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FOREWORD – BRIEF REVISION HISTORY OF RP10

The first issue of ENIQ Recommended Practice 10 (RP10) was produced by the ENIQ Task Group Qualification and was approved by the ENIQ Steering Committee for publication in June 2010. This second issue of the document updates its content and includes additional discussion on the issues of maintaining proficiency and the use of simulation tools for training (in case of the latter in coordination with the revision of RP6 “The use of modelling in Inspection Qualification”).

EXECUTIVE SUMMARY

This Recommended Practice (RP) has been developed as a consensus document among the members of NUGENIA Technical Area 8 (TA8) - ENIQ. This RP is meant to assist those involved in the qualification of inspection personnel to meet the principal objective of personnel qualification, i.e. to ensure that those carrying out an inspection are appropriately trained, experienced and examined to ensure the inspection is applied correctly and effectively. Detailed guidance on how to conduct personnel qualification, handle qualifications to be renewed, and defining the role and responsibilities of the parties involved is not provided.

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1 Introduction

The European Methodology Document [1] is intended to provide a general framework for the development of qualifications for the inspection of specific components to ensure they are developed in a coherent and consistent way while still allowing qualification to be tailored in detail to meet different national requirements.

This ENIQ Recommended Practice (RP) provides recommendations to assure the qualification of inspection personnel where this is required. The RP does not give guidance of when personnel qualification may be performed – this is a matter to be agreed with the relevant organisations.

This RP is relevant to any non-destructive testing method. It is emphasised that the general principles given in this RP can also be used for qualification of manufacturing inspections or of inspections performed in the non-nuclear field, although it was developed with in-service inspection of nuclear power plant components in mind.

The definitions given in the ENIQ Glossary of Terms [2] apply to this RP.

2 Objectives

The principal objective of personnel qualification is to ensure that those carrying out an inspection task are appropriately trained, experienced and examined to ensure that the inspection is applied correctly and effectively. To do so the factors that could degrade the effectiveness and reliability of the qualification should be addressed.

Some inspections usually involve several stages which may be performed by different personnel, for example automated inspections often involved three distinct roles: manipulator operators, data acquisition staff and data analysts. When the procedure requires human intervention from one of the roles which may impact the outcome of the inspection it may be necessary to qualify some or all of the personnel undertaking these roles in different ways to demonstrate that they are capable of performing the individual tasks required of them.

2.1 Personnel qualification vs personnel certification

It is important to define the difference between personnel qualification and personnel certification. In the context of the European Methodology, personnel qualification is defined as a process to demonstrate that personnel are capable of implementing specific inspections at the required level of proficiency. Certification is defined as a process to demonstrate that personnel have the basic skills to implement an inspection method and may not refer to specific procedures.

Usually, countries will have their own certification schemes that meet some recognised standards such as ISO 9712 [3]. It is common for such schemes to have different levels of certification corresponding to the different demands imposed by inspections.

- In the development of an inspection procedure it is necessary to determine the requirements which the personnel who will carry out the inspection should meet. These will be clearly defined and will be determined by a number of factors.
- Whether the inspection is manual or automated and the different roles fulfilled by different groups of personnel in the latter case.
- If the inspection is applied manually, whether the inspection imposes technical demands beyond those examined through a national certification scheme such as those discussed above.
- If the inspection is automated, whether it has features which require particular skills beyond those addressed via training or certification schemes specific to the data acquisition system in question.

- The complexity of applying the procedure and the level of proficiency required of the inspectors in order for the procedure to satisfy its requirements. In some cases, this requirement will be strongly influenced by factors should as the defect types sought or materials and inspection techniques applied.
- The likelihood of variations in the proficiency of personnel leading to the procedure failing to meet its requirements.

In the framework of the European Methodology a certificate from a national certification scheme is accepted as a pre-requisite. Any other requirements necessary for the qualification may be settled in the specification and justified in the technical justification (TJ) or related training and qualification plan.

In some cases the inspection itself may be simple and the objectives, in terms of defects to be detected and sizing accuracy required, may not be very demanding. In this case it could be claimed that by obtaining a national certificate of competence the inspector has already demonstrated the required level of competence. Such a certificate requires that the inspector has attended a recognised training course and in addition there are often experience requirements. If all this information is included in the TJ [4] for the inspection, the qualification body (QB) will need to consider whether it is sufficient and whether additional qualification is necessary.

