Gaseous Oxygen Pneumatic Impact Test
(ASTM G-74)

Materials, Processes, and Manufacturing Department
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		Chemistry Group Leader	ED36	
		Industrial Safety	QS30	

Revision	Date	Originator	Description	Affected Pages
Baseline	xx/xx/04	Eddie Davis		

This document baselines the Organizational Work Instruction (OWI) for the Gaseous Oxygen Impact Test. Any change to this OWI must be submitted to and approved by the Chemistry Group Leader, ED36. 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 ED36.

Concurring organizations:
ED36B Team Leader
Environmental Health, AD02M

Contents

To be revised

This page is deliberately blank.

1.0 Scope

1.1 Scope

The scope of this operating instruction is the Gaseous Oxgyen Pneumatic Impact Test, as performed in Marshall Space Flight Center's (MSFC's) Materials Combustion Research Facility, in accordance with ASTM G-74, *Standard Test Method for Ignition Sensitivity of Materials to Gaseous Fluid Impact*.

1.2 Purpose

The Gaseous Oxygen Pneumatic Impact Test is performed to determine the sensitivity of materials in contact with gaseous oxygen (GOX), when in direct contact or as the result of a single barrier failure when subjected to pneumatic impact (adiabatic compression). Materials are tested over a pressure range defined by the test plan.

1.3 Applicability

This instruction applies to the Chemistry Group of the Materials, Processes, and Manufacturing (MP&M) Department.

2.0 Applicable Documents

ASTM G 74. *Standard Test Method for Ignition Sensitivity of Materials to Gaseous Fluid Impact.*

MPG 1840.2. *MSFC Hazard Communications Program*.

MPG 1840.3. *MSFC Hazardous Chemicals in Laboratories Protection Program*.

MPG 8715.1. *Marshall Safety, Health, and Environmental (SHE) Program*.

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

MSFC-SPEC 164B. *Cleanliness of Components for Use in Oxygen Fuel and Pneumatic Systems Specification*.

MWI 8715.2B. *Lockout/Tagout Program*.

MWI 8715.4. *Personal Protective Equipment (PPE)*.

MWI 8715.6. *Hazardous Operations*.

MWI 3410.1. *Personnel Certification Program*.

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

3.0 Definitions

3.1 Definitions

NASA Marshall Space Flight Center ED36 responsible personnel

Lockout/Tagout Placement of a tag-out device on an energy isolating device to indicate that the energy-isolating device and equipment being controlled must not be operated until the tag-out device is removed by the authorized person who placed it there

No access. No one may enter the test cell at any time. Lock the back gates, or ensure that they are locked. Ensure that no one is in the testing area. Turn on the facility warning beacon to indicate that a test is in progress or that part or all of the test system is pressurized.

3.2 Acronyms

GOX Gaseous Oxygen

MCRF Materials Combustion Research Facility (Building 4623)

MP&M Materials, Processes, and Manufacturing Laboratory at Marshall Space Flight Center

MSFC Marshall Space Flight Center

NASA National Aeronautics and Space Administration

OWI Organizational Work Instruction

4.0 Instructions

All operations of this equipment will be conducted using the applicable documents referenced above (section 2). All critical measuring devices, *e.g.*, *pressure gauges and pressure transducers*, must be in current calibration (section 9.4). All data and test results will be recorded on form ED36-F-xxx, the Gaseous Oxygen Pneumatic Test data sheet (section 7.2, Figure x). A summary of pertinent test information and test results will be compiled in a NASA memo, signed by the test organization management, and mailed to the test requester.

The purpose of the Gaseous Oxygen Pneumatic Test is to determine the sensitivity of materials in contact with gaseous oxygen, when in direct contact or as the result of a single barrier failure when subjected to pneumatic impact.

4.1 Sample Preparation

The *sample preparation technician* **shall prepare** test samples according to ED36-OWI-042, *Test Sample Preparation for Testing in the Materials Combustion Research Facility (current version)*. When non-standard samples are required, the *sample preparation technician* **shall follow** the directions written in the test plan for that test request. *If this information is not provided with the test plan*, the *sample preparation technician* **shall seek clarification** from the test engineer.

