THIRD PART TECHNICAL SUPPORT EXPERIENCE ON THE QUALIFICATION OF THE INSPECTION SYSTEMS USED IN THE SPANISH NUCLEAR POWER PLANTS PROJECT DEVELOPED BY UNESA

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INTRODUCTION

In several occasions the "in situ" inspections of complex components and with high requirements, performed by means of NDT, have not achieved the proposed objectives.

Therefore it is necessary to verify all the elements that participate in the inspection, that is, procedures, equipments, and personnel so on.

Products quality, in manufacture as well as in service, is assured by the industry using NDT.

When a piece, an area or a component is inspected may arise reasons to think that the obtained results do not satisfy completely the quality level required for the inspected object. That may happen due to different reasons, among them:

-Type of material.
-A complex geometry.
-The type of discontinuities to be detected.
-The complexity of the testing system due to access problems, environmental conditions…

The validation of the NDT inspection systems, consists in the systematic evaluation using the necessary means to assure that the NDT method to be validate guarantees the results in actual inspection conditions, in other words: that the techniques, inspection procedures, equipments and personnel, that apply them, fulfil the requested requirements to assure that the inspection objectives are accomplished.

BACKGROUND

The validation concept aroused at the end of the 70´s, when the Organization for the Cooperation and the Economic Development (OECD) were promoting programmes, coming from the European and North American countries, that develop nuclear energy, as the "Programme for the Inspection of Steel Components" (PISC), that consists in the performance of practical exercises, using the ultrasonic method, on mock-ups containing typical defects in critical components of NPP.

During the 3 phases of the PISC programme, the inspection enterprises as well as the testing laboratories were solving the problems, under the coordination of the Joint Research Centre (JRC) of the European Commission.

The PISC I and II phases were performed according to the ASME code and *addendas* before 1986, meanwhile for the PISC III was used the Section XI of 1986, with the aim of ascertain the confidence degree in the NDT techniques used in the in the in-service inspections of the NPP (ISI).

As a consequence of this programme, two initiatives were implemented to validate the inspection techniques used till then: one in the USA and the other one in Europe.

VALIDATION IN THE USA

Following the results of the PISC programme, the ASME code includes in its 89 Edition of the Section XI, the appendix VII and VIII in which foresee a practical demonstration of the ultrasonic techniques with the aim of validating them; as a consequence the NPP joint to set up, in the same year, the “Performance Demonstration Initiative” (PDI) that will be managed by the EPRI NDE Center. The appendix VIII of the Section XI requires, among others, blind exams to validate simultaneously the procedure, the equipments and the personnel. These blind exams consist in a practical demonstration on mock ups of some components manufactured at actual scale, containing a number of defects based on the acceptance sizes included in the tables in Section XI and whose location and dimensions only are known by the PDI.

Discussions arise between the American nuclear industry and the nuclear regulatory bodies, during the programme development, due to the following questions:

-The possibility allowed by the appendix VIII of using in the mock ups artificial reflectors instead of actual defects, without justifying their similarity from the point of view of the NDT techniques.
-The actual defects included do not represent the more difficult defects to be located and sized.

Finally the Nuclear Regulatory Commission (NRC) inserts in 1999, in the Section XI of ASME code, a “Code of Federal Regulations” that includes these and other requirements. The PDI was including them in the mock ups as well as in the validation process and therefore several inspection enterprises were forced to repeat their validation processes to cover the new requirements and then been able to go on with the inspection tasks in the NPP.

VALIDATION IN EUROPE

At the beginning of the 90´s the European Commission (JRC), establishes a forum to study the results of the European Network for the Inspection Qualification (ENIQ) that put together inspection enterprises, R+D laboratories, universities, that in this time participate in the verification of the PISC results, together with European electric enterprises, in a new forum whose objective is to reach a consensus over a validation strategy and to develop an European methodology.

At the same time, the Regulatory Bodies of 10 European countries set up the Nuclear Regulators Working Group (NRWG-TF-NDTQ) following this initiative. This NRWG is a working group with the aim to present a common view on validation essential aspects and to establish the philosophy and basic principles of the validation.

The first version of the European Methodology to validate the NDT is issued in 1995 and is reviewed in 1997, including a group of “Recommended Practices” describing the technical aspects of the methodology.