The same considerations apply to manual and automated inspections except that national qualification schemes for automated inspections which determine competence in data collection and analysis are less common, since the detailed personnel requirements are usually equipment and system-specific. In addition, there are usually no international standards to which automated schemes can be developed and against which they can be assessed. SNT-TC-1A [5] provides for the development of specific certification arrangements relating to a particular inspection using specific equipment. Organizations not working according to SNT-TC-1A may also use such certification arrangements. However, such schemes are usually developed and implemented by the organisation carrying out the inspection and so may lack independence.

An alternative may be the proposal in ISO 9712, chapter 3.21 [3] allowing an organisation to authorise its staff on the duties it may exercise. This authorisation may depend on specific training for the job of the staff involved.

If possession of a certificate awarded by a national or organisation based scheme is cited in the TJ as evidence of competence, it may be necessary for the QB to examine the scheme itself[1] from a number of standpoints to determine whether they can accept such certificates at face value or whether they could be used as the foundation for further qualification:

- Training activity and experience requirements for candidates;
- Written examination questions and pass marks;
- Practical examination and its relevance to the inspection in question;
- Independence of the assessment process.

In executing its role in the qualification of personnel, the QB is not responsible for the certification of personnel.

[1] *The information should be included in the training dossier evaluated in the TJ*

3 Personnel Qualification

This section discusses the way in which personnel qualification is carried out when it is judged that more confidence is needed than that provided by a national or organisational based personnel certification scheme. It is assumed, throughout this discussion, that the procedure and the equipment have already been qualified as intrinsically capable of meeting the defined inspection objectives.

The general principles of personnel qualification will be similar for most inspections within each method group, but at the detailed level there will be variations depending on the specific nature of the inspection. Here the TJ plays a very important role in considering all of the features of the inspection and justifies why the proposed training, experience requirements and personnel assessment will ensure that the site inspection procedure is applied reliably. Consequently, the specific method of qualifying the personnel will follow the QB's assessment of the TJ as described below.

Three levels of personnel qualification are recommended for qualified inspections and assessed in the TJ depending on the component:

a) Inspections requiring only ISO 9712 (or similar) certification;

b) Level a) + supervised training / practical trials;

c) Level b) + examinations / interviews / blind trials.

3.1 Human Factors assessment

The TJ for an inspection will identify any factors which might influence the outcome of the inspection because of their effect on the personnel carrying it out. Such factors might include:

- Difficult access involving working in cramped or precarious conditions;
- Obstructions which prevent ready access to all or some of the component under test;
- High temperatures or noise levels;
- The need to wear protective clothing;
- Restricted access times to limit radiation exposure;
- Low signal/noise ratio.

Problems of the kind listed above could be minimized beforehand wherever possible, but often some remain which are intrinsic to the inspection. In such a situation, it is important that any practical trials of the personnel reproduce such factors as closely as possible. If this is not done, there is a danger that the qualification could be unrealistically easier than the real inspection.

It should be noted that the guidance in this section does not address human factors that may have been included in the requirements of the inspection specification and controlled in the TJ.

3.2 Training

Any trials or written examinations that are carried out can only examine a fraction of the range of knowledge needed to be a competent inspector. Confidence that personnel has the required knowledgebase comes from their attendance at a course whose syllabus is sufficiently comprehensive to cover all relevant issues associated with the specific inspection. This may require a training course specially devised and provided for the inspection rather than a more general one. Whatever the utility / inspection vendor determines to be suitable may be justified in detail in the TJ and assessed by the QB. The required training will be clearly identified in the TJ or in a separate training and qualification plan.

Practical trials may be performed on mock-ups, real components or by the use of software simulation tools. The specific tool and the data to be used similarly to the physical pieces proposed could be

assessed by the QB to assure that the requirements of the inspection procedure are fulfilled and that it addresses the requirements of RP6 [6].

