TA-55

Detailed Operating Procedure

Approval Cover Sheet

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Table of Contents

1.0 INTRODUCTION

1.1 Purpose

The purposes of this procedure are to describe the process of performing helium leak testing, to provide forms for recording test results, and to define leak test acceptance criteria. The final leak test shall demonstrate the leak tightness of the finished system.

1.2 Scope

This procedure was written for use at Los Alamos National Laboratory (LANL). This procedure satisfies the requirements for the following standards:

- American Society for Testing and Materials (ASTM) E499, *Standard Practice for Leaks using the Mass Spectrometer Leak Detector in the Detector Probe Mode*, Method A, Direct Probing
- ASTM E498, *Standard Practice for Leaks Using the Mass Spectrometer Leak Detector or Residual Gas Analyzer in the Tracer Probe Mode*, Test Method A
- ASTM C854, *Standard Test Method for Resistance to External Loads on Metal Reflective Pipe Insulation*
- 10 CFR 830.122, *Quality Assurance Criteria*
- American Society of Mechanical Engineers (ASME)/ANSI NQA-1, 2008/2009a, *Quality Assurance*
- American Society for Nondestructive Testing (ASNT) SNT-TC-1A, *Personnel Qualification and Certification in Nondestructive Testing*
- American Glovebox Society AGS-G001, *Guideline for Gloveboxes*
- American Glovebox Society AGS-G004, *Standard of Practice For Leak Testing Methodologies for Gloveboxes and other Enclosures*
- American Glovebox Society AGS-G006, *Standard of Practice the Design and Fabrication of Nuclear Application Gloveboxes*
- DOE Order 420.1 C, *Facility Safety*
- LANL Master Specification 11 5311.10, *Glovebox Fabrication*
- LANL Master Specification 11 5311.12, *Glovebox Installation*

This leak test procedure shall be modified only by a request for information (RFI), supplier deviation disposition request, by a pre-award specification, or another applicable LANL contract document in order to meet the pressure, sensitivity, and leak-rate requirements for specific systems.

1.3 Applicability

NDE Level II and III leak testers must be currently listed in the Chapter 13 database of the LANL Engineering Standards.

1.4 Technical Safety Requirements (TSRs)

Not Applicable.

2.0 PRECAUTIONS AND LIMITATIONS

2.1 General

A. Pause/Stop Work

All workers are responsible for pausing or stopping work when they have a reasonable belief that quality, work risks, or hazards are not effectively controlled and workers have the right to do so without fear of reprisal. LANL policy P101-18, *Procedure for Pause/Stop Work,* provides more information on the differences between pausing or stopping work and the process for resuming work in either case.

If this procedure cannot be completed as written or abnormal conditions are encountered, PAUSE WORK, place the work in a safe configuration if possible, and notify the first line manager (FLM).

2.1 **General** (continued)

B. Hazards and Controls

Hazard	Controls
Ergonomics	• Workers change work positions periodically and stretch muscles to reduce fatigue, additionally taking breaks as needed to reduce strain. • Proper lifting techniques and/or coworker assistance is used. • Caution is used when manipulating heavy objects in a glovebox. Sliding (not rolling) of heavy items, push-stick is used, as necessary.
Hazardous Chemicals (Inert gases)	• Comply with P101-14, *Chemical Management*. • Use compressed gases only in areas with adequate ventilation. Adequate ventilation is defined as sufficient ventilation to totally replace the atmosphere in a work area in 10 minutes. • Before using a compressed gas cylinder, ensure that the regulator is in place. • When gas cylinders are not in use, close the main tank valve. • Use proper fittings and periodicaly leak test gas cylinder valves, regulators, and other components of the gas delivery system. • Remove gas cylinders with leaking tank shut-off valves
Ionizing Radiation and Radiological Contamination	• Follow radiological postings. • Radiological Control Technicians (RCTs) are notified to perform a radiation survey if radioactive material is surveyed. • As Low as Reasonably Achievable (ALARA) principles are to be used (time, distance, and/or shielding) to minimize dose to workers. • RWPs are required when dose rates ≥ 75 mrem/hr at 30 cm or ≥ 700 mrem/hr on contact.

