ABSTRACT

The European Network for Inspection and Qualification (ENIQ) was founded in 1993 as a network driven by European nuclear power companies and is since then supported by the European Commission's Joint Research Centre in Petten. It is active in the two areas of inspection qualification (ENIQ Task Group Qualification) and in risk-informed in-service inspection (ENIQ Task Group on Risk).

Today ENIQ has some 35 active member organisations from 14 European countries, with IAEA and EPRI as observers. The ENIQ methodology is a widely known and accepted method, which has been introduced in most of the participating countries and is also considered for introduction in several other states. The methodology aims mainly on the nuclear power industry, but can of course also be applied on other branches of industry

ENIQ has produced a number of documents on Risk-informed in-service inspection (RI-ISI), e.g. the “Framework Document on RI-ISI, which is providing guidelines to utilities for developing their approaches to RI-ISI and for adapting already established approaches to the European environment.

ENIQ has also produced a number of recommended practices, and continue to do so, in both its areas of activities. These recommended practices give more detailed guidance on specific issues of inspection qualification and RI-ISI, thus helping organisation with implementing the methodologies and principles in the two main documents.

The impact of ENIQ on in-service inspection continues to be an issue high on the agenda of the last conferences. With ageing plants, life-extensions and further opening of the electricity market it is as important as ever to maintain high safety and reliability of plants.

This paper will review some of the trends and recent developments that can be observed in Europe in relation to ENIQ.

It also outlines the concept for future activities in ENIQ.

OVERVIEW OF ENIQ AND PROGRESS

History

ENIQ was set up in 1992 as the importance of the issue of qualification of NDE inspection systems (procedures, equipment and personnel) used in ISI programmes for nuclear power plants was identified. Driven by European nuclear utilities and managed by the European Commission Joint Research Centre (JRC) in Petten, ENIQ was meant to be a network in which the available resources and expertise could be pooled at European level. The parties involved in ENIQ also recognized that harmonization in the field of codes and standards for inspection qualification would represent important advantages for all, with the ultimate goal of increasing the safety of European nuclear power plants. A significant milestone was reached with the publication of the first issue of the European Methodology for Qualification of non-destructive tests in 1995. The European Qualification Methodology Document (EQMD) contained guidelines for the qualification of non-destructive tests.
Qualification as defined in that document is a combination of technical justification, which involves assembling mainly the following supporting evidence for test capability:

- results of capability evaluation exercises
- feedback from site experience
- applicable and validated theoretical models
- physical reasoning
  and test piece trials using deliberately defective test pieces.

This document was the first to be published in Europe on this issue and contained a number of innovative proposals such as the use of technical justification, the separation between procedure/equipment and personnel qualification and the use of non-blind trials for procedure and equipment qualification.

Since the publication of the EQMD the issue of inspection qualification was discussed widely both at national and international level and some evolution in thinking occurred. The Steering Committee of ENIQ thus decided to conduct a first pilot study to explore ways of applying the European Methodology for inspection qualification to a specific component. A number of important lessons were learned from this pilot study. All this led the Steering Committee of ENIQ to issue a second version of the EQMD, which was approved by the Steering Committee of ENIQ in February 1997.

In 1999, the final report of first pilot study was published. Between 1999 and now, ENIQ produced a series of 10 Recommended Practices, i.e. documents supporting the high-level EQMD with more specific guidance, see Table 1.

Based on the results of the second ENIQ pilot study and based on experience feedback from applying the ENIQ methodology in Europe the Steering Committee decided to revise the European Methodology Document. This third issue of the EQMD [1] has been produced by ENIQ TGQ, and was approved for publication by the ENIQ Steering Committee. The main changes from Issue 2 are as follows:

- Updating of the foreword to reflect the much more mature status of qualification in Europe prevailing today
- Adding references to the text citing existing supporting Recommended Practices wherever possible
- Rewriting of Appendix 3 to summarise the content of Recommended Practices which have actually been issued
- Editorial changes and changes to clarify the text.

No changes to the actual principles of the European Methodology have been made.

In 1999, ENIQ also recognized the importance of addressing at European level the issue of optimising inspection strategies on the basis of risk. Traditionally, strict regulations and codes specify the locations, frequency and methods of inspection based primarily on the type and safety class of the component. However, it has been recognized that many resources have often been spent inspecting sites of negligible risk for plant safety. On the other hand, practical experience and the use of probabilistic safety assessments have demonstrated that failures with high risk significance can occur at locations not covered by the traditional inspection programme. As the costs of qualifying and performing such effective inspections are very high, the effort must be targeted at the most risk-significant locations. For this reason, in 1996 ENIQ set up a sub-group in order to homogenize the different activities on RI-ISI for nuclear reactor safety and to develop a harmonized European approach to RI-ISI.

