Regulations and Equipment Qualification Programme for Increased Operating Safety at Ignalina NPP

Aleksander Alejev

State Nuclear Power Safety Inspectorate (VATESI) - Lithuania

Michel Chouha

Institut de Radioprotection et de Sûreté Nucléaire (IRSN) - France

Robin Shipp

Firecrest Consulting Ltd - UK

George A. Georgiou

Jacobi Consulting Ltd - UK

Abstract: In 1996 Ignalina NPP issued the Safety Analysis Report (SAR) for its unit 1. Task 6 of this report was dedicated to the Equipment qualification. An independent group of International experts performed an In-Depth Safety Review of the SAR. One major conclusion of the SAR/RSR assessment was that there was no formal EQ programme at Ignalina NPP and the respective recommendation of the SAR /RSR was to develop and implement an EQ programme for equipment important to safety. The first step of this development work is the preparation of VATESI requirements for qualification of systems important to safety of Nuclear Power Plant. Since 1999, in co-operation with SIP, VATESI started collecting the available information about experience in EQ, in parallel with their efforts in familiarisation with relevant IAEA Codes on the Safety of NPP, international standards (or national regulations of other countries), codes and guides of countries having advanced approaches such as Germany, the UK, France and other EU countries. As result, in 2000 VATESI had already prepared a draft of the document "General regulations for qualification of system important to safety of a Nuclear Power Plant".

From November 2000 to October 2001, a PHARE-funded project, entitled "Support to the Lithuanian Nuclear Power Safety Inspectorate VATESI and its Technical Support Organisations (TSOs)" was performed. The Task 3 of this project was dedicated to the assistance to VATESI and its TSOs in the development of national regulatory guidelines for the Equipment qualification and the implementation of the ENIQ (European Network for Inspection Qualification) methodology in Lithuania

This paper describes the work performed on the Equipment Qualification and the implementation of the ENIQ methodology within the framework of the PHARE Project mentioned above. The paper presents also the main results of the project regarding these issues, the current progress at INPP in this area, the main recommendations and the future planned actions for the implementation of the EQ Programme and the ENIQ methodology in Lithuania.

Introduction

Lithuania is a small country, with a population of some 3.7 million, but it is home to two of the largest civil nuclear power reactors in the world – the RMBK-1500 units at Ignalina nuclear power plant (INPP). The Ignalina NPP was built at the time when Lithuania was part of the Union of Soviet Socialist Republics. One of the challenges that the country had to face in its 10 years of independence has been to set up a State Nuclear Power Safety Inspectorate (VATESI) to oversee the safety of this plant.

Ignalina NPP is the only Nuclear Power Plant of Lithuania, operating two RBMK-1500 type nuclear reactors. The first unit was commissioned in 1983 and the second unit in 1987. In 1999 VATESI issued the licence for the operation of Unit 1 following the conditions of the NSA Grant agreement with EBRD. VATESI supervises the fulfilment of the licence conditions and will review the Safety Assessment Report of Unit 2. The Licence for the operation of Unit 2 is expected to be issued by the end of 2003.

VATESI as the national regulatory authority is responsible for the establishment and implementation of state nuclear power safety regulatory policy and supervision of safety relevant activities at the Ignalina NPP.

With the objective of entry into the European Union Lithuania is actively seeking harmonisation with European standards in a wide number of areas. In the nuclear power field, One of the points that VATESI is considering actively relates to the implementation at INPP of an adequate programme for the Equipment Qualification including the implementation of the European Network for Inspection Qualification (ENIQ) methodology [(1)].

A PHARE project, LI9806-01, entitled “Support to Lithuanian Power Safety Inspectorate and its Technical Support Organisations” was performed between November 2000 and October 2001. The project included six different tasks among them the Task 3 “Qualification of Equipment Important for Safety of INPP” and Task 6 “Development of National Guidance for NDE Techniques Performance Demonstration and Inspection Qualification”.

