POSIVA 2008-07

Background Information for NDT Qualification of Finnish Disposal Canisters of Spent Fuel

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December 2013

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ISBN 978-951-652-167-4
ISSN 1239-3096

Posiva-raportti – Posiva Report

Posiva Oy
Olkiluoto
FI-27160 EURAJOKI, FINLAND
Puh. 02-8372 (31) – Int. Tel. +358 2 8372 (31)

Raportin tunnus – Report code
POSIVA 2008-07

Julkaisuaika – Date
December 2013

Tekijä(t) – Author(s)

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Toimeksiantaja(t) – Commissioned by

Posiva Oy

Nimeke – Title

BACKGROUND INFORMATION FOR NDT QUALIFICATION OF FINNISH DISPOSAL CANISTERS OF SPENT FUEL

Tiivistelmä – Abstract

This report presents a review to basic concepts, which are applied in the qualification of non-destructive testing (NDT) techniques. The qualification systems developed and used in some countries are briefly described in the beginning of the report. Anyway the report mainly discusses the qualification practices applied in the Finnish nuclear industry.

The Finnish Radiation and Nuclear Safety Authority (STUK) in the YVL Guide 3.8 define the Finnish qualification approach applied for the in-service inspections. The principles presented in this document follow the views of the international organisations: Nuclear Regulator Working Group (NRWG) and European Network for Inspection and Qualification (ENIQ). For the practical qualification work a national guideline is established using so called SP -documents that include specific rules and instructions for execution of qualifications in accordance with YVL Guide 3.8 principles. Altogether the Finnish qualification system can be seen very well to follow the European (ENIQ) methodology.

The report discusses several qualification terms and documents. Thus the normally necessary tasks and parts of a qualification are described. The qualification can be seen as a project that includes several tasks, which will be performed by different parties. Enough resources and time should be reserved for the planning and control of a qualification project to ensure its fluent progress. Some tasks are discussed in the report taking into account the situation in the qualification cases that are seen to be linked to the inspections of disposal canisters of spent fuel.

Avainsanat - Keywords

ISBN
ISBN 978-951-652-167-4

ISSN
ISSN 1239-3096

Sivumäärä – Number of pages
24

Kieli – Language
English

Posiva-raportti – Posiva Report

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Raportin tunnus – Report code
POSIVA 2008-07
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Joulukuu 2013

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Nimeke – Title

SUOMALAISEN KÄYTETYN POLTTOAINEEN AINETTA RIKKOMATTOMIEN TARKASTUSMENETELMIEN PÄTEVÖINNIN PERUSTA

Tiivistelmä – Abstract

Tässä raportissa on esitetty katsaus peruskäsitteisiin, joita noudatetaan rikkomattomien tarkastustekniikoiden (NDT) pätevöinnissä. Alussa on tiiviisti tarkasteltu eräissä maissa sovellettavia pätevöintijärjestelmiä. Pääpaino raportissa on kuitenkin annettu Suomen ydinvoimateollisuudessa sovelletulle pätevöintikäytännölle.

Suomessa noudatettavia pätevöintikäytäntöjä, joita sovelletaan ydinvoimaloiden määräaikaistarkastuksissa, on määritetty Säteilyturvakeskuksen (STUK) toimesta ohjeessa YVL 3.8. Nämä periaatteet noudattavat näkemyksiä, jotka on esitetty kansainvälisellä tasolla Nuclear Regulator Working Group:n (NRWG) ja European Network for Inspection and Qualification:n (ENIQ) tahoilta. Käytännön pätevöintitoimintaa varten on niin kutsuttujen SP -ohjeiden avulla luotu kansallinen säännöstö, joka antaa yksityiskohtaista ohjeistusta pätevöintien toteuttamiseksi YVL 3.8:ssa esitettyjen periaatteiden pohjalta. Kaiken kaikkiaan suomalaisen pätevöintikäytännön voidaan todeta noudattavan varsin tarkoin eurooppalaista (ENIQ) metodologiaa.

Raportissa käydään läpi useita pätevöinneissä esiintyviä käsitteitä ja dokumentteja. Siten luodaan kuva tarvittavista tehtävistä ja toiminnoista, jotka tulevat normaalisti sisältymään pätevöinnin toteutukseen. Pätevöinti voidaan nähdä projektina, jossa on useita, eri osapuolien toteutettavaksi tulevia tehtäviä. Pätevöintiprojektin suunnitteluun ja ohjaukseen tulisi varata riittävästi aikaa ja resursseja, jotta pätevöinti saadaan etenemään hallitusti. Eräitä tehtäviä on raportissa tarkasteltu pyrkien huomioimaan tilanne niiden pätevöintitapausten kannalta, jotka ovat tässä vaiheessa nähtävissä käytetyn ydinpolttoaineen kapseleiden tarkastuksissa.