The NRWG publishes in 1996 the document “Common Position of European Regulators on Qualification of NDT systems for Pre- and In-service Inspection of light water Reactor Components” that was also reviewed in 1997.

Both documents have many coincidence points on the validation requirements, since they came from the PISC programme results.

The European Methodology of Validation in based upon the use of Technical Justifications and Practical Demonstrations (open or blind) on mock ups that represent the areas to be validated.

The Technical Justification is the document that is used for analysing the essential variables (these have a fixed class of values, beyond them, the result may be very different), as for example:

-The components characteristics (material composition and structure, geometry, welds and so on).
-The defects (type, location, orientation, morphology, and so on).
-The techniques of the NDT methods (probes, NDT equipments, cables, and so on).

In the Technical Justifications are shown the evidences that fulfil that the inspection procedure will meet the required detection and sizing objectives, to assure previously that the procedure has the defined abilities.

To verify these essential variables as well as their rank are used the results of physical-mathematic analysis of the proposed techniques, parametric studies of the variables, simulation models for computer, laboratory inspections over a limited number of mock ups with defects that allow to generalize the practical results, and so on, to perform detailed study of the inspection procedure to supply the evidences of its capability.

The practical demonstrations are performed on mock ups that represent the component in which the inspection validation in carried out.

The mock ups have a sufficient number of defects and have into account those that have a bigger difficulty to be detected and sized.

In the inspection on mock ups is mandatory to detect and size the 100% of the defects with the higher detection difficulty, and so will be assured the detection and sizing of all defects.

To verify the procedure an open practical demonstration is carried out, in a way that does not exist operator influence, since he knows the location and sizing of the defects in the mock up, including the more unfavourable cases, therefore he must follow, word for word, the procedure instructions without any type of interpretations.

Once validated the procedure, it is validated the inspection personnel; to do so it is used the blind mock up where is unknown the defects population and therefore the knowledge and capability of the operators and analysis of the procedure data are checked.

Doing so we can distinguish whether is the procedure or is the inspection personnel capabilities that have to be extended by means of additional training in case of not exceed the validation.

VALIDATION IN SPAIN

Since the beginning of the 90´s appears in Spain initiatives from the Spanish NPP to implement a validation methodology that takes into account the experiences in the USA and in Europe. UNESA (Spanish Association of the Electrical Industry) develops, between 1997 and 1999, the Validation Methodology of the NDT Systems used in the In-Service Inspections (ISI) of the Spanish NPP.

This methodology is based in the principles fixed by ENIQ, but taking into account the Section XI of the ASME Code that is the reference standard for the ISI in Spain. UNESA and the CSN (Spanish Nuclear Regulatory Body) start in 2000 the project VENDE, to validate the proposed methodology, that is issued in 2003 as a document UNESA CEX-120, rev. 2, and in 2004 the CSN approved it and, therefore, all the inspection procedures systems used in the areas and components included in the methodology scope have to be validated.

The UNESA CEX-120 methodology is composed by the base document and seven technical documents that are the guidelines to value every one of the validation steps. In these documents are established the philosophy, principles and requirements that are demanded to the ISI systems of the Spanish NPP components, with the consensus of the CSN and the NPP, following the ENIQ and NRWG premises.

The UNESA CEX-120 methodology establishes the technical and administrative scopes as well as the responsibilities related with the preparation, carrying out and certification of the ISI systems validation.

The organizations involved in the validation process are: the NPP, the CSN and the ISI enterprises.

The figure 1 shows the organization scheme of the validation methodology.