This paper describes the main features of the work performed within these two tasks, their results and conclusions. The paper summarises the current situation regarding inspection qualification in Lithuania and presents the recommendations for further continued development in this area.

1. QUALIFICATION OF EQUIPMENT IMPORTANT FOR SAFETY OF INPP

1.1 Training of VATESI Staff/TSO Experts in the Application of EQ at NPPs

The objective of this task was to identify the fundamental purpose of EQ, the Regulatory Basis of the EQ process, the Responsibilities, the Programme Scope and the Procedural Controls that make up an EQ Program. To carry out the above mentioned objectives, the current situation in Lithuania with regard to the EQ process has been reviewed in comparison with the approach and practice in force in France.

A first workshop took place in Vilnius dedicated to the “Application of EQ at NPPs”. During this workshop, EU experts presented to the Lithuanian Safety Authority and its TSO the EQ approach as applied in France, including general rules for equipment qualification and organisation. In preparation to this workshop, EU experts had transmitted to VATESI a questionnaire on the Draft 9 of the Lithuanian regulatory EQ document.

Following the workshop, in light of all the discussions and technical information exchanged on EQ, VATESI and its TSO (ITECHA) carried out a new version of the

Draft 9 of the regulatory document on EQ. This new document was transmitted, before the second workshop, to the EU experts for comments.

1.2 Development of National (VATESI) Guidelines for EQ at Ignalina NPP

The second workshop took place in Fontenay-aux-Roses (France). During this workshop, the Lithuanian experts and the EU experts focused mainly on the responses to the questionnaire on the Draft 9 of the document on EQ in order to provide the sound comments for the revision of the above mentioned document.

A clear consensus between the EU experts and the Lithuanian experts was perceived regarding the different issues that were discussed during the workshop, especially about the general approach to follow in establishing the EQ process at Ignalina NPP.

Based on the final discussions of the workshop, the EU experts formulated their recommendations presented hereafter:

- classify all the equipment involved in accident analysis,
- qualify all the safety related components:
  - Electrical components, and
  - Non-static mechanical components.

The EU experts stressed the point that an equipment non-qualified for accident conditions can not be credited within the accident transient scenario. They emphasised that it is the responsibility of the plant operator to define safety requirements for each safety class, and to submit these requirements to the Regulator for approval.

The EU experts insisted on the necessity for the plant operator to:

- qualify not only equipment submitted to harsh conditions but also equipment submitted to mild conditions. Moreover, ageing effects (temperature, humidity for example) have to be taken into account for qualification demonstration for equipment submitted to harsh environment as well as for equipment submitted to mild environment.
- demonstrate the seismic resistance of the equipment on the basis of the local seismic characteristics and data.

Generally, the equipment qualification must be demonstrated with regard to the expected lifetime of the NPP. In the French EQ process for PWRs, the qualification demonstration covers the expected lifetime of 40 years; i.e., the qualified equipment (electrical components as well as mechanical ones) are demonstrated to perform their safety functions in case an accident (DBA) occurs after 40 years of plant operation.

The EU experts insisted on the necessity that the demonstration should not base the qualification process only on calculations, analogy approach and/or operating experience feedback. They stressed the fact that the test programme is an essential part of the EQ process. They also emphasized the importance for the qualification assessment to include the EQ theme in the inspection programme of VATESI.

On the basis of the results VATESI agreed to prepare their document "Regulations on EQ", and communicate it to the EU experts for their information, in the perspective of a further continuation of the work that has been started and performed in the framework of the above mentioned project.

The next steps were agreed to consist in the definition and establishment of:

- Clear safety classification of the Equipment of Ignalina NPP,
- Safety requirements for each class of components,

• Specific Qualification programmes (profiles, specifications, schedules ...).