3.3 Experience

Previous experience in the application of similar inspection techniques to the one under qualification is often judged necessary. The utility / inspection vendor may determine what is required for the particular inspection and justify it in the TJ for assessment by the QB.

Often staff that develops inspection procedures then goes forward as an inspector requiring qualification. Here, some credit may be claimed that the inspection development exercise could replace some of the training (and examination) requirements. Again such arguments may be made in the TJ.

3.4 Examinations

In certain cases, practical trials alone may not provide a sufficiently rigorous test of the inspector's skills and experience. Written examinations or interviews may therefore help in assessing whether an inspector understands the inspection procedure to be applied. A comprehensive written examination can explore understanding of all aspects of the inspection. Both written examinations and practical trials will be graded and evaluated against standardised and documented pass/fail criteria.

Practical trials may still be needed to give the analyst data specific to the particular inspection to interpret. Guidance in the balance between practical trials and other examination methods may be provided and justified in the TJ.

3.5 Blind trials

The essence of a blind trial is that it aims to present an inspector with all the significant problems that they could encounter in a site inspection. Here, an analysis of the essential parameters presented in the TJ will identify those aspects of the inspection that may be included during the blind trials. Whilst it is not feasible to directly simulate all of these conditions, their effect would normally be considered[2]. For example, the impact of many factors can be simulated by imposing time limits on the blind trials.

Such trials can give confidence that the inspector is capable of applying the written procedure as required and can obtain satisfactory results in practice. The need for realism means that the blind trial test pieces should replicate the actual component as closely as possible, certainly in terms of those aspects of component geometry which pose the greatest inspection problems, but also in other factors affecting the human performance.

As a result of the factors discussed above, it is necessary to differentiate between blind trials for manual inspection and automated inspections. Blind trials for analysts are usually conducted with recorded data. Field conditions will be included by the selection of the data sets for the site specific performance testing. i.e. - some data should have evidence of real field conditions – noise, lift off (ET) etc. In contrast manual inspections must be carried out in representative conditions and the procedure applied in real time.

3.5.1 Blind trial test pieces

This sub-section summarises the basic principles which govern the form that blind trial test pieces should take. Further detailed information is given in RP5 [7].

It is important for the QB to use the information presented in the TJ to understand the particular challenges for the inspector and to represent these as far as possible in the test piece design. This

[2] *The likely field conditions, including space, lighting, temperature and physical constraints (such as fall arrest or breathing apparatus) should be modelled where possible.*

analysis needs to consider all aspects of the inspection from the defect simulations to whether it is necessary to simulate all of the access conditions of the inspection.

The total number of defects included in a test piece is arbitrary. The defect population needs to include both worst-case and non-worst case. The total number of defects will be sufficient, such that a range of defect parameters are covered, to give confidence in the ability of the inspector to detect defects reliably (or for a data analyst to identify all defects in the recorded data in the case of automated inspections). If the defect population is small, any failures would provide relatively low confidence in good detection ability.

The following issues could be considered when designing test pieces[3]:

- Those defects whose response has the smallest margins above the reporting thresholds;
- Defects in the vicinity of geometrical reflectors where a small defect signal may have to be recognised in the vicinity of a large geometrical echo (it may not be practicable for blind trial test pieces to contain sufficient defects that cover all situations which the inspector might encounter in practice);
- Defects locations which require the probe to be located at the extremes of achievable coverage, e.g. due to scan restrictions;
- Defects which are difficult to size, possibly because they are at long range where beams are widest or normal to the beam so there are no range differences between signals from the defect extremities.

However, a range of defect sizes at various through wall percentages with parameters such as orientation and position will ensure that the inspector's ability is assessed for all the situations they might encounter in practice.

