The application of Quality Assurance in NDT Measurements

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Abstract - A major task in the industry is the application of NDT methods during the inspection of various pressure equipment (steam boilers, vessels, LPG tanks etc.) For safety reasons according to current EU Directives (PED, simple pressure vessels, TPED) and National Laws all these pressure equipment must be inspected and certified during construction and, of course, subjected to periodic inspections during operation.

This paper contributes in the field of application of Quality Assurance during various NDT inspections as well as quality plans in such work in order to comply with certain directives and laws, thus contributing in increasing the level of services provided in the industry. The paper describes also practical problems in application of quality plans during NDT inspection of various types of pressure equipment during initial construction as well as during periodic inspection in order to comply to certain standards.

1 Introduction

ISO/IEC 17020 is the current international standard which defines the basic requirements for all bodies (inspection offices etc) who perform technical inspections of all types. It replaces the European standard EN 45004:1995. The requirements of this standard are enforced when an inspection body seeks accreditation, but are a very good guideline for the organisation of the inspection body even if no accreditation is necessary (for example, if it operates under a ISO 9001 quality management system). The specific references given in this paper apply mainly to the application of NDT methods to welded joints of metallic products.

2 Types of Inspection bodies

The standard defines three types of inspection bodies, called “Type A”, “Type B” and “Type C”.

A Type A inspection body is an entity (office, company, public institution) that specializes in technical inspection services and provides them as “third party”, without being connected with the entity that designs and manufacture the products. Most companies providing NDT services to the open market, either exclusively or as part of wider product inspection services, fall in this category. If EN 10204:2004 applies to the products, the inspection body is one of the two parts validating a Type 3.2 certificate.

A Type B inspection body is usually an independent department of an organization. This type of inspection body is only “contracted internally” to inspect the products of the organization it belongs. Typically it is an inspection and quality control laboratory, which is physically part of a production facility (factory), but has its own management and is independent of the design and production departments. If EN 10204:2004 applies, the inspection body issues a Type 3.1 Inspection

Certificate and is one of the two parts validating a Type 3.2 certificate.

A Type C inspection body is a part of a wider organization without most of the limitations imposed on Type A and B inspection bodies.

3 Organization

The standard is quite clear in the requirements for the organization and management of an inspection body and requires that if the same body is involved in testing and certification, the relationship of these functions must be clearly defined. While it is quite feasible to keep the certification function separate, this approach does not apply always to the testing function, as there is usually considerable overlap between inspection and testing.

There is a requirement for a Technical Manager, who is a permanent employee of the inspection body. This post must be held by a qualified and experienced person, which means that in an ideal situation he must be certified at Level III for the NDT methods used by the inspection body. Desired experience is previous employment in the manufacture, operation or servicing of the inspected products.

The standard also requires that there must be job description for other positions, which affect the quality. These job description must include the requirements for education, training, technical knowledge and experience. It is, therefore, essential to keep track of an employee's academic qualifications, training and experience systematically, in order to fulfil the requirements of ISO 17020 and to be able to demonstrate this to potential customers. A simple personnel database may fulfil this requirement. Job descriptions for personnel involved in the application of NDT methods shall include certification to Level I or Level II, as appropriate.

The personnel of the inspection body is required to make "professional judgement" relating to the conformity of a product with a standard or a specification. Therefore, in addition to specific knowledge of testing methods, they need a wider knowledge about the manufacturing and service of the inspected products. This can only be achieved by training in the facilities where the products are manufactured or used. This requirement is frequently disregarded in order to reduce costs.

Any NDT certification scheme is acceptable in principle, as long as it covers the specific requirements of the customers or of other applicable standards, but the current trends in the European market show that the EN 473 scheme is more appropriate. If the inspection body is involved with inspection of equipment covered by the Pressure Equipment Directive (PED – 97/23/EC), then certification according to EN 473 is required. For inspection of gas and oil pipelines or other applications, certification to either ASNT SNT-TC-1A or EN 473 is usually acceptable. EN 4179 and ISO 9712 cover this requirement for specialized markets. For visual inspection of steam boilers and similar equipment, it is explicitly stated (EN 12952-6, clause 9.2) that no formal certification applies. In Greece, the national gas supplier, DEPA, accepts both ASNT and EN 474 certification schemes for gas pipepline third party inspection.

A problem is caused by clause 8.6 of the standard, which specifies that payment of personnel involved in inspection shall not depend on the number of inspections carried out and the results of the inspections. This clause can not be reasonably applied in many cases in the Greek market, as often inspectors must be hired specifically for a specific small or medium project and no solution has been found so far, nor has the requirement been actively enforced by our accreditation body.

There is also an additional requirement for a person responsible for quality assurance within the Inspection Body. While ISO 17020 sets no specific education, training and experience requirements for the person holding this position, good knowledge of the NDT methods used is also essential in order to perform his duties. In addition, specific training of quality management systems is required. Attendance of a five-day seminar for ISO-9001 internal auditors shall cover most requirements.

4 Quality System

The inspection body should have a quality system. The requirements of ISO 17020 for this quality system are sketchy and, generally, similar to those of ISO 9002:1994.