2. IMPLEMENTATION OF THE ENIQ METHODOLOGY IN LITHUANIA

As noted above, the only nuclear plant in Lithuania comprises the two RMBK-1500 units at INPP. Many of the inspections carried out there already reflect European practice, with equipment and procedures provided under European funding by western companies. INPP themselves now have a strong NDT capability, with around 20 of their own staff qualified to Level 2 in various methods, 10 of them in ultrasonics.

The Lithuanian State Nuclear Power Safety Inspectorate (VATESI), working in co-operation with the Ministry of Environment and the Ministry of Health, exercises the regulatory control of INPP.

INPP is unique among the RBMK type reactors in the scope and comprehensiveness of international studies that have been conducted to verify its design parameters and to analyse its level of risk. VATESI has been an integral part of the organisation of these studies.

VATESI is helped in its work by Technical Support Organisations (TSOs). the Kaunas University of Technology (KTU) Ultrasound Institute acts as TSO in the area of NDT, reviewing procedures and providing technical advice. In addition, KTU have produced a number of inspection devices for use at INPP.

Reviews of the NDT scene in Lithuania and of the NDT activity at INPP have been given in a recent issue of “Insight” [3,4].

2.1 Elements of the ENIQ methodology

It is not proposed to describe the ENIQ methodology in detail here. Full details are available in the ENIQ document [1] and in many conference papers [2]. The main principles are, however, briefly summarised here.

Qualification is defined as “the systematic assessment, by all those methods that are needed to provide reliable confirmation, of an NDT system to ensure that it is capable of achieving the required performance under real inspection conditions”. It can be considered as the sum of (a) practical assessment conducted on test pieces representing the component to be inspected and (b) a technical justification, which involves assembling all evidence on the effectiveness of the test, including previous experience, laboratory studies, mathematical modelling, physical reasoning, and so on. The qualification covers the NDT procedure, the equipment and the personnel.

A key feature in the ENIQ methodology is the need to define the input information which includes the qualification objectives, the description of the component and the defects of interest and, most importantly, the inspection performance (in terms of detection, sizing and location) which are to be achieved. The methodology defines the way in which the qualification is conducted, including the need to prepare a qualification procedure and to set up a qualification dossier containing all the information relevant to the qualification, in a form suitable for audit if required.

The methodology defines the responsibilities of the various parties involved, including the plant operator, the regulatory body and the vendor of inspection services. In particular, it requires the setting up of a qualification body which is responsible for managing the qualification, including preparing the qualification procedure, reviewing documents, invigilating practical trials, assessing results and, finally, issuing a qualification certificate if the qualification is successful.

2.2 Work performed within the project

In planning the work of this task, careful consideration was given to the need to obtain maximum benefit from what was relatively short duration project (January to August, 2001). The European experts were also mindful of the need to maximise the involvement of the local participants in order to build up experience and capability. Four workshops were held in Lithuania and the two Lithuanian co-authors visited the UK for meetings with organisations that have had experience of inspection qualification. All the participants of course did much additional work outside the formal workshops.

The project included a pilot study which was based on inspections currently carried out at INPP to detect inter-granular stress corrosion cracking (IGSCC) at the bore in the heat affected zone of welds of 325mm diameter austenitic pipework. This is a problem common to all RMBK reactors although it appears less serious at INPP, possibly because of the newer design and construction of these reactors.

The first workshop was held in January 2001 and comprised an introduction to the ENIQ methodology and an opportunity to plan the details of the rest of the project. It was accepted that it would not be possible to carry out a formal ENIQ qualification of the IGSCC inspection within the budget and time limits of the project. However, it was decided to undertake all of the elements of such a qualification in order to provide the maximum amount of experience. The key points from this exercise are discussed below.

2.2.1 Qualification procedure

A qualification procedure was produced and this identified R Šliteris, R Shipp and A Alejev as the qualification body. In a formal ENIQ qualification it would be necessary to have a quality system which demonstrated that the qualification body was acting independently from commercial or operational considerations. In this case, however, that requirement was relaxed with all participants being involved in all activities in order to gain the maximum experience.