C. Unique Entry Conditions

Not Applicable.

D. Basis for Use Categorization/Sequence of Steps

This is a reference procedure.

This procedure may be performed by a trainee or Level I Leak Tester under the direction of a Level II or III Leak Tester who meets the requirements of ASNT SNT-TC-1A or ANSI/ASNT CP-189.

E. Criticality Safety Requirements

Not Applicable.

F. Required Permits

A radiological work permit (RWP) is required for boxes that are already in use.

2.1 General (continued)

G. Training and/or Qualification

For personnel performing nondestructive examination (NDE) or nondestructive testing (NDT), the helium leak testing operators or trainees shall be qualified and certified as Level II or Level III, or a Level I working under the direct supervision of a Level II or Level III in all applicable test methods. This is in accordance with the recommended practices of ASNT SNT-TC-1A or ANSI/ASNT CP-189. Reading about the level of training on this procedure is required.

NDE Level II and III leak testers must be currently listed in the Chapter 13 database of the LANL Engineering Standards.

This procedure must be performed by a trainee or Leak Tester complete in OJT #34620 – Helium Leak Testing, working under cognitive system engineer (CSE) direction.

H. Cautions

Cautions and warnings are noted in the procedure prior to the applicable steps.

I. Nuclear Material Control and Accountability

Not Applicable.

2.2 Additional Requirements and Conditions

Not Applicable.

3.0 PREREQUISITE ACTIONS

The sections and the steps in this section are not required to be performed in sequence, unless otherwise stated.

3.1 Planning and Coordination

- Schedule the work with the Facility Operations Director organization.
- Ensure that a pre-job brief has been conducted in accordance with PA-AP-01020, *Pre-Job Briefing and Post-Job Review*.
- The PIC is responsible for ensuring that work shall be performed to the most current procedure and associated performance documents.
- Ensure tools, equipment, and materials in the work area are available as specified.

3.2 Performance Documents

RWPs for specific locations described in the pre-job briefing.

3.3 Special Tools, Equipment, Parts, and Supplies

Table 1 Equipment Description and Location [a]

Equipment Number (N/A if no number)	Equipment Name	Manufacturer/ Model	Description	Location
N/A	Helium MS Leak Detector with Sniffer Probe	N/A	N/A	N/A
N/A	Roughing Pump	N/A	N/A	N/A

Table 2 Tools and Fixtures N/A

Table 3 Measuring and Test Equipment

Description	Range	Accuracy
Helium Standard Leak	10^{-6} to 10^{-8} sccs	N/A
Oxygen Analyzer	N/A	N/A
Manometer	N/A	N/A
Pressure Gauge	N/A	N/A

Table 4 Process Materials

Process Material Number	Title/Description	Amount Required (if required)
N/A	Helium	N/A

Table 5 Floor Stock/Shop Aids N/A

Table 6 Software N/A

3.4 Field Preparation

- Ensure tools, equipment, and materials in the work area are available as specified.
- Keep the leak test area well ventilated, clear of sources of contamination, and clear of unnecessary components where tracer gas may cling or accumulate.

3.5 Approvals and Notifications

- Notify the CSE of the actions to be performed under this procedure.

4.0 ACCEPTANCE CRITERIA

For acceptance, the maximum allowable leak rate shall be 1.0×10^{-6} standard cc/sec.

5.0 PERFORMANCE

NOTE 1: Sections within 5.0, Performance, may be performed in any order at the PIC's discretion.

NOTE 2: Sections within 5.0, Performance, may be performed independently and do not need to be performed each time.

5.1 Documentation

[1] Fill out page 1 of Attachment A, *Helium Leak Test Report*.

[2] During testing, record the following on Attachment A:

- Date, time and type of test
- System sketch or drawing; system description, including major components listing and tie-in points (attach to report; provided by Leak Testing Requester)
- Make, model, and serial number of test equipment used
- Maximum allowable leak rate by specification and final leak rate leak, and system sensitivity used
- Description of test article and all other fixtures and components used (attach to report)
- Location of leaks and comments, if applicable
- Test vacuum (including units)
- Background (Rb)

[3] Record the following additional information on Attachment A, if performing an E499 leak test:

- Relief device set pressure
- Relief device make and model
- Test pressure (include units)

[4] Record calibration expiration date and file numbers for gauge, O_2 analyzer, and certified standard leak.