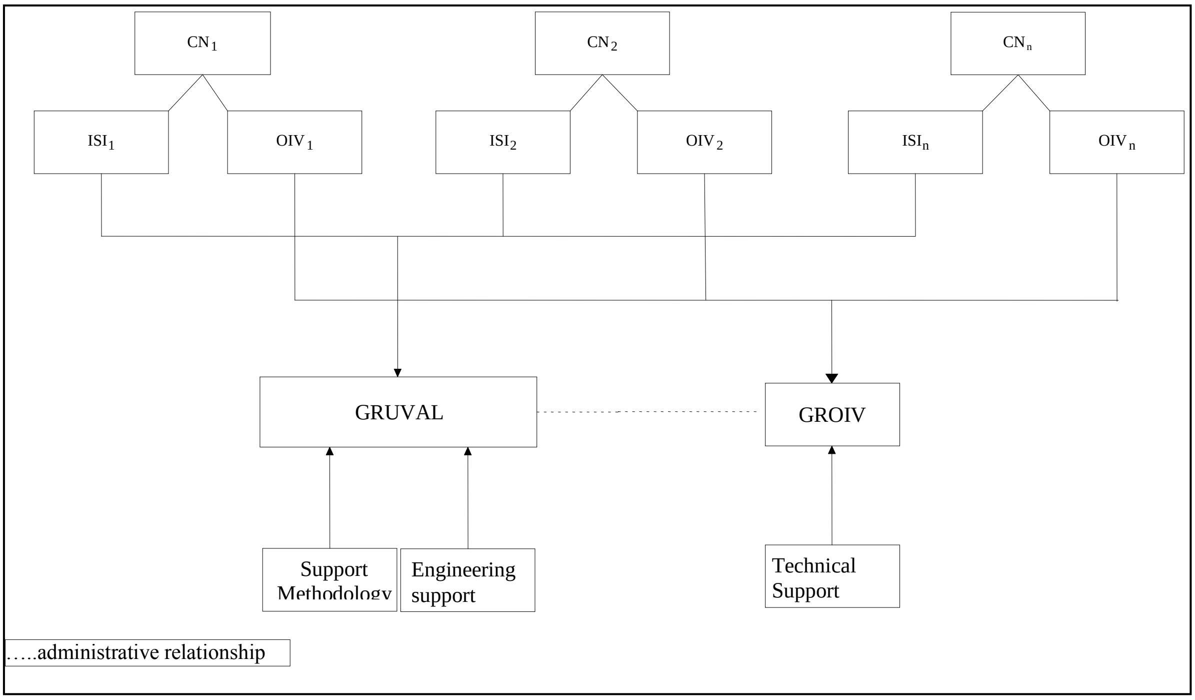

Figure 1 the organization scheme of the validation methodology

Every nuclear power plant has the responsibility on the validation of the inspection systems used in its in-service inspection programmes, although the validation methodology UNESA CEX-120 allows the grouping of areas of different plants, similar components with similar solutions, with the aim of optimizing the technical and economical resources. This question is made through the GRUVAL (Validation Group END-ISI).

On the other hand every NPP has an OIV (Independent Organization of Validation) meeting the independence criteria of the European Standard EN 45004 (General criteria for the performance of the different types of organisms that carried out inspections); the methodology allows the joint work inside the GROIV (Group of Validation Independent Organizations).