2.2.2 Input information

The input information for this pilot study was developed based on ENIQ Recommended Practice 1 [(5)]. This document defines 'influential parameters' as those which could potentially influence the outcome of an inspection and 'essential parameters' as those which really do affect a particular inspection. The document divides the parameters into three groups:

- An input group, defined by the particular inspection problem. These would be the parameters that must be identified when an inspection problem is first presented.
- A procedure group, which includes those parameters chosen to ensure that the NDT to be used is matched to the component and defects to be sought. In the case of this pilot study, these had already been determined.
- An equipment group, defining the equipment to be used in the inspection. Again, these had already been determined for this pilot study.

The ENIQ document [(5)] includes an example checklist for an automated ultrasonic inspection and this was prepared as a table, which was filled in during a workshop session in which the relevance and effect of each parameter was discussed.

2.2.3 Technical justification

The first draft of a technical justification was produced by G Georgiou and was then developed by L Mažeika of KTU, although again all participants contributed. The use of a technical justification is highly recommended in the ENIQ methodology and it can be used to minimise or even avoid the need for expensive test pieces. It also allows credit to be taken for experimental results and experience from other qualifications.

In the technical justification the tables of influential parameters produced as 'input information' were discussed and the 'essential parameters' identified.

2.2.4 Inspection procedure

The procedure used at INPP for IGSCC inspection was developed by Westinghouse Atom TRC AB. It employs a motorised scanner controlled by an R/D Tech Tomsocan® system, with the data being analysed by R/D Tech Tomoview® software. A copy of the procedure was made available for review although, being confidential, details cannot be discussed outside this project. This review was carried out in a workshop session to ensure that all participants were able to contribute and to share in the conclusions.

2.2.5 Practical trial

The ENIQ methodology identifies two types of practical trial:

- An open trial, where the participants are aware of the defect content of the test piece. Such trials are commonly used to qualify the procedure and equipment;
- A blind trial, where defect content of the test pieces is kept secret from the participants. These trials are used to qualify individual operators and are usually necessary only where the result of an inspection depends critically on the skill of the operators.

Restrictions on time and budget in the pilot study meant that it was only possible to carry out an open trial, using an existing test piece containing a series of electro-discharge machined (EDM) notches. This trial was carried out at INPP during one of the workshops. The qualification body had prepared a checklist of items to be checked, based on the procedure, and had identified the criteria for success in the trial. INPP operators carried out the inspection on the test piece under the invigilation of the qualification body members and witnessed by all the other participants in the project. The equipment was set up and calibrated, and the data collected from the test piece. This data was then analysed to demonstrate the detection and sizing of the various EDM notches. Within the limits placed on it, it was agreed that the trial was successful.

2.2.6 Regulatory guidelines

One of the strengths of the ENIQ methodology lies in its flexibility, allowing it to be used in a wide variety of situations. The document states that "the methodology is intended to be flexible so that different countries can use it to develop qualifications which are consistent throughout Europe but which also meet their different national legal, regulatory and technical requirements". In most cases this will mean that regulatory bodies will want to develop agreed codes, standards or guidelines to identify how the ENIQ methodology is to be applied in a particular country or industrial sector.

For Lithuania, VATESI intend to produce regulatory guidelines for the application of the ENIQ methodology to inspections at INPP and one of the aims of this project was to build up experience to assist in the production of such guidelines. A report has been

produced giving recommendations for the guidelines and has identified areas where further work is needed.

2.3 Conclusions for ENIQ task

Although the existence of the ENIQ methodology was well known in Lithuania prior to the start of this project, there was no experience in applying it. It became clear however, from the first workshop held during this project, that there was already in existence a good basis for introducing the methodology:

- There was a strong nuclear regulator, VATESI, with good links with INPP;
- INPP was already using inspection techniques which reflected good European practice, and they had their own competent NDT staff;
- VATESI was supported by a TSO, KTU, with a good technical knowledge of NDT.

