IN-SERVICE INSPECTION OF NUCLEAR FACILITY PRESSURE EQUIPMENT WITH NON-DESTRUCTIVE TESTING METHODS

1	Introduction	5
2	Scope of application	5
3	In-service inspections	6
3.1	In-service inspection requirements, documents and their updates	6
3.2	Plan for principles of in-service inspections	7
3.3	Pre-service inspection plan	9
3.4	Summary programme for in-service inspections	10
3.5	Individual in-service inspections	11
3.5.1	Inspection programme for an inspection interval	11
3.5.2	Inspection plan for operation period	12
3.6	Updating of the summary programme for in-service inspections and individual in-service inspection programmes	12
3.7	Exceeding a threshold set in the acceptance standard	13
3.8	Reporting of results of in-service inspections	14
3.8.1	Results of pre-service inspections	14
3.8.2	Results of in-service inspections	14
4	Risk-informed selection process for the in-service inspections of piping	15
4.1	General	15
4.2	Area of application of the risk-informed in-service inspection programme for piping	16
4.3	Risk-informed selection process documents	16
4.4	Collection and analysis of input information	17
4.5	Assessment of consequences of pipe failure	17

continues

With regard to new nuclear facilities, this Guide shall apply as of 1 June 2014 until further notice. With regard to operating nuclear facilities and those under construction, this Guide shall be enforced through a separate decision to be taken by STUK. This Guide replaces Guide YVL E.5, 15 November 2013.

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4.6 Specification and assessment of piping failure potential 17
4.7 Risk categorisation 17
4.8 Selection of inspection areas 18
4.9 Assessment of risk effects posed by updates to the inspection programme 18
4.10 Long-term management of the risk-informed in-service inspection programme 18

5 General requirements for inspection system qualifications, organisation, strategy plans and qualification body 19

5.1 General qualification requirements 19
5.2 Organisation of qualifications, strategy plan and procedures 19
5.3 Qualification body 20
5.3.1 Fundamental requirements and tasks of qualification body 20
5.3.2 Personnel of the qualification body 21
5.3.3 Qualification body's quality manual 22
5.3.4 Approval of a qualification body 22

6 Qualification activities 23

6.1 Qualification process 23
6.2 Qualification dossier 23
6.3 Qualification input information 24
6.4 Qualification procedure 26
6.5 Technical justification 26
6.5.1 General 26
6.5.2 Essential parameters 27
6.6 Practical trials 28
6.6.1 Test pieces 28
6.6.2 Implementation of practical trials 29
6.6.3 Assessment of the results of practical trials 30
6.7 Qualification of inspection personnel 30
6.8 Qualification assessment report 31
6.9 Qualification certificates 31
6.9.1 Issue of qualification certificates 31
6.9.2 Withdrawal or review of qualification certificates 32
6.9.3 Licensee's obligations 32
6.10 Archiving of qualification documentation and storage of test pieces 33

7 Regulatory oversight by the Radiation and Nuclear Safety Authority 33

7.1 Control in general 33
7.2 Plan for principles of in-service inspections 33
7.3 Control of pre-service inspections 34
7.4 Summary programme for in-service inspections 34
7.5 Control of individual in-service inspections 34
7.6 Control of the risk-informed selection process 35
7.7 Control of qualifications 35
7.8 Control of document updates 36

Definitions 36

References 42

ANNEX A Document diagram for in-service inspections 43

ANNEX B Evaluation of inspection results 44

ANNEX C Qualification process for inspection system 45

ANNEX D Qualification body 46

ANNEX E Contents of the qualification procedure 47

ANNEX F Contents of the technical justification 48

Authorisation

According to Section 7 r of the Nuclear Energy Act (990/1987), *the Radiation and Nuclear Safety Authority (STUK) shall specify detailed safety requirements for the implementation of the safety level in accordance with the Nuclear Energy Act.*

Rules for application

The publication of a YVL Guide shall not, as such, alter any previous decisions made by STUK. After having heard the parties concerned STUK will issue a separate decision as to how a new or revised YVL Guide is to be applied to operating nuclear facilities or those under construction, and to licensees' operational activities. The Guide shall apply as it stands to new nuclear facilities.

When considering how the new safety requirements presented in the YVL Guides shall be applied to the operating nuclear facilities, or to those under construction, STUK will take due account of the principles laid down in Section 7 a of the Nuclear Energy Act (990/1987): *The safety of nuclear energy use shall be maintained at as high a level as practically possible. For the further development of safety, measures shall be implemented that can be considered justified considering operating experience, safety research and advances in science and technology.*

In accordance with Section 7 r(3) of the Nuclear Energy Act, *the safety requirements of the Radiation and Nuclear Safety Authority (STUK) are binding on the licensee, while preserving the licensee's right to propose an alternative procedure or solution to that provided for in the regulations. If the licensee can convincingly demonstrate that the proposed procedure or solution will implement safety standards in accordance with this Act, the Radiation and Nuclear Safety Authority (STUK) may approve a procedure or solution by which the safety level set forth is achieved.*

Translation. Original text in Finnish.

1 Introduction

101. The purpose of non-destructive in-service testing of a nuclear facility's pressure equipment is to ensure that pressure equipment maintains its integrity, and that any failures developing in it is observed before it can cause a risk to nuclear safety. This Guide sets forth the requirements that apply to the planning, qualification, performance, reporting and supervision of non-destructive in-service tests in all stages of the nuclear facility's life cycle, from design to decommissioning.