Further issues that could be considered in the design and management of test pieces are:

- Defects will be randomly distributed in test pieces so that any regularity in position cannot be used to guide detection.
- The defect population needs to include both worst case and non-worst case defects such that the full defect specification is sampled.
- Test pieces could include areas where there are no defects. so that inspectors cannot rely on seeing defect signals from all parts of the test piece. Such un-flawed sections also assess the ability of the inspector to avoid reporting false calls. In the case of welds, the weld length can be regarded as being made up of inspection zones long enough to contain a defect which can be detected without interference from defects in adjacent zones depending on the inspection method used and the weld geometry.
- Blind trial test pieces should be stored in a secure area, or container, when they are not in use. The area or container should be accessible only to members of the QB or other approved agency performing the qualification testing.
- Blind trial test pieces should be uniquely identified in a permanent way. In some cases it may be beneficial to conceal identification marks when test pieces are presented to inspectors in such a way that test pieces which are nominally identical in external appearance are not distinguishable. Such anonymity adds to confidence that collusion between inspectors has not benefited any of them.
- For the qualification of data analysts, inspection data from the inspection of components or test pieces, ("data only" in electronic or any other format) will be considered as "test pieces".

[3] *Where the analyst and data collection/manipulator operator are distinct roles, ensuring the analyst are aware of field limitations is also important to encourage them to be questioning of suspect data.*

3.5.2 Conduct of blind trials

The principles governing the conduct of blind trials are given below. Further information is given in RP5 [7]. A dedicated, securable space is needed to carry out blind trials. This will contain the test pieces and inspection equipment. Once data has been acquired for automated inspections there is a requirement for office space to conduct the data analysis. In both cases, secure document storage is needed for details of test pieces, data records, candidates' results etc. Secure storage is needed for the blind trials test pieces as discussed above.

Candidates should be briefed by the QB (or the agency approved to perform them) before the trials to ensure they understand the qualification process and how long they have to carry out their inspection. Inspectors should be invigilated by the QB, or designated agent, during the trials to ensure there is no collusion between candidates and that no data is removed from the examination area. This might be either paper records or data recorded on digital inspection equipment.

During blind trials, the QB or designated agent must ensure that inspectors are applying the procedure correctly. The time allowed for the inspection of each test piece must be related to any time restrictions applicable to the real inspection. However, care must be taken in setting time limits as the number of defects the inspector must detect and size will exceed any they are likely to encounter in practice. Consequently, the time allowed for each test piece must provide for this. If there are no fixed time restrictions on the real inspection, an estimate of the time needed can be obtained by using an experienced inspector to apply the procedure and then adopting the time they found to be necessary.

3.5.3 Detection assessment

For assessment of detection, inspectors should be asked to inspect (or review data in the case of automated inspection) a portion of the test piece judged necessary to satisfy the requirements for the blind trial. As discussed above, it is recommended that the defect population presented to the inspector needs to include both worst-case and non-worst case defects, as well as a significant length of un-flawed material. The advantage of only asking an inspector to inspect a portion of the test piece is that there is more opportunity to vary the blind trials between operators in a similar fashion to the use of several physical test pieces.

When marking the results of the defect detection phase, the number of allowable false calls will be set at a level that reflects the requirements of the inspection objectives and the volume of material seen by the inspector in the blind trial.

If it is desired to qualify several inspectors at the same time, sufficient test pieces will be available for this. There may be a greater number of test pieces than the number of inspectors so that some can be held in reserve. It is recommended that any test piece identification marks are blanked out during the trials so that the identity of the test piece is not clear to the inspectors. Collusion during the trials themselves can be avoided by supervision, but measures of the kind discussed above can be beneficial and help to minimise the benefits of any collusion outside the examination area.

A possible improvement over the use of physical test pieces is the use of software and inspection simulation tools for training and blind testing, allowing as many different "test pieces" to be produced as needed.

3.5.4 Sizing and positioning assessment

When personnel are qualified, the procedure and equipment will normally already have been qualified through a combination of TJ and open trials. Qualification of the procedure, equipment and training package (where applicable), will normally have established the sizing and positioning accuracy of the procedure. The primary role of the blind trial for sizing and positioning is to test the inspectors to determine if they are capable of applying the procedure with sufficient proficiency that the claims made in the TJ are valid. Therefore, inspectors should be assessed by comparing the reported positions and sizes of defects with their actual position and size (e.g. ASME specifies a minimum of 10 flaws circumferentially). It is important that tolerances associated with the test piece and the procedure (as reported in the TJ) are taken into consideration during this assessment.

A secondary role of the blind trial is to highlight any disparity between the performance of the procedure as observed during the blind trial compared with the performance reported in the TJ. Any differences in performance may suggest that the results from the open trial need to be reassessed.