5.2 Environmental Requirements

[1] Consider provisions to prevent pressure and temperature fluctuations during testing.

[2] If necessary, engineer accordingly for failure to compensate or correct such discrepancies.

5.3 Cleaning Preparation

NOTE: Cleanliness is important, since oils or grease may affect the necessary time and ability to achieve even a partial vacuum.

[1] Keep test articles to be examined clean of all contaminants, such as small particles, grease, or liquids that may clog very small holes and crevices or may mask the areas to be surveyed.

[2] Exercise control during stages of fabrication and installation to minimize exposure of stainless steel to contaminants, in particular to any chloride that might cause stress-corrosion cracking.

[a] Avoid chloride-bearing compounds; however, if they are used, completely remove them by thorough cleaning.

[b] Do not use compounds, liquids, or markers with more than 250 ppm of chloride content by weight on stainless-steel surfaces.

5.4 Equipment and Calibration Instructions/Procedures

NOTE: Refer to the operations and maintenance manuals for the leak detectors and O_2 analyzer.

5.5 Material

NOTE: *Test Gas Requirements:* Either helium or helium mixed with air meets the requirements.

5.6 Pre-Test Steps

NOTE: Following installation and connection of the gloveboxes to testing arrangement systems, perform these final helium leak testing, pre-test verification steps.

[1] Ensure that the system under testing is clean and free from vapor, oil, grease, and other contaminants

[2] Ensure that all openings on the system under testing are temporarily sealed with test blanks, plugs, duct putty, Teflon tape, or other suitable sealing means.

[3] Ensure that the leak detector standard is calibrated within current LANL-appropriate limits against a LANL Calibration Laboratory helium standard leak.

[4] Perform functional verification of gauge using the U-shaped pressure relief device capable of reading 6 inches water gauge or less (for ASTM E-499 Leak Test). This will verify gauge is reading accurately.

[5] Record results on Attachment A.

5.7 Test Steps

NOTE 1: Sections 5.7.1 and 5.7.2 provide instructions for leak testing in accordance with ASTM E499 and ASTM E498.

NOTE 2: Select the leak test method, such as ASTM E498 or ASTM E499; however, other test methods may be acceptable, based on the component and configuration that is being tested:

- Gloveboxes, and piping that is tested with the glovebox, shall be leak tested in accordance with the ASTM E499 method.
- For piping systems that are tested independently of the glovebox, or small-volume items that can be fully evacuated, using the method described in ASTM E498 may be beneficial.
- On every weld joint (refer to a Weld Map for this test), and every attachment to the GB shell, to include Airlocks and other appurtenances.

5.7.1 ASTM E499 Test Method

[1] Ensure that helium leak test equipment is turned on, allowed to warm up before testing, has had calibration checked, and is adjusted in accordance with the manufacturer's instructions.

[2] Record the sensitivity setting on Attachment A.

[3] Connect the sniffer probe to the leak detector.

[4] Verify that the helium supply connection to the system being tested has a shut-off valve connected to the helium supply line

[5] Perform testing at a test pressure of 4 inches water gauge and hold test pressure for one hour and record this on Attachment A.

[6] During testing, provide an atmosphere within the glovebox and connected equipment that is composed of at least 90% helium.

[7] Verify using the O_2 analyzer.

[8] Establish the required atmosphere by using one or both of the following methods:

[a] Purging Method:

- Connect a helium gas supply to a penetration near the highest point of the system under testing (a penetration panel coupling in the top of the glovebox might be appropriate).
- Locate a vent near the lowest point of the system under testing.
- Flow gas from the top to the bottom of the installed glovebox system. Since helium is much lighter than air, the helium coming in at the top of the system should layer on top of the air and drive the air out of the low vent in the system.