102. By virtue of the Nuclear Energy Act (990/1987) [1] and as stipulated in Section 117 of the Nuclear Energy Decree (161/1988) [2], the Finnish Radiation and Nuclear Safety Authority (STUK) determines the requirements that apply to the measures and procedures that fall under the licensee's responsibility in terms of ensuring the safety of nuclear facilities' pressure equipment. By virtue of the Nuclear Energy Act, STUK also monitors the fulfilment of these requirements.

103. According to Section 26 of the Government Decree on the Safety of Nuclear Power Plants (717/2013) [3], *systems, structures and components important to the safety of a nuclear power plant shall be available as detailed in the design basis requirements. Their availability and the impact of the operating environment shall be supervised by means of inspections, tests, measurements and analyses. Availability shall be confirmed in advance by means of regular maintenance, and preparations shall be made for maintenance and repair to avoid reduced availability. Condition monitoring and maintenance shall be designed, instructed and implemented in a manner that can reliably ensure the integrity and operability of the systems, structures and components throughout their service life.*

2 Scope of application

201. This Guide presents the requirements for the planning, qualification, implementation, reporting and supervision of the in-service inspections performed on the pressure equipment of nuclear power plants using non-destructive testing methods.

- Inspections shall be performed on pressure equipment belonging to safety classes 1 and 2, other pressure equipment that is considered significant in terms of nuclear safety, and for the flywheels of the main circulation pumps.
- The piping in-service inspection programme shall be prepared in a risk-informed manner, analysing all of the nuclear facility's systems in safety classes 1, 2, 3, and EYT (non-nuclear) as a single complex independently of the safety classifications and nominal dimensions of the piping.
- The inspection systems shall be qualified.

202. If the primary objective of the in-service inspections mentioned above is to discover failures other than crack-like defects, the licensee may take care of the inspections according to its condition monitoring programmes discussed in Guide YVL E.3.

203. An up-to-date probabilistic risk assessment that meets the requirements of Guide YVL A.7 shall be used when drawing up the risk-informed piping in-service inspection programme.

204. If qualifications are required for the manufacturing inspections of a nuclear facility's mechanical equipment and structures, such as the final disposal canisters for spent nuclear fuel, they shall be performed by applying this Guide.

205. This Guide shall apply to licence applicants, licensees, plant suppliers, qualification bodies, and testing organisations.

206. This Guide covers all stages of a nuclear power plant's life cycle, from design to decommissioning.

207. The requirements and supervision of other in-service inspections (periodic inspections) of pressure equipment are presented in Guides YVL E.3 and E.8. Furthermore, Guides YVL E.9, E.10 and E.11 set forth the requirements for in-service inspections to be carried out on mechanical equipment other than pressure equipment. The inspections shall be conducted by STUK or an inspection body approved by STUK in accordance with the division of inspection responsibilities presented in Guide YVL E.1. Guide YVL E.12 sets forth the requirements for the testing organisations and testing personnel.

3 In-service inspections

3.1 In-service inspection requirements, documents and their updates

301. This chapter sets forth the requirements for in-service inspections performed on pressure equipment using non-destructive testing methods, the primary purpose of which is to detect, characterise and size in time the crack-like defects endangering safety that have developed during operation in nuclear safety-significant pressure equipment.

302. The basic requirement level of in-service inspections shall be the standard ASME Boiler and Pressure Vessel Code, Section XI, Rules for In-service Inspection of Nuclear Power Plant Components, Division 1, (ASME Code, Section XI) [4]. Deviations from the Code shall be justified and it shall be demonstrated that a corresponding level of safety and reliability can be achieved.

Supplementary guidelines concerning the procedures are provided in the International Atomic Energy Agency's guide document IAEA Safety Standards Series No. NS-G-2.6, Maintenance, Surveillance and In-service Inspection in Nuclear Power Plants [5], and the Western European Nuclear Regulators' Association's (WENRA) reference document WENRA Reactor Safety Reference Levels, January 2008, Issue K: Maintenance, In-service inspection and Functional Testing [6]; the requirements in these documents shall be met.

303. The flywheels of main coolant pumps shall be inspected. The justification and instructions for the inspections are provided in the reference U.S. NRC Regulatory Guide 1.14 Reactor Coolant Pump Flywheel Integrity [7].

304. The risk-informed in-service inspection programmes for piping shall be drawn up on the basis of the risk-informed selection process presented in chapter 4.

305. The systems used for surface inspections and volumetric inspections during the pre-service and in-service inspections shall be qualified according to the qualification requirements set forth in chapters 5 and 6 of this Guide. Similar principles may also be applied in the qualification of visual inspection systems.

306. The testing organisations performing non-destructive in-service testings and their testing personnel shall be approved by STUK pursuant to Guide YVL E.12.

307. The scope and manner of performance of in-service inspections shall be defined in the following documents:

- Plan for principles of in-service inspections
- Summary programme for in-service inspections
- Risk-informed selection process
- Inspection qualification documents
- Pre-service inspection plan
- In-service inspection programme for an inspection interval
- Inspection plans for operation periods

308. All in-service inspection results shall be reported.

309. According to Section 7 e of the Nuclear Energy Act (990/1987) [1], *compliance with requirements concerning the safety of a nuclear facility shall be proven reliably.*

310. According to Section 9 of the Nuclear Energy Act (990/1987) [1], *it shall be the licensee's obligation to assure safe use of nuclear energy. This obligation cannot be delegated or transferred to another party.*

311. It shall be the licensee's obligation to draw up a summary of justifications for each in-service inspection document submitted to STUK for approval, and enclose it with the document.