Before testing begins, the *test operator* **shall review** the information supplied on the test data sheet (prepared by the sample preparation technician) to make certain the information is complete and appears sound. *If a problem is identified*, the *test operator* **shall notify** the test engineer and **await further instruction**. The *test operator* shall also:

- **Verify** that the test request number and material designation are identical on all paperwork.
- **Confirm** that the prepared sample agrees with the test request.
- **Verify** that the sample preparation technician has noted if the sample has been cleaned or if the sample does not require cleaning.
- **Note** any flaws or imperfections in the sample, and **record** these on the test data sheet.
- **Review** the test plan and the original test request before proceeding. *If the test plan and the test request do not agree,* **request** clarification from the test engineer.

4.2 Pre-Test Photography

The *sample preparation technician* **shall take** a pre-test photograph of at least one of the samples, and **place** three copies of the photograph in the test folder. *If the pre-test photograph has not been taken*, the *test operator* must **take** this photograph and **place** three copies of the photograph in the test folder before proceeding with the test. The entire sample must be visible in the photo. Steps for photographing samples are outlined in the *Photography Operating Guide*, located in Room 126.

4.3 Equipment Checkout

At the beginning of each test day, **perform** the following steps:

4.1.1.

4.1.1.1.

4.1.1.2.

4.1.1.3.

4.4 System Setup and Sample Loading

4.4.1. **Ensure** that the test chamber has been cleaned after the last test. If not, flush the specimen material from the reaction area with a suitable solvent. If this does not remove visible evidence of contamination, replace the test chamber subassembly with a clean assembly or components.

4.4.2. **Clean** all component parts of the test system that will be exposed to the test media or test specimen or both to a level compatible with the test media.

4.4.3. **Place** the sample in position within the sample cup.

4.4.4. Loosely **install** the sample cup in the test chamber.

4.4.5. **Purge** the test chamber and sample cup with low-pressure oxygen by opening the purge valve (V-1) to ensure that a 95 (+5 -0??) percent oxygen environment is established within the test chamber.

4.4.6. **Wrench tighten** the sample cup.

4.5 Detailed Test Procedure

4.5.1. **Pressurize** the high-pressure accumulator to the desired test pressure with oxygen.

4.5.2. **Stabilize** the test chamber temperature at the desired test conditions.

4.5.3. **Subject** the material speciment to cyclic high pressure oxygen.

4.5.3.1. **Ensure** that purge valve V-1 is closed.

4.5.3.2. **Open** vent valve V-4 until the chamber pressure sensor indicates atmospheric pressure; **close** V-4.

4.5.3.3. **Open** pressure isolation valve V-2.

4.5.3.4. **Cycle** high-speed valve V-3 open until test chamber pressure sensor indicates the same pressure as the accumulator; **close** V-3.

4.5.3.5. **Maintain** pressure in the test chamber for 5 seconds.

4.5.3.6. **Open** vent valve V-4 for 5 seconds to allow the test chamber pressure to decay to atmospheric pressure; **close** V-4.

4.5.4. **Repeat** steps 4.5.8.4, 4.5.8.5, and 4.5.8.6 until five complete cycles have been performed.

4.5.5. **Close** pressure isolation valve V-2.

4.5.6. **Close** V-3 and V-4 when the test chamber pressure sensor indicates atmospheric pressure.

4.5.7. **Remove** sample cup from the test chamber.

4.5.8. **Remove** the material speciment, and **examine** it for evidence of reaction.

Note: A reaction is indicated by an abrupt increase in test specimen temperature or by obvious changes in odor, color, material appearance, or a combinaton thereof.

4.5.9. **Record** all observations on the test data sheet (Section 7.2, Figure 7.2-2) in accordance with section 4.7.

4.5.10. **Repeat** the above sequence to obtain data on a total of 20 specimens at each specified test pressure.

4.6 Shutdown Procedure

what is the shutdown procedure?

4.7 Data Recording and Reduction; Post-Test Photography

4.7.1. **Fill out** the test report data sheet (section 7.2, Figure7.2-2) completely. **Place** the test data sheet and the completed Pre-Test Checklist (section 7.2, Figure 7.2-1) in the work folder, and **return** the folder to the test engineer for evaluation.