5 Equipment, Facilities

All equipment used by the inspection body shall be clearly identified and properly maintained. Before use all measuring instruments must also be calibrated. There is no requirement to perform calibration at accredited calibration laboratories, but traceability to national or international standards and evidence of calibration accuracy are clearly required. Conformity to these requirements is most easily demonstrated by the use of accredited laboratories.

6 Inspection methods and procedures

There is a requirement for documented methods and procedures. In the case of NDT inspections, these methods are available in the form of EN and/or ISO standards. Examples of these standards are: Liquid Penetrant: EN 1289, Visual: EN 970, Radiography: EN 1435 and ISO 1106, etc. In addition, national standards (like ASME BPVC section V and former BS 3923) are used extensively as a result of market requirements. Based on these standards, simple working and reporting forms may be designed, where all relevant parameters and results are recorded.

If non-standarized techniques are used, full documentation of the method (procedure, calculation of accuracy, validation records) are required.

A special requirement exists for sampling and for statistical techniques. In some cases sampling parameters (sampling method and size of sample) are part of the contract or are specified at an application standard. For example application standards like EN 12952-6 and EN 13445-5 specify the size and location of the welds that shall be subjected to NDT. In other cases, the sampling method and size of sample must be specified by the inspection body. A suitable standard, which can be used as guidance, is ISO 2859 (Parts 1-4). The US standards MIL-STD-105, MIL-HDBK-53-1A and ANSI/ASQC Z1.4 can also be used.

Conformity shall be judged against a standard or against specific contract terms, which have been agreed upon before the inspection. General quality requirements for application of NDT on inspecting metal welds are given in EN 12062. A number of applicable standards are listed in paragraph 11.2, the most important of them being EN ISO 5817.

7 Handling of samples

In the case of normal metal welding samples, no special handling and treatment is required. Marking for identification of the samples is essential, if they are not already marked. In some applications of NDT, special handling of the samples may be required and specified in the contract.

8 Records

All important information related to inspections and tests (filled-in forms, printouts, X-ray films, photographic evidence) shall be kept in record according to well defined procedures.

The following procedure works best:

There should be a unique logbook for each inspector or work position. This must be used for writing down all information during the inspection and other important information. The logbook shall remain as part of the inspection body archives.

The various report forms shall be filled in based on the results recorded in the log books and the other documentary evidence (films, printouts), which also remain in the archive.

9 Inspection reports and certificates

The standard specifies that the work carried out and the results must be reported in document form. This document is called “inspection report” or “inspection certificate”. Annex A of EN 10204:2004 lists the current terms used in Europe mainly for inspection documents of metallic products.

The report or certificate must include:

- Identification of the item(s) inspected and/or tested
- Reference to the inspection and testing method
- Reference to the acceptance standard
- Results obtained from inspection and testing
- Judgement of conformity against the acceptance standard or other requirements (contracts etc)

10 Subcontracting

This is a sensitive issue. There are well-defined requirements in the standard about subcontracting and they cover most situations.

It is important that the client bust be notified about which work (laboratory tests or inspections) was carried out by subcontractors. Normally he must be notified in advance, during contract negotiations.

In practice, investigation of competence of the subcontractor is delegated to the accreditation bodies, by choosing to use only accredited subcontractors.

11 Normative and informative references

11.1 General – Certification - Sampling

ISO/IEC 17020 “General criteria for the operation of various types of bodies performing inspection”

EN 473 “Qualification and certification of NDT personnl – General principles”

EN 10204:2004 "Metallic products – Types of inspection documents"

ISO 2859:1995 "Sampling procedures for inspection by attributes", Parts 0-4

EN 12062 "Non-destructive examination of welds – General rules of metallic materials"

11.2 Methods

EN 571 "Non destructive testing – Penetrant testing"

EN 583 "Non destructive testing – Ultrasonic examination" (Parts 1-3)

EN 970 "Non destructive examination of fusion welds – Visual examination"

EN 1290 "Non destructive examination of welds – Magnetic particle examination of welds"

EN 1435 "Non-destructive examination of welds – radiographic examination of welded joints"

EN 1714 "Non-destructive examination of welds – ultrasonic examination of welded joints"

EN 14127 "Non-destructive testing – Ultrasonic thickness measurement"

11.3 Characterization & Acceptance

EN ISO 5817:2003 "Welding – Fusion-welded joints in steel, nickel, titanium and their alloys (beam welding excluded) – Quality levels for imperfections"

EN 1289 "Non destructive examination of welds – Penetrant testing of welds – Acceptance levels"

EN 1291 "Non destructive examination of welds – Magnetic particle examination of welds – Acceptance levels"

EN 1712 "Non-destructive examination of welds – ultrasonic examination of welded joints – acceptance levels"

EN 1713 "Non-destructive examination of welds – ultrasonic examination of welded joints – Characterization of imperfections in welds"

EN 12517 "Non-destructive examination of welds – Radiographic examination of welded joints – Acceptance levels"

EN ISO 10042 "Welding – Arc welded joints in aluminium and its alloys – Quality levels for imperfections" (replaces EN 30042)