312. The licensee shall draw up the summary of justifications for the document in a manner where it is a good and convincing argument and answers the question of why the licensee expects

STUK to approve the document; see "Argumentti ja kritiikki" [8].

313. The licensee shall demonstrate the acceptability of the document and the actions presented therein by means of the argumentative summary.

314. The licensee shall demonstrate the scope and thoroughness of its own inspection proceedings with the summary of justifications.

315. The licensee shall present the following issues as part of its argumentation in the summary of justifications:

- A summary of the matter submitted for approval, the planned actions and any deadlines.
- Procedures to approve issues that are outside the scope of application of the document but that are essential for the approval of the matter.
- The connections of the document to other in-service inspection and qualification documents, the history and future of in-service inspections, and references to letters from the licensee and STUK.
- References to other issues that are essential for the processing of the matter.
- As part of the argumentation, factual justifications and references to statutes and standards as justification of the acceptability of the document and the actions presented therein.

316. Any references to statutes, standards, and recommendations used in the preparation shall be unambiguous; references to names and chapters of standards are acceptable, for example.

317. The licensee shall maintain and update the in-service inspection documents in line with the requirements set forth in the appropriate subsections 3.2 and 3.6 and in chapter 4.

318. The diagram in Annex A illustrates the in-service inspection documents and their updates.

3.2 Plan for principles of in-service inspections

319. Section 35 of the Nuclear Energy Decree (161/1988) [2] stipulates that an applicant shall submit a plan for principles of in-service inspections to STUK together with the application for a construction licence.

320. The plan for principles of in-service inspections shall demonstrate that the prerequisites for comprehensive and qualified in-service inspections have been planned for all stages of the nuclear facility's life cycle, from design to decommissioning.

321. The plan for principles of in-service inspections shall be drawn up in a manner where it covers all components and structures in safety classes 1 and 2 as well as others considered important to nuclear safety, such as pressure vessels, pumps, piping, valves and their supports, reactor pressure vessel internals, the flywheels of main coolant pumps, and the inspection areas of piping that have been selected in a risk-informed manner.

322. The licence applicant shall draw up the plan for principles of in-service inspections such that it can be used as the basis for drawing up the pre-service inspection plan (subsection 3.3) and enabling the updating of its contents into a summary programme (subsection 3.4).

323. Together with the construction licence documents, the licence applicant shall submit to STUK for information a document that presents the principles for drawing up a risk-informed in-service inspection programme for the piping, and the preliminary methodology description and indication of source materials for the risk-informed selection process.

324. The plan for principles of in-service inspections shall be drawn up in a manner connecting it to the construction project management of the nuclear facility.

325. The licence applicant shall include in the plan for principles a description of the in-service inspection document system in order to demonstrate that the document system created is clear and unambiguous to all parties. The plan for principles shall include the plans for the main contents of the in-service inspection documents, and the following individual documents shall be named:

- Plan for principles
- Preliminary methodology description of the risk-informed selection process
- Pre-service inspection plan
- Summary programme
- In-service inspection programme for an inspection interval
- Inspection plans for the operation period
- Notifications of inspections completed
- Summary reports of inspection results
- Qualification documents
- Drawings
- Inspection procedures.

326. In the plan for principles, the licence applicant shall demonstrate the following:

- The preparedness of the licence applicant and plant supplier to begin preparations for the pre-service inspection plan immediately after the construction licence has been granted
- The preparedness of the licence applicant, plant supplier and qualification organisation to begin the qualifications of the in-service inspection systems immediately after the construction licence has been granted.

327. In order to demonstrate the preparedness for drawing up the pre-service inspection plan and for starting the qualifications, the plan for principles of in-service inspections shall present the following issues:

a. A schedule for the construction stage presenting the link between the qualifications and the timing of the pre-service inspections, and the delivery times for the in-service inspection documents
   - The timing of the construction licence, operating licence and commissioning, and the links between them
   - Proposal for the delivery time of the pre-service inspection plan, or, if prepared in parts, proposals for the delivery times of the parts
   - The delivery times for the summary programme, the summary reports for the pre-service inspection results and the inspection programme for the first inspection interval
   - The starting time of the pre-service inspections, or, if performed in parts, the starting times of the parts.

b. Those principles and assessment criteria based on which the updating and development of the pre-service inspection plans and other inspection programmes are administered and according to which components and their inspection areas are chosen, such as the following:
   - Preparation and acceptance procedure of inspection programmes
   - General principles for selecting the areas, methods, extent and intervals of inspection
   - Preliminary methodology descriptions of the risk-informed methods and selection processes that are used in the drawing up of the risk-informed in-service inspection programme for piping
   - Procedures for reporting inspection results and evaluating flaw indications

c. Any deviations from the requirement level of ASME Code, Section XI [4] and justification for their acceptability

d. The main components in the primary and secondary circuits and the flywheels of main coolant pumps subjected to in-service inspection
   - Inspection categories, ASME Code, Section XI [4]
   - Principles of inspection
   - Inspectability (material, geometry, accessibility)

e. Qualification principles for inspection procedures, equipment and personnel
   - Named qualification body
   - Demonstration of preparedness to collect the qualification input information and draw up the input information document
   - Plan for reserving material for the qualification test pieces

f. Drawings required to indicate the inspection areas
   - Diagrams of main components and structures (with inspection areas marked on them)
   - Flow charts with safety classes.