4.7.2. **Photograph** any visual changes, and **document** these in writing on the test report data sheet. **Do not photograph** post-test samples that did not react. *(Is that last statement true for this test?)* **Take** the required photographs as close to the sample as possible. More than one sample or reaction per photo is acceptable, as long as the details of reactions are visible. Procedures for taking photographs are outlined in the *Photography Operating Guide*. **Place** three copies of each post-test photograph in the test folder before returning the folder to the engineer. Photographs shall be retained indefinitely.

4.7.3. **Package** the samples in clear photography slide sleeves. **Label** the protector with the test request number, pressure, and test date. **Identify** the samples by test order number and reaction indication. **Return** the samples with the test folder to the test engineer for evaluation. The *test engineer* **shall return** samples to the sample preparation laboratory for archival purposes.

5.0 Notes

Custodians for ED36-OWI-060	
Master List and Document Control	ED36 Management Support Assistant
Alternate Document Control	ED36 Group ISO Representative
Quality Records	Materials Compatibility Team ISO Representative
Memoranda	Materials Compatibility Team ISO Representative

6.0 Safety Precautions and Warning Notes

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

6.1 Hazards

Safety shall have precedence over all activities. The Gaseous Pneumatic Impact tester involves several hazards to the system operator and facility. These hazards include:

- Pressurized systems (oxygen)
- Potential for exposure to oxygen-enriched environment
- Possible shock hazard from electrical components.

6.2 Safety Precautions

6.2.1. **Plan** test setup, testing, and shutdown so that at least one test operator is in the test area and one other person is 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 five personnel** shall be in the cell at any given time. Operation of the tests shall comply with ED36-OWI-050, *Materials Combustion Research Facility Guidelines for Test Operations.*

6.2.2. **Wear** appropriate PPE during all testing activities:

- Goggles
- Gloves, *if the system vent is adjacent to the tester*
- Ear protection, *if the system vent is adjacent to the tester*

6.2.3. **Refer to the MSDS** for information on personal protective equipment required for materials being handled (sample materials, solvents used, gases.)

6.2.4. During testing, the test cell is in a *No Access* condition. No personnel are permitted in the test cell when remotely controlled valves are operating or when testing is in progress.

6.2.5. When personnel are working in the test cell, **place** a warning sign on the monitoring console.

6.2.6. **Keep** this OWI accessible during operation of the test equipment.

6.2.7. **Smoking is not permitted** in Building 4623. The test area is generally an oxygen-enriched environment. **Open flame or other high-temperature sources are not permissible** in the testing area while enriched-oxygen conditions exist. **Do not smoke or expose clothing** to an open flame or high-temperature source for 30 minutes after exposure to solvents and oxygen-enriched gasses.

6.2.8. **Do not store** anything in the test cell area other than parts or compo-

nents of the test apparatus that are designated as spare parts and the tools necessary for equipment maintenance. **Remove** all other materials from the test area. **Place** any spare equipment that will be exposed to an oxygen-enriched environment in the secured inventory area.

6.2.9. **Activate** the building warning system, including warning lights, for the duration of the test, in accordance with ED36-OWI-050. **Evacuate the test cell immediately if the oxygen warning systems sound and lights flash**: **close** the door between the control room and the test cell, and **turn on** the test cell ventilation. **Leave** the control room until the oxygen in the area has balanced or Facilities has checked the system.

6.2.10. **Do not try to extinguish** any fire in the test cell. **Evacuate** the area immediately, and **call 911** to notify the fire department.

6.2.11. **Ensure** all electrical components, wiring, *etc.*, are in good condition and properly connected and grounded. **Use caution** when operating any electrical equipment; **do not operate** electrical devices when the floors in the test cell are wet.

6.2.12. 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 Emergency Shutdown

Is there an emergency shutdown procedure?

6.4 Accident Reporting

6.4.1. In case of fire, **pull** the alarm, and **exit** to a safe location.

6.4.2. From a safe location, the *test operator* **shall immediately call 911** and **notify** the ED36 Safety Monitor. (**Call** 544-4357 if using a cell phone.)

