Subject:	Effective Date:	Initiated by:
Hydrostatic and Pneumatic Testing	August 7, 1998	Head, Engineering and Technical Infrastructure
	Supersedes: TOP 23.026 dated 12/22/89	Approved: Director

Applicability

This procedure applies to all activities at C and D-Sites of the Laboratory.

Introduction

This procedure defines the approved methods for conducting hydrostatic and pneumatic testing to ensure leak tightness for any system, component or part which operates at, or could possibly be exposed to, pressures greater than 15 psig. (The actions and precautions of this document should also be applied to vacuum testing if a separate procedure for the test has not been developed).

WARNING: Hydrostatic testing is always preferred, since pneumatic testing is inherently dangerous due to the amount of stored energy in the compressed gas contained within the system during the test.

NOTE: Some items may be exempted from this procedure with the agreement of Engineering and QA. Future revisions to this procedure will provide a listing of these items as they are identified.

Reference Documents

1. PPPL Health and Safety Manual, Section 9.11, "Pressure Systems".
2. ASME Boiler & Pressure Vessel Code: Section I, Power Boilers; and Section VIII, Pressure Vessels. (basis for procedure)
3. ANSI/ASME B31.1, Power Piping. (basis for procedure)
4. GEN-003, Document Distribution Control

Responsibility	Action
Cognizant Engineer/Physicist	1. Specifies that systems, components or parts be hydrostatically or pneumatically tested. NOTE: pneumatic testing is only allowed if: a) the piping systems are so designed that they can not be filled with water; b) systems are to be used in operation where traces of the test medium cannot be tolerated; or c) it is specified in Code (e.g., Dry sprinklers may be pneumatically tested per NFPA 13).
	2. Specifies test boundary, test conditions, type of test (hydrostatic or pneumatic), test equipment, and test pressure on the Pressure Test Record, Attachment 1, in accordance with the guidelines provided in Attachment 2.
Field Supervisor	3. Verifies test set up, valve lineup and safety precautions.
Cognizant Engineer/Physicist	4. Notifies the appropriate departments involved with initiating the pressure test so that calibrated test equipment and experienced personnel are available to perform the test.

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Cognizant Engineer/Physicist	5.	Notifies ES&H prior to pressure testing so that safety precautions can be observed and approved. (Note: maybe waived if generic hazardous work permit exists - see step 6).
ES&H	6.	Reviews safety precautions and if appropriate, allows testing to begin by signing and dating Attachment 1, and providing a Hazardous Work Permit per reference document 1. When appropriate, issues a generic hazardous work permit for testing which is always performed the same way (i.e., testing of hoses - same test setup, same pressure, etc).
Cognizant Engineer/Physicist	7.	Witnesses each critical component, subsystem, or system pressure test and validates that test was performed correctly and accurately, OR, notifies Quality Assurance to witness any "critical" pressure testing. NOTE: Cognizant Engineer/Physicist or QA presence during the tests is mandatory for critical items.
Quality Assurance	8.	Witnesses critical component, subsystem, or system pressure test and validates that test was performed correctly and accurately, when requested by the Cognizant Engineer/Physicist.
Cognizant Engineer/Physicist	9.	Documents results of test on Pressure Test Record (Attachment 1) and forwards to the Department's/Project's designate files (typically the PPPL Operations Center) in accordance with GEN-003, Document Distribution Control.

Attachments

1. Pressure Test Record
2. Guidelines for Hydrostatic & Pneumatic Testing

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PRESSURE TEST RECORD

SYSTEM ID _____ DRAWING NO _____

CLASSIFICATION: ☐ CRITICAL ☐ NON CRITICAL

SYSTEM BOUNDARY _____

TYPE OF TEST: ☐ HYDROSTATIC ☐ PNEUMATIC

TEST MEDIUM: ☐ DEMIN. WATER ☐ NITROGEN

☐ OTHER _____

PRESSURE GAGE: NO. _____ CALIBRATION DATE _____

RANGE _____

DESIGN PRESSURE: _____ psig TEST PRESSURE: _____ psig*

RELIEF VALVE PRESSURE SET POINT: _____ psig

TEST DESCRIPTION: _____

SAFETY REVIEW OF SETUP: _____ DATE _____

(OR LIST GENERIC HAZARDOUS WORK PERMIT PREVIOUSLY APPROVED AND ISSUED BY SAFETY)

TEST RESULTS: ☐ ACCEPT ☐ REJECT

TEST PERFORMED BY: _____ DATE: _____

WITNESSED BY : _____ DATE: _____

The COG or QC must witness Critical Pressure Tests

ALLOWABLE TOLERANCE ON ESTABLISHING INITIAL TEST PRESSURE

TEST PRESSURE	TOLERANCE
16 TO 50 PSIG	-0/+2 PSIG
51 TO 100 PSIG	-0/+5 PSIG
101 TO 250 PSIG	-0/+10 PSIG
251 + PSIG	-0/+20 PSIG

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GUIDELINES FOR HYDROSTATIC AND PNEUMATIC TESTING

Note: All helium leak checking must be completed before pressure testing.