Avainsanat - Keywords

ISBN
ISBN 978-951-652-167-4

ISSN
ISSN 1239-3096

Sivumäärä – Number of pages
24

Kieli – Language
Englanti

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1 INTRODUCTION

The qualification practice has been established in many countries to enhance the reliability of the non-destructive tests (NDT) applied in the nuclear industry. In practice qualification means a systematic assessment of the capability of the whole inspection system according to set qualification rules. Usual way is that the regulatory body has set to the licensee the requirement about the qualification. So far the qualification requirement concerns usually the in-service inspections.

During the qualification process it shall be shown that all elements of the inspection system fulfil the set capability requirements. The capability requirements of in-service inspections are defined in such a way that the inspection reliably detects, characterises and/or sizes defects that would endanger structural integrity and nuclear safety. The assessment of the inspection capability is performed by an independent expert body according to qualification rules that are established on national level and varying in some extent in different countries.

2 SOME EXAMPLES OF NDT QUALIFICATION APPROACHES

In the following paragraphs a very brief review of some qualification approaches is made.

2.1 ENIQ Qualification methodology

The European approach for NDT qualifications is developed by ENIQ (European Network for Inspection and Qualification), which is a utility driven network. The main principles are defined in the document European Methodology for Qualification of Non-Destructive Testing (ENIQ 1997). This document gives a general framework for development of qualifications. The main document is supported with number of documents called Recommended Practices, which give next level guidance below the main document. Until now eight Recommended Practice documents are published discussing different issues of qualification (ENIQ 2005b, ENIQ 1998a, ENIQ 1998b, ENIQ 1999a, ENIQ 1999b, ENIQ 1999c, ENIQ 2002, ENIQ 2005a). However the European Methodology does not provide a detailed description of how the inspection of a specific component should be qualified. The ENIQ documents are general guidelines that can be used in development of detailed qualification practices at national level.

ENIQ has also performed two Pilot Studies in which the qualification processes have been tested in practice (1999d, 2006a). In connection to these studies several publications have been produced providing useful examples of the documents and other information needed in different phases of the qualification (ENIQ 1998c, ENIQ 1998d, ENIQ 1998e, ENIQ 1998f, ENIQ 1998g, ENIQ 1999e, ENIQ 1999f, ENIQ 1999g, 2005c, 2006b)

The qualification methodology defined by ENIQ can be applied to qualify the NDT system, which consists of three parts: inspection procedure, equipment and personnel. Any individual part or combination of them can be the object of the qualification. The "tools" to provide evidences about the capability of the inspection system parts in the qualification are practical trials and technical justification (TJ). The type of the practical trials can be "open" or "blind" depending of the defect information available to the inspectors (discussed in more detail in chapter 4.4). Usually the technical justification and open practical trials are used in the qualification of the procedure and inspection equipment. The personnel are normally mainly qualified by blind practical trials but some justifications are usually included in the technical justification. The inspection system parts and their links to the qualification "tools" are shown in Figure 1.

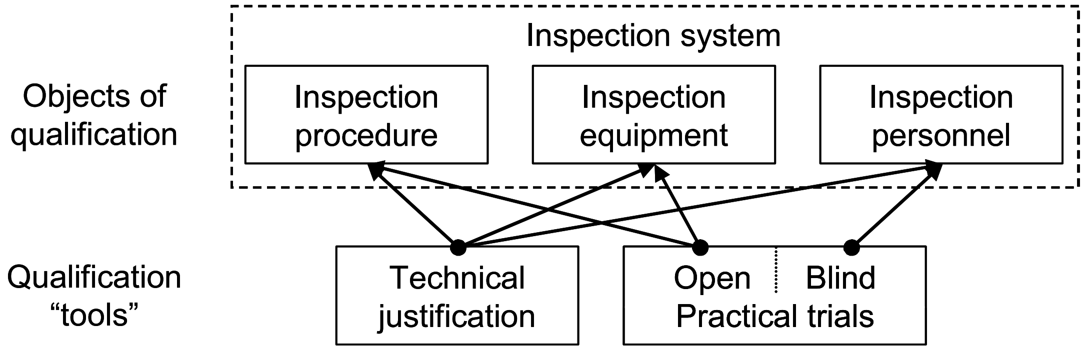

Figure 1. *ENIQ qualification approach.*

One of the main ideas in the development of the ENIQ qualification methodology has been to give an important role for the technical justification. When extensive evidences about the performance of the inspection system are presented in the technical justification it is seen that the amount of the practical trials and thus also the number of the test pieces can be reduced.

The ENIQ qualification methodology is applied in many European countries, which have developed their national qualification system based on the ENIQ approach.

