM10-F-CHM-005, HPC Test Data Sheet (section 7.2, Figure 7-4). A summary of pertinent test information and test results shall be compiled in a NASA memo, signed by the test organization management, and mailed to the test requester.

4.1 Sample Preparation

Samples shall be prepared as outlined in EM10-OWI-CHM-042, *Test Sample Preparation for Testing in the Materials Combustion Research Facility*. When non-standard samples are prepared, the test plan for that test request shall outline the specific method of sample preparation.

The *sample preparation technician* shall provide materials information, weights, measurements, and the test request number on the test data sheet (section 7.2, Figure 2). The *test operator* shall:

- **Review** the test data sheet before testing.
- *If this information is not present*, **fill in** the data sheet information that is missing.
- *If the information appears incorrect*, **notify** the test engineer, and **await** further instruction.

4.2 Pre-Test Photography

The *sample preparation technician* **shall photograph** one of the samples, per the test request, before testing and **place** three copies in the test folder. *If the pre-test photograph has not been taken*, the *test operator* **shall take** this photograph and **place** three copies of the photograph in the test folder before proceeding with the test. The entire sample **shall be visible** in the photo. Steps for photographing samples are outlined in the *Photography Operating Guide*.

4.3 Equipment Checkout

The test operator **shall perform** the following before starting any testing:

4.3.1. **Ensure** that the oxygen level in the test cell is acceptable before entering. Oxygen levels in each test cell are constantly monitored. If the oxygen levels drop below 19.5% or rise above 23.5%, an alarm will sound, accompanied by a red flashing light. Exact oxygen levels can be observed at the facility monitoring station located in Room 113.

4.3.2. **Inspect** the sapphire sight glass(es) for cracks. **Visually inspect** windows from the outside using a flashlight or other light source.

- **Check** for cracks, slag spatters, and scratches.
- **Check** static face seals for deformation or protrusions.
- **Report** problems to the test engineer.
- **Inform** the test engineer before replacing damaged components.

Note: Even minor cracks can result in catastrophic failures at high pressures.

4.3.3. **Check** sight windows' torque. Every 3 months, **reverify** the sight port retaining nut torque.

- Randomly **select** one of the six sight ports, and **use** a 5/8-in. x 3/8-in. drive socket to loosen (counterclockwise) and remove the 10 outer jam nuts.
- **Place** the socket on a calibrated torque wrench having a minimum reading of 300 in.-lb. Slowly **torque** (clockwise) each retaining nut in sequence to a maximum of 200 in.-lb. **Refer** to the configuration notebook for torque sequence.
- After retorquing is complete, **replace** the jam nuts, and **tighten** (clockwise) finger tight.
- Using the same torque wrench, **torque** each jam nut in the same sequence as the retaining nuts to a maximum of 100 in.-lb.
- If, during the torque sequence, the window retaining nut starts to turn before 200 in.-lb is achieved (less than 175 in.-lb), **finish** the complete torque sequence for that window's retainer and jam nuts.
- **Select** another window, and **repeat** the above steps until all windows have a complete 200 in.-lb torque with no nut rotation at less than 175 in.-lb.

4.3.4. **Inspect** all system hardware for cleanliness.

4.3.5. **Inspect** cables and electrical interface for wear, wetness, damage, or other deterioration. **Replace** items if wear, damage, or deterioration is evident.

4.3.6. **Inspect** monitors, cameras, video cassette recorders (VCRs), and the character generator to ensure that they are operational.

4.3.7. **Verify** through the MCRF GOX system point of contact that the facility oxygen system is operational.

4.3.8. **Ensure** that the facility warning beacon is operational.

4.3.9. *If using the intercom system,* **ensure** that it is working.

4.3.10. At the beginning of each testing day, **verify** the ignitor power supply voltage/amperage setup, and **check out** the system as follows:

4.3.10.1. Ensure the control console **EMERGENCY POWER SHUT OFF** button is in the off position (fully depressed and locked.)

4.3.10.2. **Place** the test cell in *Limited Access Condition*.

4.3.10.3. In the test cell at the test platform gas supply panel (located on the panel attached to the east wall), **ensure** that GOX supply valve is closed (turned clockwise).

4.3.10.4. **Ensure** that the main GN_2 supply valve is closed (handle in the 3 o'clock position).

4.3.10.5. At the gas supply panel on the platform, **ensure** the following:

4.3.10.5.1. The GN_2 supply valve to the panel (MV-MGN-P200) is closed (turned fully clockwise).

4.3.10.5.2. The GN_2 supply valve (MV-MGN-P213) to the chamber purge supply regulator, valve actuation, and intensifier pump actuation is closed (turned fully clockwise).

4.3.10.5.3. The GN_2 intensifier actuation regulators (PCV-MGN-P240) and (PCV-MGN-P241) are fully reduced (knobs turned fully counterclockwise).

4.3.10.5.4. The GN_2 chamber purge regulator (PCV-MGN-P220) is fully reduced (turned fully counterclockwise).

4.3.10.5.5. The GN_2 valve actuation regulator (PCV-MGN-P230) is fully reduced (turned fully counterclockwise).

4.3.10.5.6. The GN_2 purge isolation ball valve (MV-MGN-P223) is closed (handle turned fully clockwise to the 3 o'clock position).

4.3.10.5.7. The GN_2 valve actuation isolation ball valve (MV-MGN-P233) is closed (turned fully clockwise).

4.3.10.5.8. The GN_2 system line vent valve (MV-MGN-P201) is closed (turned fully clockwise).

4.3.10.6. At the GOX panel in the test cell, **ensure** that the GOX supply pressure transducer isolation valve (MV-MGO-P100) is open (turned fully counterclockwise).

4.3.10.7. **Ensure** that the ignitor power supply is plugged into the 208/220VAC source.

4.3.10.8. **Ensure** that the ignitor power supply main switch is in the off position.

4.3.10.9. **Ensure** that the local power switch to the Heise gauge is on and that the gauge is **working** properly, reading 0 psig.

4.3.11. At the control console, rotate the red **EMERGENCY POWER SHUTOFF** and the **INDUCTION COIL POWER EMERGENCY SHUTOFF** buttons approximately 1/8 turn clockwise or until the switches reach their full out positions.

Note: The control computer is not an "instant on" system. The control computer must be powered on manually. To power on the control computer, **open** the console access door, and **depress** the power button on the front of the computer. *If the system or the computer does not boot,* **contact** the test engineer

4.3.12. At the test console, **ensure** the following:

4.3.12.1. The Windows® XP system has booted properly.

4.3.12.2. The control console DC power supply switch is **on** (indicated by the light above the switch). This switch energizes all relays and pressure transducers.

4.3.12.3. To load the LabVIEW® Control Software:

- **Click** on the HPC Configuration profile icon.
- After the configuration profile is loaded, **click** on the HPC Control icon.
- When the control screen appears, **click** on the "run" arrow in the top left corner of the control screen.

4.3.13. In the test cell, **prepare** the igniter power supply:

4.3.13.1. **Ensure** that the power supply is plugged into the 208/220 AC power source.

4.3.13.1.1. **Ensure** that the igniter power supply switch is off. The display screen will be blank.

4.3.13.1.2. **Ensure** that the power supply leads are open and not grounded, *i.e.,* the leads are not touching anything.

4.3.13.1.3. **Toggle** the power supply switch to the **ON** position.

4.3.13.1.4. **Verify** that the initialization screen is present during the power supply boot cycle. After the initialization screen appears, the words **REMOTE DISABLED** appear in the display.

Note: *If the initialization screen does not appear,* **ensure** the 208-220 VAC power source is **on**. *If the AC source is on and the intialiation screen still does not appear*, **contact** the lead engineer.

4.3.13.2. To set the voltage:

- **Press** the voltage key on the power supply panel, and **enter** the desired voltage using the key pad on the power supply panel.
- After the desired voltage is set, press the **ENTER** key.

Note: The normal test voltage is 30 VDC.

4.3.13.3. To set the current:

- **Press** the **CURRENT** button on the power supply panel, and **enter** the desired **Amps** using the key pad on the power supply panel.
- After the desired **Amps** value is set, **press** the **ENTER** key.

Note: The normal test current is 40 Amp.

4.3.13.4. **Verify** the **POWER LIMIT** is set to 2,000 W by pressing the **MENU** button on the power supply panel until **SET POWER LIMIT** is shown in the display. **Use** the up (↑) or down (↓) arrows until **2000 WATTS** is displayed. **Press** the **ENTER** button. The limit is now set.

4.3.13.5. **Verify** the **CONTROL SOURCE** is set to **KEYBOARD** by pressing the **MENU** button on the power supply until **CONTROL SOURCE** is displayed. **Use** the up (↑) or down (↓) arrows until **KEYBOARD** is displayed. **Press** the **ENTER** button. The control source is now set.

Note: The **MENU** button has several different functions, including **POWER SUPPLY CALIBRATION**. **Do not attempt to calibrate** this power supply. The Calibration Laboratory shall do the calibration of this power supply only.

4.3.13.6. When the voltage and current have been set, these values can be saved to memory in the power supply. To save these values to memory:

- Press the **MENU** button until **SAVE VALUES TO MEMORY** is displayed, and press the **ENTER** button

- To recall these values, **press** the **MENU** button once. The **RESTORE FROM MEMORY** message will be displayed with the voltage and current values. *If the values are correct,* press the **ENTER** button.

Note: Each time the power supply is turned on, the voltage and current values have to be reset.

4.3.14. **Perform** the following steps to set up the system nitrogen pressure check:

4.3.14.1. **Place** the test cell in *Limited Access Condition*. **Ensure the roll-up door** is open and the back gates are locked.

4.3.14.2. At the tester Gas Supply Panel, located on the east wall, **slowly open** the main GN_2 supply valve by tuning the handle counterclockwise until it reaches the 12 o'clock position.

4.3.14.3. At the platform Gas Supply Panel, **slowly open** (**turn** the handle counterclockwise) the GN_2 panel supply valve (MV-MGN-P200).

4.3.14.4. **Slowly open** the GN_2 actuation supply valve (MV-MGN-P213) by turning the knob counterclockwise.

4.3.14.5. **Open** both GN_2 intensifier actuation regulators (PCV-MGN-P240) and (PCV-MGN-P241) by turning the knobs clockwise, simultaneously, to 140 ±5 psig as read on the actuation pressure supply gauge (PI-MGN-P241).

4.3.14.6. **Open** (turning clockwise) the GN_2 chamber purge regulator (PCV-MGN-P220) until 1,500 psi (or maximum facility supply pressure) is indicated on the purge supply gauge (PI-MGN-P221).

4.3.14.7. **Open** the GN_2 purge isolation ball valve (MV-MGN-P223) by turning the valve handle 90 deg counterclockwise until it reaches the 12 o'clock position.

4.3.14.8. **Fully open** (by turning the valve handle counterclockwise) the GN_2 chamber purge isolation valve (MV-MGN-P226) located behind the platform Gas Supply Panel.

4.3.14.9. **Turn** the GN_2 valve actuation regulator knob (PCV-MGN-P230) clockwise, until approximately 90 (±5) psi is indicated on actuation supply gauge (PI-MGN-P231).

4.3.14.10. **Open** the actuation supply ball valve (MV-MGN-P233) 90 deg counterclockwise.

4.3.15. With the test chamber open:

4.3.15.1. **Ensure** the chamber plug and cap are in place on the pneumatic lift. *If not,* **notify** the test engineer**.**

4.3.15.2. **Slowly rotate** the pneumatic lift valve handle clockwise until the lift begins to rise. (The pneumatic lift valve handle is located on the southeast corner support post of the platform.)

