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RECORD OF REVISIONS

Rev	Date	Description	POC	RM
0	02/05/2018	Initial issue. Supersedes KSL PT Procedure 16-30-007.	David Bingham, *ES-EPD*	Larry Goen, *ES-DO*

Contact the Welding Standards POC for upkeep, interpretation, and variance issues.

ITM-1306-NDE-PT-101	**Welding POC and Committee**

This document is online at http://engstandards.lanl.gov

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1.0 Purpose & Scope

This procedure provides minimum requirements for Bubble Leak Testing using the liquid film technique (direct pressure & vacuum Box). Testing is performed to ensure that items conform to design specifications and acceptance criteria that originate with the customer (e.g., Design Agency or Design Authority).

The scope of this document includes all stages of the Bubble Leak Testing process, and specifies values for the essential variables. This document describes the stages of the process from surface cleaning requirements, test medium selection, pressure boundary identification, technique selection, personnel qualification requirements, and preparation of test data—and includes documentation and forms needed to report the test data. The intent is to ensure that items are tested with reliability and accuracy, and that documentation is appropriately and accurately prepared and items correctly dispositioned.

Items tested by the bubble leak test methods shall be considered failing if there is an indication of leakage. No quantitative determination of a leak rate is required. The sensitivity of the method is dependent on the pressure differential, the gas used to create the differential, and the liquid used for testing. As long as the pressure differential can be maintained across the area to be tested, this method can be used. The normal limit of sensitivity for this test method is $4.5 \times 10{-}10$ mol/s ($1 \times 10{-}5$ Std cm3/s).

This procedure meets the requirements of ASME Section V Article 10 and Appendix I *Bubble Leak Test – Direct Pressure Technique* and Appendix II *Bubble Leak Test – Vacuum Box Technique*.

2.0 Authority and Applicability

A. Authority

This procedure is issued under the authority of the ES-DO. It applies to Bubble Leak Test activities as described herein, performed within the scope defined in Section 1.0.

Issuing Authority (IA) and Responsible Manager (RM)/Office: Conduct of Engineering Office Director.

B. Applicability

The process consists of creating a pressure differential across a pressure boundary and observing bubbles in a liquid medium located on the low pressure side. Bubble Leak Testing is necessary to ensure that systems and/or system components meet specification or fitness for service requirements. This practice is not intended to measure leak rates, but to locate leaks on a go/no-go basis. Inspection plan shall be supplied by the customer/designer of the items. These tests are to ensure that the quality characteristics are met as specified by the customer/designer or by the shop responsible for manufacturing the items.

C. Revision Control

Changes to this written procedure require a revision to the procedure.

3.0 Personnel Qualification and Training

A. Qualification/Certification

1. Personnel performing Bubble Leak Test Examinations in accordance with this procedure shall meet the following minimum qualifications:

   a. Be certified Level II or Level III in accordance with ESM Chapter 13, Volume 6, WGIN 2-02 (*Para. 5.2*) which meets ASNT Recommended Practice No. SNT-TC-1A, *Personnel Qualification and Certification in Nondestructive Testing*, or

   b. Be certified or approved Level I in accordance with ESM Chapter 13, Volume 6, WGIN 2-02 (*Para. 5.2*), working under the direct supervision of a Certified Level II or Level III.

   c. *Guidance: The Chapter 13 webpage has a link to the database of qualified Inspectors.*

2. Personnel performing bubble leak test examinations to this procedure shall be familiar with this procedure and the acceptance standards specified for the item, system, or component that is under test.

3. Education, Training, and Experience Requirements of Practitioners

   a. Thoroughly familiar with the bubble leak test attributes needed to be verified and able to perform examinations based on the attributes. This shall be verified and documented via interview with the Responsible Level III.

   b. Trained in the use of necessary equipment and ensure that the equipment is calibrated if required in accordance with P330-2. If required, on-the-job training shall be provided by the Responsible Level III or his/her designee.

   c. Able to interpret and evaluate results with respect to applicable codes, standards and specifications.

   d. Able to organize and report the results of the examination and handle in accordance with organization's records management practices.

   e. Level II personnel shall exercise assigned responsibility for on-the-job training and guidance of Level I and trainee personnel, if applicable.