2.2 Qualification in USA

The NDT qualification system followed in USA is based on ASME XI Appendix 8 and is usually called performance demonstration initiative (PDI). Concerning UT method detailed rules are given about the specimens, applicable defects, defect location and distribution, required detection capability etc. PDI is based solely on the application of blind test pieces. The qualification system is run by EPRI, which possesses large amount of test specimens required in this approach type.

2.3 Qualification in Sweden

Swedish qualification system applied for in-service inspections is based on the ENIQ qualification system. Substantial effort is made to develop the national qualification organisation and system. The qualification body is permanent and it is operating as a company (Swedish NDT Qualification Centre, SQC), which is owned by the Swedish nuclear power plant utilities.

The main principles followed in the NDT qualifications of Swedish nuclear industry are described in the published guideline (SQC 2002).

2.4 Qualification in Finland

Concerning the Finnish qualification practice the basic requirements and rules are set in Guide YVL 3.8 (STUK 2003). The main principles are defined according to views of European nuclear regulators (NRWG 1997) and ENIQ methodology.

For detailed guidance of the qualification process and practical work a set of guidelines has been compiled and published as so called SP guide documents (Inspecta Certification 2006a, Inspecta Certification 2006b, Inspecta Certification 2006c, Inspecta Certification 2005a, Inspecta Certification 2004, Inspecta Certification 2006d, Inspecta Certification 2006e, Inspecta Certification 2005b, Inspecta Certification 2006f). These guidelines form the Finnish national qualification practice, which follows the principles of ENIQ methodology.

The responsible permanent organisation for organising the qualifications is Inspecta Certification Oy. The qualification bodies for each actual qualification case are formed according ad hoc principle. Anyway at least one member in each qualification body is from Inspecta Certification Oy and the other members are NDT experts that are impartial in the qualification case, which is under consideration.

3 ORGANISATION OF THE QUALIFICATION

3.1 Qualification process planning

The qualification can be seen as a project involving several tasks and parties. In this project the licensee has to take the overall project responsibility because it has the practical need to accomplish a qualification. It also owns/controls the necessary financial resources of the project. Thus the general planning, scheduling and over all control of the qualification process are typically tasks belonging to the licensee as the project coordinator.

Qualification is usually time-consuming process and the practice has shown that it will take often longer than expected. The planning, background information collection and production of the test blocks should be started in early stages.

The qualification process involves many organisations and has several phases as it can be stated in the Figure 2 that is presenting the current Finnish qualification scheme. Typically some phases of the qualification are not quite straightforward processes and some iteration may be required to finalize tasks and documents.

