Validation of Practical Examination Specimens

Juan Manuel VELASCO, Rodolfo RODRÍGUEZ, Emilio ROMERO, Spanish Society for Nondestructive Testing (AEND), Madrid, Spain

Abstract. A fundamental part in a NDT personnel certification scheme is the examination and, particularly, the practical exam.

To achieve a good performance in the practical exams it is necessary to dispose of a number of specimens big enough as to be representative of the products to be tested by means of NDT methods in the different sectors and containing natural, artificial and implanted discontinuities.

In this paper are shown the actions developed by the Spanish Society of NDT (AEND) to validate its specimens bank, with the criteria established in the document CEN/TS 15053:2006 "Non destructive testing – Recommendations on the discontinuities types in the exam specimens", as well as in the European standards, with the aim of obtaining high quality records and reproducible results.

Introduction

The NDT personnel certification scheme contains the use of a series of procedures to demonstrate the technical capability of a person to perform NDT; this scheme finalizes with the acquisition of a certificate in a method, level and sector.

The Spanish Certification Body (CERTIAEND) assures the technical accomplishment of the certification scheme following the UNE-EN ISO/IEC 17024 and UNE-EN 473 standards requirements. This CERTIAEND is duly accredited by the Spanish Accreditation Body (ENAC).

To carry out the certification process, CERTIAEND has a structure and a quality system to manage, control and administrate the qualification and certification of the personnel devoted to perform and evaluate NDT.

The CERTIAEND procedure PC03 establishes and defines the general requirements for the management of the certification process, covering presently 7 methods, 3 levels, 4 sectors and 6 limited applications, as is shown in the Table I.

LEVELS	METHODS	SECTORS	LIMITED APPLICATIONS
1 2 3	ULTRASONS (UT) INDUSTRIAL RADIOLOGY (RT) MAGNETIC PARTICLES (MT) LIQUID PENETRANTS (PT) EDDY CURRENTS (ET) LEAK TESTING (LT) (Hydraulic test excluded) VISUAL TESTING (VT)	METALLIC MATERIALS (Cast, wrought, forged, ferrous and non ferrous) WELDING (Ferrous and non ferrous) NON METALLIC MATERIALS (Concrete, ceramics,…) AEROSPATIAL MULTISECTOR (Combination of several sectors)	RT: Radiographic interpretation UT: Thickness measurement UT: Welding by points UT : Automatic inspection ET: Inspection of wrought products ET: Steam generators and heat exchangers tubes inspection

Table I. Certification issued by CERTIAEND based on UNE-EN 473

To obtain the certificate in any of the methods, levels and sectors in the Table 1, the candidate must pass a theoretical- practical examination; to be allowed to carry out this examination, it is necessary to satisfy and to document that accomplishes the standard requirements related to the education, training and experience, as well as the visual acuity verification.

The theoretical exam has a general part and a specific part, each one is a questionnaire with multiple choice questions that in the first case correspond to the general theory of the NDT method and in the second case correspond to specific applications of the method in the sector object of the certification.

The practical exam shall have the complexity and extension that allow to the examiner to verify the capability of the candidate to carry out the NDT method on a certain number and type of specimens.

The practical exam has a very high relevance because its weight is higher than the theoretical exams in the final rating. The theoretical exams have a ponderable weight of 25 % each one while the practical exam has a ponderable weight of 50 % of the final rating.

In the practical exams the candidate has to be evaluated as a result of his knowledge, experience, ability and skill in the detection of discontinuities located in the specimens.

To do so, it is relevant that these specimens have reliable and complete records that contain objective evidences of the number, type, location and dimensions of the discontinuities in the specimens as well as the equipment, testing techniques and evaluation conditions.

To maintain the reliability on the specimens used in the practical exams, CERTIAEND has a permanent review system of these specimens and has created a validation methodology for the complete specimens bank that is written in a technical instruction.

The result of the validation process of every specimen used in the practical exams is a record with objective evidence of the discontinuities found.

Standards Requirements

In the process of exam specimens validation and record owned by CERTIAEND the reference standards are:

- UNE-EN 473 (2000)
- CEN/TS 15053 (2006)
- EN and UNE standards for every method and sector that allow to define the testing techniques, the record criteria and the acceptance and reject criteria.

The practical exam is composed by the four following parts:

Part 1: Knowledge of the NDT equipment.
In this part the examiner will evaluate the candidate knowledge on the method and the verification of the equipment performance as well as the additional material that is necessary to carry out the testing.

