VISUAL TESTING METHOD PERSONNEL QUALIFICATION AND CERTIFICATION: AN OVERVIEW

BY MIKE ALLGAIER

Most major nondestructive testing (NDT) personnel qualification and certification (PQ&C) schema address visual testing (VT) as a standalone NDT method. However, there are significant differences between the details of these elements. Various codes, standards, and specifications delineate various requirements for personnel education, experience, training, and examination of the candidates for certification. This article addresses the common elements needed for PQ&C across different codes, standards, and guidelines.

Introduction

Visual testing (VT) has long been integral to other NDT methods, as it historically has served as a prerequisite for those methods. It was a prerequisite to liquid penetrant testing (PT), magnetic particle testing (MT), ultrasonic testing (UT), and radiographic testing (RT) when it was stated in those methods that "surface conditions that would interfere with the examination should be evaluated and removed." Level I/II certification took for granted that the prerequisite to PT and MT included the VT knowledge and skills.

The VT method has gained its own method status over the last 50 years. Early VT tools included the human eye, a magnifying glass, a dental mirror, a 6-in. steel scale, a 12-in. wooden ruler, and maybe a 50-ft tape measure. Today, how to examine an object has changed. The advent of digital imaging has offered a great expanse in the variety of instruments available to capture digital images and allow analysis of the part condition, including measurement techniques that are more and more sophisticated. Remote visual inspection, also known as RVI, can be used to inspect areas of infrastructure from a distance that are too dangerous, remote, or inaccessible for direct visual inspection. RVI technologies include remotely operated cameras, borescopes, videoscopes, fiberscopes, and drones.

Background

When exploring PQ&C schema for VT, we discover two major categories. The first is direct VT (DVT) and the second is indirect VT, more commonly referred to as RVI.

The DVT examination definition taken from the *ASME Boiler and Pressure Vessel Code,* Section V: *Nondestructive Examination*, Article 9, *Visual Examination,* states that the eye should be within 24 in. of the surface to be examined and at an angle not less than 30°. This can include aids such as a magnifier or mirror. The term "aid" implies that the surface can be inspected without these tools, hence the direct method of VT.

RVI is used when the above criteria for DVT cannot be met—for example, when the surface under inspection is *only* accessible with a mirror, a magnifying glass, a series of lenses in a borescope, a bundle of fibers, a charge-coupled device transmitting the image to a monitor (such as a videoscope), or a telescope for long-distance inspections.

With either category for evaluating hardware, there are three pillars, or goals:

- to acquire an acceptable image,
- to evaluate the part, component, or system test results, and
- to disposition those test results to the appropriate acceptance or recording criteria.

To perform these steps, the inspector or examiner needs to possess the core knowledge and basic skills for common applications. In addition, industry-specific knowledge and skills unique to various industries, products, or VT techniques are also required. These are called industry specific segments (ISS). When comparing various industry PQ&C requirements, we observe overlaps, omissions, and unique criteria across different programs. Some VT requirements are common across all industries, while others are unique to certain ISS.

Elements of Personnel Qualification and Certification

Proper execution and evaluation of any VT application requires the inspector or examiner to be qualified in the VT method using the applicable techniques. Compliance with those qualifications, along with written documentation and a summary sheet, is known as certification. Following are a few of the common schema for VT PQ&C used in the NDT industry.

American Society for Nondestructive Testing (ASNT)

The original recommendations for NDT PQ&C date back to 1968 with the publication of ASNT Recommended Practice No. SNT-TC-1A: *Personnel Qualification* *and Certification in Nondestructive Testing.* Its main distinction is that it is a guideline, not a standard. It provides guidelines for employers to establish in-house certification programs for the qualification and certification of NDT personnel and provides education, experience, and training recommendations for each NDT method. Therefore, the primary driver is the employer's written practice, which can vary across individual companies.

When an employer has a contract with a customer, the customer's specification will call out the primary standards, codes, and regulations that must be complied with to satisfactorily complete the contract. Originally, SNT-TC-1A had its own body-of-knowledge outline referenced for each NDT method as a supplement, but it was up to the employer to modify the program to suit their needs. Training content and duration would be especially subject to customization by each employer. SNT-TC-1A provides the recommended number of training hours in a table (see Table 1 for VT recommendations).

Today, ANSI/ASNT CP-105: *ASNT Standard Topical Outlines for Qualification of Nondestructive Testing Personnel* specifies the body of knowledge to be used as part of a training program qualifying and certifying NDT personnel. It applies to personnel whose tasks or jobs require knowledge of the technical principles underlying the NDT methods for which they have responsibility. These tasks include performing, specifying, reviewing, monitoring, supervising, and evaluating NDT work. These outlines are approved by the American National Standards Institute (hence the ANSI in its title).