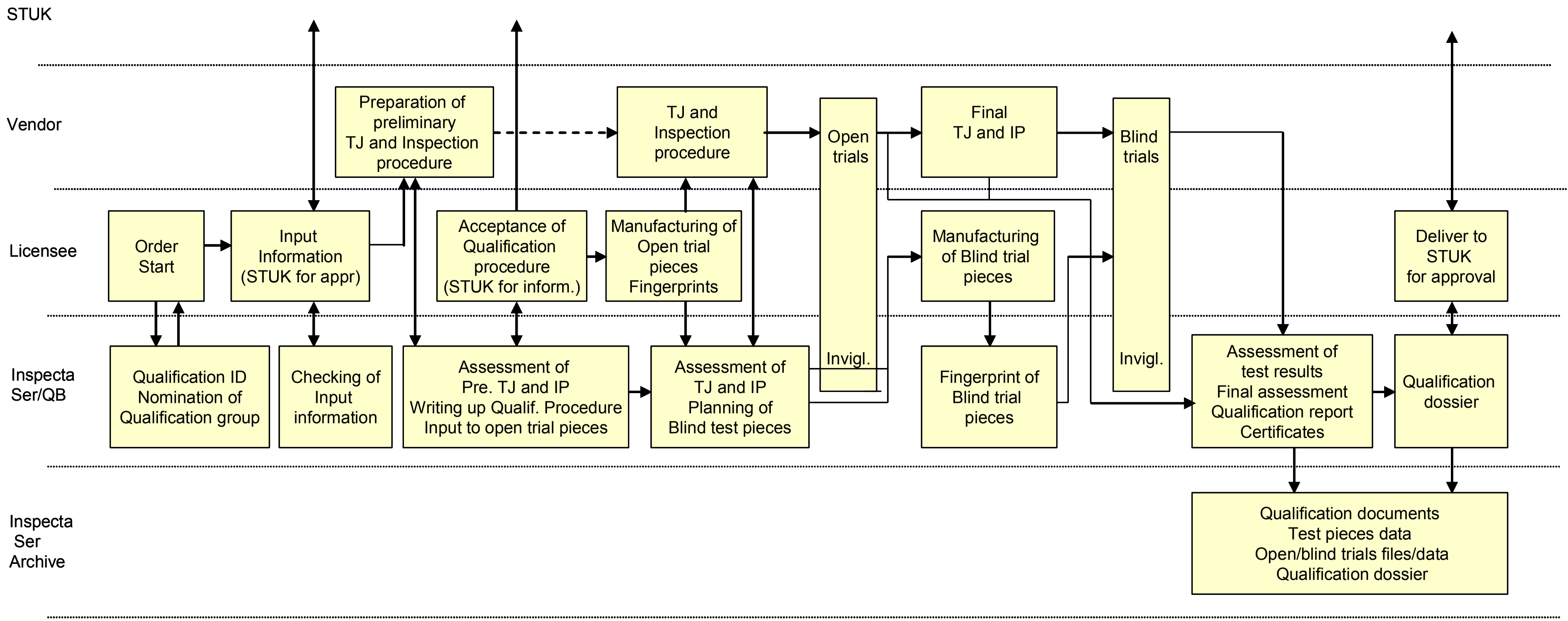

Figure 2. *Main phases/tasks, their relations and responsible organisations during the qualification process (Inspecta Ser = Inspecta Certification Oy, QB = qualification body, TJ = technical justification, IP = inspection procedure, STUK =Radiation and Nuclear Safety Authority.).*

The overall planning should include the grouping of similar inspection cases together. When making the grouping for example the similarity of the components and inspection technique should be considered. Using clever grouping the number of qualification cases may be reduced and unnecessary repeating of work can be avoided. After grouping the overall planning should assess total amount of work of the identified qualification cases and set the structure and realistic timescale for them.

The input information forms a basis for the qualification case. Therefore the compilation should be started early. The input information shall be checked and accepted by the regulatory body and reasonable time has to be reserved also for this phase. Before the regulatory body acceptance of the input information there exists a risk that some additional requirements may be presented which will lead to changes in the qualification itself.

In the production of test blocks same material and manufacturing techniques are needed as in the production of the real components. Thus the material blocks can often be purchased at reasonable costs when the blocks are fabricated in connection with other test samples during pre-production phase. Test block production is a time-consuming process and it has in many qualification cases been the critical factor that has set the final schedule for the other phases. Therefore start of the design, purchase of suitable material blocks, study and qualification of the defect manufacturing techniques etc. in early phase are important to keep the qualification project in set schedule.

3.2 Qualification process of the spent fuel canister inspections

The qualification process of the spent fuel canister inspections is still at its early stage. The development of the inspection techniques is including several tasks and phases. Preparation for the qualification of different NDT techniques is planned to be started in connection with the inspection research and development work. The preliminary planning for scheduling different inspection development phases linked with qualification process is presented in Figure 3.