4.3.15.3. **Guide** the chamber plug and cap carefully into position directly under the chamber until the cap makes contact with the threaded portion of the chamber.

4.3.15.4. When the cap has made contact, **rotate** the lift valve handle counter-clockwise until the valve handle is in the center position parallel with the chamber platform or at a 3 o'clock position.

4.3.15.5. **Rotate** the cap clockwise when looking up from the bottom of the cap. With the left hand, **grasp** the handle on the lifting collar adapter to keep the collar from rotating while the cap is being threaded.

4.3.15.6. After the cap threads have engaged with the chamber threads, **rotate** the cap four complete turns.

4.3.15.7. With the access opening in the lifting collar facing south (toward the operator), **maintain** grasp on the lifting collar handle with the left hand to keep it from rotating.

4.3.15.8. Using the right hand, **rotate** the cap until it has cleared the cap support ring on the lifting collar (approximately 1/2 in.).

4.3.15.9. Slowly **rotate** the lift valve handle clockwise until a tight fit is achieved between the plug and the chamber.

Note: **Leave** the valve open for 3 or 4 seconds after the plug has made contact with the chamber; this will ensure a tight fit and prevent the plug from rotating while the cap is being tightened.

4.3.15.10. Using both hands, **finish** tightening the cap. Only tighten the cap hand-tight

4.3.15.11. Slowly **rotate** the pneumatic lift valve handle located on the southeast corner support post of the platform counterclockwise, and **lower** the lift to its full down position.

Note: The three-way valve starts to vent the pressure in the lift as it lowers. This venting is normal.

4.3.16. **Place** the test cell in a *No Access Condition*.

4.3.17. At the control console, perform the following:

Note: At several points in this OWI, the reader will find text printed in a **different font.** This font indicates button titles or actions to take on the LabVIEW® **screen.**

Note: With all software-controlled valves, **use** the mouse to move the cursor over the desired soft-key switch/button, and **click** the left mouse button to toggle the valve setting between **Open** and **Close**.

4.3.17.1. **Close** the main vent valve **(V-105)**.

4.3.17.2. **Open** the GOX supply valve **(V-101)**.

4.3.17.3. **Check** that the chamber pressure increases (in the box labeled **Chamber Pressure**).

4.3.17.4. When **Supply Pressure** and **Chamber Pressure** have equilibrated, **set** the pump drive valve **(V-102)** to **ON**, and **verify** proper operation as shown by a pressure increase on monitor **Chamber Pressure**. *If the intensifier fails to operate,* **verify** that step 4.3.15.5 was completed. *If the intensifier still fails to operate*, **follow** the procedure in section 9.4.7.

4.3.17.5. **Allow** the chamber to pressurize to the highest test pressure to be used during the shift (+100 psi/-0 psi) to proof test the chamber.

4.3.17.6. **Turn** the pump drive valve **(V-102)** to **OFF**.

4.3.17.7. **Monitor Chamber Pressure** for significant changes in pressure. *If* **Chamber Pressure** *drops too rapidly (exceeds 10 psig/sec) or cannot be held*, **perform** a leak check, in accordance with section 9.4.8.

4.3.17.8. **Toggle** the pump drive valve **(V-102)** as necessary to achieve a stabilized pressure.

Note: Adiabatic compression will cause the gas to expand. As the gas cools, a pressure drop may be observed giving the false indication of a leak.

4.3.17.9. **Close** the GOX supply valve **(V-101)**.

4.3.17.10. When **Chamber Pressure** has stabilized in the desired range, **Open** the main vent valve **(V-105),** and **allow Chamber Pressure** to reach ambient pressure (0 psig), as indicated on the control screen, the pressure gauge (PI-MGO-P131), and the digital pressure indicator (PT-MGO-P130).

4.3.17.11. **Place** the test area in *Limited Access Condition*.

4.3.17.12. At the GN_2 panel, fully **reduce** the GN_2 chamber purge regulator (PCV-MGN-P220) by turning the knob counterclockwise.

4.3.17.13. **Close** the GN_2 chamber purge isolation valve (MV-MGN-P226) located behind the GN_2 test panel by turning the knob clockwise.

4.3.17.14. **Slowly turn** the chamber purge isolation vent valve handle (MV-MGN-P227) located behind the GN_2 test panel counterclockwise to open the valve and to vent the lines.

4.3.17.15. **Close** the chamber purge isolation vent valve (MV-MGN-P227) by turning the valve handle clockwise.

4.3.17.16. **Slowly rotate** the pneumatic lift valve handle clockwise until the lift adapter starts to rise. **Guide** the lift adapter into contact with the bottom of the chamber plug, while aligning the access window in the lift adapter with the induction coil capacitor clamps to protect the clamps.

4.3.17.17. When the lift adapter is in place, **rotate** the lift valve handle counterclockwise until it reaches the center position parallel with the chamber platform or a 3 o'clock position.

Note: When the lift plate is in position, the pneumatic lift valve can be left open for 3 or 4 seconds to allow enough lift pressure to hold the plug securely in place. At times, this may be necessary to keep the plug from rotating while the cap is being removed.

WARNING: All the areas between the lifting adapter, the coil feedthrough, and the chamber plug, are pinch points. **Do not place** hands between the lift adapter and any of these objects.

4.3.17.18. **Loosen** the chamber cap by turning it counterclockwise until it comes to rest on the cap support ring on the lift adapter.

4.3.17.19. **Slowly rotate** the lift valve handle counterclockwise until the lift starts to move downward. **Lower** the lift adapter until the cap support ring is approximately 1/4 in. to 1/2 in. lower than the cap.

4.3.17.20. **Rotate** the pneumatic lift valve located on the southeast corner support post of the platform counterclockwise to its center position to stop the lift.

4.3.17.21. With the access opening in the lifting collar facing south (toward the operator), **grasp** the lifting collar handle with the left hand to keep it from rotating.

4.3.17.22. Using the right hand, **rotate** the cap counterclockwise until the cap

comes to rest on the cap support ring and the cap threads are completely free for the chamber.

Note: At this point, the lift should be supporting the cap and plug assembly.

4.3.17.23. Slowly **rotate** the pneumatic lift valve handle located on the southeast corner support post of the platform counterclockwise, and **lower** the lift until the lift shaft is approximately 1/2 in. to 1 in. from its full down position.

Note: This will allow the cap and plug assembly to rotate freely while the sample is being loaded and easy inspection of the coil components and slag cup.

4.4 System Setup and Sample Loading

The test operator **shall perform** these steps at the beginning of each test:

4.4.1. **Ensure** that the facility oxygen supply pressure is in the normal operating range (1,800 to 2,200 psig) as indicated by the digital Facility Supply Pressure gauge on the Oxygen Supply Master Control Panel, located at the east end of Room 106. *If it is not,* **report** this situation to the test engineer.

4.4.2. **Verify** that all facility oxygen supply valves are open, as indicated by the green lights above each valve switch on the Oxygen Supply Master Control Panel.

4.4.3. At the console, if the LabVIEW® system is not loaded, **load** the LabVIEW® control system.

4.4.3. In the test cell, **verify** that the test chamber is visually clean. *If not clean,* **follow** the maintenance procedures in section 9.4.1.

4.4.4. **Ensure** that the retainer ring threads and associated threads at the bottom of the chamber have been lubricated with a perfluoropolyether and molybdenum disulfide grease, such as Braycote® 640AC-MS. **Wear** *clean latex* gloves when applying lubricant.

4.4.5. **Install** a sample:

Note: During chamber assembly, loading sample, and servicing, **minimize contamination**. **Wear** clean gloves at all times during the handling of pre-test samples, promoters, ignitors, and any other internal chamber component to be exposed to GOX.

4.4.5.1. **Use** one sample to pre-wrap enough Pyrofuze® wire for each sample to be tested. **Wrap** the Pyrofuse® wire one complete turn around the igniter

so that the ends of the wire are of even length (6.5in.). **Hold** the Pyrofuse® at the intersection of the loop, and **curve** the two remaining lengths of the wire in opposite directions so that the complete wire forms an "S" shape. This "S" shape accommodates the coil post when the sample is loaded in the coil. (**See** Figure 9-3.)

4.4.5.2. **Wipe** the sample and promoter with trichlorotrifluoroethane, unless directed otherwise by the test engineer. Trichloroethylene or Brulin® 815 MX may be substituted to trichlorotrifluoroethane, *if cleaning is performed in a well-ventilated area*.

4.4.5.3. Using a metal rule at least 12 in. long, **place** the igniter end of the sample (without the Pyrofuse® wire) on the 12-in. mark of the ruler.

4.4.5.4. Moving up the sample toward the 1-in. mark on the ruler to a point on the ruler that will indicate an 8 11/16-in. (3 5/16-in. mark on a 12-in ruler) sample length, **place** a mark on the sample with a fine tip permanent marker at this point (Figure 4.1).

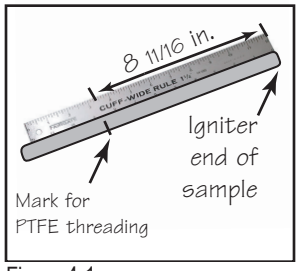


Figure 4-1.
Marking the HPC sample.

4.4.5.5. **Wrap** the marked end of the sample with PTFE thread tape 7 complete turns so that the lower edge of the PTFE tape is on the mark made with the permanent marker (Figure 4.2). **Place** the sample back on the metal rule. **Verify** that the length of the sample from the lower edge of the PTFE tape to the bottom of the igniter is 8-11/16 in.

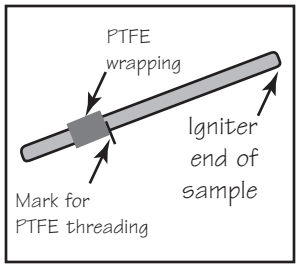


Figure 4-2.
Wrapping the HPC sample.

4.4.5.6. The brass sample holder is designed with a split type clamp and an offset base. **Ensure** the slit clamp screw is loose; if it is not, **use** a 1/8-in. Allen wrench to loosed the screw.

4.4.5.7. Holding the brass sample holder in the left hand and with the offset downward, **insert** the top of the sample through the hole in the split clamp until the PTFE tape is inside the clamp and the mark made by the permanent marker is at the bottom of the clamp. To keep the PTFE tape from curling, **twist** the sample in the direction of the wrap as it is being slid into the clamp.

Note: The PTFE wrap shall be completely under the brass sample holder to insolate the sample from the holder.

4.4.5.8. **Tighten** the split clamp screw using a 1/8-in. Allen wrench enough to hold the sample.

4.4.5.9. **Crimp** an alligator clip (NSN 5999-00-683-3508 or equivalent) to each end of the pre-made Pyrofuse® wire, but do not install the wire on the sample.

4.4.5.10. **Ensure** a quartz coil liner is in place in the center of the induction coil. **Inspect** the liner for slag buildup that might interfere with the normal burning of the sample. *If slag buildup is severe,* **replace** the liner. **Insert** the liner from the top through the center of the coil with the flared portion of the liner pointing upward so that the flare comes to rest on the top of the induction coil.

4.4.5.11. With the sample holder installed on the sample, **insert** the sample through the top of the coil liner, igniter end first.

4.4.5.12. **Align** the sample holder so that the offset base is directly over the induction coil post. **Insert** a 1/4-28 screw through the sample holder into the threaded hole in the coil post, and **tighten** with a Phillips screwdriver.