VALIDATION PROCESS UNESA CEX -120

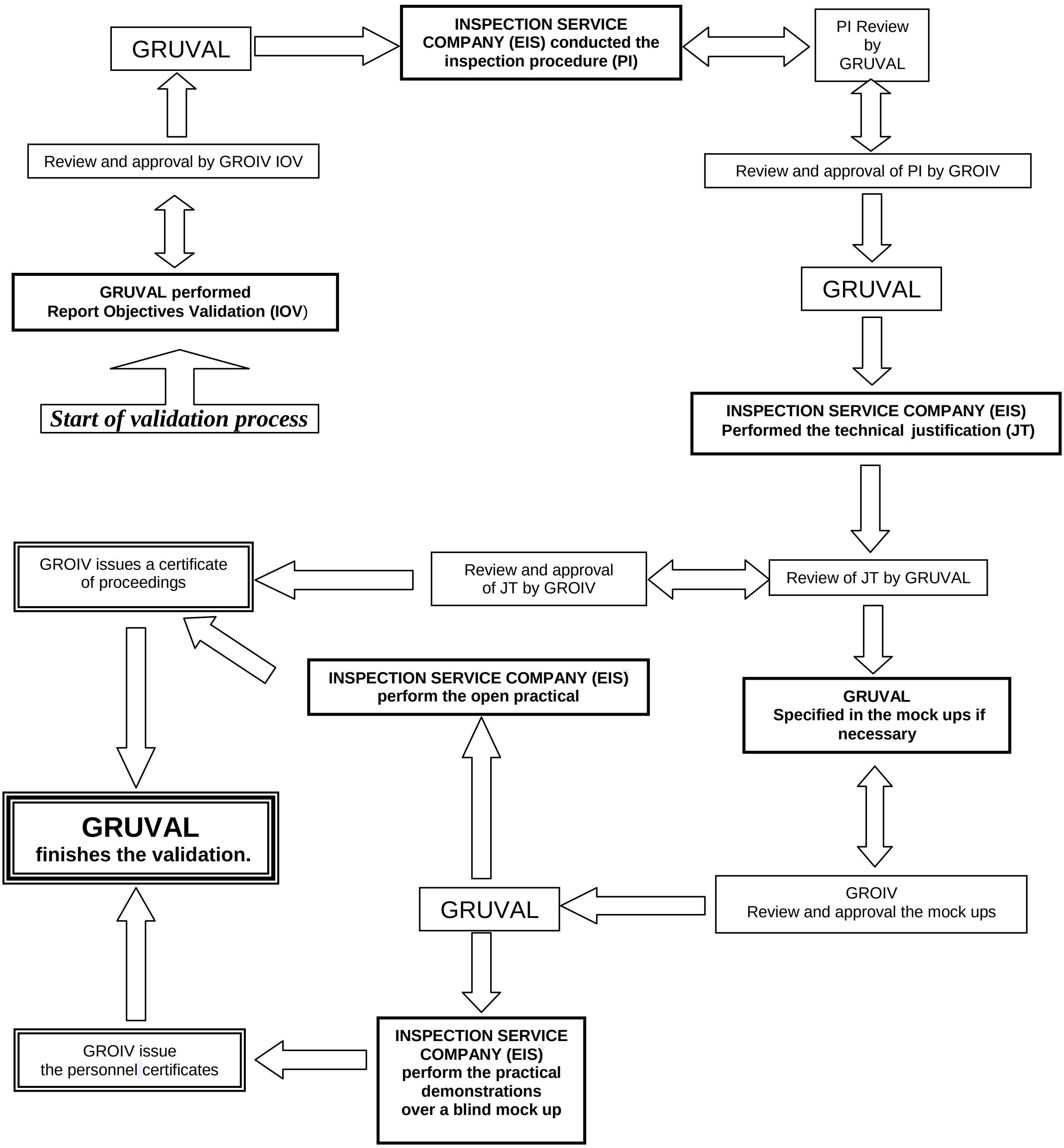

Figure 2 the validation process

The GRUVAL is responsible of defining the validation specifications in a Validation Objectives report in which are defined:

-The inspection method of the area and the component information (as–built drawings, manufacture and welding processes, materials, and so on).

-The ISI requirements about the detection probability, false calls, errors in the defects sizing, that is, defining the essential variables corresponding to the component and to the defined defect.

The EIS (ISI enterprise) is responsible of carrying out the validation documentation requested by the NPP that is:

-To draw up the inspection procedures before its validation.
-To draw up the technical justifications that shows the abilities of these procedures.
-To perform the practical demonstrations of the inspection systems according with the methodology.

The GROIV has the responsibility of verifying:

-The fulfilment of the fixed objectives and, in the case that any of the established objectives cannot be fulfilled, to draw up the justifications of the deviations.
-That the inspection procedures have been drawn according with the methodology.
-That the technical justifications show enough evidences and analyse all the essential variables.
-The data included in the justifications for the design of the practical demonstrations of the mock ups and to be present in these demonstrations, writing a report on their results.
-The final report.
-That the validation certificate is issued.

The personnel that carry out these verifications should be familiar with the inspection methods and with the ISI procedures, to do so exist a Technical Support with the technical capability and the necessary experience to analyse and verify according the UNESA CEX-120 methodology all the works made by the GROIV.

Figure 2 shows the validation process.

The validation process of in-service inspection of an area or component begins with the Validation Objectives Report (IOV) issued by the NPP based on the technical document 1 of the UNESA CEX-120 methodology, in which all the essential variables are taken into account:

-Of the component (geometry, surface condition, materials, physical and environmental access limitations).
-Of the defect (type, origin**,** orientation, length, depth, location shape factor, and so on).
-Of the inspection validation objectives (detection, probability, false calls, measurement errors, and so on).

The GROIV issues a verification document of the IOV, doing the appropriate comments (that require answer of the GRUVAL since can be methodology non compliances) or observations (they are taken into account by the GRUVAL and they do not need to be answered since they are mistakes or improvement proposals), the document goes in a reviewing process until the IOV fulfil the methodology.

Once approved, this IOV is the starting point for the inspection enterprise to prepare the inspection document for that area, according with the technical documents 1 and 2 of the methodology, it is approved by the GRUVAL and then verified by the GROIV, who issues another document giving the OK or pointing out the comments and the appropriate observations, starting a process of document review. The inspection enterprise writes the technical justification of the procedure essential variables, according with the methodology technical document 3, where are justified the essential variables of the NDT system as:

-The inspection technique (access limitations, coupling, record and storage modes, recording sensibility, length between pass, distance between acquisition points, acquisition grid, and so on).

-The parameters of the ultrasonic or eddy currents inspection equipment (of the emitter, of the receptor, of the digital card, and so on), mechanical equipments and cables.

This document is also reviewed by the GRUVAL and verified by the GROIV that issues, again, a document with the corresponding comments and observations till obtaining the OK.

In the case that the area or component needs a practical demonstration according with the methodology, the NPP (GRUVAL) will specify the needed mock ups, as is said in the technical document 4 of the methodology and the GROIV will verify that fulfils the methodology, issuing a document.

The inspection enterprise will perform the practical demonstration on the mock up, following the technical document 5 of the methodology.

First will perform an open practical demonstration, in which the inspection and the evaluation personnel, know the location and the size of the defects, and therefore apply the detection, sizing and evaluation procedures, without doing any interpretation, and so the GROIV verify the application and the results, writing a report with the evaluation of the procedure.

Once got from the GROIV the certification of the procedure, the ability of the inspection and evaluation personnel is validated over a blind mock up, where only the GROIV knows the location and sizing of the existing defects, with the aim of verifying the inspection personnel capabilities. If the practical demonstration fails with the two mentioned phases it can be established whether the problem is the procedure or is in the personnel.

The GROIV issues a final report according with the technical document 6 of the methodology, with the inspection results and, if it is satisfactory, it issues a personnel certificate and the GRUVAL finishes the validation.

THIRD PART TECHNICAL ADVISORY

As it was seen in this paper, there are different organizations participating in the validation process.

To be sure that the evaluation of every one of the phases to be impartial and independent of any predominant interest, the participation of an independent organization seems necessary, this organization offers the needed technical support to analyse the different documents and processes that take part in the validation and have been described in this paper.

The Spanish Association for NDT (AEND) is a partner in the present validation project, giving technical support to the GROIV, adding to the complete process the following advantages:

-Provides professional competence with technical knowledge and the necessary experience to perform the technical support tasks.

-Gives independence and confidentiality since it is not a supplier of direct services to the NPP and therefore has not any external influence to take decisions that could affect in the validation process.

-Does not worry to the inspection enterprise since it knows that its “know how” will not be used to be a competitor as the AEND is not a services enterprise with the same business framework.

To perform the entrusted tasks the AEND has the needed structure and organization, ruled by the integrity, impartiality and independence principles with the same it carries out its activities, among them the NDT personnel certification through the certification body CERTIAEND.

The process to verify each one of the documents consists in their analysis and evaluation, by experts from the Technical Committee, and afterwards be verified by a Revision Committee before sending the report to the GROIV. Important tools in the whole process are the evaluation questionnaires for each one of the different documents (Validation Objectives Reports, Inspection Procedures, Technical Justifications, and so on) where the aspects required by the methodology are gathered as well as the applicable code and standards.

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UNESA CEX – 120.3 rev. 1	Guide for the writing of the Final Validation Report (Technical Document 3).
UNESA CEX – 120.4 rev. 1	Guide for the specifications of the validation Process Mock Ups (Technical Document 4).
UNESA CEX – 120.5 rev. 1	Guide for the preparation and carrying out of Practical Demonstration (Technical Document 5).
UNESA CEX – 120.6 rev. 1	Guide for the writing of the Final Validation Report (Technical Document 6).
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