

PERSONNEL QUALIFICATIONS FOR PRESSURE AND LEAK TESTING

In the last edition of **THE GOLD FRONT**, we discussed the principles and practices of pressure and leak testing for industrial ammonia piping systems. In this issue, we review code requirements for qualifications of those personnel involved in all aspects of pressure and leak testing.

BACKGROUND

In the last **GOLD FRONT** (Vol. 11, No. 3), we discussed safety, technical and basic procedural aspects of pressure testing piping systems. Recall that *pressure testing* is a process intended to demonstrate (1) the integrity of a piping system and (2) that the piping system is free from leaks; prior to being placed into operation. In this edition, we consider the competencies and qualifications of personnel involved in leading and conducting pressure testing. Jackson and Sherlock (1998) summarize the situation this way:

“The best equipment that can be devised & assembled for pressure tests & leak testing of pressure vessels and systems is useless without properly trained and competent leak testing personnel.”

IRC Staff

Director

Doug Reindl 608/265-3010
or 608/262-6381
dreindl@wisc.edu

Assistant Director

Todd Jekel 608/265-3008
tbjekel@wisc.edu

Research Staff

Dan Dettmers 608/262-8221
didettme@wisc.edu

In This Issue

- Personnel Qualifications for Pressure and Leak Testing **1-8**
- Upcoming Ammonia Classes **2**
- Noteworthy **2**
- Test Your Knowledge – Pressure Testing **8**

IRC Contact Information

Toll-free 1-866-635-4721
Phone 608/262-8220
FAX 608/262-6209
e-mail info@irc.wisc.edu

Mailing Address

1513 University Avenue
Suite 3184
Madison, WI 53706

Web Address www.irc.wisc.edu

Of course this raises the immediate question - *What constitutes "properly trained and competent leak testing personnel?"* Let's begin to answer that question by first reviewing relevant codes and standards to identify whether they establish any clear requirements for personnel training and qualification for pressure testing.

CODES AND STANDARDS

Per ASHRAE 15 [§9.10.1] and IIAR 2 [§10.1], industrial refrigeration piping systems must comply with ASME B31.5 "Refrigeration Piping and Heat Transfer Components." Section VI of the ASME B31.5 piping code, hereafter referred to as the "Code", prescribes the requirements for *examination, inspection, and testing* of the piping systems within its scope. Prior to initiating the process of pressure testing of a newly constructed piping system, the Code requires that piping system to undergo a successful *examination and inspection*. Section 536.1 of the code defines examination as:

536.1 Definition

Examination applies to visual examination and to nondestructive examination when specified in this Code or in the engineering design. These quality control functions are performed by an examiner employed by the manufacturer, fabricator, or erector.

Section 536.3 further prescribes the qualification credentials of personnel conducting examinations:

536.3 Examination Personnel Qualification and Certification

Examiners shall have training and experience commensurate with the needs of the specified examinations. For this purpose, SNT-TC-1A, "Recommended Practice for Nondestructive Testing Personnel Qualification and Certification", may be used as a guide. The owner shall determine whether examination by other than personnel performing the work is required.

UPCOMING AMMONIA COURSES

Introduction to Ammonia Refrigeration Systems

March 7-9, 2012

Madison, WI

Ammonia Refrigeration System Safety

April 18-20, 2012

Madison, WI

Achieving Energy Cost Savings for Ammonia Refrigeration Systems

May 22-24, 2012

Madison, WI

Design of NH₃ Refrigeration Systems for Peak Performance and Efficiency

September 17-21, 2012

Madison, WI

Introduction to Ammonia Refrigeration Systems

October 8-10, 2012

Madison, WI

Process Hazard Analysis (Emphasizing Ammonia Refrigeration Systems)

October 19-21, 2012

Madison, WI

Intermediate Ammonia Refrigeration Systems

December 5-7, 2012

Madison, WI

Process Safety Management Audits for Compliance and Continuous Safety Improvement

January 16-18, 2013

Madison, WI

NOTEWORTHY

- Mark your calendars now for the **2012 IRC RESEARCH AND TECHNOLOGY FORUM – May 2-3, 2012** at the Pyle Center in Madison, WI.
- Send items of note for next newsletter to **TODD JEKEL**, tbjekel@wisc.edu.