6.4.3. From a safe location, the *ED36 Safety Monitor* **shall immediately report** the accident to the NASA Safety Monitor and the appropriate supervisor(s).

6.5 Emergency Response Plan

Emergency procedures and plans for Building 4623 are incorporated into this OWI and are stated in MPG 1040.3G. *MSFC Emergency Program. 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 ED36 Safety Monitor must prepare a managerial report within 7 days. Both reports must be reviewed by the technician's supervisor and by the NASA Safety Monitor. The detail and extent of the mishap report will depend on the nature and extent of the damage. *If personal injury or equipment damage does occur,* the mishap report will be completed in accordance with MWI 8621.1 *Mishap/Incident Reporting and Investigation*.

7.0 Attachments, Data, Reports, and Forms

7.1 Attachments

7.2 Forms

Figure 7.2-1.
Pre-Test Checklist

Gaseous Oxygen Pneumatic Impact Test Pre-Test Checklist

Request No. _____

	Initial Yes	No
1. ASTM G-74 reviewed?	☐	☐
2. OWI reviewed?	☐	☐
3. All safety equipment available and working properly?	☐	☐
4. Test equipment checked out per OWI?	☐	☐
5. Sample MSDS read?	☐	☐
6. Test plan read and changes noted and approved by engineer?	☐	☐
7. Adequate supplies of _____?	☐	☐
8. Facility warning beacon activated?	☐	☐

Remarks/Discussion of Discrepancies:

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____ _____

Test Operator Date

x/04 ED36-F-xxx

Gaseous Oxygen Pneumatic Impact Test Data Sheet

Project:_____ Date:_____Test No.:_____
Request ID No.:_____ Requester:_____
Generic Name:_____
Lot No.:_____ Set No.:_____Batch No:_____
Manufacturer Designation:_____
Manufacturer:_____
Composition:_____
Specification:_____
Requested Pressure:__(psia) Requested Temperature:_____
Previous Cleaning/Conditioning: _____
_____
Use Thickness:_____(in.) Sample Thickness: _____ (in.)

Samp #	Pressure Change Caused by Reaction (Y/N)	Temperature Change Caused by Reaction (Y/N)	# Test Cycles	# Failures	Post-Test Sample Condition
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					

Remarks _____
_____
_____
_____

Test Conductor _____

xx/04 ED36-F-xxx

Figure 7.2-2.
Test Data Sheet.

Figure 7-1.
Sample Maintenance/Repair Log

Note: Illustration is representative. Actual appearance may vary.

8.0 Quality Records

8.1 Memos

Memos concerning the Oxygen Supply System shall be maintained for 10 years by ED36.

8.2 Calibration

Pressure transducer calibration shall be kept current. Form ED36-F-018 (current revision) will be a quality record used to document the calibration of the pressure transducers. Calibration records will be maintained for a minimum of 10 years.

8.3 Quality Records

All quality records will be kept for historical purposes after 10 years. All quality records will be filed and indexed by report or memo number. These will be stored in a manner that will protect them, *e.g.*, in a folder stored in a metal file cabinet.

9.0 Tools, Equipment, and Materials

9.1 Equipment

The Gaseous Pneumatic Impact Test system is designed to expose material speciment or small components/elelments to high-velocity (dynamic) gaseous impact environments. The system, shown schematically inFigures 9.1-1 and 9.2-2, consists of:

- a high-pressure accumulator: provides gaseous test fluid storage and is precharged to the desired test pressure; sized to limit static head loss to <4% of initial pressure during the test sequence
- a test chamber/fixture: pressurized to 95% of test pressure in not less than 10 or more than 50 msec
- system pressurization lines: between accumulator and pressurization valve; sized to minimize flow losses and enable pressurization described above; contain isolation valve to provide a safety factor during operation
- a high-speed pressurization (impact) valv
- test chamber purge and vent systems
- a valve sequencer/control device: controls opening and closing of pressurization and vent valves during the test so that each impact/vent cycle is identical in timing.

The test system supports investigations under dynamic pressure conditions up to ____ psi at ambient temperature. Figures 9.1-1 and 9.2-2 illustrate the test system.