A Training and Qualification plan could be used when required.

3.6 Recommended information to include in the qualification dossier in relation to personnel qualification

It is recommended that the following information should be included in the Qualification Dossier:

- The reasoning of the QB (or their representative) for determining the particular form of personnel qualification carried out. This will involve an explanation of why the difficulties posed by the inspection for personnel are appropriately assessed by the qualification approach used.
- Information that demonstrates that each inspector subject to personnel qualification activities meets the certification and experience requirements stated in the TJ.
- Information on written examinations carried out and results for each inspector.
- Information on blind trial test pieces used. If it is intended to use the test pieces again, then information about the defects must be restricted. If the dossier is to be public, only outline information can be included that would be of no benefit to anyone being examined in the future using these test pieces.
- Performance achieved by each inspector/analyst in detection. This could include the number of defects presented to the inspector together with margins of detection achieved and information about any false calls recorded.
- Performance achieved by each operator in sizing/positioning. Comparison with accuracies demonstrated to be possible in procedure/equipment qualification and with the requirements of the inspection objectives.
- Examination papers and inspection reports produced by candidates, unless this information would undermine the future use of test pieces or data.

RP4 provides guidance on the content of a qualification dossier (see [8]).

3.7 Activities following qualification

It is recommended that the following activities should be completed following the completion of a qualification:

- The procedure may need to be modified after blind trials if the trials reveal any difficulties relating to the ability of inspectors/analysts to carry out the procedure in practice. If any changes are in fact made to the inspection procedure then supplementary personnel qualification may be necessary.
- Feedback should be provided on any inspectors who failed aspects of the qualification so appropriate re-training can be completed.
- An opportunity would normally be provided to allow inspectors who received a fail to be re-tested[4] using different test pieces, or test piece areas.

[4] *An appeals process should be in place to allow inspectors who are failed to request redress.*

4 Maintaining Personnel Qualification

The qualification of a NDT system provides a licensee with confidence about the reliability of the inspection results. During this process, the inspection system is subjected to rigorous evaluation.

By introducing personnel qualification requirements, licensees initially establish an individual's proficiency during the NDT qualification process. The qualification process should demonstrate that the inspection personnel have the required capability to correctly apply the procedure, along with the pre-requisite training and NDT certification specified within the inspection procedure. A qualification data base or equivalent can be used to track these qualifications.

When personnel qualification is invoked there is a requirement to consider how personnel re-qualification is managed. Personnel re-qualification is defined to as a process, usually conducted at defined intervals or trigger points (e.g. prior to an inspection), whereby a previously qualified inspector re-confirms his / her competency before an independent QB or other agent with respect to their performance using a qualified inspection procedure. Re-qualification is a separate process from requirements related to re-certification of personnel as defined, for example, under a general NDT certification scheme such as ISO 9712 [3].

It should be noted that it is the responsibility of the individual and his / her employer to maintain the credentials in accordance with the procedures and practices applicable to the qualified procedure and to a quality assurance program.

This section discusses methods for the maintenance of personnel qualification and high level guidance on how such systems could be implemented. Discussion is included on the reasons why personnel re-qualification may or may not be employed, and also describes examples of how a re-qualification programme could be implemented.

4.1 Renewal of personnel qualification

Today, the initial qualification of NDT systems is considered routine and well understood in many countries. Within the countries and organisations currently operating personnel qualification there are a range of solutions to the control of operator proficiency following the successful qualification of personnel. These solutions include:

- A reliance on personnel training and robust QA systems to ensure the maintenance of proficiency - in this case, no time frame is specified between the initial qualifications of the NDT system, including personnel, and the time it is applied by the inspection vendor at the licensee's plant. Similarly there is no statement or restriction on the amount of time allowed between subsequent applications of the qualified NDT system. This approach can be supported and justified on the basis of a strong quality assurance (QA) program to control the customary practices and essential parameters within a qualified NDT system. These include document control, equipment calibration, equipment substitution and personnel training and certification.
- A reliance on personnel re-qualification to ensure the maintenance of proficiency - a specified time restriction is usually placed on the duration of the validity of the personnel qualification, and/or a limit on the length of time between applications of a procedure for the qualification to remain valid. In some cases, the time restrictions are selected based on arbitrary time limits, while in other cases the restrictions are based on regulatory requirements.