Note, that the Code identifies the American Society of Nondestructive Testing's (ASNT) recommended practice SNT-TC-1A as a guide for credentialing those personnel undertaking the examination process but the owner is ultimately responsible for establishing the minimum qualification requirements for personnel performing all *examinations* required by the Code. Furthermore, the owner must determine whether required *examinations* should be conducted independently from the organization fabricating the piping system. Section **537.2** of the Code reinforces a similar owner responsibility for conducting *inspections*.

537.2 Responsibility

Prior to operation, it is the owner's responsibility to inspect a piping system to the extent necessary to assure compliance with the engineering design, and with the material, fabrication, assembly, examination, and testing requirements of this Code.

What minimum qualifications or credentials should those conducting inspections have? Section **537.4** of the Code prescribes the minimum qualifications for those personnel conducting *inspections*:

537.4 Qualifications of the Owner's Inspector

The Inspector shall be designated by the owner. The Inspector (or Delegate) shall be an employee of the owner or of a company acting as the owner's agent. The Inspector (or Delegate) shall neither represent nor be an employee of the manufacturer, fabricator, or erector unless the owner is the manufacturer, fabricator, or erector. **The Inspector (or Delegate) shall have at least five years' experience in the design, fabrication, examination, testing, or inspection of industrial piping.**

These provisions of the Code raise a number of questions.

1. *If you are an owner, are you or someone you designate inspecting your piping systems "to the extent necessary to assure compliance with the engineering design, and with the material, fabrication, assembly, examination, and testing requirements of the code?"*
2. *Are those piping system inspections being conducted with your own employees or with an outside agent (consultant, independent inspector, independent contractor, etc.)?*
3. *Do the in-house or outside personnel conducting those inspections have at least five years of experience in the design, fabrication, examination, testing or inspection of industrial piping systems as required by **537.4** of ASME B31.5?*
4. *Do you have appropriate documentation to demonstrate compliance with the code-required inspections – including pressure testing?*
5. *Are you documenting both the inspections and the credentials/qualifications of those individuals performing them to incorporate into the process safety information for your plant's PSM program?*

Whether you assign the inspection responsibility to a contract employee such as a construction project manager, design professional, or other technical specialist, how are you demonstrating the Code requirements are being met? Keep in mind that if your piping system is part of a PSM-covered process, Section **537.2** of the Code is consistent with the prestart-up safety review provision [1910.119(i)] of the PSM Standard so this should not be viewed an added requirement.

From a documentation perspective, Section **539.3** of the Code defines the minimum extent and retention of records associated with a B31.5 compliant piping system. Section **539.3** states:

539.3 Extent and Retention of Records

The following records shall be maintained for three years:

- (a) procedure specification, procedure qualification, and performance qualification records
- (b) results of weld examinations other than visual
- (c) records of the testing of each piping system, which shall include the following information:
 - (1) date
 - (2) identification of piping system tested
 - (3) testing medium
 - (4) test pressure
 - (5) signature of examiner and inspector

Although the Code only requires retention of these documents for three years, facilities that are covered under PSM must retain this information for the life of the piping system (see testing record retention sidebar).

**PRESSURE TEST RECORD
RETENTION**

For PSM-covered processes, all checklists, examination records, test records, or other documents associated with demonstrating that a piping system installation system meets the requirements of ASME B31.5 should be retained for the life of the process. *Why?* The process safety information portion of the PSM Standard [1910.119(d)(3)(ii)] states:

“The employer shall document that equipment complies with recognized and generally accepted good engineering practices.”

The above record retention provides evidence that the piping system has met the requirements of the Code and, in this case, serves the requirement of (d)(3)(ii).

Section **539.3(c)(5)** eludes to “examiner” and “inspector” personnel by signature requirement but it does not explicitly identify whether this also applies to those actually conducting pressure tests. The Code is not explicit in defining requirements for the credentials or qualifications of personnel conducting or otherwise involved with the field pressure testing of refrigerant piping systems; however, we can refer to the Section V of the ASME Boiler and Pressure Vessel code to get clarification on personnel qualification requirements. In the “scope” portion of Section V of the B&PV Code, T-110, it states:

NDE methods are intended to detect surface and internal imperfections in materials, welds, fabricated parts, and components. They include radiographic examination, ultrasonic examination, liquid penetrant examination, magnetic particle examination, eddy current examination, visual examination, **leak testing**, and acoustic emission examination.