Part 2: Knowledge of the technique used on the specimen.
The examiner evaluates the candidate ability and skill during the testing of the specimen. The candidate can choose the NDT technique as well as the operating conditions with respect to the furnished code, standard or specification.

Part 3: Detection and location of the discontinuities.
The examiner evaluates the testing basic parameters recorded and the results of the inspection, expressed in detected and located discontinuities with respect to the code, standard and specification.

Part 4: Level 2 radiographic testing.
In the radiographic exam, the level 2 candidate will take by himself the radiographs except when he is already certified as level 1. In that case he has to radiograph, at least, a specimen for every sector applied. Ha has also to interpret, at least, 12 radiographs for every industrial sector applied.

Methodology of the Validation Process

As it has been said above, the validation methodology is developed in a technical instruction and its fundamental milestones are:

- A system to identify and to give references to the examination specimens.
- To carry out the test.
- To design and to work out the results forms.
- A record of the detected discontinuities.
- A final validation with identification of the mandatory detection discontinuities.

In this methodology we have followed the requirements of the technical specification UNE-CEN/TS 15053 regarding the types of discontinuities to include in the specimens to be used in the practical exams.

This specification defines, for de different product sectors (wrought, welded, forged, rolled, tubes), the specimen configuration depending on the geometry, that is, the specimen can be of cylindrical cross section, flanges, joints, nozzles, couplings, elbows, reductions, profiles, plates and strip sheets.

This specification also defines the discontinuities to be contained by the exam specimens depending on the applied product sectors.

All the CERTIAEND exam specimens have the above mentioned characteristics and contain, at least, a planar and/or volumetric discontinuity, with appropriate location and dimensions for the NDT method to be used.

The records prepared for each specimen also accomplish the criteria recommended by the UNE-CEN/TS 15053, identifying, at least: name and logo of the organization, specimen identification number, product, material, NDT method, reference standard, acceptance and reject criteria, equipments, indications and final evaluation.

Objective

To carry out the complete validation of the CERTIAEND certification specimens bank, by means of NDT methods and techniques, and to elaborate the corresponding testing records, in agreement with technical instructions.

Scope

The complete specimens bank that covers all NDT methods and sectors in which CERTIAND certifies, as well as the radiographs used in the radiographic interpretation exercise.

The test extension covers the 100 % of the specimen volume or the testing surface and, in the case of welding sector specimens, the 100 % of the bead and the heat affected zone (HAZ).

The inspected specimens dimensions are comprises in the range of:

0 to 400 mm in length
0 to 30 mm in thickness
0 to 400 mm in diameter.

Standards and documentation used

All the standards and documents relevant to the inspection process and to the record and acceptance levels have been furnished by the Spanish Society of NDT (AEND), and are:

- UNE-EN 473: 2001
- Procedure PC09 of CERTIAEND
- European standards
- Spanish standards
- CEN/TS 15053: 2006.

Personnel

All people participating in the process have an EN 473 certificate as, at least, level 2 in the applying method and sector:

- In the tasks of inspection, recording and evaluation, the personnel was certified, at least, as level 2.
- The person to carry out the validation process has to be certified as level 3 and has to be a CERTIAEND examiner.

In this process participated also the CERTIAEND technical committee and personnel subcontracted by the AEND.

To assess the confidentiality, all the validation process has been carried out in the AEND facilities and all the external personnel participating in it have signed a confidentiality compromise in the sense of no disseminate the inspection results, nor taking out forms or documents used in the inspection process.

How to identify and reference the specimens

All CERTIAEND specimens are identified by a number, for instance, C0046 as it is shown in the Figure 2; this number is marked in a indelible way on a visible place of the specimen. The specimens have been classified in two big groups from the point of view of their identification: Specimens with an irregular configuration and specimens with a regular one.

In the first group an easily identifiable zone of the specimen is chosen (Figure 3).

The regular specimens like the type of planar weld (Figure 1) have been identified on the opposite corner to the corner where the reference system is marked. In the specimens with geometric surfaces of revolution, the identification number is placed on the same reference system generatrix but on the back (Figure 4).

To locate and sizing any discontinuity a reference coordinates system has been defined and, to do so, a point has been marked, in an indelible way, on the corner that identifies the zero of the XYZ axis.

In the specimens with a regular configuration, the side in which this point has been marked is defined by the reference 0> showing the positive direction of the X axis. The directions of the Y, Z axis are shown in the Figures 1, 2 and 4.