328. The licence applicant shall supplement and specify the contents of the plan for principles of in-service inspections during the construction stage in a manner that allows for the best possible information to be always available for drawing up the pre-service inspection plans and the summary programme. The contents shall be updated in a manner that makes it possible for project management to utilise it during the construction stage of a nuclear facility.

329. In the updated document that corresponds to the plan for principles in terms of content, the licence applicant shall present the updated principles and assessment criteria for the pre-service inspection plan and the methods for reporting the pre-service inspection results and assessing the flaw indications.

330. The updated document corresponding to the plan for principles in terms of content shall be submitted to STUK for information no later than two years before the pre-service inspections are started.

331. The diagram in Annex A provides a visual representation of the plan for principles within the set of documents.

3.3 Pre-service inspection plan

332. The licensee shall submit the pre-service inspection plan for a new nuclear plant unit to STUK for approval no later than six months before the planned date of inspection, unless other deadlines have been approved for the delivery in a justified manner.

333. The purpose of pre-service inspections is to provide basic comparative data for the in-service inspections and obtain data supplementing manufacture and installation quality control about the original condition of the components inspected within the in-service inspection scope. As far as possible, the inspections shall be conducted using the same methods, techniques and types of inspection equipment as are intended to be used in individual in-service inspections.

The pre-service inspection plan and summary programme shall be used to draw up the in-service inspection programmes for an inspection interval (subsection 3.5.1) and the in-service inspection plans for the operating period (subsection 3.5.2.).

334. During construction and in order to enable dealing with the pre-service inspection plan, the licensee shall submit to STUK for approval an updated method description for the risk-informed selection process of the in-service inspections for piping.

335. The licensee shall submit the results of the risk-informed selection process to STUK for information together with the pre-service inspection plan.

336. The pre-service inspection plan for piping shall be drawn up on the basis of the results of the risk-informed selection process to cover the piping structural elements that have been identified as the most important to safety. The inspections shall be carried out before the facility is commissioned, in the manner described in the ASME Code, Section XI, Nonmandatory Appendix R, Risk-informed Inspection Requirements for Piping, Table R-2500 [4]. The risk-informed selection process is discussed in chapter 4.

337. Pre-service inspections shall also be performed during operation, whenever an area inspected in a component or structure within the inspection scope is repaired, modified or replaced.

338. Special attention shall be paid to the usability of the pre-service inspection plan, as it will be one of the fundamental documents in the stages of the nuclear facility's life cycle, from construction to decommissioning.

339. The pre-service inspection plan document shall include the following matters in clear and unambiguous language with source references:

a. Project plan for on-site organisation of inspections
   - Description of plant site organisation and organisation chart
   - Testing organisations and other inspection parties
   - Testing organisation-specific project plans
     - A description of the inspection
     - Prerequisites for inspections, such as the documents required at the plant site, and the preparations required from the licensee and testing organisation

- The tasks, authorities and duties of persons
- Contact between the parties in the inspection
- The technical and administrative processing of flaw indications and other deviations
- The reporting of inspection results

- The inspection responsibilities of each testing organisation
- Schedules
- Description of the qualification of the testing personnel (chapters 5 and 6).

b. List of inspection areas
- Component/structure identification
- Safety class
- Unambiguous specification of welded joints and other areas inspected (with the necessary references to drawings)
- Nominal dimensions of the inspection area
- Structural material
- Inspection category in accordance with ASME Code, Section XI [4]
- References to the results of the piping inspection's risk-informed selection process by area inspected; degradation mechanism, failure category, consequence category, and risk category
- Special failure sensitive areas of pressure equipment
- Inspection method
- The inspection procedure
- Limitations on inspection.

c. Description and detailed justification for the selection of inspection areas based on the piping inspection's risk-informed selection process and its results

d. Drawings of inspection areas
- Flow charts indicating inspection areas by safety class;
- Drawings of piping, components and structures with inspection areas marked on them
- Detailed drawings of welded joints and other inspection areas, indicating the geometry and dimensions of each area

e. Inspection procedures
- Description of the qualification of the procedures, with references to qualification documents and STUK's approval decisions

f. Information concerning inspection equipment
- Description of the qualification of the equipment, with references to qualification documents and STUK's approval decisions

g. Any deviations from the requirement level of ASME Code, Section XI [4] and justification for their acceptability.

340. The above information shall be given on inspections carried out during manufacture and installation if they are to replace some of the pre-service inspections. As far as possible, the inspections shall be conducted using the same methods, techniques and types of inspection equipment as are intended to be used in individual in-service inspections.

341. The pre-service inspections of pressure vessels shall be performed after the pressure test. If the operating temperature of a support welded on the pressurised frame varies greatly and the thermal stress is therefore high, STUK recommends that the inspections be performed after loading the structure with the operating values for pressure and temperature.

342. The licensee shall submit to STUK for information the preliminary inspection schedule for the pre-service inspections of the main components or parts thereof, and appoint a contact person to allow STUK's inspectors to supervise the practical inspection activities on site. STUK shall designate those areas of inspection for which the exact starting time of the inspection must be given.