So ASME considers leak testing, which includes pressure testing, to be a subset of non-destructive examination. Paragraph T-120 of Section V states further:

- (e) For those documents that directly reference this Article for the qualification of NDE personnel, the qualification shall be in accordance with their employer's written practice which must be in accordance with one of the following documents: (1) SNT-TC-1A, Personnel Qualifications and Certification in Nondestructive Testing; or (2) ANSI/ASNT CP-189, ASMT Standard for Qualification and Certification of Nondestructive Testing Personnel.

Here the language is more specific than B31.5 in that NDE personnel shall operate in accordance with the written practices of the testing personnel's employer and those qualification practices are in accordance with either ASNT SNT-TC-1A or CP-189 (see ASNT sidebar). One might persuasively argue that the B31.5 code does not reference ASME Section V as the basis for personnel qualifications in the non-destructive examination requirements for piping systems but Section **538.4.3** of B31.5 does reference Section V of the B&PV code as one acceptable method for the examination of leaks by bubble testing. Ultimately, the end-user owner needs to establish the minimum skill and qualification/credential requirements for those personnel who will both carry out and oversee the pressure testing of a piping system.

It is also noteworthy to mention there are similar credentialing guidelines or standards internationally. For example, the European standard EN 473 establishes requirements for qualification and certification of non-destructive test personnel. ISO 9712 is similar to EN 473 in that it specifies the qualification and certification of personnel involved in non-destructive testing (NDT) – including leak testing.

ASNT SNT-TC-1A

Recommended Practice SNT-TC-1A (2011) provides guidelines for employers that desire or need to establish an in-house personnel certification program. SNT-TC-1A recommends education, work experience, and training requirements applicable for a range of nondestructive testing techniques. It has three levels of qualification with each level blending initial training, verification by testing, and on-the-job experience. The certifying employer can subdivide each level if necessary for specific skill requirements. The guideline requires that inspectors receive training and certification for each NDT technique they use. The NDT methods include a range of non-destructive testing technologies such as radiographic inspection (RT) and ultrasonic testing (UT) but it also includes leak testing (LT).

Within the leak testing category, the following methods are covered: bubble leak testing, halogen diode detector leak testing, mass spectrometer leak testing, and pressure change measurement leak testing. Generally, bubble testing and pressure change measurement leak testing are relevant to built-up ammonia piping system pressure tests. The following briefly describe the three ASNT SNT-TC-1A certification levels.

Level I –Level I inspectors successfully pass a written test to prove their basic knowledge of the specific inspection technology they are using (or will use). In practice, Level I inspectors are permitted to use instrumentation for calibration, examination tests, and evaluate a test for acceptance or rejection according to written instructions and record results; however, they should be field-supervised by a Level II or Level III technician.

Level II –Level II technicians have significantly more experience and are permitted to: set-up and calibrate required instrumentation, independently conduct tests according to established procedures, evaluate & document test results. They are expected to be familiar with relevant codes, standards, and other documents related to the NDT method for their credential. Finally, Level II technicians can supervise and provide on-the-job training for Level I technicians.

Level III – Level III technicians represent the top of the strata for each inspection technology. In addition to actually being able to do the work of a Level I or II technician, Level III technicians are permitted to establish testing procedures (including determining the best inspection technology suited for a given requirement) and interpret codes, standards, and specifications. Generally, Level III technicians are supervisors or managers.

The structure of the SNT-TC-1A guideline means that the certification program is established by the employer and credentialing of inspector personnel stays with the inspection/testing company. Under SNT-TC-1A, inspectors that leave their employer need to be re-certified when they join another inspection/test firm. The certification programs usually consist of a regimen that includes: education, training, and experience. Knowledge acquisition by education is assessed by administering a written examination. The guideline recommends that 80% be used as a pass-fail threshold but it establishes 70% as a minimum acceptable score for a passing examination grade. The assessment of skill is by practical demonstration. Level III inspectors oversee the Level I and Level II candidates as they demonstrate their ability to conduct those inspections and tests relevant to the NDT technology they are attempting to qualify for.

In addition to knowledge and skill testing, credentialed candidates are required to undergo annual vision examinations to demonstrate they have sufficient natural or corrected vision in at least one eye. The guideline also requires the assessment of each candidate's ability to distinguish color and shades of gray contrast. This testing is recommended upon initial certification and then every five years thereafter.

ASNT CP-189

SNT-TC-1A is a “guideline” and not written in mandatory language and some segments of the industry articulated the need for more stringent requirements so ASNT established the CP-189 standard: “Standard for Qualification and Certification of Nondestructive Testing Personnel.” In contrast to SNT-TC-1A, the CP-189 standard establishes six levels of qualification for inspection personnel:

Trainee – A trainee has no certification credential but works with a NDT Level II or NDT Level III certified individual. A trainee is not permitted to independently conduct any tests or prepare reports of test results.