During the test, the test specimen is subjected to sequential gaseous impacts by alternately opening and closing the test chamber pressurization (impact) and vent valves. Test data include chamber pressures and temperatures, chamber pressure rise times, pressurization and vent valve actuation times, and sequence time.s. After the test, the specimen is examined for significant changes and evidence of reaction.

9.2 Procedure for Deviations

Deviations to the baselined oxygen supply system configuration require NASA written approval. It is the responsibility of the MSFC propellants and pressurized systems service contractor to obtain the written approval. If the system configuration has been modified, the system may require recertification.

9.3 Required Maintenance

The standard maintenance program for the Gaseous Pneumatic Impact system and related equipment _____ In addition, the program involves a maintenance log, calibration, and a required spare parts inventory.

9.4 Calibration

9.5 Required Parts Inventory

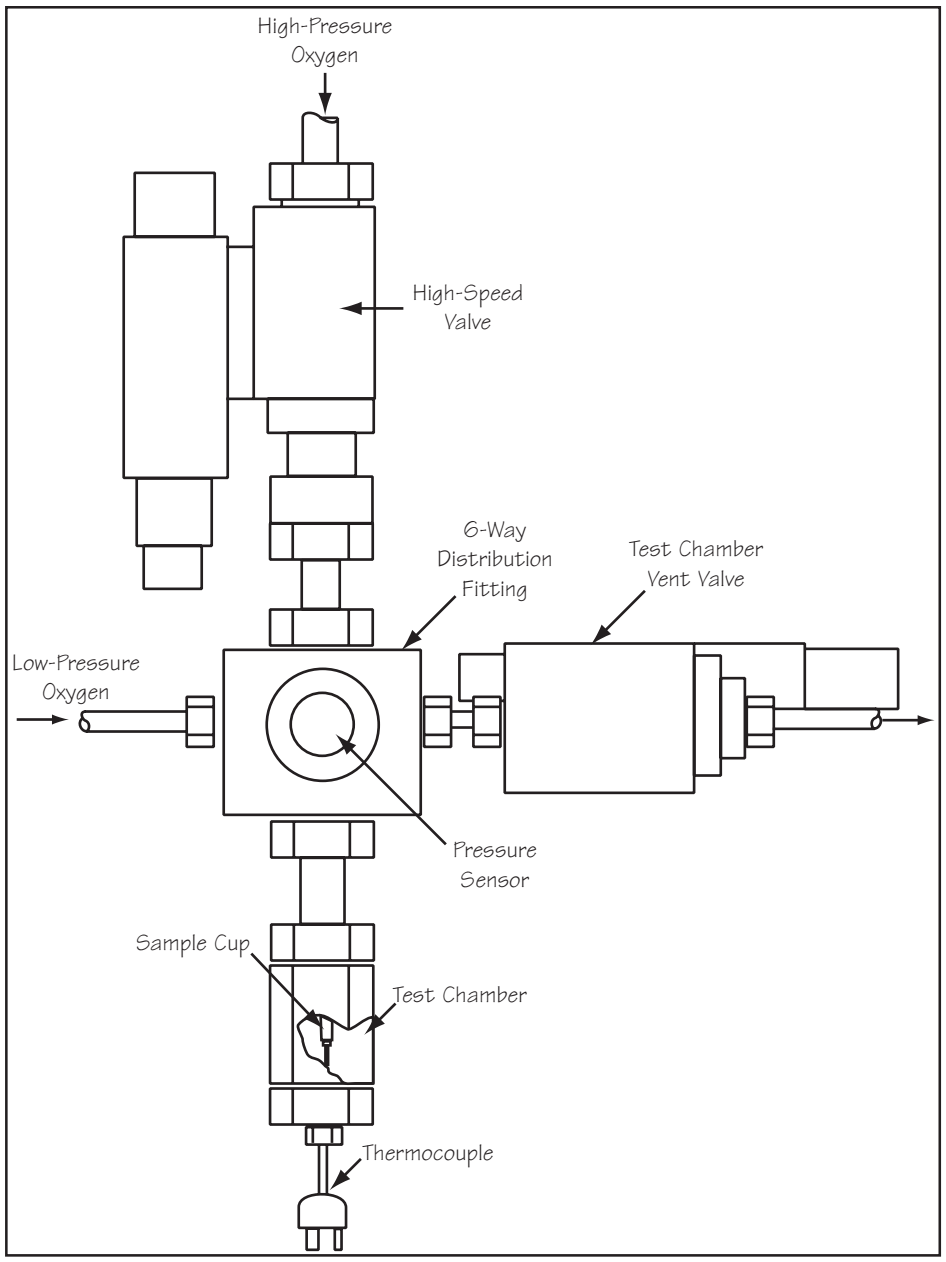

Figure 9-1.
Pneumatic Impact Test System.