ANSI/ASNT CP-189: *ASNT Standard for Qualification and Certification of Nondestructive Testing Personnel* is a standard for qualification and certification of NDT personnel. Its main distinction is that it is a standard, not a recommended practice. It builds on SNT-TC-1A by providing comprehensive minimum requirements for personnel certification, such as requirements for NDT instructors and employer certification of Level I, II, and III personnel as well as a requirement for the ASNT NDT Level III certification of Level III personnel. This standard is approved by ANSI and also references CP-105 for training outlines. When CP-189 is referenced in a contract, the vendor, contractor, or prime must meet the requirements listed therein.

The common certification elements addressed in both the guideline (SNT-TC-1A) and the standard (CP-189) include education, training, experience, and exams. Exams include three types: physical (visual acuity) exams, written exams, and practical exams.

American Petroleum Institute (API)

API has its own requirements for vessel inspection, including VT. API 510, API 570, API 653, and API 1169 (note: this list is not exhaustive) each have their own checklists of what to inspect for in internal and external visual inspections. Vessels, piping, new piping construction, tanks, and the like have broader scope inspection requirements than surface conditions alone. Licensed inspectors must be utilized to prevent catastrophic failures or unexpected operational issues. This article does not address the petrochemical specifics for inspection PQ&C.

TABLE 1

Recommended initial training and experience levels for VT*

Examination method	NDT level	Training hours	Minimum hours in method or technique	Total hours in NDT
Visual testing (VT)	I	8	70	130
	II	16	140	270

*per SNT-TC-1A (2024), excerpted from Table 6.3.1A

American Welding Society (AWS)

Prior education typically does not decrease the requirements for VT Level I or II in terms of experience, training, physical exams, written exams, or practical exams (proficiency demonstrations). However, the AWS certification for Certified Weld Inspector (CWI) does adjust the experience requirements based on an individual's education. The more education one has, the less experience is needed to obtain CWI certification. In this comparison, CWI is treated as equivalent to SNT-TC-1A or CP-189 Level II.

Table 2 shows the minimum education and work experience required to become a CWI per AWS.

TABLE 2

Education and work experience required to become a CWI, per AWS

If the candidate has:	The amount of experience required is:
4-year bachelor's degree	1 year
2-year associate degree	2 years
Eng/tech courses	3 years
Vo-tech courses	4 years
High school	5 years
8th grade	9 years
<8th grade	12 years

Note: This concept also applies to NDT Level IIIs in SNT-TC-1A, where higher education levels can reduce the required amount of experience.

Training

All these PQ&C programs require training. NDT requires skilled and qualified personnel to perform, interpret, and evaluate the tests. Training and certifying NDT personnel can help ensure the accuracy, reliability, and validity of NDT results. Moreover, training and certifying NDT personnel can help company owners reduce the risk of errors, accidents, and liabilities. Furthermore, training and certifying NDT personnel can help improve their competence, confidence, and motivation.

The industry can choose from various NDT training and certification programs, such as those offered by ASNT, the British Institute of Non-Destructive Testing (BINDT), or the International Organization for Standardization (ISO).

Most government and industry regulations include references to NDT qualification and certification standards. These documents outline the education, training, and experience requirements that must be met before completing the certification examination process.

Training topics are addressed in outlines found in ANSI/ASNT CP-105. This body of knowledge for VT is the basis for visual examination training course outlines and curriculums. (Note: As of this writing, ASNT is working to achieve compatibility with ISO TS 25107.)

The training requirements listed for both SNT-TC-1A and CP-189 state that 24 hours is the required amount of training hours needed for Level II (8 hours for Level I plus 16 hours for Level II). This includes both classroom training for knowledge transfer and laboratory training sessions for skills transfer. A significant portion of this time is spent learning about material discontinuities and defects—essentially, understanding what to look for when performing VT.

Learning how to perform VT for DVI and RVI takes less time if the equipment is basic, such as a dental mirror, flashlight, and 6-in. scale. In the past, RVI typically involved using borescopes (lens or fiber) for image transfer. However, if training on videoscopes, telescopes, or remote cameras is required, significantly more time must be allocated for training in these techniques.

The required training for CWI certification used to be a 40-hour course. Now, a CWI must complete 80 professional development hours (PDHs) through seminars, courses, or online courses such as those found on the AWS Education Portal. These courses must meet the requirements of the *AWS Specification for the Certification of Welding Inspectors* (AWS QC1:2016-AMD1).