4.4.5.13. **Rotate** the cap/plug assembly so that the sample and the coil can be examined. **Ensure** that the sample is centered with the quartz liner and the center of the coil.

4.4.5.14. **Ensure** the viewing window in the quartz coil liner is correctly positioned in relation to the coil. The coil is marked to aid in aligning the liner window. **Position** the window by rotating the lip of the quartz liner so that the center of the window is even with the mark on the coil. Slight adjustments to the left or right may be needed to align the window so that the quartz liner does not interfere with the infrared (IR) camera. **Align** the black target applied to the sample by the Sample Preparation Technician by grasping the sample by the igniter and gently rotating the sample until the black target is in the center of the window in the quartz coil liner.

4.4.5.15. With the sample igniter in easy reach, **place** the Pyrofuse® on the igniter so that the curves in the Pyrofuse® do not touch the induction coil post. **Tighten** the Pyrofuse® on the igniter by grasping each end of the Pyrofuse® as close to the igniter as possible. **Grip** both wires firmly and **apply** an even outward force in opposite directions.

4.4.5.16. **Connect** the alligator clips on the end of the Pyrofuze® wire to the electrical igniter feedthroughs.

4.4.6. **Ensure** the brass shield and a ceramic slag cup are in place under the sample to prevent damage to the chamber base and the induction-coil-to-feedthrough clamps. **Clean** the brass shield as often as necessary, and **replace** the slag cup when the cup is full or damaged to point that it will no longer safely contain the slag.

Note: Slag is **not** to come in contact with the induction coil feedthrough.

4.4.7. **Secure** the chamber:

4.4.7.1. **Rotate** the entire cap/plug assembly so that the access window in the lift adapter is facing south.

4.4.7.2. **Close t**he chamber as described in section 4.3.15.

4.4.7.3. Using a bright light source, **position** the light so that it shines into the chamber through the #6 chamber sight port (located at the uppermost section of the chamber on the east side). With the light shining into the chamber, **view** the position of the IR camera through the IR camera monitor. **Position** the camera so that the black targeting square is on the center of the sample. Once the camera is in position, **turn off** the light source, and **move** it away from the chamber.

4.4.7.4. **Connect** the capacitors to the induction coil feedthrough clamps using a 3/16" Allen® wrench to secure each capacitor

4.4.7.5. **Check** for continuity between ignitor feedthrough leads and the chamber body using a voltage/ohmmeter or equivalent device. *If continuity is found between the feedthroughs and the chamber,* **lower** the cap and plug, and **remove** or **repair** the source of the short.

Note: Grounding between the ignitor feedthroughs and the chamber body will cause faulty ignition or no ignition of the sample.

4.4.8. **Attach** the induction power supply cables to the induction coil feedthrough. Two cables are used on the induction coil. Each cable is divided into three bundles: one blue bundle, one white bundle, and a shield wire (Figure 4-3). One cable also contains a pair of smaller wires, which are the sensing wires used by the Induction Power supply.

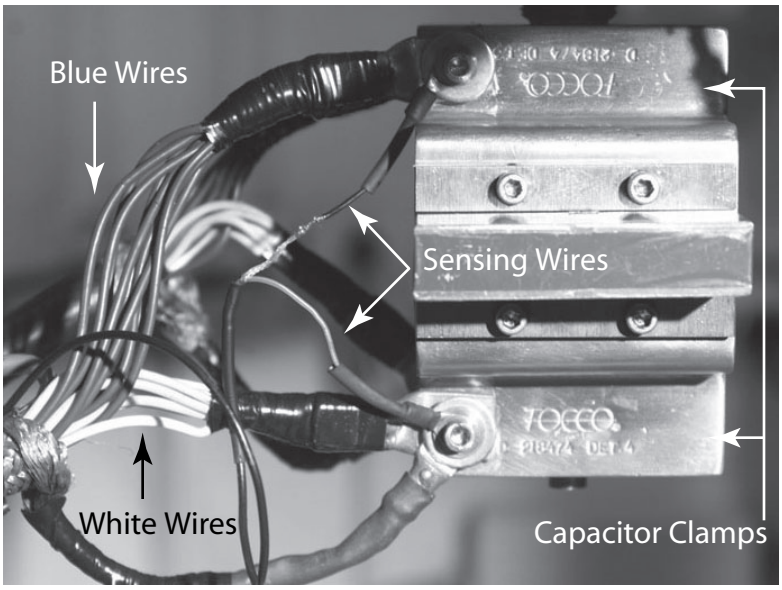
4.4.8.1. **Attach** the two blue wire bundles to the top capacitor clamps (one bundle on each side). **Ensure** the small black insulated sensing wire is connected with its corresponding blue bundle. Using a 3/16-in. Allen wrench, **tighten** each 1/4-20 bolt securely.

4.4.8.2. **Attach** the two white wire bundles with the shield to the lower capacitor clamps (one bundle on each side). **Ensure** the small clear or white insulated sensing wire is connected with its corresponding white bundle. Using a 3/16-in. Allen wrench, **tighten** each 1/4-20 bolt securely.

4.4.9. **Set up** the system to test the sample:

4.4.9.1. **Slowly turn** the main GOX supply valve handle counterclockwise until the valve is fully open. This valve is located at the gas control panel on the east wall of the test cell

Figure 4-3.
Induction Power Supply Cables



4.4.9.2. **Ensure** the ignitor power supply main switch is in the **on** position.

Note: *If the igniter power supply setup has been performed but the power supply has been turned off for a period of time,* **toggle** the power supply switch on. When the power supply has initialized, press the **MENU** button. A **RESTORE FROM MEMORY** message displays on the screen with the last voltage and current configuration. *If the parameters have not changed,* **press** the **ENTER** button to accept the values.

4.4.9.3. **Connect** the igniter power supply leads to the igniter feedthroughs.

4.4.9.4. **Ensure** the GOX supply transducer isolation valve (MV-MGO-P116) is open (counterclockwise).

4.4.9.5. **Turn** the induction coil capacitor cooling fans on by toggling the power switch located in the lower left corner of the fan mounting frame.

4.4.9.6. **Turn** the induction power supply **ON** by toggling the power circuit breaker to the up position on the back of the power supply.

4.4.9.7. On the front panel of the induction coil power supply:

- **Ensure** the **Emergency Stop** button on the front panel is in the out position. *If not;* twist the **Emergency Stop** button clockwise approximately 1/8 turn until the button pops out.
- **Verify** the MANUAL/AUTO switch is in the **MANU** position.
- **Verify** the LOCAL/REMOTE switch is in the **REMOTE** position.
- **Verify** the MAINS light, the AUXILIARIES light, and the GENERAL FAULT light are on.
- **Open** (clockwise) the water supply valve to the induction power supply, located on the west wall of the test cell.

Note: A red General Fault light on the front panel will be on. This is normal.

4.4.10. **Open** the roll-up door.

4.4.11. **Place** the test area in *No Access Condition*.

4.4.12. **Toggle** the GOX Supply Valve switch located on the console to the **ON** position.

Note: After the GOX Supply Valve switch is toggled on, an increase in the GOX supply pressure will be evident on the LabVIEW® control screen.

4.4.13. **Fill out** the pre-test checklist (section 7, Figure 7-3) before starting testing.

4.5 Detailed Test Procedure

Test one set (10 samples) per pressure and/or temperature. The test plan shall define the pressure and/or temperature threshold procedure(s) to be used. *If the test plan only requires the test to be performed per NASA-STD-6001,* **test** to the maximum use pressure and/or temperature shown by the test requester. Then, **find** the pressure and/or temperature threshold(s) as follows: *when the sample burns less than 6 in.,* **test** samples above the maximum use pressure and/or temperature. *If the sample burns more than 6 in.,* **test** samples below the maximum use pressure and/or temperature. **Continue testing** one set of samples according to the test pressure increments until the pressure and/or temperature threshold(s) is found.

If fewer samples than the test plan requires are available, **see** the test engineer for direction on what test pressure and/or temperature increments to use. *If samples are depleted before threshold determination is complete*, **note** this on the test data sheet, and **discontinue** testing.

4.5.1. At the control console, **perform** the following:

4.5.1.1. **Obtain** a blank 120-min tape from the facility supply, as needed, *i.e.*, if 10 minutes or less remain on the current tape. **Create** labels for the spine and front of the cassette; **include** tester number, date begun, tape number (year-number of tape, i.e., 02-3). When the tape is full, add date completed to labels. **Place** the tape in the tester VCR.

4.5.1.2. **Use** the Panasonic® Character Generator to create the test title. **Input** test number and material description (from test folder), pressure, and sample number. (Section 7 contains instructions on using the character generator.)

4.5.1.3. **Click** on **PURGE CYCLE**. The LabVIEW® system will automatically fill the test system with GOX to a default of 1500 psi and then vent. *If a different purge pressure is required by the test plan,* **change** value in the Purge Pressure window to the appropriate purge pressure before clicking on **PURGE CYCLE.** This action will cause two automatic purges.

Note: The calculation for number of purges required is:

purges = $-4/[\log^{10}(PA/PV)]$

where: PA = vent pressure and PV = purge pressure

4.5.1.4. **Close** the chamber vent valve (**V-105**).

4.5.1.5. **Open** the chamber supply valve (**V-101**).

4.5.1.6. **Ensure** that the chamber pressure increases in the box labeled **Chamber Pressure**. *If the pressure does not increase*, **follow** the leak-check procedure in section 9.4.8.

4.5.1.7. **When Supply Pressure and Chamber Pressure have equilibrated, set** the intensifier actuation valve (**V-102**) to **Open** , and **verify** proper operation as shown by an increase in **Chamber Pressure**. *If the intensifier fails to operate,* **verify** that step 4.3.14.5 has been completed. *If the intensifier still fails to operate,* **follow** the procedure in section 9.4.7.

4.5.1.8. **Allow** the chamber to pressurize to the test pressure (+3/-0%).

4.5.1.9. **Close** the intensifier actuation valve (**V-102**).

4.5.1.10. **Monitor Chamber Pressure** for significant changes in pressure. *If* **Chamber Pressure** *drops too rapidly (exceeds a leak rate of 10 psig/sec) or cannot be held*, **perform** a leak check in accordance with section 9.4.8.

4.5.1.11. **Toggle** the intensifier actuation valve (**V-102**) as necessary to achieve a stabilized pressure.

Note: Adiabatic compression will cause the gas to expand. As the gas cools, a pressure drop may be observed giving the false indication of a leak.

4.5.1.12. **Close** the chamber supply valve (**V-101**).

4.5.1.13. **Enable** the Induction Power Supply for the test. On the right-hand side of the console, **locate** the Induction Power supply controls. **Check** the status of the indicator lights. The General Fault indicator and the E-Stop indicator should be illuminated. *If the E-Stop light is not on,* **ensure** the red Inductor

Coil Power Emergency Shutdown Button is in its full out position. **Do** this by rotating it 1/8 turn clockwise. *If the red Inductor Coil Power Emergency Shutdown Button is in its full out position and the E-Stop Indicator light is not on,* **depress** the Reset button (located directly under the High-Frequency Control switch). *If the E-Stop Indicator does not illuminate,* **contact** the Test Engineer.

4.5.1.14. With the E-Stop Indicator light on, **depress** the Inductor Power Supply Coolant button. At this point, the General Fault Indicator light must go off. *If the General Fault light does not go off,* **ensure** the coolant water supply valve is on as mentioned in step 4.4.9.7. *If the General Fault Indicator light still fails to go off,* **contact** the Test Engineer.