At the end of 2001, ENIQ members emphasized the need to strengthen the risk-related activities and to promote the full integration of RI-ISI into ENIQ. In connection with the reorganization of ENIQ working groups, this became Task Group on Risk (TGR). At the kick-off meeting of TGR, it was decided that the task group aims at establishing a common European framework on RI-ISI.
The European Framework Document for Risk Informed In-Service Inspection [2] is intended to serve as guidelines for both developing own RI-ISI approaches and using or adapting already established approaches to European environment taking into account utility-specific characteristics and national regulatory requirements.

Meanwhile, both task groups on Qualification and Risk work closer together. It became clearer in the last years, that there is a direct link between the two task groups where the inspection qualification needs information about the required inspection quality from the risk aspect and has to state more quantitatively that the inspection quality has been met.

Recent inspection qualification activities

A key achievement of ENIQ has been the issue of the European Qualification Methodology Document [1], which has been widely adopted across Europe. This document defines an approach to the qualification of inspection procedures, equipment and personnel based on a combination of technical justification (TJ) and test piece trials (open or blind). The TJ is a crucial element in the ENIQ approach, containing evidence justifying that the proposed inspection will meet its objectives in terms of defect detection and sizing capability. A Qualification Body reviews the TJ and the result of any test piece trials and issues the qualification certificates.

In order to test the European Methodology, two pilot studies have been conducted in which qualifications have been performed for inspections of mock-ups simulating specific plant components. The First Pilot Study, on an austenitic pipework weld, is complete and has been reported elsewhere (see e.g. [3]). A Second Pilot Study has been completed, for an automated ultrasonic inspection of a clad ferritic BWR-type nozzle-to-shell weld [4]. The aim of this study was to explore the potential of a TJ to reduce or remove the need for full-scale practical trials on mock-ups.

This exercise was largely successful in demonstrating that TJs have the potential to predict the outcome of specific inspections and thus to reduce or remove the need for large-scale test pieces in qualification.

Both the first and second pilot study, as well as the experience feedback from field-qualifications, led to a number of Recommended Practices and their revision.

Meanwhile, the European Qualification Methodology Document is supported by 10 issued Recommended Practices (Table 1), covering various aspects of qualification in more detail. All these documents provide guidance on conducting qualification, while retaining the flexibility to allow detailed variations in implementation between different countries.

Recent developments on Recommended Practices include a new issue of RP2 which now merges former RP2 and RP3 which is be called “Strategy and Recommended Contents for TJs”. The document has been published in early 2010. It was updated in order to include experiences and to harmonize it with the other RP’s. Nevertheless, neither structure and contents nor the purpose of a TJ were changed.

Also in 2010 a recommended practice on personnel qualification has been issued. This became necessary because no ENIQ-documents provided specific recommendations on how to conduct personnel qualification. RP 10 covers human factor assessment, training, exams, blind trials, and demands for re-qualification in relation to personnel certification schemes.

In a survey on harmonisation of nuclear safety among EU member states, the Working Party on Nuclear Safety” (working under the European Council) concluded that the ENIQ documentation is widely used throughout Europe. Further, the usefulness of the documentation was recognized by WENRA in their recent report on reactor safety reference levels [5].

Topic works in TGQ includes revising recommended practice RP5 “Guidelines for the Design of Test Pieces and the Conduct of Test Piece Trials”. The purpose of this revision is to provide more practical guidance on issues to consider when designing test pieces or producing defect simulations. The document will include appendices that might continuously be updated on the ENIQ-website.
Recent risk-informed in-service inspection activities

ENIQ Task Group on Risk (TGR) has published the European Framework Document for Risk Informed In-Service Inspection [2], which still is a basis for its current activities. It might be worth mentioning that this document is one of the basic requirements when RI-ISI was developed in Finland for TVO3 (EPR under construction).

Recent works in Task Group Risk include the extension of RI-ISI from piping to the reactor pressure vessel (RPV) and RPV Internals. The RPV is a vital component of the risk profile in a nuclear reactor. If it is accepted that ISI should be governed by risk, then the RPV should be included in the RI-ISI programme. It is outlined in the document that special consideration should be given to the issue regarding high-consequence/low probability components as the RPV. [6]

An effective risk-informed inspection strategy requires a feedback procedure to update the risk ranking after changes are made to the plant or other relevant information is acquired. Therefore a Task Group Risk discussion document “Updating of Risk-informed inspection Programmes” was issued that is intended to help users involved in an RI-ISI application to maintain and update an RI-ISI programme. It also provides an overview of current ISI updating practices in most EU Member States with nuclear power plants in operation. [7]
The link between Risk-informed in-service inspection and inspection qualification continues to be an issue on the ENIQ agenda. There is a need for a quantitative measure of inspection effectiveness as a quantitative input to risk-informed in-service inspection. A Probability of Detection (POD) curve could provide a suitable metric. However there can be significant problems with generating realistic POD-curves by practical trials. The ENIQ inspection qualification methodology can provide high assurance that an inspection system can achieve its objectives, but is not designed to provide a quantitative measure of the type that can be used in RI-ISI analysis. [8] In recent time, work is concentrated on quantifying POD curves with reasonable efforts.