ISO 9712: *Nondestructive Testing – Qualification and Certification of NDT Personnel* is an international standard that specifies requirements for principles for the qualification and certification of personnel who perform industrial NDT. In this standard, VT training is measured in days, not hours. This is a change in the 2021 standard, which was adopted by ASNT in 2023 (ASNT CP-9712, identical adoption) (see Table 3).

TABLE 3

ISO 9712 requirements for VT training

Level	Training requirement
VT Level 1	3 days
VT Level 2	2 days
VT Level 3	3 days

Note: One day = 7 h. "Limited" and "unlimited" terms used in ISO 9712 (2012) have been deleted from the 2021 edition. Reduced training is allowed if reduced curriculum and allowed by certification body (e.g., if limited to direct VT only, then less training is required).

The nuclear power generation industry developed visual examination requirements, as outlined by the Electric Power Research Institute (EPRI) in the 1980s, to address the unique needs of the *ASME BPVC*, Section XI, for in-service inspections. The total training hours for Level I, II, and III visual examiners through EPRI is 104 hours. Distinct techniques within the Visual Examination certification address general surface conditions (VT-1), leak testing (VT-2), and a third category for hangers, snubbers, restraints, supports, and reactor vessels internals (VT-3). Level I and II training is 40 hours each for a total of 80 hours to become a Level II. An additional 24 hours are needed for Level III.

Compared to these examples from AWS and ISO 9712, the 24-hour training specification for VT Level II in SNT-TC-1A is noticeably lower.

Experience

SNT-TC-1A Level I and II experience started off as measured by months (one and two, respectively). This unit of time measurement was replaced with experience requirements expressed in hours. This calculation was based on approximately 40% of three months' worth of experience, equating to 210 hours.

AWS, as stated previously, required five years of experience if the candidate was high school educated. How to gain credit for those years of experience is not clarified.

ISO 9712 requirements for experience in VT are shown in Table 4.

Exams

Physical. Visual acuity is the primary physical attribute that must be examined for PQ&C in VT. Per SNT-TC-1A, "near vision" is one of the visual acuity requirements. According to SNT-TC-1A, an NDT technician must have the ability to read the Jaeger No. 2 test chart, at a distance of no less than 12 in. (30 cm), with or without corrective lenses, in at least one eye. This requirement applies to all levels of NDT personnel.

Color perception requirements are determined according to the specific demands of the job and are set by the employer. A special color perception test may be administered if abnormal color perception exists. The candidate must demonstrate the ability to see the appropriate colors needed for the specific exam to be performed.

TABLE 4

ISO 9712 requirements for VT experience

Level	Experience
VT Level 1	15 days
VT Level 2 (with Level 1)	45 days
VT Level 2 (directly)	60 days
VT Level 3 (with Level 2 and higher education)	180 days
VT Level 3 (with Level 2 only)	240 days
VT Level 3 (directly and higher education)	360 days

Note: One day = 7 h.

Written. Written exams are used to assess a candidate's understanding of the subject matter contained in the appropriate syllabus or outlined requirements. SNT-TC-1A and CP-189 both refer to the training outlines in CP-105 for theory. The topics of the questions contained in the general examination are found there. The number of general questions ranges from 30 (minimum) to typically 50 on the basic principles and theory applicable to the VT method. The number of specific questions is determined by the codes, specifications, and procedures applicable to the inspections mandated by customer specifications, which the inspector must adhere to during their work for the employer.

Practical. A demonstration of practical proficiency is called the practical exam. The primary requirement is to follow a 10-point checklist, though specific details of the checklist are not explicitly provided.

Table 5 shows a typical example of a practical exam's 10-point checklist.

TABLE 5

Typical practical exam checklist example

Observation item	Unsatisfactory	Satisfactory
1. Surface condition		
2. Procedure compliance		
3. Equipment usage		
4. Adequate coverage		
5. Attribute identification		
6. Discontinuity/attribute evaluation		
7. Disposition and evaluate discontinuity/attributes		
8. Report/document results		
9. Comply with safety cautions		
10. Health		

Each item on the list carries a value of 10 points. A minimum score of 70% is required to pass.

When each of the 10 checklist points carries equal weight at 10 points each, failing the practical exam becomes unlikely. Generally, with this scoring system, most candidates score 90% or higher, resulting in a pass.