343. The diagram in Annex A provides a visual representation of the pre-service inspection plan within the set of documents.

3.4 Summary programme for in-service inspections

344. Section 36 the Nuclear Energy Decree (161/1988) [2] stipulates that the applicant shall submit a summary programme for periodic inspections to the Radiation and Nuclear Safety Authority when applying for an operating licence.

345. The licensee shall draw up the summary programme in a manner where it covers all components and structures in safety classes 1 and 2 as well as others considered important to nuclear safety, such as pressure vessels, pumps, piping, valves and their supports, reactor pressure vessel internals, the flywheels of main coolant pumps, and the inspection areas of piping that have been selected in a risk-informed manner.

346. Special stresses and loadings caused by two-phase flow barriers, locations of temperature mixing/stratification and other such areas of equipment and piping important to safety shall be taken into account when determining the inspection scope and intervals, whenever these loads cannot be reliably defined during design. The procedures shall be presented in the summary programme.

347. The principles governing the selection of areas of inspection and the methods and frequency of inspection, as well as the procedures for reporting and evaluating inspection results and flaw indications, shall be presented in the programme for all stages of the nuclear facility's life cycle, from design to decommissioning.

348. The summary programme, which in essence is a supplement to the plan for principles, shall include the updated contents of the plan for principles and the following issues:

a. Those methods based on which the updating and development of the programme are administered, and according to which components and their inspection areas are chosen, such as the following:
   - Preparation and acceptance of programmes
   - General principles for selecting the areas, methods, extent and intervals of inspection
   - Methodology descriptions of the risk-informed methods and selection processes that are used in the drawing up of the risk-informed in-service inspection programme for piping
   - Procedures for reporting inspection results and evaluating flaw indications
b. Any deviations from the requirement level of ASME Code, Section XI [4] and justification for their acceptability
c. A list of the components and structures to be inspected
   - System
   - Safety class
   - Pressure vessels, pipelines, pumps and valves to be inspected, with their component identifications
   - Inspection categories, ASME Code, Section XI [4]
   - Structural material
   - Principles of inspection.
d. The mechanisation principles of the inspection equipment of the reactor pressure vessel and other main components
e. Qualification principles for inspection procedures, equipment and personnel
f. Drawings required to indicate the inspection areas
   - Structural drawings of components and structures with a high risk significance (with inspection areas marked on them)
   - Flow charts with safety class limits (with inspection areas marked on them).

349. The summary programme and pre-service inspection plan shall be used to draw up the in-service inspection programmes for an inspection interval (subsection 3.5.1) and the inspection plans for the operating period (subsection 3.5.2).

350. The diagram in Annex A provides a visual representation of the summary programme within the set of documents.

3.5 Individual in-service inspections

3.5.1 Inspection programme for an inspection interval

351. The licensee shall submit the inspection programme for the first in-service inspection interval of a new nuclear facility to STUK for approval no later than one year before the first planned refuelling outage.

352. The programmes for the following inspection intervals shall be submitted to STUK for approval no later than one year before the end of the previous inspection interval.

353. An in-service inspection programme for an inspection interval refers to an updated inspection programme that has a scope of one inspection interval, such as ten years. The programme for each inspection interval shall present the inspections selected for performance during the inspection interval in question, and the inspection procedures and other documents to which changes have been introduced after the previous interval. The requirements of the pre-service inspection plan given in subsection 3.3 apply to the drawing up of the in-service inspection programme for an inspection interval.

The inspection programme for an inspection interval may be combined with the updated summary programme for in-service inspections.

354. For piping, the in-service inspection programme for an inspection interval shall be drawn up on the basis of the risk-informed selection process presented in chapter 4. The programme shall be updated according to subsection 3.6.

355. The updated results from the risk-informed selection process corresponding to the scope of the in-service inspection programme for an inspection interval shall be submitted to STUK for information together with the submittal of the programme for the inspection interval.

356. The piping in-service inspection programme for an inspection interval shall cover the piping structural elements for which in-service inspections are required under ASME Code, Section XI, Nonmandatory Appendix R, Risk-informed Inspection Requirements for Piping, Table R-2500 [4] and the results of the risk-informed selection process.

357. The diagram in Annex A provides a visual representation of the programme for an inspection interval within the set of documents.

3.5.2 Inspection plan for operation period

358. The in-service inspection plans for operation periods shall be drawn up such that, during inspection intervals, the required number of inspections are completed in accordance with the summary programme and the programme for an inspection interval.

359. The in-service inspection plan for operation period shall be submitted to STUK for approval no later than one month prior to the planned inspection date. The planned inspection date is usually the date when the outage of the nuclear plant unit in question starts.

360. The in-service inspection plan for an operation period shall be drawn up on the basis of the requirements presented for the pre-service inspection plan in subsection 3.3.

361. The plan for each inspection shall present the inspections performed and the references to the inspection procedures used as well as their qualifications.

362. The in-service inspection plan for an operation period shall take into account the requirements for updating presented in subsection 3.6.

363. Short descriptions – length, height and position – of flaw indications to whose monitoring shorter than normal inspection intervals are applied shall be given in the inspection plan, and reference shall be made to previous documents concerning them that have been submitted to STUK.