This project has built on that good foundation and carried out a pilot study which has provided the participants with practical experience in applying the ENIQ methodology.

The next step will be to produce the regulatory guidelines for applying the methodology to inspections at INPP and the experience gained during the project should ensure that these will be soundly based. After that, it should be possible to provide a formal ENIQ qualification of the IGSCC inspections and other critical inspections at INPP.

3. PROPOSAL FOR THE FOLLOW-UP PROJECT "SUPPORT TO VATESI FOR IMPORTANT TASKS RELEVANT TO THE LICENSING ACTIVITIES OF IGNALINA NUCLEAR POWER PLANT" (PHARE LT01.18.03)

This proposed project is intended to build on the experience obtained, with the broad aim of establishing the infrastructure to enable further improvement of the skills and knowledge of VATESI employees in the field of control of EQ and ENIQ requirements at Ignalina NPP.

Within the Safety Analysis Report for Unit-2 (SAR-2) of Ignalina NPP, VATESI will receive the set of documents in response to its requirements for EQ, issued in December 2001, based on the results of first year programme. VATESI will develop the database to collect and assess the information submitted by INPP regarding the EQ.

In line with the previous project, the proposal of the future project considers two separate tasks to deal with the Equipment Qualification and the Implementation of ENIQ Methodology.

- Task 1 Qualification of Equipment Important for Safety of Ignalina NPP

  Within this task the experts of VATESI and its TSOs shall be provided with the support of EU experts in performing their main mission: the regulatory review of the Equipment Qualification of Ignalina NPP according to the practices of EU countries. It shall include familiarisation with practices in Western countries and on-the-job training on codes and standards applicable for EQ at Ignalina NPP. Improved capabilities of Lithuanian TSO in the EQ area will enhance their ability to provide VATESI with expertise support in the safety assessment of Ignalina NPP.

- Task 2 Implementation of ENIQ methodology within Lithuania

  Within the implementation of the task, an NDT Qualification body shall be established; ENIQ documentation shall be completed and comprehensive trainings

shall be provided for the TSOs and the Ignalina NPP experts. The main aim of the task is to finalise the implementation of the ENIQ methodology within Lithuania.

3.1 Work Programme of the Proposed Project

Task 1 Qualification of equipment important for safety of Ignalina NPP

Within this task, a training course shall be organised for VATESI staff and its TSO experts to familiarise them with EU activities relevant to qualification of equipment important for the safety of nuclear facilities. The Contractor shall assist VATESI in:

- Identification of requirements (methodology)
- Documentation analysis: Review of drawings, calculations, test results, inspection protocols and other data
- Recommendations for improvements and conclusions.

The training for VATESI and TSOs' personnel in EQ analysis and assessment, supported by the provision of the adequate software and hardware shall be provided by the Contractor. VATESI will receive the set of documents in response to its requirements for EQ issued in December 2001, based on the results of first year programme. VATESI will develop the database to collect and assess information related to EQ, submitted by INPP. For this, VATESI will need relevant soft- and hardware. Technical specification shall be prepared with the assistance of the Contractor. The objective of the task is to improve expertise in performing EQ analysis and independent verification of Ignalina NPP results, and in evaluating the EQ program at Ignalina NPP related to safety. The training is aimed to improve and expand knowledge of processes that occur during EQ processes, prepared by Ignalina NPP. The training will also help in better understanding and evaluating the capabilities and resources needed for development of EQ analysis (for Ignalina NPP staff) and during review the EQ results (for VATESI).