4. Vision Requirements

   a. Personnel performing Bubble Leak Testing examination shall be given an annual vision examination in accordance with WIGN 6-02.

   b. Where differentiation of colors is critical to job performance, the capability to distinguish and differentiate contrast among colors or

shades of gray used in the method shall also be demonstrated annually.

c. Records of visual examinations shall be maintained by the LANL WPA.

4.0 Materials and Equipment

A. Performance Documents

1. Drawings for item, system, or component to be bubble leak tested
2. Design specifications
3. Referenced codes and standards
4. Acceptance criteria
5. Service history of item to be inspected.

B. Special Tools, Test Equipment, Parts, and Supplies

1. Source for vacuum, compressed air, or other acceptable inert gas for creating a pressure differential.
2. Selection of proper commercial leak testing solution. The solution must be compatible with the material and temperature of the test conditions.

Note: The use of soap buds or household detergents and water is not considered a satisfactory leak test fluid for bubble test because of the lack of sensitivity due to masking by foam. The test fluid should not bubble except in response to leakage.

a. Solutions approved for use with this procedure are listed in Appendix A, *Test Fluids*, of this procedure.

3. For Vacuum Box Bubble Leak Testing the vacuum box shall be of convenient size and contain a window opposite the bottom. It shall be equipped with a suitable gasket to seal against the test surface. It shall have suitable connections, valves, lighting, and gauge. The gauge shall have a range of 0 to -15 psi or equivalent pressure units. The vacuum can be developed by any convenient method, (e.g., air ejector, vacuum pump, or motor intake manifold). An example vacuum box is shown in Appendix B.
4. Inspection mirrors
5. Calibrated pressure gauge not less than 1.5 nor more than four times the pressure or calibrated digital pressure transducer with calibration points below and above the test pressure or vacuum. For vacuum, the gauge shall resister a partial vacuum of at least 2 psi below vacuum test pressure.
6. Calibrated thermometer if required
7. GFCIs (for electrical equipment such as pumps or lights)
8. Adequate light sources to provide 100 ft-clds lights

9. Wire brush

10. Oxygen meter (if required for confined space entry)

5.0 Surface Preparation

A. The surface shall be thoroughly cleaned and free of grease, rust weld slag, etc. prior to examination.

B. If cleaning liquids are used to clean the surface they must be compatible with the surface, and be dry before the leak testing.

Note: Contaminants may be a source of bubbles giving false indications of leakage.

6.0 Procedure, General Requirements

A. Temperature. The test surface and materials shall be maintained in the temperature range of 40 ºF to 125 ºF throughout the examination period.

Note: The minimum metal temperature during test shall not be below that specified in the referencing Code Section for the hydro, hydro-pneumatic, or pneumatic test. Both the minimum and maximum temperature shall be compatible with the test method.

B. Lighting. Lighting shall be a minimum of 100 fc (1076.4 lux) at the surface of the part during evaluation. The light meter used for verification of lighting acceptability shall have been calibrated within the past year.

C. Deviation from Procedure. Any deviation or failure to comply with the steps in this procedure shall be cause for reprocessing of the part or component.

D. Gauge Placement. The dial or other type gauges shall be connected to the component and visible to the operator controlling the pressure/vacuum throughout the pressurization, evaluation, testing and depressurizing or venting of the component.

7.0 Procedure, Specific Requirements

A. Direct Pressure Liquid Application Technique – Solution is applied to a pressurized component and bubbles at the location of leaks as gas passes through low pressure boundary.