364. The licensee shall submit to STUK for information the preliminary inspection schedule for the in-service inspections of the main components or parts thereof, and appoint a contact person to allow STUK's inspectors to supervise the practical inspection activities on site. STUK shall designate those areas of inspection for which the exact starting time of the inspection must be given.

365. The diagram in Annex A provides a visual representation of the in-service inspection plan for an operation period within the set of documents.

3.6 Updating of the summary programme for in-service inspections and individual in-service inspection programmes

366. The renewal of the operating licence and the periodic safety review are mainly based on the documents referred to in Section 36 of the Nuclear Energy Decree (161/1988) [2], such as the summary programme for in-service inspections. They shall be continuously kept up-to-date, and the updated versions shall be submitted to STUK regularly.

367. The licensee shall assess the need for updating the summary programme for in-service inspections and the individual in-service inspection programmes and procedures due to the following and other reasons:

- Re-evaluation of the risk-informed selection process (chapter 4)
- Changes in standards and requirements
- Improved inspection techniques
- Inspection experience
- Feedback on the qualification system
- Nuclear facility operating experience in Finland and elsewhere.

368. When risk-informed methods are used in the selection of the inspection areas, the needs for change in inspection areas brought about by plant modifications or changes in the probabilistic risk assessments shall be assessed.

369. The updates to the risk-informed in-service inspection programme for piping shall be submitted to STUK for approval.

The maintenance and updating of risk-informed in-service inspection programmes is discussed in the report Discussion Document, Updating of Risk-Informed Inspection Programmes, ENIQ Report No 37, 2009, EUR 23929 EN [9].

370. The diagram in Annex A provides a visual representation of the updating of the in-service inspection documents.

3.7 Exceeding a threshold set in the acceptance standard

371. If a flaw indication exceeds the threshold specified in the acceptance standard, the licensee shall take necessary measures. These include repairs, structure replacements and risk analyses including fracture mechanical analyses that may result in complementary inspections, extended inspection scopes, tightened inspection intervals and special measures to prevent and monitor flaw growth, or combinations thereof.

372. An assessment of the mechanisms affecting flaw generation shall always be presented.

373. If flaw indications exceeding the threshold specified in the acceptance standard are detected in individual in-service inspections, the inspections shall be extended to cover equivalent areas of inspection, as required in ASME Code, Section XI [4].

374. Components and piping, or parts thereof, in which flaw indications exceeding the threshold of the acceptance standard are detected during individual in-service inspections shall be approved by means of fracture mechanical analyses, repaired, or replaced.

375. If the flaw indications are to be approved to remain in the structure on the basis of fracture mechanical analyses and without repairs or replacements made to the structure, the analyses may be made in accordance with the acceptance criteria of ASME Code, Section XI [4] Subarticle IWB-3600, or some other procedure separately approved by STUK. As further justification, calculations based on Leak Before Break (LBB) may be presented.

376. The effect of ambient conditions on the flaw growth rate shall be considered in the fracture mechanical analysis, and the parameter values used shall be justified.

377. The fracture mechanical analysis of a cladded structure shall take into account the effect of the cladding.

378. The licensee shall seek approval from STUK for the fracture mechanical analyses and preventive measures before the reactor is restarted after an outage. The need for further preventive measures shall be evaluated in cases where, on the basis of fracture mechanical analyses, flaw indications exceeding the threshold of the acceptance standard are permitted in a structure.

The measures shall be such that they aim to prevent and monitor flaw growth during the subsequent inspection interval. The measures may be based on the origin of the flaw, the type and material of the structure, the ambient and operating conditions, stresses and the estimated flaw growth rate.

379. Any flaw growth shall be monitored by increasing the inspection frequency as per ASME Code, Section XI [4] until it can be demonstrated that no significant flaw growth occurs during the inspection interval.

380. Any other new flaw indications, or indications which have grown compared with previous inspections, shall be submitted to monitoring, where necessary, by increasing the inspection frequency to detect any growth before the indications exceed the threshold specified in the acceptance standard.

381. An example of the decision-making process when a threshold specified in the acceptance standard has been exceeded is given in Annex B.

3.8 Reporting of results of in-service inspections

3.8.1 Results of pre-service inspections

382. The completion of the pre-service inspections is required before STUK can ascertain under Section 20(2)(1) of the Nuclear Energy Act (990/1987) [1] that the nuclear facility meets the set safety requirements. To this end, the licensee shall submit a summary report of the results of the pre-service inspections to STUK for approval in good time.

383. The licensee shall submit a summary report of the pre-service inspection results to STUK for approval within four months from the conclusion of the inspections. However, it shall be submitted at the latest so that STUK can process it and use it to assess the completion of the pre-service inspections as it draws up the safety assessment for a nuclear facility pursuant to Section 20(2)(1) of the Nuclear Energy Act (990/1987) [1].