4.5.1.15. **Rotate** the "keyed" High-Frequency Control switch to the ON position, and **monitor** the indicator lights. The auxiliaries and high-frequency On lights will illuminate. The induction coil power supply is ready for test.

4.5.1.16. **Ensure** the IR camera is visible in the monitor on the left-hand side of the console. **Select** the IR camera by pressing input button 3 on the Video Switcher located just below the monitor. At this point, the Temp and Emission text will be visible at the lower left of the monitor, and the small black "targeting" square will be visible in the center of the screen. **Adjust** the IR and the external camera views so they overlap, with both images being visible and legible. This is achieved by moving the Video slide on the video mixer between "A" and "B" to achieve the best quality picture. (**See** Figure 7-1.)

4.5.1.17. **Ensure** the emissivity of the camera is set to 83%, indicated by the numbers "0.83" after the word Emission on the monitor screen. **Do not change** this setting while the black painted target is applied to the test sample.

Note: When changing this setting, **open** the InfraWin software by double clicking the InfraWin icon on the desktop. **Select** "Pyrometer" from the top menu. In the Emissivity window, **enter** the desired emissivity value, and **click** "Close". The new setting will be visible to the right of the Emission text on the screen.

Note: When adjusting the emissivity for any material to be tested in this chamber, the filtering properties of the sapphire windows must be taken into account. The transmission factor for these windows is 0.87; if black paint is 95%, then emissivity will be 95 x 0.87=82.65.

4.5.2. **Press RECORD** on the VCR remote. Using the left mouse button, **click** on the Power Supply % Power bar pointer. While holding the left mouse button down, **drag** the pointer to the right until the sample temperature starts to increase as indicated on the IR camera screen next to the word Temp.

Note: This slide controls the power output of the Induction Power supply from 0 to 100%. **Apply** only enough power to achieve and maintain sample test temperature.

WARNING: Do not maintain power on the coil any longer than necessary to complete the test. Holding power on the induction coil for an extended period can damage the coil, its capacitors, and the coil feedthrough seals. *If the test can not be performed as soon as the test temperature is achieved,* **decrease** the power to the coil by sliding the power bar pointer completely to the left (or 0), and **let** the coil cool before testing again.

Note: As the sample temperature increases, the chamber pressure will increase. **Control** the test pressure by venting off just enough of the chamber pressure to maintain test pressure.

4.5.3. Once the sample temperature and sample pressure is controlled, **start** the timer on the Panasonic® Time-Date Generator by pressing the start/stop button labeled **STOPWATCH**.

4.5.4. **Start** the test on the LabVIEW® control screen by clicking **IGNITER POWER (S-101)**. **Pan** to the inside chamber camera moving the Mixer Wipe Control to "B" and the Fade Control to "Out." **Select** Camera 1 on the Video Switcher immediately after clicking **IGNITER POWER.**

Note: *If the promoter fails to ignite,* **follow** the procedures in section 9.4.5.

After sample ignition and *if the sample continues to burn*, **observe** the sample consumption. *If the sample stops burning,* the test is complete. *If the sample continues to burn* and as the sample burn reaches the top of the viewing area of the monitor, **switch** to Camera 2 by pressing button 2 on the Video Switcher and **repeat** until the sample stops burning.

Once the sample stops burning, **slide** the % power control pointer to the left (0%), select Camera 3 on the Video Switcher by pressing button 3, **fade** the external camera and the title graphics into view on the monitor so that all three items can be seen on the monitor.

4.5.5. Combustion is determined to be **complete** when the video monitor indicates **burning has ceased,** *i.e.,* when the last visible drop passes the window.

4.5.6. **Stop** the timer on the Panasonic® Time-Date Generator by pressing the start/stop button labeled **STOPWATCH**. **Press** the **RESET** button to reset the timer.

4.5.7. **Stop** the chamber VCR after the test is complete.

Note: *If a test is to be performed above 5,000 psi,* **place** a surveillance tape in the VCR, and **record** the chamber during pressurization to test pressure. After test pressure is reached, **place** the burn tape in the VCR to record the sample burn.

4.6 Shutdown Procedure

4.6.1. *If shutting down between samples:*

4.6.1.1. **Rotate** the "keyed" High-Frequency Control switch to the off position. **Press** the Stop button below the High-Frequency Control switch. **Press** the Induction Power Supply Coolant switch to stop water flow to the Induction Coil Power Supply.

WARNING: **Ensure** that the General Fault light is on and the High-Frequency Control switch is in the off position before the induction power cables are be removed.

4.6.1.2. **Ensure** the GOX supply valve (**V-101**) is set to **Close**.

4.6.1.3. **Open** the chamber vent valve (**V-105**) to vent the test chamber. **Allow** **CHAMBER PRESSURE** to reach ambient (0 psig).

4.6.1.4. **Rewind** tape to the beginning of the last test performed. **Play** tape and **determine** test pressure and temperature at time of ignition; **determine** time when sample burn was complete. **Record** time, temperature, and pressure on data sheet. **Forward** tape to the end of the test recording, and press STOP. **Reset** recorder timer to 0:00:00. **Change** sample number to the next sample with the Graphics Generator

4.6.1.5. **Unload** the sample:

WARNING: The slag cup may be hot. After testing, **wear** *thermal gloves*. At other times, **wear** *latex gloves* to prevent contamination of the chamber.

WARNING: **Do not use** any fluids to cool the chamber. Fluids may cause damage to the test chamber or sample.

- **Place** the test area in *Limited Access Condition*.
- **Remove** induction cables by performing step 4.4.8 in reverse
- **Remove** capacitors by performing step 4.4.7.4 in reverse
- **Slowly rotate** the lift valve handle clockwise until the lift adapter starts to rise. **Guide** the lift adapter into contact with the bottom of the chamber plug. **Align** opening in the lift adapter with the inductor feedthroughs to protect the feedthroughs.
- **Unload** the chamber by performing step 4.4.7 in reverse order
- **Turn** the chamber cap counterclockwise until it is free of the chamber.

- **Slowly rotate** the lift valve handle counterclockwise until the lift plate starts to move downward. **Lower** the cap and the plug to their full down positions.
- **Remove** the post-test sample, and **measure** its length and weight.

4.6.1.6. **Resume** testing at section 4.4.1, and **continue** through section 4.4.10. **Consult** the test engineer for thresholding procedures, if necessary. **Continue** with sections 4.5.1 through 4.5.7.

4.6.2. *If testing is complete for the shift:*

4.6.2.1. Leave the test chamber closed while performing the following to vent GOX from the system:

- In the test cell, **shut down** the GOX supply by rotating the handle fully clockwise.
- At the console, **open** the GOX supply valve (**V-101**) on the LabVIEW® screen.
- **Open** the chamber vent valve (**V-105**) to vent the test chamber. **Allow CHAMBER PRESSURE** to reach ambient (0 psig).
- **Close** the GOX supply valve (**V-101**).

4.6.2.2. In the test cell, **perform** the following:

- **Perform** step 4.6.1.3 to unload the last sample.
- **Perform** steps 4.4.7.1 through 4.4.7.5 to secure the chamber.
- Perform step 4.3.10.4 to turn off the facility GN_2 supply into the test cell.
- At the GN_2 panel, **slowly open** the GN_2 system line vent valve (MV-MGN-P201) by turning the valve handle counterclockwise. This vents GN_2 from the system .
- **Allow** GN_2 supply pressure to reach ambient pressure conditions (0 psig).
- Perform steps 4.3.10.5.1 through 4.3.10.5.8 to turn off GN_2 panel supply and regulator supply.
- **Fully reduce** the GN_2 valve actuation regulator (PCV-MGN-P230) by turning the knob counterclockwise until it stops.
- **Fully reduce** the GN_2 intensifier actuation regulators (PCV-MGN-P240 and PCV-MGN-P241) by turning the knobs counterclockwise until they stop.
- **Fully reduce** the GN_2 chamber purge regulator (PCV-MGN-220) by turning the knob counterclockwise until it stops.
- This completes closing the GN_2 system.

4.6.2.3. **Exit** the LabVIEW® system by clicking the **EXIT** button on the bottom left of the control screen. **Shut down** the Windows Operating System. Then **push** the **EMERGENCY POWER SHUT OFF** button.

4.6.2.4. **Turn off** the chamber VCR and its monitor. **Turn off** the room video recorder and monitor. **Place area** in *Full Access Condition*. **Close** and lock rollup door to the test area. *If tapes are full,* **label** and **place** them in tape storage in accordance with section 4.7.

4.7 Data Recording and Reduction; Post-Test Photography

4.7.1. **Label** the video cassette with the next number in the video tape log book in the fenced area of the inventory control room (Room 104). **Store** the tape in the same area.

4.7.2. **Complete** the test data sheet and pre-test checklist, and **return** these with the folder to the test engineer for evaluation of data. **Write** all test data on the test data sheet: initial test pressure, initial and final sample length, initial and post-test weights, and video cassette number.

4.7.3. **Photograph** all post-test samples, and **put** three copies of each photograph in the test folder before returning the folder to the engineer. Photographs shall be retained indefinitely.

Note: *If there are several burns and the samples are hard to handle,* representative photos may be taken and labeled as such. The test engineer, in consultation with NASA, will decide whether to make representative photos on a case-by-case basis.

4.7.4. **Package** samples in the original plastic bag. **Label** the bag with test request number, test pressure, tester number, and test date, and **indicate** the order in which the sample was tested.

4.7.5. **Give** the samples and the completed work folder to the test engineer for evaluation. The test engineer **shall return** samples to the sample preparation technician who shall store them for future reference.

4.7.6 For ease of locating test data on a video tape, **maintain** a video time log (section 7, Figure 7-2) that lists the time counter readings from test start to finish, the material, the test request number, the test pressure, and the number of samples. **Maintain** a hardcopy of this log with the video tape.

5.0 Notes

Custodians for EM10-OWI-CHM-064	
Master List and Document Control	EM10 Management Support Assistant
Alternate Document Control	EM10 ISO Representative
Records	Materials Test Branch ISO Representative
Calibration	Materials Test Branch Calibration Contact
Memoranda	Materials Test Branch ISO Representative

6.0 Safety Precautions and Warning Notes

6.1 Hazards

Warning
Death, severe personal injury, or loss of major equipment may result if maintenance or operating procedures, techniques, restrictions, etc., are not followed exactly.

Use of the Heated Promoted Combustion Chamber involves several hazards to the operators, including:

- Electrical load and other ignition sources applied in air and/or oxygen-enriched environments
- Heavy parts of the test apparatus handled and moved on a regular basis
- Burning materials in an oxygen enriched environment
- Pressurized systems and cylinders (oxygen and/or nitrogen)
- Risk of burns from molten metal slag
- Frostbite, which could occur when touching the chamber immediately after venting the chamber
- Handling of cleaning solvents that require personal protective equipment
- Potential for exposure to oxygen-deficient environments
- Strong electro-magnetic fields may interfere with pacemakers.

6.2 Safety Precautions

6.2.1. At least one test operator must be in the test area and one other person in Building 4623 during normal business hours. After normal business hours and on weekends, a test engineer must be in Building 4623 during all test activities. **No more than 5 persons** shall be in the test cells at any one time. Operation of the tests shall comply with EM10-OWI-CHM-050, *Materials Combustion Research Facility Guidelines for Test Operations.*

6.2.2. **Activate** the building warning system, which includes facility warning beacons, signs, and oxygen alarm sensors, for the duration of the test. **Evacuate** the test cell area immediately upon warning of oxygen depletion or saturation.