In summary, there are several acceptable solutions to the question of maintenance of operator qualifications and proficiency, and a single solution cannot be uniformly applied due to variations in the application of operator qualification across many countries, as discussed in the ENIQ Position paper [9].

Regardless of the solution selected, it is recommended that operator proficiency is controlled via application of programmes of training and QA, and/or time limited personnel qualifications. The particular solution adopted must be acceptable to the licensee, the regulator, and the QB in question.

4.1.1 Variations in the application of personnel re-qualification

Experience has shown that, prior to the qualification practical trials, NDT personnel benefit from training in the application of the procedure and by being given the opportunity to practice using test specimens simulating the inspection application and being similar to those used for the qualification. It can be shown that these actions have a positive impact on the initial qualification results, but whether the proficiency of the inspector at the time of the qualification can be maintained over time is questionable. This question appears to be the primary driver for the re-qualification of NDT personnel.

At any point in time following the initial qualifications, a licensee needs to have assurance of the qualified NDT system, including the personnel, that it can be re-deployed to the same level of reliability as originally demonstrated (e.g. in readiness of emergent needs). That is, a licensee needs to be sure that the proficiency of the personnel involved in qualification is adequate at the time of the inspection.

Although there is often no solid technical basis for fixing a period of time for a given personnel qualification to be valid, a limit is employed in several countries based on reasoned judgement in order to reduce the uncertainty that an individual's skills may have diminished. In this case, a typical figure used in several countries is 5 years, which is consistent with the requirements of ISO 9712 [3] for personnel re-certification. In some cases a frequency could be fixed arbitrarily by practical reasons, e.g. by imposing the requirement to requalify before each outage, or by regulatory requirements.

The reasons for inconsistencies in the application of operator requalification stems from:

- Variation in the regulatory requirements in different countries;
- Historical precedence created from application of processes/systems over a number of years that vary by country;
- The perception that the demands of qualification / re-qualification are too bureaucratic and costly, in regard to achieving the goals of personnel qualification in an efficient manner;
- Lack of useful, or inconsistent, feedback from personnel qualification programmes, partly as a result of the confidentiality of blind trials;
- Concern that differences in the requirements and application of qualification/re-qualification add a substantial barrier for the transport of qualification beyond national borders.

Each country/organisation should decide the requalification scheme to follow bearing in mind the key point is to assure the proficiency of the personnel in every inspection.

4.1.2 Process of personnel qualification renewal

This subsection describes some of the instances when the personnel qualification renewal process should always be considered (e.g. modification of the procedure), as well as examples of cases that could be considered where personnel re-qualification is employed. Examples are also given on how personnel re-qualification could be implemented.

In cases where modifications to the inspection procedure have been made since the original personnel qualification, the QB should assess the significance of such modifications. In many cases it may be judged that the modifications will have no significant bearing on the skills and experience needed to perform the inspection, and that the personnel qualification can simply be re-issued to refer to the latest version of the procedure. Where the inspection procedure modifications are judged to be significant, for example a new defect sizing technique may have been added, then some limited, additional personnel qualification may be needed. It is expected that a TJ will be produced along with the modified procedure to justify the technical changes and such a TJ could also justify the proposed method of retraining and reassessment for personnel.

There are some situations where the original personnel qualification may be considered to be expired and needs renewal. For example:

- Regulatory requirements, e.g. in Switzerland, Sweden and Spain. In some cases, the regulatory authority may demand periodic re-qualification;

- Personal experience where the results from a re-qualification were not favourable;
- A perception that an individual's experience declines following the qualification;
- Existing QA Programs;
- The appearance of new defects in a component or a specific area;
- Re-qualification after a fixed pre-determined period (e.g. 5 years). The period should ideally be carefully selected such that the fixed period meshes well with the inspection interval (e.g. a 5 year period would not be efficient if the inspection interval is 3 years).