384. The following information shall be given in the summary report:

a. A summary of the inspections performed
   - A description of the companies participating in the inspection and their inspection personnel
   - The inspections performed (reference to the plan)
   - A statement on the acceptability of inspection results
   - The deviations from the approved inspection plan and procedures, with justifications
   - The flaw indications detected and further actions taken or planned thereupon
   - The development needs as regards in-service inspections

b. A detailed list of the inspections performed
   - Welded joints and other areas of inspection, inspection category in accordance with ASME Code, Section XI [4]
   - Components subject to inspections not based on ASME XI (mixing, stratification and fatigue points etc.)
   - The methods of inspection
   - References to inspection procedures (revision identification) in each inspection area
   - Indications detected and their characterisation
   - Reference to inspection records
   - Reference to indication characterisation and sizing records and other supplementary analyses
   - References to deviation reports, if any

c. Description of flaw indications exceeding the recording level
   - Inspection area
   - Characterisation and sizing records for flaw indications
   - Definition of size, character, location and orientation of flaw indications according to ASME Code, Section XI [4] and their comparison with the acceptance standards, or a case-specific risk analysis containing fracture mechanical calculations
   - An assessment of the causes of any flaws
   - A statement signed by experts on the acceptability of the flaw indications
   - Further actions

d. Inspection equipment and accessories used.

3.8.2 Results of in-service inspections

385. The completion of in-service inspections is required before STUK can ascertain under Section 20(2)(1) of the Nuclear Energy Act (990/1987) [1] that the nuclear facility meets the set safety requirements and grant a start-up permit after an outage. To this end, the licensee shall submit to

STUK a written notification of the completion of the inspections, specifying the following:
- The inspections performed (references to plans)
- The inspection procedures used
- Deviations from the approved inspection plan and their causes
- Flaw indications exceeding the threshold of the acceptance standard and further actions thereupon.

386. The results from all in-service inspections of the reactor pressure vessel's inside and internals shall be presented to an inspector from STUK before the permission to close the reactor pressure vessel head is granted.

387. The results from in-service inspections shall be presented to an inspector from STUK at the plant site before the decision to start the reactor is made. One of the prerequisites for the start-up permit granted by STUK is that the in-service inspections have not brought up any issues preventing start-up.

388. Summary reports of in-service inspection results shall be submitted to STUK for approval within four months from the completion of the inspections or the ending of the outage.

389. The reports shall include matters equivalent to those included in the summary reports for the pre-service inspections, and a comparison with the results from previous inspections shall also be submitted. It shall include a comparison of the size of the flaw indications during various inspections.

390. If new inspection techniques have been taken into use, comparison shall be made with inspections performed using earlier techniques. The comparison shall form the basis for future inspections.

391. A nuclear plant unit-specific summary of in-service inspections and a progress report for the ongoing inspection interval shall be submitted to STUK for information every year. It shall contain the following information:
- Follow-up of inspections and the inspections conducted during the inspection interval
- Follow-up of results and reported indications
- Status of inspections and fulfilment of inspection scope during the inspection interval

4 Risk-informed selection process for the in-service inspections of piping

4.1 General

401. Chapter 4 sets forth the requirements for a risk-informed selection process whereby piping segments and structural elements thereof are selected as inspection areas of pre-service inspection plans and in-service inspection programmes during operation. The selection is based on the nuclear risk significance of the piping parts. The selection aims to improve the overall safety of the nuclear facility and to minimise the radiation doses to which the inspection personnel are exposed. The minimum requirement level for a risk-informed in-service inspection programme is presented in ASME Code, Section XI, Nonmandatory Appendix R, Risk-informed Inspection Requirements for Piping [4]. Supplementary instructions are presented in the European Network for Inspection and Qualification's (ENIQ) framework document concerning risk-informed in-service inspections [10], the ENIQ Recommended Practices ENIQ RP 9 and RP 11 [11, 12], and the Common Views report by the European Nuclear Safety Authorities concerning risk-informed in-service inspections [13]. The references also discuss a quantitative risk-informed selection process.

402. The risk-informed in-service inspection programme shall be drawn up following the ASME Code, Section XI, Nonmandatory Appendix R, Risk-informed Inspection Requirements for Piping. The inspections shall be defined as laid down in Table R-2500-1 [4] after the selection of the inspection areas has been performed using the following stages of the selection process:
- Selecting the systems to be analysed and specifying the system limits and functions.

- Assessing the plant-specific operating experience and operating experience from similar plants that will be included in the selection process.
- Dividing the systems selected into piping segments with the same failure potential and similar consequences of failure. Classifying these piping segments into risk categories on the basis of combined effect of the failure potential and consequences of failure. Identifying on the basis of risk categories the piping segments with the highest importance to safety.
- Selecting as inspection areas the structural elements of the piping segments with the highest importance to safety.
- Defining the inspection area, scope and method of the structural element on the basis of the degradation mechanism.
- Selecting inspection areas and optimising inspection intervals in a risk-informed manner so that, wherever possible, radiation doses are reduced when compared to the earlier deterministic or risk-informed in-service inspection programme. Presenting an estimate of the changes in radiation doses.
- Ensuring the traceability of the selection of inspection areas by carefully documenting the input information, progress and results of the selection process.

403. The diagram in Annex A provides a visual representation of the selection process within the set of documents and of the updates to the process and the in-service inspection documents.

4.2 Area of application of the risk-informed in-service inspection programme for piping

404. The in-service inspection programmes for piping of systems in safety classes 1, 2, 3 and EYT shall be drawn up using risk-informed methods regardless of the nominal sizes of the piping and other deterministic exclusion principles of ASME Code, Section XI [4] in order to ensure that the structural elements causing the greatest risk are included in the inspection scope.