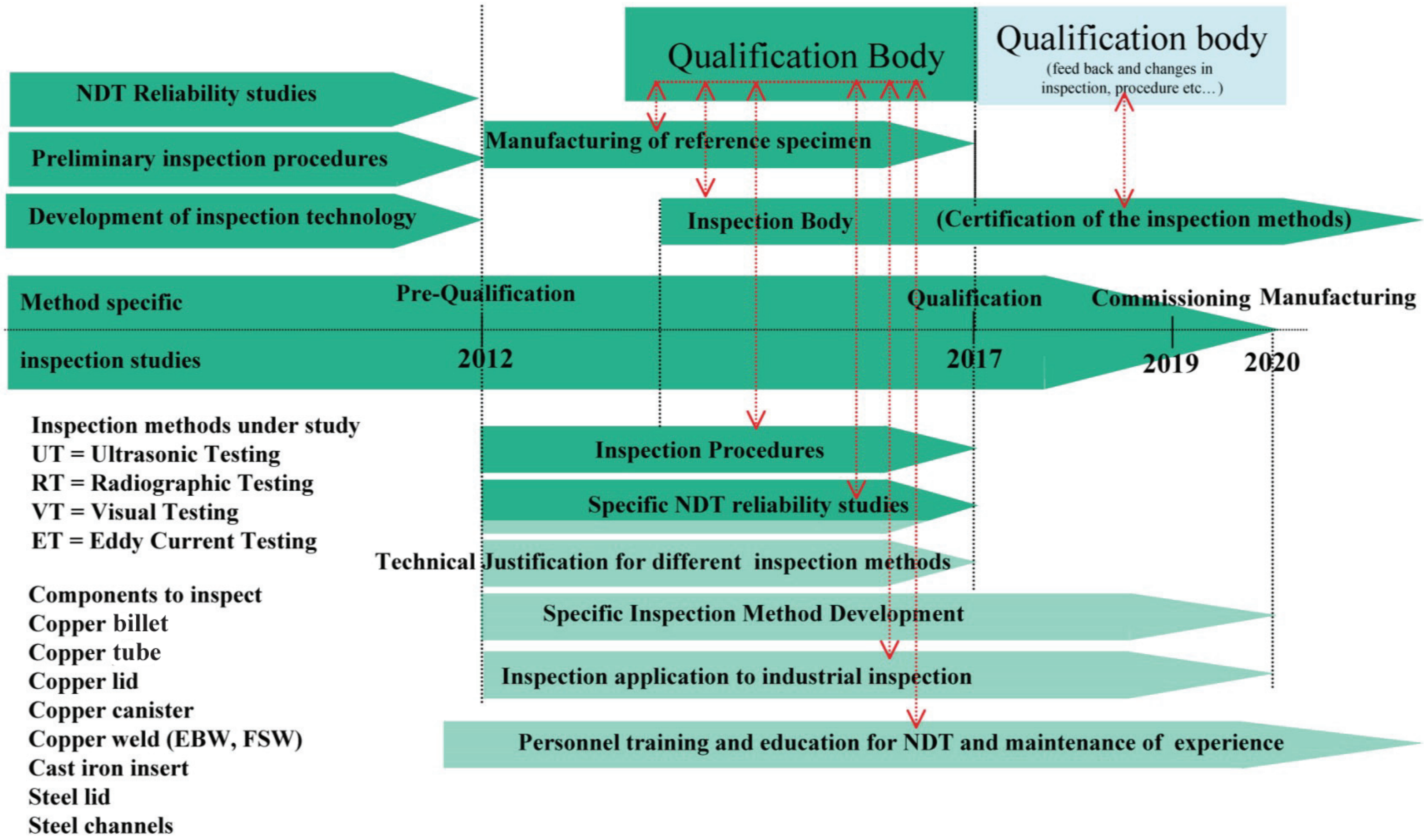

Figure 3. *Overall view of preliminary planning for the inspection development and qualification tasks and their schedule in the case of spent fuel canisters.*

3.3 Parties and roles

The parties involved into a qualification process are usually: licensee, inspection company, qualification body and regulatory body. Their main roles, tasks and responsibilities are drafted below:

Licensee (utility)

- Launching and financing of the qualification
- Overall responsibility of the qualification process
- Control of schedule and financial resources
- Compilation of the input information
- Acceptance of the qualification procedure
- Manufacturing of test blocks
- Responsibility towards authority (agreement about inspections to be qualified, submission of documents etc.)

Inspection company (vendor)

- Design and optimisation of the inspection technique and system
- Compilation of the inspection procedure
- Compilation of the technical justification
- Laboratory trials performance
- Practical trials (open and blind) performance

Inspecta Certification

- Nomination of qualification body
- Fingerprint inspection of blind test blocks
- Issue of certificates
- Archiving of qualification dossier
- Support to qualification body

Qualification body

- Check of the adequacy of the input information
- Drawing up qualification procedure
- Design / applicability check and approval of the test pieces to be applied
- Assessment of inspection procedure and technical justification
- Invigilation and assessment of the practical trials (open and blind)
- Preparation of the qualification assessment report
- Compilation of qualification dossier

Authority (STUK)

- Assessment and approval of the input information
- Check of the qualification procedure
- Final approval of the qualification

3.4 Documents

There are several documents belonging to the qualification process that are produced during different phases by the parties involved in the process. The documents applied normally and their short descriptions are as follows:

Input information
- Includes all necessary background information for the qualification case: component information, defect information, performance requirements for the inspection
- Compiled by the licensee
- Should be approved by the authority in the very early stages of the qualification process

Technical justification
- Usually an extensive document including theoretical, experimental and practical evidences and justifications about the capability of the inspection system
- Compiled by the inspection company
- Material should be collected during the development of inspection technique (documentation of laboratory trials performance and results, reasoning for the choices of technical options etc.)

Inspection procedure
- Document defining and guiding the process how the inspection is performed
- Compiled by the inspection company
- According to the ENIQ qualification principles should be very detailed
- Inspection procedure is usually the main “component to be qualified”

Qualification procedure
- Document defining requirements and criteria for the qualification
- Compiled by the qualification body
- To be sent for information to authority
- Specifies the test samples to be applied
- Includes usually planning of practical trials

Qualification report
- Document that reports the performance and outcome of the qualification
- Compiled by the qualification body
- Report on how the different parts of the qualification were fulfilling the requirements set in the qualification procedure
- Stating the possible deviations from the qualification procedure
- Stating the inspection capability based on the qualification result and the possible deviations from original capability objectives

Certificates
- Stating the subject and scope of qualification
- Issued by the permanent qualification body, Inspecta Certification

Reports from practical trials

- Documentation of the performed open and blind trials
- Compiled by the qualification body

3.5 Components to be qualified

Despite of many tasks and documents involved in a qualification it should be kept in mind that the final objective is a qualified inspection system, which includes procedure, personnel and equipment. Depending on the need all or any of the components of the inspection system may be included in the qualification. The other documents and tasks in the process are more or less just tools to accomplish the qualification.