It is important that a distinction is made between instances where personnel requalification may be required as a result of extraordinary circumstances (e.g. modification of a procedure or the failure of a procedure to detect a defect), and those instances where re-qualification is required as a result of particular systems for the implementation for personnel re-qualification (e.g. arbitrary time limits on personnel qualifications). The latter case will only be applicable where personnel re-qualification is applied.

The exact mechanism and principles for defining what renewal activities will vary but may include:

- The use of personnel experience of applying the procedure in question as a basis for re-qualification in lieu of practical tests - the ongoing involvement of the inspector in the specific inspection could be used to reduce the activities of the renewal process. For example, if, following the original qualification, the inspector has been performing the inspection on a regular basis, and there is some evidence of their performance during this interval, then it may be acceptable for the QB to extend the inspector's qualification for a further interval in lieu of a practical test. Here the proposals for renewal could be made by the employer/plant operator and assessed by the QB.
- Grouping of personnel qualifications across similar procedures to reduce the cost and effort associated with qualification and re-qualification - the inspector may not directly apply the specific procedure for which the renewal is sought but is involved in similar inspections on similar plant. Evidence of this experience could be used by the employer/plant operator to reduce the scope of any qualification renewal activities.
- The use of periods of documented training in the application of the procedure in question as a basis for re-qualification in lieu of practical tests - for example, the renewal process could consist of refresher training with a simple practical demonstration of the inspector's capability.
- Re-qualification of the personnel via examination - in the case where the inspector has not been routinely involved in applying the specific or similar inspections, then the full range of activities undertaken during the original qualification may be necessary. This range of activities could be reduced in scope compared to the original qualification in recognition that the objective is simply to check for proficiency fade rather than trying to demonstrate that the skill of the inspector is at the level required by the procedure in all areas.

The principles applicable to each individual case would normally be stated and substantiated in the TJ. It may be advisable to also clearly define the actions to be taken after a fail in a re-qualification test to avoid questioning of former inspections.

In general an inspection fulfilling all the requirements of a qualified procedure (including personnel qualification requirements) can be considered as reliable, and future modifications in the skills of an inspector should generally not undermine confidence in the reliability of historical applications of a procedure, unless there is evidence otherwise.

5 Technologies to Improve Non-Destructive Testing Inspectors Proficiency

This section discussed technologies that can be employed as a means to improve inspector proficiency or reduce the cost of personnel qualification/re-qualification.

5.1 Tools for Training and/or qualification

5.1.1 Computer based training

These technologies are related to modelling of the physical phenomena involved in NDT addressed in RP6 [6]. Computer based training (CBT) are tools with great potential for maintaining or improving proficiency of personnel involved in NDT [10]. They are able to improve the diagnostic reliability and reduce cost. They are capable of successfully substituting physical pieces and equipment, either by simulating inspection data on a computer or displaying simulated data using realistic inspection equipment and probes.

Through the use of CBT simulators the operator can follow a training program at their own pace and in the areas of interest [11]. A common platform is required that allows ease of access / delivery, material updates and uses simulation technologies

In the future it may be possible to validate a CBT for training or replacing the practical requalification approach[5]. However, to data there is no universally agreed method for validating such systems, and the essential parameters related to human factors and their impact on reliability during qualification and in-service inspection.

5.1.2 Virtual specimens

It is already possible to record data from test specimens or from field inspections and insert the data into “Virtual test specimens” [12]. This kind of specimens has several advantages over the physical ones: they are less expensive and much faster to produce (providing specimens are available to record the data from), and only require a secure computer drive for storage, and are easy to transport in comparison.

Simulators equipped with “virtual test specimens” provide opportunities to share the knowledge and lessons learned with other stakeholders, by transferring operations experiences in an easy way. These specimens can be also used also for training or qualification of new procedures.

Standards need to be developed for data collection from traditional test specimens and use by UT simulators.

5.2 Computer Assisted Data Analysis

As more advanced inspection technologies are employed, larger volumes of data can be generated for interpretation. The burden of inspecting large quantities of inspection data can lead to errors due to inspector fatigue, and in the worst case a flaw could be missed without adequate controls. Software tools can be used to help data analysts by drawing their attention to particular areas of the dataset or even automating the analysis completely. The use of such a tool within the European methodology is permissible provided that the tool is adequately validated within the TJ, and may provide benefits via cost or time reductions during inspection qualification.