5.7.1 ASTM E499 Test Method (continued)

- Relate the purge flow and time by the following equation:

  $$T = 2.3\ V/Q$$

  (Where T is the time required for the purge, Q is the helium flow rate, and V is the glovebox volume)

[b] Bag Method:

- Place one or more plastic bags inside the enclosure.
- Inflate the plastic bags with helium until the entire box is completely filled (use an open gloveport).
- Next, install a glove on the gloveport.
- Ensure that all valves, gaskets, etc., are closed, then use the glove to release the plastic bags.

NOTE: Since all space cannot be filled with this method, the enclosure must also be purged using the purging method for the estimated remaining volume. The O_2 analyzer must be used to verify enough helium is in system. A calibration verification of the O_2 analyzer must be done before and after the test.

[9] Perform functional verification of gauge/manometer using the U-shaped pressure relief device. This will verify that the gauge is reading accurately. Record results on Attachment A.

[10] Base the testing location on the following criteria:

[a] Testing gloveboxes: Move the probe along the windows, service panels, gaskets, gloveports, glove rings, feedthroughs, and welds as identified on the supplied weld map and other suspect areas.

[b] Shielded gloveboxes: Test lead-shielded gloveboxes for leakage into the shielding jacket by probing the gaps around the gloveports with the leak detector. Check neutron-shielded gloveboxes at the fill port for helium. If helium is present, locate and repair the leaks in the shell seams.

[c] Testing piping: Perform the helium leak test across the piping system pressure boundary which typically includes all GB utilities up to the point of connection to the facility systems, all installed penetrations, and the GB installation in the operating facility is complete. This does not typically include previously existing piping that are connected to facility systems. Move the probe along the welds, brazes, flanges, and threaded connections/fittings.

[d] Valves: Move the probe along the bonnets, seals, and stem.

[11] Locate and repair any detectable leak of 10^{-6} standard cc/sec (or other specified acceptance criteria). If needed, rework and repair leaks until leaks are eliminated.

5.7.1 ASTM E499 Test Method (continued)

NOTE: If the leak rate is greater than the specified amount, follow the process defined in Section 5.8, Rework and Re-Examination.

WARNING
There must be sufficient ventilation, or pressure must be released to an unconfirmed space.

[a] Follow the manufacturer's instructions to place the Helium MS in a safe post-leak test configuration.

[b] Perform manufacturer's recommended steps to ensure that the Helium MS is detecting helium. This should include the sniffing probe. This will verify that the Helium MS and sniffing probe is detecting helium. Record results on Attachment A.

[c] Remove the sniffing probe from the leak detector.

[d] Perform functionality verification of the gauge using the U-shaped pressure relief device. This will verify that the gauge is reading accurately. Record results on Attachment A.

[12] Release the pressure from the item and disconnect the helium from the test item

[13] After all testing has been completed, remove blank offs, plugs, caulking, etc. Take special care to remove caulk by means of scraping, sanding, and buffing to maintain the original finish.

5.7.2 ASTM E498 Test Method

NOTE: When testing objects that are capable of being evacuated (such as piping systems), it is acceptable to use the Leak Test Vacuum Method (ASTM E498, Test Method A).

[1] Evacuate the device to be tested until a vacuum range of 10^{-3} (roughing pump) to 10^{-7} (turbo pump) standard cc/sec is reached on the vacuum gauge.

[2] When the vacuum in the test chamber has reached the acceptable test range (10^{-3} to 10^{-7}), open the chamber to the leak detector diffusion pump.

NOTE: Maximum test sensitivity will be achieved when the inlet valve is completely open and the auxiliary pump valve is completely closed.

[3] Close off the external pump.

[4] Set the leak detector to the lowest range and record the background reading (Rb).

[5] Adjust the probe so that a small flow of helium is coming from the tip.

[6] Starting at the most suspect part of the object to be tested and using helium and a small flexible hose, spray helium along the part that will give a signal when helium is sprayed on the capillary leak.

5.7.2 ASTM E498 Test Method (continued)

NOTE: When using the vacuum method, testing should start from the top of the object and work downwards. Helium should be sprayed over the area, then moved along all containment welded joints, primary containment gasketed joints, sealed openings, and other suspect areas, with the nozzle not more than 1 mm from the area to be checked, moving about 24 inches per minute.