FUTURE ACTIVITIES IN ENIQ

The current worldwide situation in the nuclear industry is sometimes called “nuclear renaissance”. As of early 2010 there are worldwide about

- 436 reactors in operation
- 142 reactors ordered or planned and
- 53 reactors under construction.

Especially in the field of ageing reactors, the importance of in-service-inspection will still increase. With an increasing number of reactors under construction, the importance of manufacturing NDE will still grow and this is also a field, where qualification is needed and where the ENIQ methodology can be applied.

Therefore, the ENIQ Steering Committee has initiated a discussion on the future activities of this network. The discussion presented at this conference is not yet finished and therefore to be considered as a draft.

The activities in ENIQ should be guided by a vision. The topic draft is that by 2020, ENIQ will be an international organization recognized by the global nuclear industry as providing the most contemporary methodologies for the qualification of NDE inspection processes and the application of risk informed in-service inspection technologies. By developing effective and applicable methods for qualification of NDE, ENIQ will deliver input data for a contribution to the safe and reliable operation of nuclear power plants.

ENIQ could by 2020 be the qualification method which is used in the manufacturing NDE in about 15 new nuclear power plants in e.g. Bulgaria, Finland, Italy, The Netherlands, Poland, Romania, Slovakia, Switzerland and the UK. It could also be the qualification method which is in a very comparable way used in the upgraded existing plants after life time extension. Considering that ENIQ today is driven by somewhat senior experts it becomes obvious that in 10 years ENIQ will be driven by NDE-people who were in the beginning of their professional life by 2010.

In the future ENIQ also intends to support inspection qualification bodies and inspection organisations in applying best practice in inspection qualification. Traditionally, ENIQ has always been characterised by a strong European dimension. At the same time, ENIQ recognises that there will be more nuclear applications worldwide in the future and hence acknowledges the opportunity to enhance and grow its approach outside Europe. ENIQ also recognises that the fundamental flexibility provided by its approach to inspection qualification could be extended to other industries outside nuclear.

Therefore ENIQ will further aim at supporting licensees and stakeholders. This includes:

- Identifying issues where the practice and implementation of Non Destructive Evaluation (NDE) can be improved to enhance the safe and reliable operation of NPP through inspection qualification, the application of risk-informed approaches, and other processes
- Providing recommendations and guidance
- Establishing and coordinating work programmes to address improvement issues
- Continually improving the processes for inspection qualification for increased effectiveness and efficiency
- Responding to the challenges of the world-wide nuclear renaissance including plant life extension (PLEX) and new build
In order to achieve and maintain its network excellence ENIQ will complement its methodology for Inspection Qualification and its Framework Document on Risk-Informed In-Service Inspection by fostering a common method of working. Further fields of working will be:

- ENIQ will work towards establishing common procedures and practices
- Mutual recognition (across countries) of qualified inspections
- ENIQ recognises the importance of engaging young engineers
- ENIQ will aim at further improving its scientific output
- ENIQ will provide an international forum where interested parties from different countries can meet to discuss NDT issues
- hosting forums for discussing improvements to the qualification process
- continue the qualification body meetings as held in Petten06, Budapest 07 and Vienna 08

These considerations lead to technical areas for future activities:

- Ensuring a robust link between inspection and inspection qualification and the input processes such as code requirements, safety cases.
- Improving the link between RI-ISI and Inspection Qualification by establishing how risk reduction criteria could set ISI requirements(scope, interval,…) and by quantifying the output of a qualified inspection
- Contribute to plant life management and plant life extension (PLEX);
- RI-ISI for new build, including pre-service inspections
- Role of RI-ISI in Defence-in Depth (pressure vessels, qualification approach, risk, etc.);
- Development of more detailed guidance for the use of expert knowledge in RI-ISI and qualification
- Ensuring that inspection results are used effectively to inform the safety assessments made by others.

On the other hand, maintenance of the existing documents is essential for the ENIQ network to maintain its credibility. The ENIQ network will therefore continue to periodically review (and, if necessary, revise/update/expand) the Methodology Documents and Recommended Practices to confirm that the current issues remain acceptable.

CONCLUSIONS

In-service inspection continues to be an important issue, and attracts a lot of attention, shown by this conference and several reported activities in Europe.

Within the European Network for Inspection and Qualification – ENIQ – utilities, vendors, R&D etc continues to develop harmonised approaches for Inspection Qualification and for Risk-informed ISI. Inspection Qualification has been introduced broadly in Europe and the experience is used to continuously update the ENIQ Methodology and Recommended Practices. The widespread use of the ENIQ documents have been confirmed by an official survey on Nuclear Safety, performed under the European Council, and its usefulness has been confirmed by WENRA – Western Nuclear Regulators Association.

The ENIQ Steering Committee decided that the ENIQ network needs a clearer vision further drive the development of ENIQ. The network is preparing for a future with closely linked inspection qualification and risk informed ISI both applicable for ageing reactors and new builds.

Additional information concerning ENIQ and its task groups and activities, as well as publications, can be obtained from the ENIQ website: http://safelife.jrc.ec.europa.eu/eniq.
REFERENCES