In the specimens with an irregular configuration (Figure 3), this point is located in the most appropriate position for the identification of the discontinuities with respect to the specimen geometry.

How to locate and size the discontinuities

All discontinuities have been located with respect to the reference system (X, Y, Z axis) to show their starting point.

To size the discontinuities from their starting point have been used the letters: l = length, a = width and h = height. The length “l” will be the longer dimension on the X and Y axis, the width “a” will be the smaller dimension on the X and Y axis, the height “h” will be measured always on the Z axis.

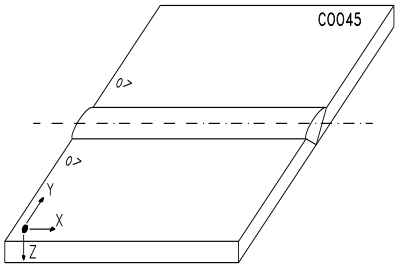


Figure 1

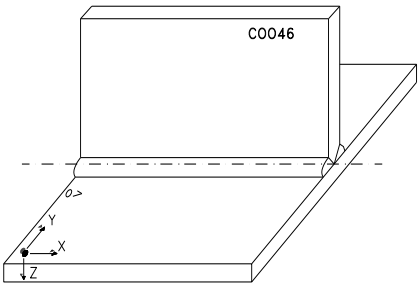


Figure 2

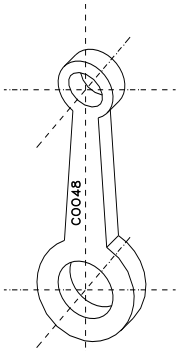


Figure 3

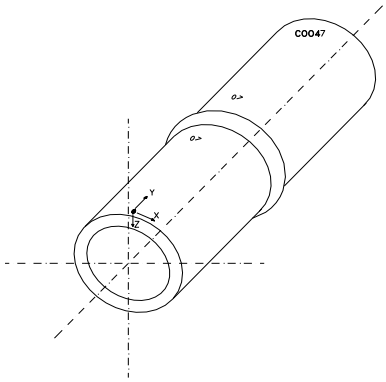


Figure 4

Equipment and materials

All the equipment and material needed to carry out the inspection has been furnished by the AEND, with specimens that are able for using on them the different methods and techniques.

Validation process description

On all CERTIAEND specimens has been carried out the following process:

1. *Testing.*

The tests have been always carried out following the criteria included in the standards for the inspection process as well as for the acceptance and reject aspects.

For each specimen has been selected the best inspection technique and, when possible, a complementary test has been carried out through other method different from the used, to perform an intercomparison whit the obtained results.

When possible, and for the same method and sector, a second test with a different technique has been carried out to evaluate the sensitivity in the discontinuities detection. In the magnetic particles method and for the metallic materials sector, all specimens have been inspected with an electromagnetic yoke and black particles in humid via and by means of a industrial equipment with fluorescent particles.

2. Records preparation. Annex 1.

Every test has a results record containing all data referred to the specimen (material, manufacturing process, surface condition, dimensions and object of the test).

A series of forms have been designed to contain all recordable data as well as to give enough space to include the necessary explanations and details for a posterior reproduction of the discontinuities, and the description of the test technique with all parameters as well as the standards used for the inspection, the recording and the evaluation.

A test description explaining the ways in which the equipment and the auxiliary material have been used on the specimen and giving information on the relevant parameters over the discontinuities as, for instance, difficulty of detection in certain conditions, sharpness or poor visualization, and so on.

To do so, are added sufficient sheets of paper to allow to the participating personnel to draw reference curves, graphs, schemes and observations, that define with maximum detail the inspection result.

The indications record has been documented with the criteria used and the number of detected discontinuities, its interpretation, location and sizing, as well as the applying acceptance and reject criteria.

All records have a sketch of the inspected specimen and a graphic record of the indications; to do so, it has been used the AUTOCAD tool, other drawing tools and digital photographs to improve the vision of the discontinuities found.

As a last action, a level 3 examiner of CERTIAEND has performed the validation consisting in the complete process verification, comparing the obtained results with the results obtained in other tests, and in the identification of the discontinuities whose detection is mandatory.

FINAL CONDIDERATIONS

The aim of this activity has been to dispose in CERTIAEND of a specimens bank for the certification practical examinations in which all the specimens have been inspected with a methodology and technical specifications based on determined standards, with personnel duly qualified, to obtain reliable and homogeneous records.