[7] Locate all leaks. The estimated leak rate can be calculated using this equation, if desired:

$$L = (R-Rb) \times S$$

(Where R is the reading, Rb is the background reading, and S is the machine sensitivity)

5.8 Rework and Re-Examination

NOTE 1: If the test fails to meet the acceptance test criteria, locate and rework or repair the leak as follows.

NOTE 2: The maximum allowable leak shall be 1.0×10^{-6} standard cc/sec unless otherwise specified by the helium leak test requester.

NOTE 3: The removal and reinstallation (including rework and repair) of a sealing component from the confinement boundary of the GB will negate the validity of any previously performed helium leak test and shall require a final helium leak test to be performed.

[1] Document leak detection and rework or repair work activities on the test report. Document the location of major leaks on physical drawings.

[2] If the leak test fails and rework or repair is required, follow the applicable procedures for the work to be performed (such as re-torque).

[3] Retest in accordance with this procedure, and submit the results on page 4 of Attachment A.

[4] Perform functional verification of gauge/manometer using the U-shaped pressure relief device. This will verify the gauge is reading accurately. Record results on Attachment A. If gauge is not functioning correctly, exchange with another calibrated gauge and perform the test again. The non-functioning gauge should be removed from this application and returned to the Standards and Calibration Lab for calibration.

5.9 Functional Verification

[1] Perform functional verification of the gauge and O_2 analyzer before and after the leak test.

[2] Sign Attachment A.

[3] Submit the signed-off results on Attachment A to Leak Testing Requestor.

6.0 POST-PERFORMANCE ACTIVITIES

6.1 Testing

Not Applicable.

6.2 Restoration

Not Applicable.

6.3 Results

Conduct a post-job review in accordance with PA-AP-01020.

6.4 Verification/Independent Verification

Not Applicable.

6.5 Records Processing

See Section 10.

7.0 DEFINITIONS AND ACRONYMS

7.1 Definitions

Term	Definition
design authority	This may include, but is not limited to, system engineering, engineering design firm, operating group subject matter expert, quality assurance/quality control (QA/QC), and facility management
engineering	This typically shall mean LANL engineering, unless designated as an outside-contracted engineering design firm
testing	The determination or verification of the capability of an item to meet specified requirements by subjecting the item to a set of physical, chemical, environmental, or operating conditions

7.2 Acronyms

Acronym	Definition
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
ASNT	American Society for Nondestructive Testing
ASTM	American Society for Testing and Materials
CFR	Code of Federal Regulations
CSE	cognizant system engineer
M&TE	measurement and test equipment
NDE	nondestructive examination
NDT	nondestructive testing
P&ID	Process and Instrumentation Diagram
PDM	project deliverable manager
PM	project manager
QA	quality assurance
QC	quality control
Rb	background reading
RFI	request for information

8.0 RESPONSIBILITIES

Not Applicable.

9.0 REFERENCES

Document Number	Title
10 CFR 830.122	*Quality Assurance Criteria*
AGS-G001	*Guideline for Gloveboxes*
AGS-G004	*Standard of Practice For Leak Testing Methodologies for Gloveboxes and other Enclosures*
AGS-G006	*Standard of Practice the Design and Fabrication of Nuclear Application Gloveboxes*
ASME/ANSI NQA-1, 2008/2009a	*Quality Assurance*
ANSI/ASNT CP-189	*Standard for Qualification and Certification of Nondestructive Testing Personnel*
ASNT SNT-TC-1A	*Personnel Qualification and Certification in Nondestructive Testing*
ASTM C854	*Standard Test Method for Resistance to External Loads on Metal Reflective Pipe Insulation*
ASTM E498	*Standard Practice for Leaks Using the Mass Spectrometer Leak Detector or Residual Gas Analyzer in the Tracer Probe Mode*
ASTM E499	*Standard Practice for Leaks using the Mass Spectrometer Leak Detector in the Detector Probe Mode*
DOE Order 420.1 C	*Facility Safety*
LANL Master Specification 11 5311.10	*Glovebox Fabrication*
LANL Master Specification 11 5311.12	*Glovebox Installation*
P 101-3	*Lockout/Tagout for Hazardous Energy Control*
P101-14	*Chemical Management*
PA-AP-01020	*Pre-Job Briefing and Post Job Review*