6.2.3. **Keep** this OWI accessible during operation of the test equipment. The Emergency Shutdown Procedure shall be posted in view of the test console.

6.2.4. **Do not operate** test controls when personnel are working with the test chamber. **Place** on the control console the sign warning that personnel are working in the test cell.

6.2.5. **Perform** all testing **remotely**. **No one shall have access** to the test cell, associated areas behind or adjacent to the test cell, the fenced area behind the test cell, or the roof above the test cell **when the chamber is pressurized above 1,200 psig**. **Open** the roll-up door behind test cell at any time the pressure exceeds ambient in the test chamber.

6.2.6. **Ensure** that monitors and cameras are operating correctly to aid in troubleshooting during leak-checks and for room observation.

6.2.7. **Read** the MSDSs for gaseous nitrogen and oxygen, lubricants, all samples and cleaners. **Don** personal protective equipment (lab jacket, safety shoes, clean chemically resistant gloves, thermal gloves, eye goggles, respirator) as deemed necessary by the sample and cleaner MSDSs when cleaning and handling samples. **Personnel must be qualified to use a respirator, and the respirator must be supplied by MSFC.**

Note: Read the test material's MSDS to ensure familiarity with all safety precautions associated with the material. Verify that the test engineer is aware of all highly hazardous, reactive, or toxic components of the test material. The *test engineer* shall direct the test operator in proper safety procedures concerning these test materials.

6.2.8. **Wear** safety glasses at all times while in the test cell.

6.2.9. **Smoking is not permitted** in Building 4623. The test area can be an oxygen-enriched environment. **Open flame or other high-temperature sources are not permitted in the test area when oxygen-enriched conditions exist.**

6.2.10. **Do not use** the test cell as a storage area for anything other than parts or components of the testing apparatus that are designated as spare parts and tools necessary for equipment maintenance. **Remove** all other materials from the testing area. **Place** all trash and combustibles in proper fire retardant containers.

6.2.11. In case of a GOX fire, **follow** the emergency shutdown procedure (section 6.4), **evacuate** the area immediately, and **call 911**.

Note: The Emergency Shutdown Procedure is posted at all tester control consoles.

6.2.12. In case of injury from a hot chamber or a GOX fire, **follow** the emergency shutdown procedure, and **call 911** for medical help.

6.2.13. **Ensure** that all electrical components are in **good condition** and **properly connected** and **grounded.**

6.2.14. **Wear** safety shoes in the test area, machine shop, and while handling and moving heavy items.

6.2.15. **Do not eat or drink** in the test area.

6.2.16 When handling cylinders and dewars or when making connections for compressed gases and/or liquids, **refer** to *Working Safely with Compressed Gases and Cryogens* and *NSTC 313-Cryogenics Safety.* (**See** the test engineer for these resources.) **Comply** with the suggestions inside these presentations.

6.3 Special Precautions Associated with Compressed Gases and Liquids

6.3.1. All operations involving compressed gases and liquids shall be conducted using the buddy system.

6.3.2. All operating personnel shall be instructed on the nature of hazards associated with compressed gases and liquids.

6.3.3. Before removal of any component of the system for servicing, the operator shall secure and inspect the system to ensure that no unsafe condition exists.

6.3.4. Personnel shall perform continuous monitoring, *e.g.,* check operating pressures, look for leaks, listen for unusual noises, during all operations. Personnel shall ensure that oxygen leak levels are adequate throughout operations.

6.4 Emergency Shutdown Procedure

The *test operator* **shall shut down** the test equipment in case of an emergency. *If the operator cannot do so*, *any person* may read the posted emergency shutdown procedures and shut down the equipment. The *test operator* **shall also notify** the test engineer of the emergency shutdown.

6.4.1. **Push** the **red EMERGENCY POWER SHUT OFF** button on the control console in any emergency. This closes the GOX and GN_2 supply valves, opens the line and chamber exhaust vent valves, and turns off the power supply for the ignitor assembly.

6.4.2. Once the system has been safed, **shut down** the GOX supply and GN_2 supply at the source by **turning** the valves **clockwise** as viewed from the top of the valve. **Do not enter the room, if there is the oxygen alarm is activated or if a fire hazard exists.**

6.5 Accident Reporting

6.5.1. From a safe location, the *test operator* **shall immediately call 911 and notify** the EM10B team lead.

6.5.2. From a safe location, the *EM10B team lead* **shall immediately report** the accident to the Building 4623 Safety Monitor and the appropriate supervisor(s).

6.6 Emergency Response Plan

Emergency procedures and plans for Building 4623 are incorporated into the building emergency plan and are stated in MPR 1040.3G. *MSFC Emergency Plan*. Plans will be modified if operations change in a significant manner.

6.7 Mishap Reporting

Report all mishaps occurring in Building 4623 to the test engineer, who shall report the mishap to the area coordinator/Safety Monitor. An initial verbal report must be made within 8 hours, followed by a written report within 3 days. The EM10B team lead must prepare a managerial report within 7 days. Both reports must be reviewed by the test operator's supervisor and by the Building 4623 Safety Monitor. The detail and extent of the mishap report will depend on the nature and extent of the damage. *If personnel injury or equipment damage does occur,* the mishap report will be completed in accordance with MWI 8621.1, *Close Call and Mishap Reporting and Investigation Program.*

7.0 Attachments, Data, Reports, and Forms

7.1 Attachments

7.1.1. Heated Promoted Combustion Test Cell Software Glossary

7.1.1.1. Starting the Software

The computer's operating system file contains the execute command for the LabVIEW® control software. **Boot** the computer via the console power/**EMERGENCY POWER SHUT OFF** button. At the Windows^{XP} screen, **click** the HPC control profile; **click** the HPC Control icon; and **click** the run arrow in the top left-hand corner of the screen under the menu.

Note: Under normal shutdown procedures, **always exit** the control software before shutting down the console power. To do this, **click EXIT** on the control screen. Then exit Windows^{XP} normally.

7.1.1.2. Main Screen (**Refer** to section 9.1, Figure 9-4.)

Software Operation. Move the mouse over the soft-key in question, and **click** the left mouse button to toggle the valve or enter the data.

Igniter Power Duration: **Use** this soft-key, as directed by the test engineer, to enter the length of time in seconds that the power supply will remain on after **Igniter Power** (**S-101**) is pressed.

Path: Use this soft-key to name the data file that stores the data acquired during the test (the full path and file name). The system will store all the input data from the sensors to this file for a period of time determined by the **Data Acquire Time** setting. All data must write to the **C:** drive first and then can be downloaded to the **A:** drive. To copy the data to the **A:** drive, use the last four numbers on the test request number and the sample number. (Example: For test request number 105222, sample 1, use **A:\52221.dat**)

Igniter Power S-101: Starts the ignition power supply. When activated, the switch will keep the power supply active for the number of seconds determined by the operators entry in the **Igniter Power Duration** box located in the lower left hand corner of the main screen.

Data Acquire Time: Time, measured in seconds, that the LabVIEW® system will continue to acquire data after **Igniter Power S-101** is pressed. A typical data-acquisition time is 100 sec; this amount of time can be changed.

GOX Supply V-101: Operates the chamber supply valve.

Pump Drive V-102: Starts and stops the O_2 intensifier by starting and stopping the GN_2 actuation pressure to the intensifier.

Auxiliary Vent V-103: Auxiliary chamber vent; the LabVIEW® system is set up to run this additional vent at the user's request when the additional valve is integrated.

Main Vent V-105: Vents the chamber.

O2 Analyzer: Only used if post-test oxygen is to be measured and only if chamber pressure is 10 psig or less.

Purge Pressure: This soft-key allows the user to set the upper limit for the pressure to be used when purging the chamber. The typical default is 1500 psig.

7.1.1.3. Setup Screen

Access the Setup Screen by selecting **Enter Calibration Data** on the control screen.

Supply Pressure: Use this tab to enter configuration information for the specific O_2 supply pressure transducer being used or to change the range of the transducer without affecting system operation. See section 9.5.2 for instructions on how to calculate offsets and slopes for pressure transducers.

Chamber Pressure: This tab allows the same control for the chamber transducer as the supply transducer.

7.1.2. Operating Instructions for the Panasonic® Character Generator

The title format is normally saved (if power is not lost) in the character generator, and the only requirement is to edit the sign from one test to the next. (Section 7.1.3 contains instructions for starting the Panasonic Mixer or restarting the mixer after power has been lost.)

7.1.2.1. To edit the sign, the mode selection switch (at the top of the generator board directly to the right of Panasonic model number) must be set on **EDIT TITLE**. This will display the title on the video monitor. **Move** the cursor (by the arrow keys) until the desired editing position is reached. **Type** the necessary changes on the keypad. To delete a character, **press** the **DELETE** button located on the far right side of the second row. To add a space, **press** the **SPACE** button located in the center of the board at the bottom. No more editing

operations should be required. **Refer** to the *Panasonic® Character Generator WJ-TTL5 Operating Instructions* if more information is required.

7.1.2.2. To record the sign on the tape, the mode selection switch must be set to **REC TITLE**. The title will be displayed on the screen, but the extraneous editing marks will disappear.

7.1.3. Operating Instructions for the Panasonic® WJ-AVE5 Digital AV Mixer

7.1.3.1. Even though only a few features of the Panasonic® WJ-AVE5 Digital AV Mixer are used during Test 17 operations, the mixer will lose all of its settings if the power to the unit is turned off or if a power outage occurs. To restart the mixer after a power loss, **perform** the following steps to reset the needed features of the equipment, referring to Figure 7-1, as needed:

7.1.3.1.1. **Turn** the unit's **Power On/Off Switch** on, *if it is off*. (This switch is located in the upper left-hand corner of the Mixer.) The switch is on *if the red light above the button is illuminated*.

7.1.3.1.2. To set/reset the Superimpose Effect feature:

- **Turn on** the **Superimpose On/Off Switch**. (The red light on the switch illuminates when the switch is on.)
- **Turn on** the **A-bus Selection Switch,** the **Back Color Switch,** and the **Title Effect Switch**.

Note: Turning on the Tittle Effect Switch is optional.

- **Place** the **Key Level Control** in the Down position.

7.1.3.1.3. To set/reset the Mix Wipe Effect feature:

- **Select** the **Mix Mode** by pressing the **Mix Mode Selection Switch**. This mode provides a smooth transition between the A and B channels.
- In the A column, **select Source 2**.
- In the B column, **select Source 1**.
- The **Mix/Wipe Control Slide** is used to transition from channel A (the outside camera) to channel B, the inside camera.

7.1.3.1.4. To set/reset the Fade Control feature, which fades the title when recording from the inside camera:

- **Select Title**.
- **Select Back Color**.