The external personnel participating in the inspection and report project has worked on a full time basis, to avoid a poor concentration due to other activities.

With this working way we have obtained, for each specimen, complete records with all the information necessary to to a candidate that wants to review his exams, as well as to facilitate its use and interpretation to all the CERTIAEND examiners.

At the same time the standards requirements are accomplished.

In the ANNEX 1 is shown a model of a final record containing all the above considerations.

Acknowledgements

The authors want to thank the participation of Blas Romero, member of the AEND Technical Committee, in the working out of the records performed in this project.

ANNEX 1 MASTER REPORT

CERTIAEND

HOJA DE DATOS DE PROBETA DE EXAMEN

HDPE - PT_____.
FECHA _____.
REV _____.
HOJA 1 DE 3

MÉTODO: **LÍQUIDOS PENETRANTES** SECTOR: M Nº PROBETA:

PROBETA

Material: A. CARBONO SAE 1040 Proceso de fabricación: FORJADO

Estado superficial: ESTÁNDAR CALIDAD 2 Dimensiones: VER CROQUIS PÁGINA 2/4 Espesor: N/A

Objeto del ensayo: OBTENCIÓN DE DISCONTINUIDADES SUPERFICIALES.

PARÁMETROS DE ENSAYO

Normas aplicables: UNE-EN 10288-2:1998 ENSAYOS NO DESTRUCTIVOS DE PIEZAS DE ACERO FORJADO
(de inspección/de aceptación y rechazo)

Limpieza previa: BAÑO DE UT Temperatura de la pieza: ~~N/A~~ 20°C

Tipo de penetrante	ARDROX 996-P COLOREADO	Tipo de aplicación	BROCHA	Tiempo	20 min	Nº lote	034051
Tipo de Emulsificador	N/A	Tipo de aplicación	N/A	Tiempo	N/A	Nº lote	N/A
Tipo de Eliminador	ARDROX 9 P5	Tipo de aplicación	N/A	——	N/A	Nº lote	153041
Tipo de Revelador	ARDROX 9D1B HÚMEDO NO ACUOSO	Tipo de aplicación	PULVERIZACIÓN	Tiempo		Nº lote	294041
Presión de lavado		N/A		Temperatura de lavado		N/A	
Secado		N/A		Temperatura de secado		N/A	

Iluminación:

Ambiental: 700 Lux Pieza: 600 Lux Luxómetro: DLM-1000 Nº serie: 203114A / 203114L

Lámpara: N/A

DESCRIPCIÓN DE LA INSPECCIÓN PRIMERA INSPECCIÓN POR LA CARA A Y SEGUNDO POR LA CARA B DE ACUERDO CON LAS VISTAS INDICADAS EN EL CROQUIS DE LA HOJA 2 DE 2

EXPLORACIÓN: CARA A, LAS INDICACIONES Nº 1 y 2 APARECEN CLARAMENTE A LOS 5 min. DE REVELADO, LA INDICACIÓN Nº 3 APARECE A LOS 15 min. EXPLORACIÓN CARA B, LA INDICACIÓN Nº 4 APARECE A LOS 10 min DE REVELADO Y SE EMPIEZAN A VISUALIZAR PEQUEÑAS INDICACIONES CIRCUNFERENCIALES QUE SE CLARIFICAN A LAS 2 HORAS DE REVELADO.