1. Test Pressure shall be at least the lesser of 15 psig or 25% of the design pressure.

2. Test Pressure shall be shall be held for a minimum of 15 minutes prior to examination (Soak Time)

3. The pressure shall be gradually increased until a gage pressure of the lesser of one-half the test pressure or 25 psig is attained, at which time a preliminary check shall be made. Then the pressure shall be gradually increased in steps until the test pressure is reached, the pressure being held long enough at each step to equalize piping strains.

4. Application of Solution – Bubble-forming solution shall be applied to the surface to be tested by flowing, spraying, or brushing the solution over the examination area.

5. Light Intensity - The light intensity shall be measured with a white light meter prior to the examination or a verified light source shall be used. Verification of light sources is only required to be demonstrated once and documented as adequate, and then filed for future reference.

6. Remote visual examination is not approved without Level III written concurrence.

B. Direct Pressure Liquid Immersion Technique – Item or component area of interest is submersed under liquid bath; bubbles at the location of leaks occur as gas passes through low pressure boundary into the liquid.

1. Test Pressure shall be at least the lesser of 15 psig or 25% of the design pressure.

2. Test Pressure shall be shall be held for a minimum of 15 minutes prior to examination (soak time)

3. The pressure shall be gradually increased until a gage pressure of the lesser of one-half the test pressure or 25 psig is attained, at which time a preliminary check shall be made. Then the pressure shall be gradually increased in steps until the test pressure is reached, the pressure being held long enough at each step to equalize piping strains.

4. Submerge the test item under the test solution.

5. Light Intensity - The light intensity shall be measured with a white light meter prior to the examination or a verified light source shall be used. Verification of light sources is only required to be demonstrated once and documented as adequate, and then filed for future reference.

6. Remote visual examination is not approved without Level III written concurrence.

C. Vacuum Box Technique – Used to locate leaks in components that cannot be directly pressurized. Solution is applied to the surface and vacuum box is placed over the localized area to create the differential pressure boundary.

1. Vacuum pressure shall be a minimum of 3 psia for testing at LANL.

Note: Ambient pressure at LANL is 11.1 psia.

2. Application of Solution – Bubble-forming solution shall be applied to the surface to be tested by flowing, spraying, or brushing the solution over the examination area before placement of the vacuum box.

3. Vacuum Box Placement – The vacuum box shall be placed over the solution-coated section of the test surface and the box evacuated to partial vacuum.

4. Vacuum Retention – Required differential pressure (vacuum) shall be maintained a minimum of 10 seconds for examination.

5. Overlap - An overlap of 2 inches minimum for adjacent placement of the vacuum box shall be used for each subsequent examination.

8.0 Evaluation and Interpretation/Evaluation of Indications

A. The test is acceptable when no continuous bubble formation is observed.

B. Testing may be performed by Level I, II, or III. Level I performing testing shall be supervised by a Level II or III.

C. Interpretations are required to be performed by a Level II or III.

9.0 Repair/Retest

A. When leakage is observed, mark the location of the leak(s) and depressurize the component. At customer's discretion, the leak(s) may be repaired as required by the referencing code or specification and the areas retested. Where repairs may induce leakage in originally acceptable areas, those areas (or entire item) shall also be retested.

10.0 Post-Examination Cleaning

A. Remove solutions from the test item after testing is completed. Cleaning is to be done with materials and methods suitable for the item.

11.0 Responsibilities

LANL-qualified personal are the primary users of this document.[1] Performance may be subcontracted by LANL. Use by other LANL groups (e.g., Applied Engineering Technology AET-6 NDE group) with permission of LANL Level III or Welding Program Administrator.

A. Responsible Line Manager (RLM). The RLM shall ensure only those personnel who meet the requirements of this procedure are permitted to perform inspections/activities covered by this procedure. Personnel performing inspections shall be qualified and certified in accordance with Paragraph 3.0 of this procedure.