7.1.4. Detailed Video Procedure

7.1.4.1. On the Video Cassette Recorder (VCR) remote control, **select** "line" as the input source by depressing the **Input** button until an **L** appears on the

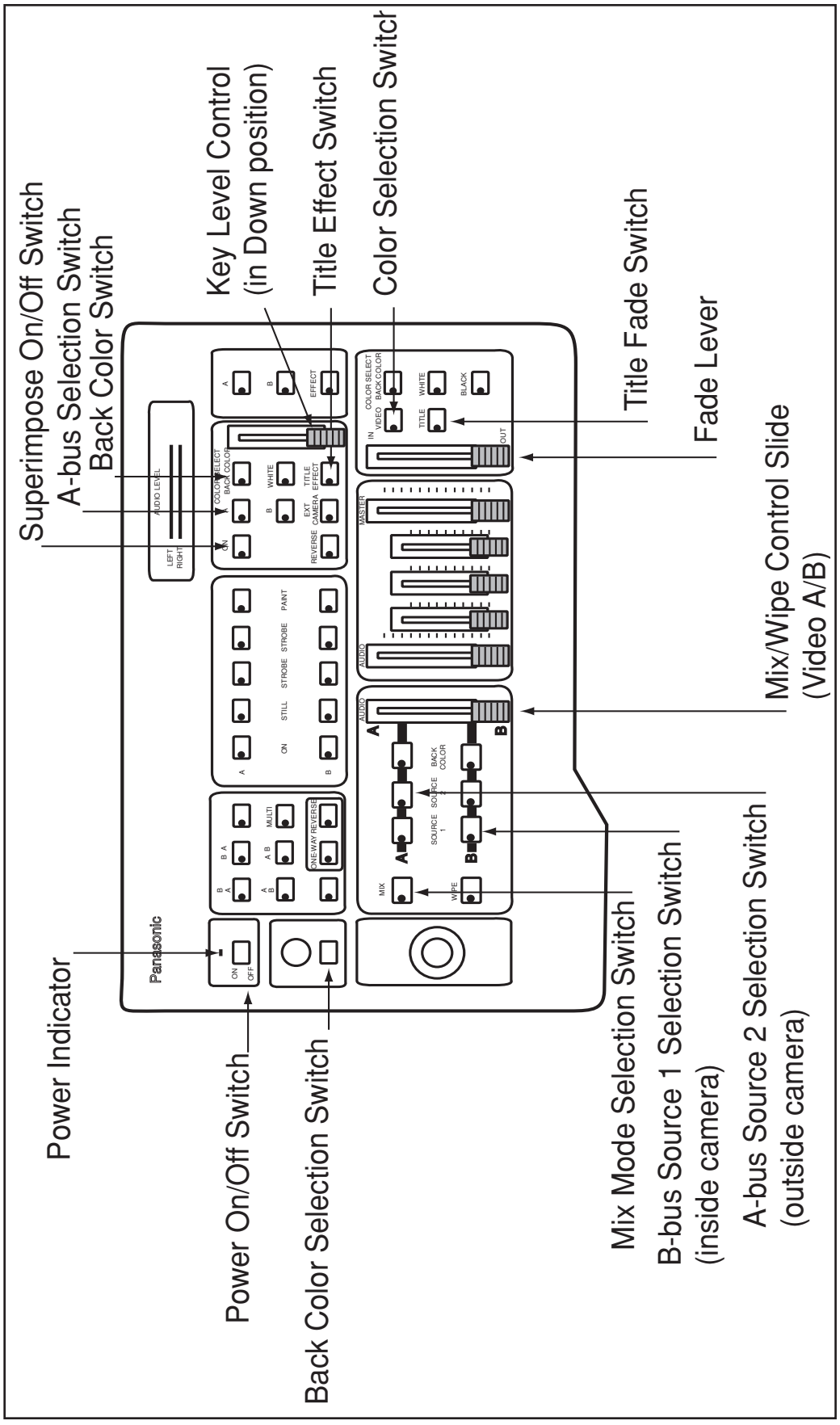


Figure 7-1.
Primary Controls on the Panasonic Mixer Board.

VCR display window. **Depress** the **Clock/Counter** button until the counter is displayed on the VCR display window. **Depress** the **Clear Rest** button to ensure that the counter is set to **0:00:00**. To ensure that the VCR is recording at "Standard," **depress** the **Speed** button until the letters **SP** appear in the VCR window.

7.1.4.2. **Insert** a blank cassette or a cassette with ample tape to record the test being performed. This step can be performed at any time before the test begins.

Note: Some VCRs rewind a newly inserted cassette a few seconds. When recording with a tape that contains other tests, it is good practice to press **Play** on the VCR remote control for a few seconds to ensure that previous test data are not lost.

7.1.4.3. Ensure that the **Video** slide is near the **A** position and the **Fade Lever** slide is at the **In** (up) position.

Note: The **Video** slide (**Mix/Wipe Control Slide**) and the **Fade Lever** (**In/Out** slide) are the only slide controls used during the test. The **Video** slide should stay near the **A** position and the **Fade Lever** slide should stay in the **In** position until the **START (Ignitor Power S-101)** button is selected on the LabVIEW® test screen (step 7.1.4.6). Positioning the **Video** slide selects between the inside and outside cameras. Since the Burn Timer is superimposed on the inside camera video screen, leaving the **Video** slide in the upper half of the slide area before the sample is lit allows viewing of the counter and the outside camera and the Chamber and Pressure Gauge readings.

7.1.4.4. **Begin recording** by pressing the **Rec** button on either the VCR remote control or on the VCR itself.

7.1.4.5. **Start** the Burn Timer by pressing the **Start/Stop** button on the Timer.

7.1.4.6. Using the mouse, **select** the **Start** button on the LabVIEW® test screen. Simultaneously, **move** the **Video** and **Fade Lever** slides to their bottom positions (**B** and **Out**, respectively).

Note: There is an ~3-sec delay from the time the **Start** button is selected and sample ignition.

7.1.4.7. After the sample burn is complete, **move** the **Video** and **Fade Lever** slides back to their top positions (**A** and **In**, respectively).

7.1.4.8. **Stop** the Burn Timer by pressing the **Start/Stop** button on the timer. **Reset** the Burn Timer by pressing the **Reset** button on the timer.

7.1.4.9. **Stop** recording.

7.1.4.10. **Rewind** the tape to the **0:00:00** time set before the test. **Play** the tape, and **record** the pressure and burn time.

7.1.4.11. **Stop** the tape.

7.1.4.11. **Reset** the **Clock/Counter** to **0:00:00** in preparation for the next test.

7.2 Forms

Figures 7-2, 7-3, 7-4, and 7-5 present typical forms used to document the conduct of Test 17.

Figure 7-2.
Typical Video Data Log.

Promoted Combustion #1
Video Data Tape #02-5
03-30-02 to 08-15-02

Time	Material	Request	Pressure	# of Samples
00:00 - 06:52	Inconel X750 Rod	105277	750	1-10
06:52 - 08:54	Monel 400 H#513903 rod	105161	10,000	1-2
08:54 - 09:46	Ni 298 NRA 8-21	106222	5,000	11

Promoted Combustion Tester Pre-Test Checklist

Request No. _____

Initial

1. ____ NASA-STD-6001 reviewed within the last year?
2. ____ Promoted Combustion OWI reviewed within the last year?
3. ____ Equipment reflects baseline in OWI?
4. ____ Equipment checked out per OWI?
5. ____ Samples wiped clean before loading into test chamber?
6. ____ Adequate supply of gaseous oxygen?
7. ____ Chamber wiped to visually clean?
8. ____ Facility warning beacon activated?
9. ____ Chamber leak checked with GN_2?
10. ____ Sample MSDS read?
11. ____ Pre-test photographs taken and in test folder?

Remarks/Discussion of Discrepancies:

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____ _____

Test Operator Date

2/2006 EM10-F-CHM-065, Rev. A

Note: Representative Checklist. Refer to Forms Master list for current version.

Figure 7-3.
Typical HPC Pre-Test Checklist.

Figure 7-4.
Typical Test 17 Test Data Sheet.

Test 17 Promoted Ignition/Heated Promoted Ingition Data Sheet

Item No. _____ Date Tested _____ Project _____

Test Report No. _____ Mtrl. Code _____ Requestor _____

Heat No. _____ Lot _____ Batch _____

Set No.

Manufacturer Designation _____

Manufacturer _____

Composition _____

Specification _____

Pressure _____ Chamber volume _____ (cu ft) Percent O2 _____

Percent 2nd gas _____ Name second gas _____ Ignitor Mtrl _____

Test stand _____ Test temperature _____ Ignitor Weight _____ (g)

Standard Test: _____ Y _____ N

Samp #	Sample Length (in.)	Sample Width (in.)	Sample Dia/Thick (in.)	Pre-test Weight (g)	Post-test Weight (g)	Ignition Press (psia)	Burn Length (in.)	Burn Time (sec)	Prop Rate (in./sec)	Test Temp (°F)	Use Temp (°F)
1											
2											
3											
4											
5											
99											

Excess sample: ___ Y ___ N Quantity of excess: _____ Storage Box #: _____

Test conductor: _____

Video Tape No.: _____ PC Photo File: _____ DVD Disk #: _____

Remarks: _____

_____

_____

_____

2/06 EM10-F-CHM-005

Note: Representative Data Sheet. Refer to Forms Master list for current version.

Calibration Statement: Categories IV and V Equipment

Calibration is required before use per MPR-8730.5.

(Calibration before use for each test series and periodic testing by the Using LIne Organization)

Calibration Contacts: EM10/James Perkins, EM10/Mark Griffin

User Name:_____

Equipment Description:_____

(attach multiple components sheets if necessary)

Manufacturer:_____

ECN:_____ Serial No.:_____ Model No.:_____

Date of Calibration:_____

Type of Software and Version:_____

_____

Listing of Standards Associated with Calibration:

_____

_____

_____

_____

_____

Are standards National Institute of Standards and Technology (NIST) traceable? ☐ Y ☐ N

Did calibration meet equipment manufacturer's specifications? ☐ Y ☐ N

Calibration was performed by:_____

Remarks:

_____

_____

_____

_____

_____

_____

_____

_____

1/05 EM10-F-CHM-018

Figure 7-5.
Typical Calibration Statement.

Note: Representative Calibration Statement. Refer to Forms Master list for current version.

8.0 Records

Records for Heated Promoted Combustion Testing **shall consist** of memoranda that contain test results and that are stored electronically in the Materials and Processes Technical Information System (MAPTIS).

8.1 Memoranda

Memoranda containing test results **shall be retained** indefinitely by EM10. These memoranda **shall be stored** electronically in the MAPTIS database and **shall be accessible** by test request number or memorandum number.

8.2 Calibration

8.2.1. All equipment requiring calibration **shall be** in current calibration, in accordance with EM10-OWI-CHM-050, *Building 4623 Guidelines for General Operations.*

8.2.2. Form EM10-F-CHM-018 (Figure 1, section 7.2, Figure 7-5), **shall be used** to document the calibration of all Category IV and Category V equipment.

8.3 Quality Records

8.3.1. Memoranda less than 10 years old shall be maintained in ready-access files in MAPTIS; memoranda 10 years old or older shall be automatically transferred to historical files.

8.3.2. Calibration records shall be maintained on site for a minimum of 10 years, filed and indexed by test request number. These shall be stored in a manner that will protect them, *e.g.*, in a test folder stored in a metal file cabinet. After 10 years, calibration records shall be transferred to historical files.

8.3.3. The original test records shall be saved for a minimum of 5 years.

9.0 Tools, Equipment, and Materials

9.1 Standard Configuration

The test chamber (Figure 9-1) of the promoted combustion test system is a 17-4 PH stainless-steel cylinder, with an internal volume of approximately 5.564 ft^3, that is rated to operate at pressures up to 12,000 psig. For safety, a pilot relief valve opens if the system reaches 11,600 psig. Two burst disks are set at 12,500 psig on a branch of the supply lines connected to the chamber, and a pump relief valve is set at 10,500 psig. The inside of the chamber is fitted with a copper sleeve to protect the chamber walls from burning metal slag.