3.5.1 Inspection procedure

The procedure is usually the main subject of a NDT qualification. During the development of the procedure all methodological and technical decisions of the inspection have to be taken and finally be documented in the procedure. It usually also includes the definition of the inspection equipment (hardware and software) to be used. The general requirements for the inspection procedure are discussed in more details later in chapter 4.2. The qualification of the procedure is usually made using both technical justification and practical trial. Often the main purpose of the technical justification is to present all the evidences about the procedure capability compiled during the procedure development.

3.5.2 Personnel

The personnel performing a qualified inspection shall fulfil requirements that are stated in the inspection procedure and are assessed by the qualification body. The most demanding tasks of an inspection usually require inspection specific qualification. For example the data analysis of ultrasonic inspections is often seen as such a task. In these cases blind trials are usually applied. Basic qualification according e.g. standard EN 473 and sufficient training concerning the applied equipment is usually required for personnel performing system calibration and data acquisition. The personnel assembling and operating scanners shall usually have sufficient equipment training but NDT qualification is not necessarily required.

3.5.3 Equipment

The inspection equipment is an important part of the system influencing significantly to the outcome of the inspection and shall therefore be qualified. The inspection procedure shall define in detail the hardware and software components to be used. Usually the equipment is qualified together with the inspection procedure. When same equipment is used during the laboratory trials a lot of necessary evidences about its functionality and accuracy of the equipment can in many cases be obtained and presented in the technical justification. The qualification body in an open trial usually checks the functionality and accuracy of the scanners.

If hardware or software components are changed it affects the validity of the qualification and some re-qualification actions are necessary. In case of minor changes specific technical justification showing that the performance of the new equipment component is equal or better than that of the previous is sufficient.

4 DESCRIPTION OF THE CENTRAL QUALIFICATION COMPONENTS

The following paragraphs include some considerations of the key issues of the qualification with specific links to spent fuel canister qualification case.

4.1 Input information

The input information is a document that is compiled by the licensee in the start phase of the qualification. It should include necessary information that is needed by the inspection company (vendor) for the development of the inspection system and also by the qualification body for planning of the qualification case. Therefore the early compilation of this document is important. The input information also has to be delivered to the authority approval. It should be born in mind that changes of the input information might lead to redesign of the inspection system and also to re-qualification requirements.

On main level issues of the input information are given in guide SP - 4 (Inspecta Certification 2006d) as follows:

- Component information
- Defect information
- Determination of qualification level
- Inspection objectives
- Schedule of qualification

4.1.1 Component information

The component information includes facts about the object to be inspected like material, dimensions, fabrication methods etc. It is usually rather easily compiled after component fabrication if documentation is made carefully during production phase.

The input information document should include explicit numeric values for several details. This data can then be applied as numeric values for so called input parameters of the qualification. An example of input information parameters concerning ultrasonic inspection of welds can be found in the document ENIQ Recommended Practice 1 (ENIQ 2005b). The given list is as follows:

- Geometry of the component
- Access possibilities (including radiation, etc.)
- Surface conditions
- Weld crown configuration
- Weld root configuration
- Wall thickness of the straight pipe
- Diameter of the pipe
- Counterbore
- Counterbore dimensions

- Weld mismatch (misalignment)
- Macrostructure of the base material
- Macrostructure of the weld
- Presence of buttering (in case of dissimilar metal welds)
- Temperature.

Considering spent fuel canister qualification case plenty of the basic component information is already available. On the other hand some details of the constructions and the fabrication processes of the components are still under development. Thus the drafting of the component information is already possible but the final values can be fixed only after the finalisation of the component construction.

4.1.2 Defect information

Defect information shall summarize all available knowledge about the known or possible flaws and flaw mechanisms.

Defects can be divided into three groups based on the predictability and probability of their nature (ENIQ 1997, p. 23):

- Specific defect: specific defects have been found in a specific component
- Postulated defect: existence of defects of particular types is postulated in a particular component. The exact characteristics of the defects are not known and have therefore to be postulated.
- Unspecified defect situation: neither a specific defect has been detected nor a defect has been postulated, nor a damage process has been identified.