NDT Level I - An NDT Level I technician has sufficient skills and abilities to: prepare specific calibrations, conduct tests, and perform specific interpretation and evaluations of results (with written approval of an NDT Level III). NDT Level I technicians receive guidance and supervision from NDT Level II or NDT Level III inspectors.

NDT Level II Limited - An NDT Level II Limited technician has all of the skills of a Level I technician as well as being able to interpret, evaluate and document results in accordance with procedures developed by an NDT Level III inspector. The Level II Limited professional must be familiar with the scope and limitations of the NDT techniques to which they are credentialed. The limitation of this credential applies to the following NDT skills: radiographic film interpretation, digital radioscopy, ultrasonic digital thickness measurement, and ultrasonic straight beam (A-scan) measurement. In addition, a Level II Limited should be capable of directing the work of trainees and Level I personnel.

NDT Level II - An NDT Level II technician requirements are identical to the Level II Limited but without any limitations on the NDT skills noted above.

NDT Level III - An NDT Level III technician can establish techniques, interpret codes, standards & specifications, designate inspection techniques to be used, and verify adequacy of procedures. The NDT Level III professional can also conduct, direct, and examine NDT personnel for the techniques in which they are qualified. The NDT Level III professional is also expected to be generally familiar with all NDT technologies.

NDT Instructor – The NDT Instructor has the skills to plan, organize, and present classroom, laboratory, and on-the-job training in accordance with outlines approved by a NDT Level III professional.

Like SNT-TC-1A, CP-189 also requires candidates to undergo a vision examination to verify visual acuity and discern colors or shades as required by the tests methods for which they are being credentialed. Also like SNT-TC-1A, inspectors must be certified in each type of inspection technology they intend to use (i.e. leak testing, ultrasonic, magnetic, dye-penetrant, radiography). Certification in one technology does not provide reciprocal certification in other inspection technology types. In contrast to the credentials accrued under the SNT-TC-1A guideline, certification under the CP-189 standard stays with each individual inspector regardless of their employer. Although CP-189 is similar to SNT-TC-1A in terms of training, experience, and examinations, it does differ in that the standard establishes more stringent minimum requirements such as: instructors must meet qualifications outlined in the standard.

RECOMMENDATIONS

Based on this information, the following are recommendations you should consider to ensure those personnel conducting pressure tests on piping systems at your facilities are suitably equipped.

- 1) Develop clear procedures for pressure and leak testing your piping systems.
- 2) Develop suitable checklist(s) and/or test data form(s) to document you are meeting the ASME B31.5 requirements for examination and testing of newly constructed piping systems.
- 3) Assign appropriate personnel for conducting and/or overseeing the pressure test.
- 4) Verify that the personnel involved in executing the established pressure test procedures have been trained not only on the written pressure testing procedures but that they also have the appropriate knowledge, skill, and experience consistent with the guidance given in ASNT STN-TC-1A. This applies to in-house personnel

who may be leading or conducting pressure tests as well as contract personnel. The following would be supportive of these recommendations:

- a) Ensure test personnel have a foundational understanding of the following:
 - i) principles of leak and pressure testing of piping systems
 - ii) safety considerations of leak and pressure testing
 - iii) requirements for preparing a piping system to undergo a leak and pressure test
 - iv) fluids suitable (and not suitable) for leak and pressure testing
 - v) the use of equipment (plugs, gags, regulators, gauges, reliefs, bubble solution, etc.) and operating principles of that equipment for pressure testing
 - vi) typical sequences of operation for leak and pressure testing
 - vii) pass/fail criteria for leak and pressure testing
 - viii) basic steps that need to be taken in the event repairs are required
 - ix) importance of documenting pressure testing and typical documentation requirements

This may require conducting some basic training on the principles of leak testing or administering a written test to ensure the individual's knowledge inventory is acceptable. In either case, you should document that each individual involved in pressure testing understands the principles of pressure testing. See the "Test your knowledge" section at the end of this article.