TEST BOUNDARY

Define the boundary that will be tested with the pressure medium on a drawing or the Pressure Test Record, Attachment 1. The entire system, if it is new, or the newly added components or parts of the system must be exposed to the test pressure. The drawing must define which valves of the system are to remain open, as well as those that will remain in the closed position.

The boundary drawing must also specify the test setup. This includes the following:

Location of the connection for the application of the pressure (Note: This connection must have a shutoff valve so that the system being tested can be isolated from the pressure source).

Location and range of the calibrated pressure gauge.

Location of high and low point drains for the test (Required only for hydrostatic tests - high point drain is required to assure that all compressible gas is removed from the system prior to testing. Depending on the system, more than one high point drain may be required. Low point drain(s) are required to assure that the test medium is removed from the system).

Location of a safety relief valve that will be used to assure that the system is not over pressurized during the test. The relief pressure of the valve should be set no more than 25 psig over the test pressure.

Location of each joint or connection which needs to be inspected during the hydrostatic test. (Note: each connection must be readily visible- i.e., no paint on welds, no insulation etc).

TEST MEDIUM

Note: Hydrostatic testing is the preferred method for testing due to the inherent danger of pneumatic testing with the stored energy of a compressible gas.

Hydrostatic Tests

The preferred medium for performing hydrostatic testing is demineralized water. The individual determining what testing is required

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shall determine the quality of the water introduced to the system. The temperature of the test medium shall be the same as the equipment.

No other test medium for hydrostatic testing other than water is allowed. Review of any other medium will be on a case by case basis, with written approval by the Head of the Engineering and Technical Infrastructure Department for any exceptions.

Pneumatic Testing

The preferred medium for pneumatic testing is nitrogen. Other noncombustible/non- flammable gases may be used but nitrogen is preferred. In no case shall a flammable gas or oxidizer be used as the test medium for a pneumatic test without the written approval by the Head of the Engineering Department. The temperature of the test medium shall be the same as the equipment. Compressed air may be used for sprinkler systems.

TEST PRESSURE

NOTE: the test pressure shall not exceed the maximum allowable test pressure of any non-isolated component such as a vessel, pump or valve in the system as determined by engineering calculation or manufacturer's specification.

Note: 1) the gage must have been calibrated within one year of the pressure test; 2) the pressure gage must be visible to the person applying the pressure to the system; 3) the range of the gage must be at least 1.5 times the test pressure and preferably 2 times the test pressure so that an accurate reading of the test pressure can be established. The spacing between graduations shall be such that the inspector shall be able to determine that the required test pressure has been applied.

Hydrostatic Testing

The test pressure for a hydrostatic test shall be 1.5 times the maximum allowable working pressure (i.e., system designed for 200 psig, test pressure shall be 300 psig). Pressure for sprinkler systems shall be in accordance with NFPA 13.

Pneumatic Testing

The minimum test pressure for a pneumatic test shall be 1.2 times the maximum allowable working pressure. The maximum pressure shall not exceed 1.3 times the design pressure(i.e., system designed for 200 psig, test pressure shall be 240 psig). Pressure for sprinkler systems shall be in accordance with NFPA 13.

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APPLICATION OF TEST PRESSURE

The test pressure shall be gradually increased in the system to not more than one - half of the test pressure. Thereafter, the pressure shall be increased in steps of approximately one tenth of the test pressure until the required pressure has been reached. Once the pressure has been achieved and stabilizes (at least ten minutes) the system must be isolated from the pressure source.

Completion of the test can be by one of two methods:

OPTION 1. The test pressure shall be maintained without any change for at least ten minutes from the time the system was isolated from the pressure source, during which time there shall be no change in the pressure reading on the calibrated pressure gage. After the ten minute time period, the pressure may be reduced to the design pressure (or 100 psig whichever is less for pneumatic tests) and held for a sufficient time to permit inspection of each of the connections. Any leaks or failure to maintain pressure requires a repair and retesting.

OPTION 2. The test pressure must be maintained for a period not less than one hour during which time there shall not be a pressure drop on the calibrated gage greater than 2 percent of the test pressure for the one hour period. Failure to achieve this criterion would require a reduction in the pressure, examination for leaks, and repair and retesting.

SAFETY PRECAUTIONS

The following safety actions are mandatory during the application of a test pressure, when appropriate to the test being performed (consult with ES&H if assistance is needed to determine appropriate safety actions for a specific test):

Each member of the test team shall wear goggles, a full face shield and ear protection whenever pressure is applied to the system being tested.

Each valve which has been closed to contain the pressure shall be appropriately tagged to prevent inadvertent operation and assure that it will be returned to its normal position after the test.

The area where the test is being performed shall be roped off to prevent access to the general work force with signs posted on the ropes warning about the test.

Joints in the system which would be subjected to failure or flexible tubing shall be restrained during the test to prevent personnel injury.

Requirements of PPPL ES&H Directives Manual Section 9.11 "Pressure Systems" shall be complied with.

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