10.0 RECORDS

Record Identification	Record Type Determination	Temporary Storage Method and Location	Disposition
Attachment A, *Helium Leak Test Report*	Record	Complete any records in accordance with the requirements of the process or procedure invoking this procedure or invoked by this procedure.	After 12 months transfer to ADPSM Records Management. The ADPSM-RM shall retain these records until final disposition in accordance with PA-AP-01040.
Attachment B, *Operator's Log for M&TE Usage*	Record	Complete any records in accordance with the requirements of the process or procedure invoking this procedure or invoked by this procedure.	After 12 months transfer to ADPSM Records Management. The ADPSM-RM shall retain these records until final disposition in accordance with PA-AP-01040.

11.0 APPENDICES AND ATTACHMENTS

Appendix	Title
	None.

Attachment	Title
A	*Helium Leak Test Report*
B	*Operator's Log for M&TE Usage*

Attachment A, Helium Leak Test Report

(Page 1 of 4)

WORK ORDER

Project Title _____

Work Order Number _____

Requester _____

LOCATION

TA_____ Building _____ Room No._____

SYSTEM

Description of System_____

Major Component Tag ID No.'s_____

System Sketch or Drawing No._____

System P&ID_____

Design Pressure

TESTING DEFINITIONS

Type of Test - ASTM E498 (Vacuum), ASTM E499 (Pressure), or CSE-acceptable alternate

_____

Relief Device Set Pressure (Pressure Test Only)

_____

Tracer Gas Used/Purity

Cognizant System Engineer

Name/Z Number/Date	

Attachment A, Helium Leak Test Report

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ASTM E498, LEAK TEST (Vacuum)

DATE OF TEST	**TYPE OF TEST**
START TIME	**END TIME**
Test Equipment Make and Model	
Test Equipment Serial Number	
Test Vacuum (including units)	
Maximum Allowable LEAK RATE by Specification:	
Final LEAK RATE (L)	
Sensitivity (S)	
Background (Rb)	
Certified Leak Calibration Expiration Date and File Number	
PASS	**FAIL**

SIGNOFF

Operator, Level I or Trainee Signature _____

Date_____

Level II or III Signature _____ Date_____

Note: If rework and/or repair is required, provide description of where leak(s) was found and what repairs/rework was performed on the attached comment sheet.

Attachment A, Helium Leak Test Report

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ASTM E499, LEAK TEST (PRESSURE)

DATE OF TEST	**TYPE OF TEST**
START TIME	**END TIME**
Relief Device Set Pressure	
O_2 Final Reading	
Test Equipment Make and Model	
Test Equipment Serial Number	
Test Pressure (include units)	
Maximum Allowable LEAK RATE by Specification:	
Final LEAK RATE	
Sensitivity	
Background	
Certified Leak Calibration Expiration Date and Serial Number	
Gauge Calibration Expiration Date and Serial Number	
Functional Verification of Gauge Pre-Test and Post-Test –Pass or Fail (if gauge does not Pass, restart test with new gauge)	
Functional Verification of O_2 Analyzer – Pass or Fail (if O_2 Analyzer does not Pass, restart test with new analyzer)	
PASS	**FAIL**

SIGNOFF

Operator, Level I or Trainee Signature _____ Date_____

Level II or III Signature_____ Date_____

Note: If rework and/or repair is required, provide description of where leak(s) was found and what repairs/rework was performed on the attached comment sheet.

Attachment A, Helium Leak Test Report

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Rework/Repair Comments Sheet

Location of Leaks	Comments (Work performed)	Rework/Repair Results

Rework/Repair SIGNOFF:

Level I or Trainee Signature _____Date_____

Level II or III Signature _____Date_____

Attachment B, Operator's Log for M&TE Usage

(Organization) Measurement and Test Equipment (M&TE) Usage Log	
M&TE Number: Manufacturer: Item Name: Serial Number: Model Number:	Date Last Calibrated: Calibration Expiration Date: M&TE Owner: M&TE RLM:

Date	Name	Z Number	Description of usage (Identify equipment used on/measurements taken...)