An alternate is a checklist like shown in Table 6. In this scenario, mandatory elements must be successfully completed with a score of 80% or higher, otherwise the entire practical exam is considered failed. Performance, evaluation, and disposition should be mandatory checklist items where a pass or fail decision is required. The points assigned to other listed items can be discretionary.

The technique and order of conducting a practical proficiency demonstration

TABLE 6

Proposed example of 10-point checklist for VT practical exam Level II (VT or RVI)

Categories	Point weight
1. Procedure selection	3
2. Surface preparation/cleanliness	2
3. Method application—satisfactory technique	10
4. Equipment and material selection	10 (min 8 pts req'd)
• Equipment	
• Material (cleaning; pre and post)	
5. Adequate area of interest coverage	10
6. Interpretation of indications and disposition	40 (min 32 pts req'd)
• Complete coverage for interpretation	
• Determination of relevance	
• Appropriate application of acceptance criteria	
• Appropriate disposition of part, component, or system	(min 80% accurate)
7. Standard practice codes or procedure usage	10
• Familiarity	
• Compliance	
8. Records	10
• Completeness	
• Appropriate data entry	
• Control of records	
• Compliance with routing requirements	
9. Health factors	3
• Site procedures familiarity	
• Adherence	
• Compliance	
10. Safety factors	2
• Volatile liquids	
• Electrical hazards	
• Light and infrared radiation	
80% min required total and for Sections 4 and 6 as noted	100 pts possible

only require a test piece and a 10-point checklist. However, the scoring protocol or the value assigned to each point is not specified. It is up to the method Level III and the employer's written practice to provide such details.

Conclusion

Visual inspection has come a long way from a few decades ago. Recent developments have brought us to new frontiers. Given this, the industry now has an opportunity to standardize the key elements of qualifying DVT and RVI NDT personnel.

Additional ISS can address written and practical exams as needed, in addition to minimum core knowledge and skills common to all DVT/RVI inspectors. The same goes for the training curriculum. There can—and should—be a core of knowledge and skills common to all VT inspectors/examiners. Each industry can produce Industry Segment Qualifications (ISQ) with subtechniques delineated.

Further discussion is necessary to cover the specific visual examination requirements outlined in various codes, standards, and specifications. Visual examination techniques and equipment vary in VT, DVT, and RVI. Industry-specific qualifications are required to tailor the education, training, and experience necessary for certification in this distinct field. ME

REFERENCES

ANSI/ASNT CP-105: *ASNT Standard Topical Outlines for Qualification of Nondestructive Testing Personnel.* American Society for Nondestructive Testing.

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FROM THE WAY-BACK MACHINE

The following excerpt was taken from an article titled "A Look Ahead at Nondestructive Testing," authored by NDT giant Robert C. McMaster and published in *Materials Evaluation* in April 1986:

> Past experience has shown that more than one type of nondestructive test may be needed to detect various types and locations of defects and to provide assurance of quality based upon confirming or additive evidence obtained from these different test indications. A major problem arises when the test records produced by different test methods are not compatible. Today, many human inspectors have the training and experience needed to provide such correlations between X-ray, ultrasonic, magnetic particle, liquid penetrant, eddy current, and other commonly used types of tests. Robotic or computer-controlled nondestructive test systems will typically require consistent forms of test records, possibly bitmapped graphic images which can be enlarged, reduced, rotated, and rectified to fit new coordinate systems. Fortunately, these techniques have been well developed for use in aerial mapping of the Earth's surface and in "Landsat" images recorded by satellites in space. Three-dimensional analyses of defect locations, shapes, sizes, and planes of view feasible with computer graphics today offer examples of the programs and techniques required. Contrast enhancement, as well as color identifications of types or severity of defects (similar to those widely broadcast in television weather shows today), can also be used for defect identification, locations, shapes, and analyses of the severity of hazards they could present in service. Coincidence of defect indications obtained from different types of tests, or from tests made on the same test objects at different points during manufacture, or at different times during service, or whenever test evaluations are required for legal or other purposes, could be demonstrated by sequences of such rectified images (just as the movements of air masses, fronts, and jet streams are shown on television nationwide as time-lapse maps of the weather movements over the Earth's surface). Even when the test object moves about on the Earth's surface, at sea, in the air, or in outer space, its defect images could still be correlated after transmission of test data to earth stations at fixed locations. For critical applications, such images could be reproduced at highly qualified analysis facilities, such as national or international standards laboratories. The system reliability attainable by these means could far exceed that obtainable today from repeated inspections by certified human operators.

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"We are often reminded that those organizations and individuals who do not know their own history are forced to live it again."

–ROBERT C. MCMASTER