B. Test Personnel. Personnel performing examinations per this procedure are expected to verify that their certification in the Bubble Test method is current. It is the responsibility of test personnel certified to Level I, II, or III to perform the

[1] Should responsible organizations change, applies to successor organizations.

tests described herein and record the results of that examination. Personnel certified to Level II or III shall supervise the examination, when performed by a Level I, and evaluate the results of this examination. Personnel performing Bubble Testing shall wear appropriate safety and protective equipment during field-testing as noted in the Integrated Work Document and have the appropriate personal protective equipment (PPE) as defined in the Material Safety Data Sheet (MSDS).

12.0 Implementation

As noted throughout.

13.0 Documents and Records

Test reports generated as a result of this procedure shall be maintained in accordance with LANL records policies. The test object owner shall ensure that records are appropriately stored and are traceable to the part that has been examined.

14.0 Acronyms and Definitions

Acronym/ Term	Description
ASME	American Society of Mechanical Engineers
ASTM	ASTM International, formerly American Society for Testing and Materials
Inspection	A phase of quality control, which by means of examination, testing, observation, or measurement determines the conformance of materials, supplies parts, components, appurtenances, systems, processes, or structures to predetermined quality requirements. For this procedure, examination and inspection may be considered to have the same definition.
Test personnel	Personnel qualified and certified Section 3.0 of this procedure
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, operating conditions.

For other definitions, see LANL Definition of Terms or Conduct of Engineering definitions.

15.0 History

This document supersedes any conflicting requirements in O&M Criterion 419, Inspections and Testing of Pressure Vessels and Pressure Relief Valves, but the Criterion remains in force and effect for each nuclear and high-hazard facility until they complete any necessary Unreviewed Safety Question (USQ) or Unreviewed Safety Issue (USI) review determinations.

16.0 References

American Society of Mechanical Engineers, *(ASME) Boiler and Pressure Vessel Code, Section V, Nondestructive Examination.*

ASNT SNT-TC-1A, *2017, Qualification and Certification of NDT Personnel.*

ASTM E515-11, *Standard Practice for Leaks Using Bubble Emission Techniques*.

17.0 Forms

ITM-1306-NDE-LT-101-FM01, *Bubble Leak Testing Report*

18.0 Contact

POC: Welding Program Administrator (ES-EPD)
Telephone: (505) 664-0416
Location: TA-00, Building 0726, Room 232AD
E-mail: dbing@lanl.gov

Appendix A, Test Fluids

The following test fluids may be used provided they are not detrimental to the component being tested:

Bubble Test Fluid

A solution of commercial leak-testing fluids may be used.

- Swagelok – Snoop® Liquid Leak Detector
- Oatey 45801 Hercules Mega Bubble Leak Detector
- LA-CO Sure-Chek All Temperature Liquid Leak Detector
- LDF Heavy-Duty Leak Detector (www.leakdetectionfluid.com)
- ComStar 90-209 Leak Seek HVAC and Gas Leak Detector
- BrassCraft Gas Leak Detection Solution

Immersion Technique Test Fluids

- *Water* — Should be treated with a wetting agent up to 1⁄3 by volume to reduce surface tension and promote bubble growth.
- *Methyl Alcohol (Technical Grade), Undiluted* — Not suitable for the heated-bath technique or the vacuum technique.
- *Ethylene Glycol (Technical Grade), Undiluted.*
- *Mineral Oil* — Degreasing of the test specimens may be necessary. This is the most suitable fluid for the vacuum technique.
- *Fluorocarbons or Glycerin*

Notes on fluids:

1. If the component to be tested has parts made of stainless steel, nickel, or chromium alloys, the test fluid must have a sulfur and halogen content of less than 10 ppm of each.
2. If the component to be tested has parts made of polyethylene or structural plastic, the test fluid must not promote environmental stress cracking (E.S.C.).
3. If the test fluid is to be used on oxygen systems it must meet the requirements of MIL-L-25567D.
4. Contaminated detection fluid or one that foams on application can cause spurious surface bubbles on the test specimen.
5. Fluorocarbons are not recommended for stainless steel nuclear applications.
6. Leak detector solutions for brasses and copper alloys must meet ASTM G188-05.

Appendix B, Example Vacuum Box