Six 2-in. diameter sight ports in a helical pattern around the chamber allow personnel to monitor testing with 6 video cameras. Two thermocouples may be used to determine internal temperatures in the chamber; an IR camera measures sample temperature. The base is sealed with a retaining ring that is threaded to allow access to the chamber for sample loading. An air cylinder lift system, powered by facility-supplied gaseous nitrogen, helps the technician lift and position the heavy base and retaining ring.

The test chamber typically accommodates cylindrical test specimens (Figure 9-2) of up to 0.25 in. in diameter and a minimum of 9 in. in length, but other sample configurations may be tested. The test specimen is held at its top by a clamp mounted to the top post of the coil. The standard ignition promoter is a 6061-T6 aluminum cylinder (0.25-in. outer diameter, 0.16-in. length) that is press-fit onto the end of the test sample. Other types of ignitors may also be used. A 0.022-in. diameter palladium-coated aluminum wire (Pyrofuze®) is wrapped around the promoter and attached to the ignitor terminals by means of copper alligator clips (Figure 9-3). Ignition is accomplished when the Pyrofuze® is electrically heated. A power supply capable of supplying a minimum of 40 amps RMS at 30 VDC is used to supply the necessary current. A drip cup in the bottom of the chamber prevents damage to the base by molten metal.

GOX is supplied to the test chamber from a high-pressure LOX-to-GOX conversion station. For test pressures above the source pressure, an oxygen intensifier is used. Facility GN_2 provides the pressure to actuate all remote valves (90 psig), the air cylinder lift (90 psig), and the intensifier (150 psig).

Data from thermocouples and pressure transducers are digitally processed and recorded on disk via a LabVIEW® data acquisition system. The LabVIEW® controller controls the ignition, purge, pressurization, sample temperature, and vent systems and displays the system data, *e.g.*, GOX supply pressure, chamber pressure, temperatures, percent power supply, and valve positions (Figure 9-4) on a monitor on the console. (Section 7.1.1 contains the Heated Promoted Combustion software glossary.) Another monitor at the console is used to view the inside of the test chamber. All tests are recorded on video, and the recordings may be used to calculate propagation rates.

Figure 9-1.
Heated Promoted Combustion Tester

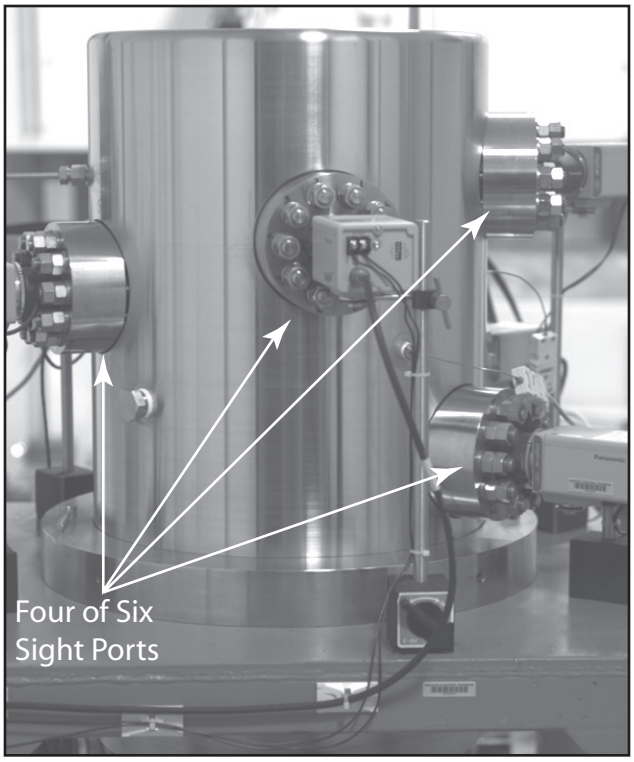


Figure 9-2.
Induction coil with sample in position

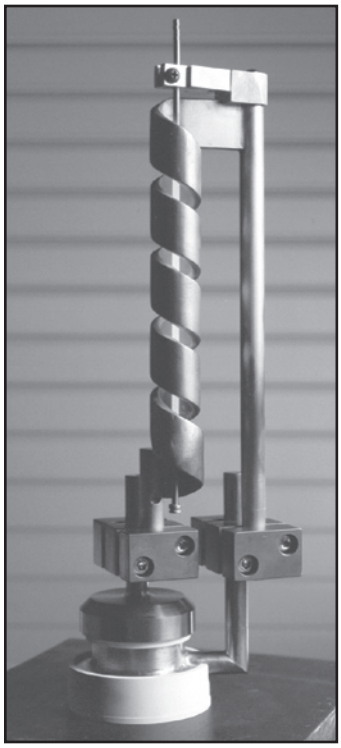
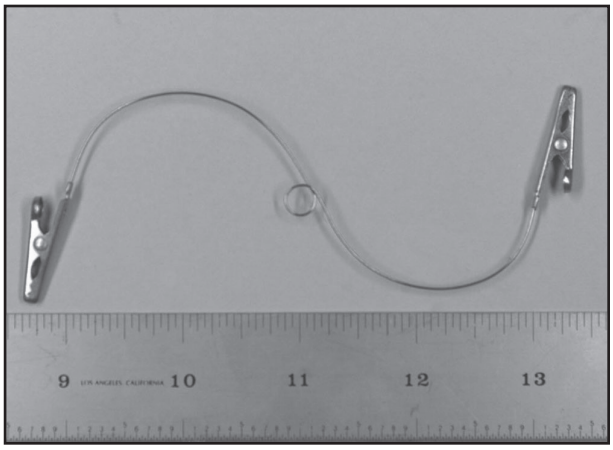


Figure 9-3.
Pyrofuze® wire with alligator clips



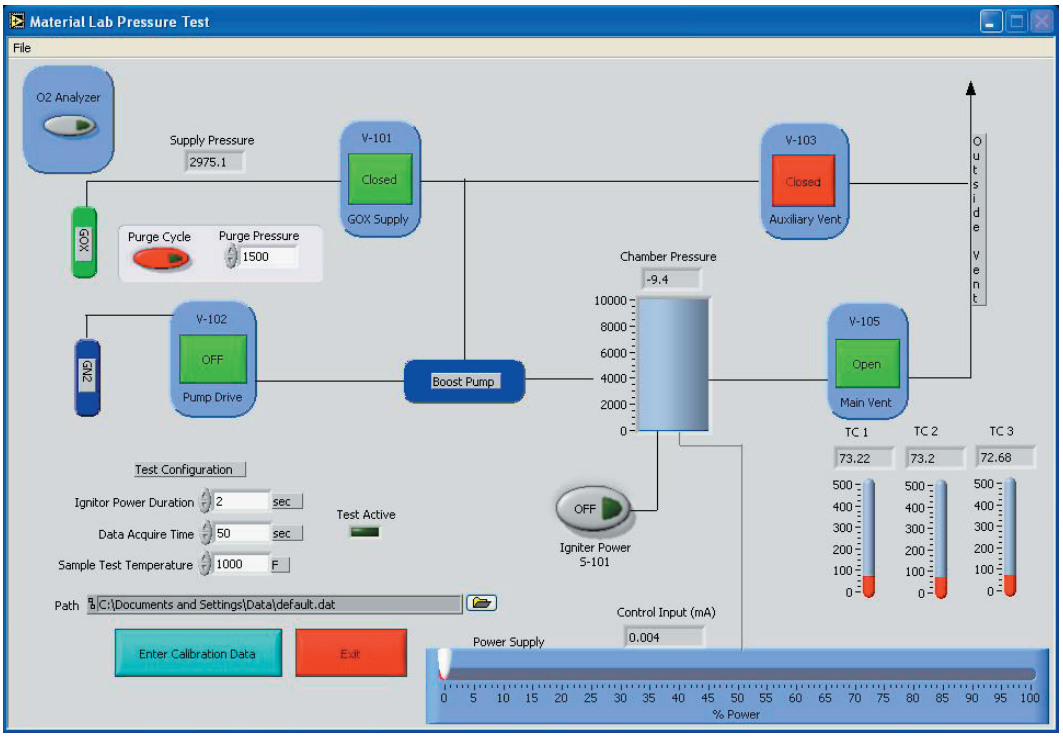


Figure 9-4.
Typical LabVIEW® Control Screen for the Heated Promoted Combustion Test.

The test operator uses a Panasonic® character generator to place the test request number, sample number, and test conditions on the video recording. (Section 7.1.2 contains information on operation of the character generator).

9.2 Procedure for Deviations

Deviations to the baselined tester configuration require NASA written approval. The test engineer is responsible for obtaining the appropriate approval. After written approval is received, the change shall be added to the appropriate configuration control book.

9.3 Other Defined Configurations

The voltage and amperage on the power supply **may require adjustment** to accommodate low-pressure (~50 psi) ignition of the aluminum promoter. The sample size may vary from the standard size and shape. The promoter may be omitted and the Pyrofuze® wire directly wrapped around the sample. All of these are non-standard tests configurations **must be requested** in the test plan by the test engineer and **noted** in the pre-test checklist by the test operator.

9.4 Maintenance Instructions

9.4.1. When the test chamber requires cleaning, **disassemble** and **scrub** all parts, including the chamber base, with a cleaning solution of 2.5 ounces of Micro Cleaner® to 1 gallon of distilled or deionized water. **Clean** all chamber cavities. **Use** plastic scouring pads or brushes with nylon bristles. (**Wear** nitrile gloves and goggles when handling the cleaning solution.) **Clean** all ports. **Rinse** with distilled/deionized water, and then **blow dry** with GN_2. *If the cleaning solution appears not to be cleaning sufficiently*, **ensure** that the chamber is dry, and then **wipe** it with trichlorotrifluoroethane. (Trichloroethylene or Brulin® 815 MX may be substituted for trichlorotrifluoro-ethane, *if the cleaning is performed in a well-ventilated area*. *If this substitution is made*, **refer** to the MSDS for the appropriate gloves to use.)

WARNING: Do not clean a hot chamber.

9.4.2. Using an adequate light source, visually **inspect** all the window static face seals and the plug static face seal daily for signs of distorting, leaking, or damage. **Replace** all brittle, deteriorated, or damaged static face seals in accordance with the following steps.

9.4.2.1. **Loosen** and **remove** all the 1/2 -20 jam nuts from the window flange. (Refer to Figure 9-5.) Then **remove** all the 1/2-20 flange nuts and washers to free the window flange.

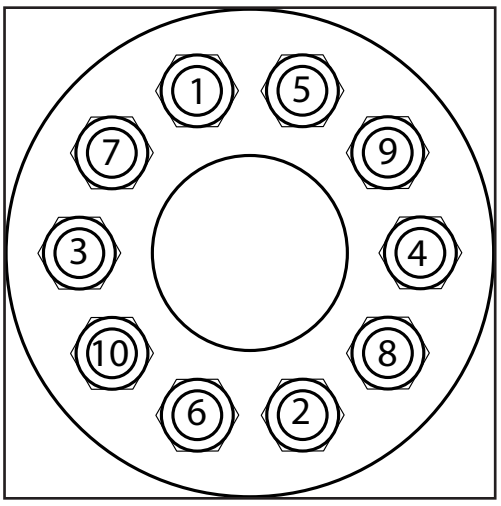


Figure 9-5.
Jam nut and flange torque pattern

9.4.2.2. When all nuts and washers have been removed, carefully **slide** the flange and window assembly away from the chamber and off the studs and **place** the window and flange on a flat surface with the window facing upward.