The input information shall define the flaw cases using explicit values for all the defect parameters that can then be applied during the qualification. A useful starting point for these defect parameters might be the following list given in the ENIQ Recommended Practice 1 (ENIQ 2005b):

- Type of defect
- Degradation mechanism
- Shape of the defect
- Through-wall extent of the defect
- Position of the defect along the through-wall extent of the component
- Position of the defect along the axis of the component
- Tilt angle of the defect
- Skew angle of the defect
- Roughness/branching of the defect
- Presence of residual stresses

Defect information compilation requires research and analysis of possible defects possibilities and their origins. In spent fuel canister qualification case the defects originate probably from manufacturing processes of the components, sealing of the canister and handling of the components. The extensive research activity of manufacturing processes surely produces plenty of very useful information about the possible flaw cases. A systematic compilation and organisation of this information forms also a good base for the defect description to be presented in the input information document. Also there will be plenty of research documents that can be referenced in this connection.

4.1.3 Qualification level

The qualification level is defined by YVL 3.8 as the reference level of reliability required of the inspection system to be qualified (STUK 2003, p. 6). The qualification level shall be defined in the input information by the licensee based on the nuclear risk significance of the structure failure and reduction in the probability of failure arising from inspection.

The Finnish qualification system has three qualification levels: level one (1) is the lowest and three (3) is the highest and most demanding. In practice all in-service inspection qualifications have so far in Finland been treated applying level three.

The application of the lower qualification levels (one and two) shall be justified in the input information. If the highest qualification level is chosen no justification is necessary but the requirements for qualification are the most challenging.

The qualification case of the spent fuel canister inspections will be some different compared with the in-service inspection cases. Anyhow probably also in this case high reliability requirements will be set to the inspection systems and that will steer the definition of the qualification level to be applied.

4.1.4 Inspection objectives

Inspection objectives define the requirements for NDT techniques to be used. Such requirements are for example type and minimum size of defects to be detected and also the accuracy that is needed in the defect size measurement. During the definition of inspection target values viewpoints of both structural integrity and inspection shall be taken into account.

The volumes to be covered with inspection shall be defined according to the critical locations of defects. The defect nature may further steer the choice of areas that shall be covered by different methods and techniques.

The smallest defect size of certain defect type that has to be detected is defined using the term “detection target”. Usually structural analyses are applied to justify the made choices concerning detection target. These analyses or other justifications shall be presented as reference material. The final definition of detection target shall also include the defect orientation (tilt and skew angles).

The modern NDT methods aim also to size the found defects. Therefore the input information should define the tolerances of defect length and height sizing techniques. Usually also defect positioning requirement is given in the input information.

4.1.5 Time schedule

The guide SP - 4 (Inspecta Certification 2006d) proposes also inclusion of the time schedule in the input information. Some general schedule is possible to be included to give preliminary target times for the phases and to estimate the total time span of the qualification. Anyhow the qualification project planning should include more specific and more detailed schedule, which can be also updated more flexibly.

4.2 Inspection procedure

The inspection procedure is a document defining, instructing and documenting in detail how all parts of the inspection shall be performed. Detailed guidance about the preparation of the inspection procedure is not directly available as a ENIQ Recommended Practice nor as a Finnish SP document. Anyway the document Inspection Procedure for ENIQ Pilot Study (ENIQ 1998d) can be used as an example. Also the checklist about the issues of the inspection procedure in the appendix 3 of the Finnish guideline SP - 2 (Inspecta Certification 2006b) is useful. The inspection companies have today rather good practices for preparation of inspection procedures according to ENIQ requirements.

The licensee has a quality system, which contains typically also inspection procedures accepted by the authority. In the frame of this quality system licensee is responsible for inspection procedures and updating them according to technical development in the applied NDT field. Practical inspection work is carried out by the inspection companies and reported by them to the licensee. Finally the licensee is responsible to report the results to the authority.

In a qualification case the inspection procedure is usually the main issue to be qualified. The qualification body should make formal assessment of the procedure concerning content and unambiguousness in the first phase. Finally the performance of the inspection procedure is assessed based on the evidences presented in the technical justification and on the results of the open trial.

4.3 Technical justification

The technical justification is one of the two main components of ENIQ qualification system to prove the performance of the inspection system. Usually its main role is to justify that the inspection procedure has the required capability. Usually it also includes description and justification for personnel requirements and for equipment performance and suitability.

The technical justification is usually prepared by the inspection company and is closely linked to the development of the inspection procedure. When the justifications for technical choices of the inspection technique and results of the laboratory trials are documented during the development of the inspection procedure substantial part of material needed for the technical justification is compiled.

Guidance and requirements for the preparation of the technical justification can be found in the documents YVL 3.8 (STUK 2003) and SP - 6 (Inspecta Certification 2006f). A detailed checklist included as appendix 2 in the SP - 2 (Inspecta Certification 2006b) is applied by qualification body during the assessment process and it can thus be seen as one of the requirements to be fulfilled. Also ENIQ documents Recommended Practice 2 (ENIQ 1998a) and Recommended Practice 3 (ENIQ 1998b) give plenty of useful information about the preparation and application possibilities of the technical justification.