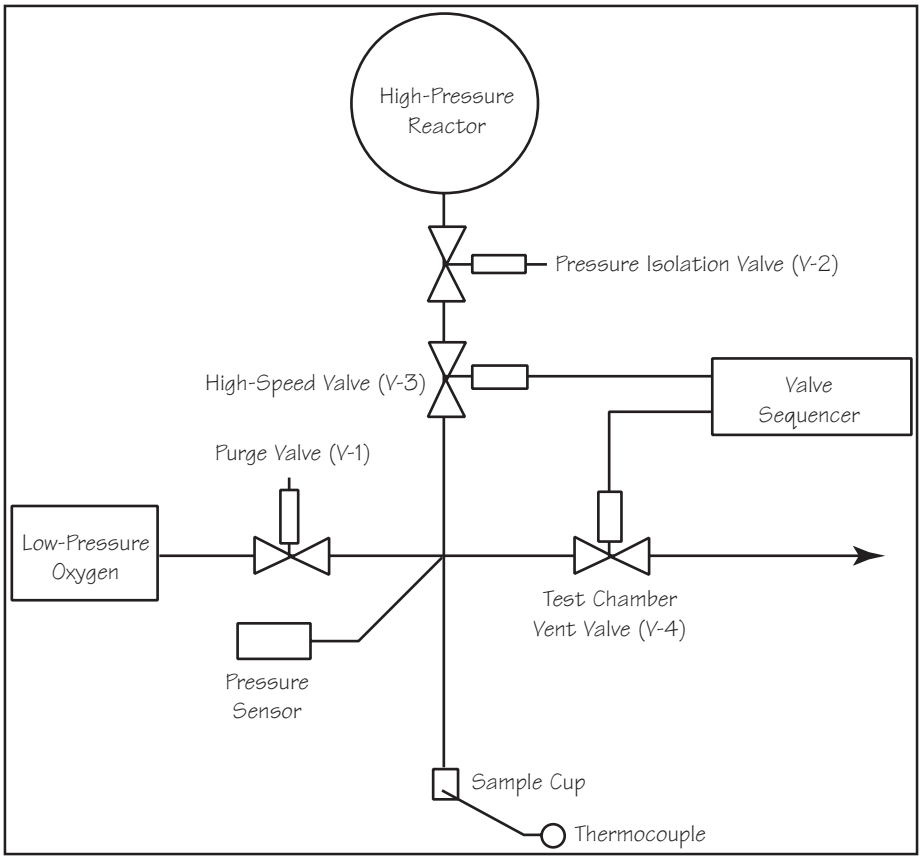

Figure 9-2.
Pneumatic Impact System.

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 performing oxygen supply system operations.

To be certified for basic operations (Category 1), an operator must complete training in the following areas:

- High Pressure Systems Safety
- Safe Handling of Cryogenic Fluids (LN_2 and LOX)
- Oxygen Compatibility.

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 oxygen supply system and equipment by completing two successful system startups 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 this 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, will constitute verification of certification. Training records will be kept on file as proof of training. These records will include training expiration dates and required refresher courses.

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

This page is deliberately blank.

EMERGENCY PHONE NUMBERS

Emergency..... 911
Cell Phone..... 544-4357

Medical Center..... 4-2390

Industrial Safety..... 4-0046

Chemical Spills..... 4-4357

Safety Monitor
Building 4643..... 4-2490