Caution: **Ensure** the window remains in the flange during the flange removal step.

Note: The static face seal may remain stuck to the window while the flange and window are being removed.

9.4.2.2.1. **Remove** the seal backing ring. Then **remove** the seal. Compressed air may be used to remove the static face seal.

Note: **Never use** a metal object to remove the static face seal from the chamber. Damage to the seal and gland groove may occur.

9.4.2.2.2. **Don** clean, chemically resistant gloves.

9.4.2.2.3. **Wipe** the static face seal gland groove with a cotton-tipped applicator soaked with trichlorotrifluoroethane. (Trichloroethylene or Brulin® 815 MX may be substituted for trichlorotrifluoroethane, if the cleaning is performed in a well-ventilated area). **Inspect** the gland groove to ensure it is clean.

9.4.2.2.4. Clean the chamber side surface of the window using a three-ply tissue soaked with trichlorotrifluoroethane. (Trichloroethylene or Brulin® 815 MX may be substituted for trichlorotrifluoroethane.)

9.4.2.2.5. **Inspect** the static face seal for cracks or damage. *If the seal is damaged,* **discard** the old seal and replace. *If the seal is only slightly contaminated with combustion particles,* **wipe** it clean using a three-ply tissue soaked with trichlorotrifluoroethane. (Trichloroethylene or Brulin® 815 MX may be substituted for trichlorotrifluoroethane). **Reuse** the seal.

9.4.2.2.6. **Insert** seal in the gland groove followed by the backing ring.

9.4.2.2.7. **Replace** the window/flange assembly on the studs, and carefully **slide** the assembly until the window makes contact with the static face seal.

9.4.2.2.8. **Place** the 10 flat washers on the studs, and **torque** the flange nuts and outer jam nuts using torque pattern in Figure 9-5, as described in section 4.3.3.

Note: **Maintain** cleanliness throughout this process, as impurities could cause a GOX fire.

Note: Once the window/flange assembly has been completely removed from the chamber for any reason, **torque** all flange nuts in 50 in.-lb increments to a maximum of 200 in.-lb.

9.4.3. **Inspect** the chamber plug static face seal for damage or particulate contamination. *If damage is evident,* **replace** with approved material in accordance with the configuration control drawing. **Clean** the seal with trichloro-trifluoroethane before installation. (Trichloroethylene or Brulin® 815 MX may be substituted for trichlorotrifluoroethane

9.4.4. **Ensure** that soft goods wetted with oxygen are of approved materials.

9.4.5. *If an ignition problem occurs*, **vent** the chamber and lines, *i.e.*, set **V-105** to **Open.**

9.4.5.1. **Turn off** the power supply in the test cell. **Ensure** that:

- Both copper terminal rods are **isolated** from the baseplate.
- The ignitor feedthrough is **not shorted** internally by placing one voltmeter lead on the feedthrough and one on ground.

9.4.5.2. **Turn on** the power supply in the test cell. **Ensure** that the main switch light for the power supply in the test cell is **on**, when the remote ignitor power supply switch at the console is on.

9.4.6. The sight ports' 1/2-20 jam nuts and flange nuts may require a periodic re-torque. **Refer** to section 4.3.3.

9.4.7. *If the intensifier fails to operate,* **perform** the following:

9.4.7.1. Ensure the chamber supply valve (**V-101**) is set to **Close**.

9.4.7.2. **Open** the chamber vent valve (**V-105**).

9.4.7.3. **Ensure** the system is vented, as indicated by readings of ambient (0 psig) in **Chamber Pressure** and on the Heise gauge (PT-P130).

9.4.7.4. **Ensure** the intensifier actuation valve (**V-102**) is set to **Close**.

9.4.7.5. At the GN_2 panel, **ensure** that the intensifier actuation regulators (PCV-P240) and (PCV-P241) are fully reduced (closed) by turning the knob counterclockwise.

9.4.7.6. **Remove** the pump, and **provide** it and the following information to maintenance: manufacturer, model, serial number, NEMS number (if any), and a brief description of problem. **Notify** the test engineer.

9.4.7.7. **Install** a serviced intensifier.

9.4.7.8. At the GN_2 panel, **adjust** both intensifier actuation regulators (PCV-P240) and (PCV-P241) simultaneously to 140 ±5 psi.

9.4.7.9. **Place** the test area in *No Access Condition*.

9.4.7.10. **Open** the chamber supply valve (**V-101**).

9.4.7.11. **Close** the chamber vent valve (**V-105**).

9.4.7.12. After **Chamber Pressure** and **Supply Pressure** have equalized, **start** the intensifier by setting the intensifier actuation valve (**V-102**) to **Open**. **Allow Chamber Pressure** to reach the desired pressure specified in the test plan, and **maintain** this pressure by toggling **V-102** to **Open** and **Close** as required.

9.4.7.13. *If the intensifier pump is working properly*, **continue testing**. *If not*, **notify** the test engineer.

9.4.8. *If a leak is suspected*, **perform** the following:

9.4.8.1. On the LabVIEW® screen, **Close** the chamber supply valve (**V-101**).

9.4.8.2. **Close** the intensifier actuator valve (**V-102**).

9.4.8.3. **Open** the system vent valve (**V-103**) and the chamber vent valve (**V-105**).

9.4.8.4. When **Chamber Pressure** and the Heise gauge reach ambient (0 psig), **place** the test cell under *Limited Access Condition*.

9.4.8.5. At the GOX panel in the test cell, **ensure** that:

9.4.8.5.1. The GOX supply valve (MV-MGO-P113) is **closed,** *i.e.,* the handle is turned fully clockwise.

9.4.8.5.2. The GOX supply pressure transducer isolation valve (MV-MGO-P116) is **open** by turning the handle fully counterclockwise.

9.4.8.6. **Position** cameras to view suspected leak areas.

9.4.8.7. **Perform** steps 4.3.14.6 through 4.3.14.10 to set up the GN_2 supply pressure for leak check.

9.4.8.8. **Apply** Sherlock® 5-Second Leak Detector, Type 1, (or equivalent) to the suspected leakage area(s) with a syringe.

9.4.8.9. **Perform** steps 4.3.17.11 through 4.3.17.15.

9.4.8.10. **Close** the chamber supply valve (**V-101**).

9.4.8.11. **Monitor Chamber Pressure** or **Supply Pressure**, whichever is suspected of leaking, for significant changes in pressure.

9.4.8.12. **Monitor** the TV screen for bubbles coming from suspected leak area(s).

Note: Steps 9.4.8.9 through 9.4.8.11 may take more than 10 minutes, which is the limit of the leak detector. *If this is the case*, **set** the chamber supply valve (**V-101**) to **Close**, **set** the chamber vent valve (**V-105**) to **Open**, **allow Chamber Pressure** and the Heise gauge to reach ambient pressure (0), **reapply** leak check, and **pressurize** the chamber to a pressure of no greater than 2200 psi (steps 9.4.8.7 through 9.4.8.11). **Repeat** step 9.4.8.12.

9.4.8.13. **Vent** the system by setting the chamber vent valve (**V-105**) to **Open**. **Allow Chamber Pressure** and the Heise gauge to reach ambient pressure (0).

9.4.8.14. **Perform** steps 4.3.17.11 through 4.3.17.15.

9.4.8.15. **Obtain** the test engineer's approval before performing any replacements. **Repair** the leak by **replacing** parts or **retorquing** bolts, as described in the configuration control manual. **Reclean** any surfaces dirtied by the process, as described in the maintenance section.

9.4.8.16. **Perform** steps 9.4.8.1 through 9.4.8.15 to pressurize the system with nitrogen to ensure the leak has been fixed .

9.4.8.17. **Continue** the test or the setup at the point where the leak was discovered.

9.4.9. Maintenance Log. **Document** any maintenance to the test chamber or setup in the appropriate Promoted Combustion tester's maintenance log to provide a history of the tester. Any deviation to standard maintenance shall be documented and approved on the maintenance log by the responsible test engineer.

9.5 Calibration

Pressure transducers require calibration **yearly** and must be in calibration before testing. **Submit** these items to the calibration laboratory through the MCRF calibration contact, as required. When replacing pressure transducers, **adjust** slopes and offsets in the LabVIEW® system as follows:

9.5.1. **Select** the **Enter Calibration Data** soft-key on the LabVIEW® test screen.

9.5.2. For both Supply Pressure and Chamber Pressure, **input** these values into the appropriate software fields (Figure 9-6):

Volts at 0 PSI= 0
Volts at Max Scale = 5
Pressure at Max Scale = range of pressure transducer
Offset (measured at zero) = pressure reading at atmosphere (value displayed in applicable pressure readout window)

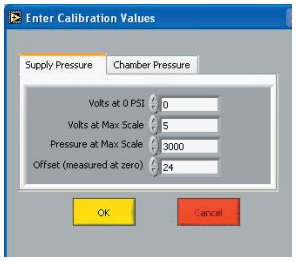


Figure 9-6.
Calibration screen

9.5.3. **Verify** that all pressure transducers returning from the calibration laboratory have the appropriate XLR connectors and that the connectors are wired correctly:

Pin 1 = Power (+)
Pin 2 = Power (-)
Pin 3 = Signal (+)
Pin 4 = Signal (-).

9.6 Required Spare Part Inventory

Before beginning each test request, **ensure** that there are spares for all pieces of test equipment.

10.0 Personnel Training and Certification

The nature of testing that occurs in the MCRF, Building 4623, is complex and involves potential hazards; therefore, all test operators must be **Category 1** certified before conducting any test, and all tester maintenance personnel must be **Category 2** certified. This section describes the two categories of certification:

- **Category 1 Certification** qualifies personnel to perform basic test operations.
- **Category 2 Certification** qualifies personnel to maintain and modify testing apparatus.

Category 1 - Basic Operations

To be certified, all test operators must complete training in the following areas:

- High Pressure Systems (>150 psig)
- Oxygen Compatibility
- General Safe Laboratory Practices
- Hazardous Waste Disposal
- Inert/Asphyxiate Gases and Liquids
- Oxygen System Handler
- Oxygen System User.

Category 1 Certification also requires an annual physical examination conducted by the medical facility at Marshall Space Flight Center (or equivalent), including a hearing exam.

The operator must demonstrate knowledge of the test and equipment by completing two successful test sets under the supervision of the test engineer. In addition, the test operator must show proficiency in performing the emergency shutdown procedure.

Test operators shall thoroughly read the test OWI as part of the certification process. They shall sign a statement that they have read and understand the OWI and shall be issued personal copies of the OWI. The test engineer shall give the candidate a written test covering the OWI. A copy of this test, along with the signed statement and the training record, shall constitute verification of certification. Training records shall be kept on file as proof of training. These records shall include training expiration dates and required refresher courses.

These certifications shall expire after a period of 2 years. After that time, recertification shall be required.

Category 2 - Tester Maintenance and Modifications

Personnel seeking **Category 2 Certification** must become qualified and certified in the following areas:

- Compressed Gases and Working with Compressed Gas Lines and Fittings
- Basic Electrical Wiring.

This qualification/certification may be achieved through training classes approved by the candidate's supervisor or through training classes completed during previous employment.

EMERGENCY PHONE NUMBERS

Emergency..... 911

Medical Center..... 4-2390

Industrial Safety..... 4-0046

Chemical Spills..... 4-4357

Safety Monitor
Building 4623..... 4-3571