- b) Conduct initial training on the specific written procedures for pressure testing the piping system undergoing testing. This would include relevant documentation requirements for the pressure test. If a period of more than three years has elapsed since the initial procedure training, refresher train each person involved in the testing.
- c) Verify the visual acuity of test personnel in accordance with the criteria in SNT-TC-1A or CP-189.
- d) Consider developing an in-house pressure-testing credential based on the SNT-TC-1A guideline. This could be similar to other in-house credentials you may have for your skilled trades – LOTO, mechanic or operator levels.

CONCLUSIONS

The piping code, B31.5, requires that pressure tests are conducted for newly constructed piping systems. Consistent with the requirements of the process safety management standard, the piping code assigns the responsibility of inspection and testing of a piping system to the owner. In many cases, the owner delegates the role of inspection and test to a contractor or other third party. The Code does not allow the inspector (or delegate) to represent or be an employee of the manufacturer, fabricator, or erector of a piping system unless the piping system is owned by the manufacturer, fabricator or erector [B31.5 **537.4**]. The Code also requires that the inspector (or delegate) has at least five years of experience in the design, fabrication, examination, testing or inspection of industrial piping [B31.5 **537.4**].

Personnel involved in executing post-construction piping system pressure tests need to be suitably qualified. Although not required Code, some owners may elect to stipulate that pressure test personnel are certified under ASNT SNT-TC-1A or CP-189. At a minimum, owners should develop minimum criteria for qualifying pressure test and other inspection personnel.

REFERENCES

- ANSI/ASHRAE 15, "Safety Standard for Refrigeration Systems", American Society of Heating, Refrigerating, and Air Conditioning Engineers, Atlanta, GA (2010).
- ASME B31.3, "Process Piping", American Society of Mechanical Engineers, (2010).
- ASME B31.5, "Refrigeration Piping and Heat Transfer Components", American Society of Mechanical Engineers, (2010).
- ASME Section VIII Div. 1, "Boiler and Pressure Vessel Code – Rules for Construction of Pressure Vessels", American Society of Mechanical Engineers, (2010).

- ANSI/IIAR 2, "Equipment, Design, and Installation of Closed-Circuit Ammonia Mechanical Refrigerating Systems", including Addendum A, International Institute of Ammonia Refrigeration, (2008).
- CP-189, "Standard for Qualification and Certification of Nondestructive Testing Personnel", ASNT, (2011)
- EN 473, "Non-destructive testing — Qualification and certification of NDT personnel — General principles", Austrian Standards Institute (2009).
- ISO 9712, "Non-destructive testing – Qualification and certification of personnel", International Organization for Standardization, (2005).
- Jackson and Sherlock, Nondestructive Testing Handbook: Volume 1 – Leak Testing, Third Edition, American Society for Nondestructive Testing, (1998).
- SNT-TC-1A, "Personnel Qualification and Certification in Nondestructive Testing", ASNT, (2011).

TEST YOUR KNOWLEDGE – PRESSURE TESTING

1. A pneumatic pressure test is inherently safer than a hydrostatic pressure test – True or False
2. A pressure test conducted on a piping system is intended to accomplish the following (circle all that apply)
 - a. Demonstrate the gross integrity of a piping system following its construction or repair
 - b. Verification of the leak tightness of a piping system
 - c. Ensure the materials of construction for the piping system are appropriate
 - d. Determination of the remaining useful life of a piping system
 - e. Ensure that all joints have been properly primed and painted
3. For *leak testing* a piping system is pressurized to its design pressure – True or False
4. For any leaks discovered during leak testing, repairs shall only commence after the piping system is depressurized – True or False
5. A piping system that has undergone repairs to fix leaks discovered during leak testing does not need to undergo a subsequent leak test – True or False
6. A full pressure test is required before conducting a leak test – True or False
7. Household liquid soap is suitable test fluid for bubble testing during a leak test – True or False
8. It is essential that the temperature of a piping system undergoing a full pressure is below its minimum design metal temperature – True or False
9. A the final test pressure for a piping system needs to be at least 3 times (3 x) the design pressure – True or False
10. It is acceptable to use anhydrous ammonia as the test gas when conducting a full pneumatic pressure test of a piping system – True or False.
11. It is essential that the pressure relief devices normally connected to the piping system for operational service are in-service and active during a full pressure test – True or False
12. It is essential that all joints in a newly constructed piping planned to undergo leakage testing be primed and painted prior to pressure leak testing – True or False
13. The letters psia stand for
 - a. Pressure Standard Institute of America
 - b. Pounds per square inch absolute
 - c. Pascals per square inch absolute
 - d. Pressure Standard in Absolute