[5] *As an example in 2018 EPRI will replace the traditional practical requalification approach for manual ultrasonic operators with a process where simulators are a tool that can be used to maintain proficiency.*

6 Roles and Responsibilities

This section discusses the roles of the parties involved in personnel qualification and summarises the recommended requirements for records relating to such activities.

The judgement on what form of personnel qualification, if any, is appropriate will be made in the first instance by the plant owner / vendor. Whatever decision is reached will need to be justified and the reasoning included in the TJ for consideration by the QB. This will include an analysis of the difficulties of the inspection for personnel and the reasons why the approach to demonstrating personnel competence is appropriate to these problems.

The role of the inspection vendor is to:

- Propose personnel qualification / certification requirements taking into account potential environmental conditions (Human factors) and justify these in the TJ;
- Define the requirements for personnel qualification, set this out in the qualification plan, and justify it in the TJ;
- Provide records of personnel to be used including certification possessed and experience. Personnel records may also include any internal training or certification courses completed;
- Determine inspection-specific training requirements and implement these;
- Determine additional training requirements for inspectors who fail their initial attempt.

The QB will assess the TJ and the proposed personnel qualification included and, if so, what form it could take including the training packages. The QB will also assess the pre-requisite certification and experience requirements stipulated in the inspection procedure and determine whether these are sufficient. This will be done as part of the assessment of the TJ. The exact responsibilities of the QB will vary depending on how personnel qualification is implemented.

In summary, the role of the QB may include:

- Assess the requirements for personnel qualification (experience, training, practical trials, etc.);
- Assess how personnel will be qualified;
- Witness personnel training, if appropriate;
- Conduct any written examinations;
- Design blind trials test pieces and manage test piece manufacture;
- Conduct blind trials;
- If inspectors fail, provide feedback on the performance of the individual and their employer so that further training can be addressed;
- Maintain security of information;
- Administer secure storage of blind trial test pieces and records relating to them.

It is emphasised that, in executing its role in the qualification of personnel, the QB is not responsible for the quality of the actual site inspection.

6.1 Personnel qualification records

A record of successful candidates should be issued and maintained by the QB (or the agency approved to represent them). This record is usually in the form of an issued certificate to the inspector or as information stored in a database. It is recommended that the record contains the following information:

- Inspector’s name and company affiliation;

- Inspection procedure and function for which they are qualified;
- Qualification procedure used to qualify them;
- Duration of validity of the qualification;
- Any requirements to maintain the validity of the qualification, e.g. continuing training or regular practical application;
- The means by which the qualification is renewed following its expiry;
- Grounds for withdrawal of qualifications;
- Any caveats or restrictions on the personnel qualification, for example the inspector may pass detection and not sizing.

Alternatively, some of the above information could be recorded and communicated as part of the QBs quality system and referenced on the certificate/database, e.g. standardised requirements for maintaining or renewing qualifications.

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ABOUT NUGENIA AND ENIQ

NUGENIA is an international non-profit association under Belgian law established in 2011. Dedicated to the research and development of nuclear fission technologies, with a focus on Generation II & III nuclear plants, it provides scientific and technical basis to the community by initiating and supporting international R&D projects and programmes. The Association gathers member organisations from industry, research, safety organisations and academia.

The activities of NUGENIA cover plant safety & risk assessment, severe accidents, reactor operation, integrity assessment and ageing of systems, structures & components, development of fuel, waste & spent fuel management & reactor decommissioning, innovative light water reactor design & technologies, harmonisation and in-service inspection & their qualification.

The European Network for Inspection and Qualification (ENIQ) is a utility driven network working mainly in the areas of qualification of non-destructive testing (NDT) systems and risk-informed in-service inspection for nuclear power plants. Since its establishment in 1992 ENIQ has issued over 50 documents. Among them are the “European Methodology for Qualification of Non-Destructive Testing” and the “European Framework Document for Risk-Informed In-Service Inspection”. ENIQ is recognised as one of the main contributors to today’s global qualification guidelines for in-service inspection. ENIQ became Technical Area 8 of NUGENIA in 2012.

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