Task 2 Implementation of ENIQ methodology within Lithuania

To finalise implementation of ENIQ methodology within Lithuania the Contractor shall provide assistance in performance of the following steps:

(i)Setting up the infrastructure for inspection qualification

This action will be based on the ENIQ guidelines and will focus on involving the three principal participating organisations in Lithuania: the Regulatory Authority VATESI, the local TSO (the Ultrasound Institute at Kaunas University of Technology (KTU)) and Ignalina Nuclear Power Plant (INPP) (only the relevant inspection staff and operators). One important aspect of the inspection qualification infrastructure is the Inspection Qualification Body (IQB), which will comprise selected members from the above organisations in a way that will not compromise the integrity of the inspection qualification so as to avoid any potential conflict of interests.

(ii)Updating and Developing Current NDT procedures

In any safety critical plant it is necessary to have quality systems in place that are used to review NDT procedures on a continuous basis. The relevant NDT procedures are for inspecting austenitic pipe welds and these will be critically reviewed with the objective of modifying, updating and developing them further. This is likely to include both editorial and technical issues where evidence and strong scientific argument are used to demonstrate that the procedures are inadequate in some way, particularly for the

detection, sizing and positioning of IGSCC. Where necessary other relevant NDT procedures associated with the inspection of IGSCC will also be updated.

(iii) Manufacture of Defect Specimens

Two defect specimens, relevant to the inspection of austenitic pipe welds, will be manufactured. The manufacture of each specimen will need to be of high quality to reflect the real welds at INPP and contain a sufficient number of different sized defects in different positions in the weld. The specimens will be used both in the development of the NDT procedures for austenitic pipe welds as well as the inspection qualification process.

(iv) Completion of all ENIQ Documentation for VATESI

This is perhaps the most important action of this task as it involves bringing together all the relevant parts of the project in the form of documentary procedures and guidelines to enable a full and early inspection qualification of austenitic pipe welds.

(v) Equipment procurement

Equipment procurement should be limited to procuring the TOMOVIEW software that accompanies the TOMOSCAN equipment and colour-printing device for inspecting austenitic pipe welds. VATESI will receive a set of documents in response to VATESI requirements for ISI. VATESI will develop the database to collect and assess information related to ISI, submitted by INPP. For this, VATESI need relevant soft- and hardware. Technical specification shall be prepared with the assistance of Contractor. This software is required by VATESI in order to view and analyse inspection data produced by Ignalina NPP, other than in hard format. It is crucial that Lithuanian authorities have the capability to process and analyse digital field data produced by Ignalina NPP and use of this software would give them a data analysis capability equivalent to that at Ignalina NPP. This would enhance the efficiency of the qualification process, particularly when preparing and writing Technical Justifications.

4. REFERENCES

1. "European Methodology for Qualification. Second Issue", ENIQ Report No. 2, EUR 17299 EN, 1997*.
2. C Waites, M J Whittle and R V Booler, "International experience in the application of the ENIQ Methodology", Proceedings of the BINDT annual conference, Buxton, 2000.
3. R Kažys, "A review of NDT activities in Lithuania", Insight, Vol 43, No 6, pp 369-371, June 2001.
4. Y Saburov, R Kažys and R Šliteris, "NDT activity in the Ignalina nuclear power plant", Insight, Vol 43, No 6, pp 372-375, June 2001.
5. "ENIQ Recommended Practice 1: Influential/Essential Parameters", ENIQ report No. 6, EUR 18101 EN, 1998*.
6. Final report „TA Support to the Lithuanian Nuclear Power Safety Inspectorate VATESI and its Technical Support Organisations (TSOs)" PHARE LI 9806-01-01-0001
7. Analysis of compliance of the draft of VATESI "General regulations for qualification of systems important to safety of a Nuclear Power Plant" with existing safety standards for qualification", ITECHA Report No. 9806.01-01
8. Terms of reference for project „Support to VATESI for important tasks relevant to the licensing activities of Ignalina Nuclear Power Plant", PHARE Project: LI 01.18.03

* ENIQ documents are available as PDF files on www.jrc.nl/eniq/publication.html