Usually the technical justification is rather extensive document when all the required parts of a complete technical justification are included. But technical justification can also be used for specific purpose and its content is in that case modified accordingly. For example in a case of inspection system modification a specific technical justification may justify and present evidences that the made change is improving not lowering the performance.

The qualification body assesses the technical justification. The content of the technical justification has to be balanced with the proof material from the practical trials in a way that convinces the qualification body of the inspection system capability. Very often some correction, addition and modification requirements may be presented by the qualification body before final approval.

4.4 Practical trials

Practical trials are used to show in practice that the capability of inspection system components is fulfilling the set requirements. During the practical tests experimental inspections are performed using test blocks having representative material, geometry and defects. Qualification body members invigilate practical trials.

The defect properties of the test blocks shall be such that the detection and/or sizing capability of the inspection system can be assessed. The qualification body in the qualification procedure defines the practical trials and the test blocks to be applied. When new blocks are produced the utility normally provides suitable material. Before fabrication materials, the qualification body shall accept block and defects design as well as manufacturing.

The experimental inspections and measurements that are performed by the inspection company during the development of the technique without invigilation of the qualification body should be regarded as laboratory trials. The performance and results of laboratory trials should be documented carefully and summarised in the technical justification.

The laboratory trial documentation shall be available to the qualification body if required.

There are two types of practical trials included in the ENIQ qualification methodology. Those are according to the qualification terminology called as “open” or “blind”. Both types of practical trials are discussed below.

4.4.1 Open trial

The defects applied in a test blocks of an open trial are known by the inspectors performing test. This trial type is typically applied during the procedure qualification. The operation and accuracy tests of the equipment (e.g. scanners) can also be regarded as open trials.

Open trials should be carried out following step by step the inspection procedure to check its functionality in practise. During the data acquisition and evaluation the inspectors shall explain inspection steps and give required information to the invigilators. The inspector should be able to proof that by just following the steps of the procedure for example the detection and sizing of the defects can be performed correctly.

It may be possible to use the open test blocks also during development of the inspection technique and procedure. This requires anyway early planning and good cooperation with qualification body.

4.4.2 Blind trial

The inspectors performing the test do not know the defects inserted in the test blocks of blind trials. Typically the blind tests are applied during the qualification of the personnel. When blind tests are performed acceptance for the inspection procedure to be applied should already be received in the qualification process.

In most cases blind tests are used to assess defect detection and sizing capability of the personnel but also to estimate false call rate of the applied technique. The criteria for detection and sizing performance are defined in the qualification procedure. Usually certain percentage (e.g. 80 %) of defects has to be detected and defect sizing is not allowed to exceed given limits.

The qualification body shall carefully invigilate the blind trial and take care that no information about the test block defects is revealed. Also all data and analysis results shall be handed over to the qualification body after the test. Qualification body performs the assessment of the test based on evaluation result documents received from the inspectors.

The design of the blind test blocks should be started in good time because after manufacturing also careful examination of the produced defects (so called finger print inspection) is necessary. During finger print inspections the suitability of the defects and blocks for blind trial use is checked. Usually the qualification body or Inspecta Certification performs finger print inspections.

5 SUMMARY

Qualification systems have been developed to enhance and ensure the reliability of the NDT inspections. In practise qualification means a systematic method that is applied to proof the capability of an inspection system. When the system performance is assessed the main issues are defect detection and sizing capability but often also defect characterizing and positioning ability are usually also considered.

The qualification system usually applied in Europe is called ENIQ qualification methodology. It has been developed in a European cooperation process that was coordinated by the EU supported organisation ENIQ (European Network for Inspection and Qualification). The ENIQ qualification system is documented in the published methodology (ENIQ 1997) and in several Recommended Practice documents. In many European countries national qualification practices have been developed based on the ENIQ methodology. The qualification practices have so far been applied to qualify the NDT systems used in in-service inspections of nuclear power plants.

When ENIQ methodology is applied the object of the qualification can be the whole NDT system or any of the three main components of the system (procedure, personnel or equipment). The evidences that show the capability of the inspection system can be presented using practical trials and a technical justification document. Practical trials are experimental tests where inspection system is applied and those are invigilated and assessed by qualification body. The technical justification is usually an extensive document produced by inspection developer. It includes all kind of material that can be presented in favour of the system performance e.g. justifications about the technical choices made, experimental results of laboratory trials etc. Also qualification body assesses this document as well as the inspection procedure itself.

The NDT qualification can be regarded as a project. This project has many phases with different organisations involved and this makes the situation rather complicated. The complexity of the project and time consuming production of test blocks that are needed extend the qualification time span often more than expected. The licensee is responsible for the qualification performance to the authority and it also controls the resources of the qualification process. Therefore it should also take clear overall responsibility of the qualification project including careful planning and control.

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