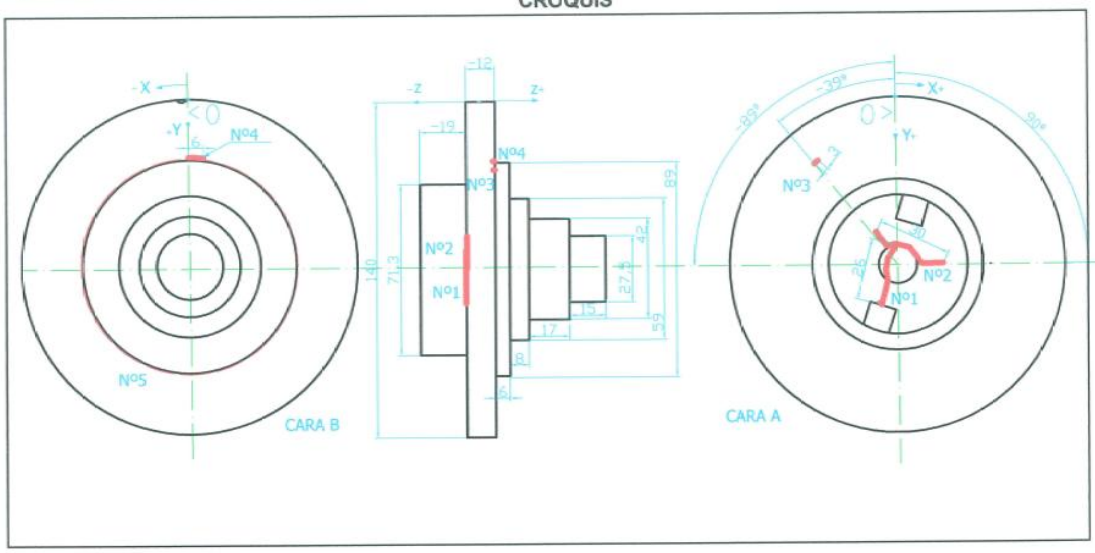
Realizado:	Validado:
NIVEL 3 Nº: A-A-0001492-PT-3-MS-O NOMBRE: AGUSTÍN MARÍN RUIZ FECHA: 27/03/07 FIRMA:	NIVEL 3 Nº: A-A-2931-PT-3-MS-O NOMBRE: Juan Manuel Velasco Carballo Nº EXAMINADOR Ex.093 FECHA: 28-03-07 FIRMA:

CERTIAEND	HOJA DE DATOS DE PROBETA DE EXAMEN	HDPE - PT_____ FECHA _____ REV _____ HOJA 2 DE 3

MÉTODO: **LÍQUIDOS PENETRANTES** SECTOR: M Nº PROBETA:

REGISTRO DE INDICACIONES

CROQUIS



Criterio de registro: SE REGISTRARÁN INDICACIONES ≥3mm (CLASE DE CALIDAD 2 SEGÚN NORMA)

Criterio de aceptación: SE RECHAZAN TODAS LAS INDICACIONES >8mm TANTO AISLADAS COMO AGRUPADAS.

Nº INDIC.	INTERPRETACIÓN	ACEPTACIÓN	LOCALIZACION			DIMENSIONADO		
			x	y	z	l	a	h
1	GRIETA LONGITUDINAL	NO	0°	60mm	-12mm	26mm	0,5mm	N/A
2	GRIETA LONGITUDINAL	NO	90°	55mm	-12mm	30mm	0,5mm	N/A
3	GRIETA LONGITUDINAL	SI	-39°	20mm	-12mm	3mm	0,5mm	N/A
4	GRIETA LONGITUDINAL	SI	0°	22mm	0mm	6mm	0,5mm	N/A
5	AGRUPACIÓN DE DEFECTOS CIRCUNFERENCIALES QUE APARECEN A LAS 2 HORAS DE REVELADO		0°	60mm	0mm	360°	N/A	N/A

INDICACIONES OBLIGATORIAS

Nº INDIC.	CRITERIO
1	NO ACEPTABLE DE MAYOR VOLUMEN. APARECEN CON POCO TIEMPO DE REVELADO
2	NO ACEPTABLE DE MAYOR VOLUMEN. APARECEN CON POCO TIEMPO DE REVELADO

Realizado:	Validado:
NIVEL 3 Nº: A-A-000/492-PT-3-MS-0 NOMBRE: AGUSTÍN MARÍN RUIZ FECHA: 27/03/07 FIRMA:	NIVEL 3 Nº: A-A-2931-PT-3-MS-0 NOMBRE: Juan Manuel Velasco Carballo Nº EXAMINADOR EX-093 FECHA: 28-03-07 FIRMA:

CERTIAEND	HOJA DE DATOS DE PROBETA DE EXAMEN	HDPE - PT_____. FECHA _____. REV _____. HOJA 3 DE 3

MÉTODO: **LÍQUIDOS PENETRANTES** SECTOR: M Nº PROBETA:

Realizado:	Validado:
NIVEL 3 Nº: A-A-000/492-PT-3-MS-0 NOMBRE: AGUSTÍN MARÍN RUIZ FECHA: 27/03/07 FIRMA:	NIVEL 3 Nº: A-A-2931-PT-3-MS-0 NOMBRE: Juan Manuel Velasco Carballo Nº EXAMINADOR: EX-093 FECHA: 28-03-07 FIRMA: