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NDT PEFORMANCE DEMONSTRATION IN SPAIN

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1. INTRODUCTION

The progressive increase in the reliability of the inspection techniques applied in the nuclear industry - especially the ultrasonic techniques used for components such as the reactor pressure vessel - along with greater insight into the mechanical and metallurgical properties of materials and the stress analysis capability provided by powerful, computer-based calculation tools, have allowed nuclear power plant component design to become increasingly accurate. The more critical components, from the point of view of safety, are periodically inspected throughout plant lifetime, this requiring the use of NDE techniques ensuring levels of reliability in keeping with the applicable Design Bases and with the type of defects postulated. One of the characteristics of materials inspection techniques based on Non-Destructive Examination (NDE) is the possibility of establishing such degrees of reliability, in order to determine their suitability and correct application.

Various programs have been undertaken at international level to verify the degree of confidence offered by inspection techniques, dedicated especially to ultrasonic inspection techniques applicable to the different areas of the reactor pressure vessel (such as, for example, PISC), and the results obtained have been reflected in the standards applicable to inspection of this component (US-NRC Regulatory Guide 1.150-83, ASME Code, Section XI, etc.).

An Appendix VIII has recently been added to Section XI of the ASME Code, which establishes the requirements applicable to the in-service inspection of nuclear power plant components, establishing the validation requirements applicable to the ultrasonic inspection systems used. This Section of the ASME Code is applicable to Spanish nuclear power plants, as is reflected in their operating licenses.

2. PROJECT OBJECTIVES

Development of an Inspection System Validation Program having the following objectives:

1. To make available a facility, or facilities, capable of housing the personnel, mock-ups

and equipment and the administrative infrastructure required for the control of recorded examinations and the associated quality assurance.

2. To make available realistic flawed mock-ups and sample sets, in accordance at least with the recommendations included in Appendix VIII of Section XI.

3. To develop methodological procedures for the validation of inspection techniques, equipment and personnel; administrative management procedures and Quality Assurance Procedures.

4. To validate the applicable in-service inspection techniques, in accordance with the areas described in Appendix VIII of Section XI.

5. To create the Spanish Center for the Validation of NDE Techniques, defining the corresponding administrative and operating organization through agreements with the interested parties.

3. PROJECT CONTENTS

The main project activities may be grouped as follows:

3.1 Mock-up Definition and Manufacturing

One of the fundamental activities of the project is development of the technical specifications for the mock-ups, defining in detail the number, size and dimensions of the sample sets and the type, size and location of the defects.

The mock-ups foreseen are as follows:

a) One PWR mock-up containing 1 KWU type nozzle and 1 Westinghouse type nozzle, with circumferential and longitudinal welds in the shell course.

b) One BWR vessel mock-up containing 1 x 10" nozzle with safe-end, 1 x 20" nozzle, also with safe-end, 1 FW nozzle and circumferential and longitudinal welds in the shell course region.

c) One mock-up of a Westinghouse reactor type stainless steel primary pipe with 4 welds.

d) One mock-up of a KWU reactor type primary pipe -carbon steel with stainless steel inner cladding- with 4 welds and one 90° elbow.

e) One mock-up of a BWR recirculation line with 4 welds.

These mock-ups will be defined depending on the specific materials, geometries and welding procedures of the different plants, although they will at the same time allow the largest number possible of areas/welds subject to testing to be represented in the most economical way possible. The mock-ups will include a given number of service defects typical of each area, the recommendations of ASME Code, Section XI, Appendix VIII being used as a reference for each specific area.

In the specific case of the nozzle mock-ups, in which the three following areas considered by the Code are included:

a)	Base metal-clad interface:	Supplement 4 of App. VIII
b)	Inner Radius Section:	Supplement 5 of App. VIII
c)	Nozzle-pressure vessel weld:	Supplement 7 of App. VIII

at least the number and types of defects referenced in each of the respective Supplements will be included, as described below:

a) Supplement 4: At least 50% of the defects must be cracks, the rest being manufacturing defects such as: inclusions, loss of fusion, etc., which may be represented by machined notches.

b) Supplement 5: At least three additional defects will be included in the inner radius area, these being cracks or notches.

c) Supplement 7: (This supplement will be previously defined by Supplement 6: Pressure Vessel Welds: at least 50% of the defects will be cracks, the rest being manufacturing defects such as inclusions, loss of fusion, etc., which may be represented by machined notches). At least three additional defects will be included, which may be cracks or notches.

Basic references are made in the Supplements to the position of the defects, their orientation, dimensions, depth-length ratio, etc.

Following definition of the mock-up manufacturing specifications, the manufacturing process will be initiated by the company Equipos Nucleares (ENSA), this including preparation of the initial working documentation, the procurement of base materials, machining, the preparation of weld edges, manufacturing of defects, defect NDE, defect inplantation and subsequent NDE of flawed areas of the cladding interface, and finally the necessary heat treatment.

On completion of the mock-up manufacturing process, the manufacturing NDE will be carried out and the mock-ups will then be documented and results obtained. This will constitute the reference documentation for the mock-ups.

3.2 Development of the validation methodology

The validation methodology will be developed by way of a series of procedures, drawn up so as to address both the administrative aspects - those relating to Quality Assurance, which would cover the auditing, data recording, etc, required for correct performance of the validation process - and the technical aspects - specifying how the inspection system and procedure to be validated has to be documented in its essential variables and the detection and dimensioning techniques suitable for each defect configuration and type, the characteristics of the inspection equipment, the requirements relating to personnel certification and the contents of the specific personnel training programs.

3.3 Validation of Inspection Systems and Procedures

In the first instance, Tecnatom will perform the validation of the in-service inspection techniques for the components in question, which will in principle be those included in the current procedures. Validation will consist of demonstrating the reliability of the detection and dimensioning of existing defects using each inspection technique and system.

With a view to optimizing the results, the use of other detection and dimensioning techniques will be addressed and, where applicable, the current inspection techniques will be modified, with comparative studies being carried out during the different validations.

For validation of the inspection techniques, the mock-ups will be subjected to the corresponding "blind" manual or automated inspections, as applicable to each area, with at least the acceptance/rejection criteria included in Appendix VIII of Section XI of the ASME Code being applied. The remaining personnel involved in the manual and automated inspection of these components will then be validated, in which respect the corresponding "blind" manual and automated inspections of the mock-ups will be performed and validated, once again on the basis of at least the acceptance/rejection criteria included in Appendix VIII of Section XI of the ASME Code.

3.4 Fixed Project facilities

As part of the project it is foreseen that fixed facilities will be made available in industrial installations for storage of the mock-ups and performance of inspection technique validation tasks. There will also be an office area for performance of the technical and administrative tasks relating to qualification, evaluation, recording, Quality Assurance, reporting and filing of the documentation generated during the inspection technique validation process.

4. BUDGET AND PERFORMANCE SCHEDULE

The current budgeting forecasts for performance of the project amount to 10 million dollars. The cost of manufacturing the mock-ups is estimated to be some 5.5 million dollars. The project performance period is 4 years, the preliminary tasks having been initiated at the beginning of 1993.

5. VALIDATION CENTRE

The aim of the Validation Centre of NDE Techniques which will result from culmination of this project will be to allow ultrasonic inspection techniques to be systematically validated using mock-ups, taking into account the characteristics of the materials, associated geometries and defects representative of those found in service, with the general objective of demonstrating the reliability of ultrasonic inspection techniques, and the specific objective of meeting the requirements of the regulations in force in those cases in which application of Section XI of the ASME Code is required. As new validation requirements are added to Section XI regarding other components inspection or NDE Techniques, will be covered within this Center.

6. RELATIONS WITH OTHER SIMILAR PROJECTS

6.1 PDI Project

Following publication of the initial drafts of Appendix VIII, which established the obligation that nuclear power plant operators have available an inspection technology allowing in-service inspections to be carried out to a high degree of reliability, the American Utilities took the first steps towards constituting what would later be known as the PDI (Performance Demonstration Initiative). The Administrator of the PDI is EPRI (NDE Center, Charlotte), which has provided technical support for all the work performed within the framework of this project. The PDI includes a Steering Committee (S.C.) on which all the American Utilities are represented.

Different European organizations are currently participating in the meetings of the S.C. as "Observers". In 1990, Tecnatom requested authorization to participate as such an "Observer", and now attends the meetings of the Working Groups and the S.C. The PDI is currently defining a framework for participation by overseas organizations in the Project.

6.2 European Initiatives

One of the steps taken by the Management of the PISC-III program of the Commission of the European Communities has been to propose that an organization be set up at European level to continue work relating to the determination of inspection technique reliability and to bringing into harmony the different inspection technique validation procedures, taking into account the tasks previously carried out in relation to the Codes and Standards applicable to In-Service Inspection.

In this respect, a series of meetings were held during the last quarter of 1992 by organizations involved in validation processes: European Utilities, inspection agencies, national laboratories, etc., as a result of which the "European Network of Inspection Qualification " (ENIQ) and corresponding Steering Committee (S.C.) were constituted. Spain is represented on this S.C. by Tecnatom and the Spanish Utilities. ENIQ will define a series of Activities to be carried out by the participating organizations and by those others considered appropriate for development, and financing formulae will be sought from the Commission of the European Communities and from the participating organizations themselves.

Parallel to these programs, certain European nations, such as the United Kingdom and Germany, have set up their own organizations for the validation of inspection techniques applied to nuclear reactor pressure vessels.

7. CONCLUSIONS

In view of what has been described above, it is foreseen that application of Appendix VIII of Section XI of the ASME Code will have direct repercussions in Spain, since the operating licenses of Spanish Nuclear Power Plants reference the American standard as being applicable in the area of In-Service Inspection.

In this context, it is important that the tasks developed within the framework of the Spanish project be related to the work and conclusions of the both the US PDI project and the European ENIQ initiative. One of the proposals made within ENIQ calls for greater harmony between validation methodologies and the possibility of setting up a European network of validation centres.

In addition to the above, and in view of developments within the PDI in the United States and ENIQ in Europe, various organizations are calling for this process of convergence of validation processes to be performed at international level. In the short to medium term it is quite probable that these programs will carry out such convergence tasks jointly (initial contacts have already been made), since several European countries have to adhere to codes identical or similar to ASME for in-service inspection, as a result both of their operating licenses and of the high levels of safety that have to be maintained with regard to these nuclear components.