4.3 Risk-informed selection process documents

405. The principles, input information, progress and results of the risk-informed selection process, and the activities of the expert panel and the assessments produced by it, shall be documented in a manner that allows the selection criteria of each structural element selected as an inspection area or excluded from the inspection programme to be traceable throughout the entire life cycle of the facility, from design to decommissioning [4, 10].

406. The licensee shall submit the risk-informed selection process documents to STUK according to the requirements in chapter 3.

407. The licensee shall draw up a methodology description of the risk-informed selection process that presents, among other things, the organisation of the workgroups and their areas of responsibility, schedules, collecting input information, identifying degradation mechanisms and consequential effects, determining the categories of failure, consequence and risk, the exclusion criteria, uncertainty analyses, the expert panel, and the drawing up of the risk-informed in-service inspection programme.

408. When the deterministic in-service inspection programme for an operating nuclear facility's piping is replaced by a risk-informed in-service inspection programme, the licensee shall draw up a risk-informed selection process methodology description discussing the approach and scope chosen.

409. Before the construction licence for a nuclear facility is granted, the licensee shall draw up a document in connection with the plan for principles that presents the principles for drawing up a risk-informed in-service inspection programme for the piping, and the preliminary methodology description and indication of source materials for the risk-informed selection process.

410. During construction, the licensee shall update the methodology description of the risk-informed selection process for the in-service inspections of piping.

411. The licensee shall draw up a results report of the risk-informed selection process.

Table 1. Example of risk matrix.

FAILURE CATEGORY	CONSEQUECE CATEGORY			
	No significance	**Low**	**Medium**	**High**
High	Low risk	Medium risk	High risk	High risk
Medium	Low risk	Low risk	Medium risk	High risk
Low	Low risk	Low risk	Low risk	Medium risk

4.4 Collection and analysis of input information

412. Operating experience from both the nuclear facility in question and from similar nuclear facilities shall be used when collecting the input information. If operating experience from the nuclear facility in question or from similar facilities is not available, operating experience from other facilities and expert evaluations shall be used where applicable. Sufficient input information for the risk-informed selection process shall be collected concerning the facility and its systems, structures and equipment.

413. An updated probabilistic risk assessment that meets the requirements of Guide YVL A.7 shall be used when drawing up the risk-informed in-service inspection programme for piping.

4.5 Assessment of consequences of pipe failure

414. To identify consequential effects, piping shall be divided into piping segments where a leak and/or break at any point of the segment will have the same consequential effects. The secondary effects of pipe breaks, such as pipe whips, water jets, steam bursts or flooding, shall be assessed using the walk-through method. Areas belonging to failure categories that have been assessed to be very low shall not be excluded, if the consequential effects of breaks, conditional core damage probability and conditional large release probability, are severe.

415. The risk-informed selection process of in-service inspections may apply the Leak Before Break (LBB) criterion to piping for which leak detection has been reliably arranged. Applicable methods are discussed in Guide YVL E.4, "Strength analyses of nuclear power plant pressure equipment". If the Leak Before Break criterion has already been a design basis and it has affected the designing of the facility's safety functions or the definition of protection requirements that would be required as a consequence of a break in the piping in question, this shall be taken into account when defining the consequential effects.

4.6 Specification and assessment of piping failure potential

416. The degradation mechanisms to be studied shall be those specified in ASME Code, Section XI, Appendix R, Supplement 2, Table R-S2-1 [4]; these include fatigue, stress corrosion and erosion corrosion. Pressure shocks, other exceptional loadings and repairs to the structure shall be taken into account in the risk analysis. If fracture mechanical reliability models are used to estimate the structural reliability, the models shall be assessed by using expert evaluations according to ENIQ's Recommended Practice ENIQ RP 9 [11].

417. The imperfections of the selection process and any unforeseen degradation mechanisms shall be assessed by means of uncertainty analysis. Uncertainty analyses shall also be used to determine the unreliability of expert evaluations, probabilistic fracture mechanical models and the inspection methods, such as the Probability of Detection (POD).

4.7 Risk categorisation

418. The selection process shall take into account the failure potential of the piping segment, and the consequential effects, conditional core damage probability and conditional large release probability, defined on the basis of the probabilistic risk assessment.

419. The failure potentials of the piping and the consequential effects of piping failures are classified into failure categories and consequence categories. The failure and consequence categories are used to create a risk matrix, where the elements are the risk categories (for example, low risk, medium risk, high risk). A leak and/or break at any point of a piping segment within the same risk category will have the same consequential effects, and it will also appear the same degradation mechanisms. The risk category defines the need for inspection in the piping segment in question. Risk-informed in-service inspections are performed on the structural elements of piping segments; these include straight piping sections, pipe elbows, fittings, flange connections, weld joints and bellows. Most of the in-service inspections are performed on the weld joints of the piping segments.

The risk matrix in Table 1 and the diagram in Annex A both provide visual representations of the risk-informed selection process.

420. When determining the risk categories, the conditional core damage probability for piping segment-specific breaks shall be assessed by using probabilistic risk assessment. The risk category for a segment-specific pipe break shall be defined by combining the failure potential and consequential effects in a risk matrix similar to that in Table 1, as presented in ASME Code, Section XI, Appendix R, Supplement 2 [4]. A suggested alternative method may be one based on the fracture frequency and importance measure of the piping segment according to ASME Code, Section XI, Appendix R, Supplement 1 [4].

4.8 Selection of inspection areas

421. The items inspected in the piping in-service inspections shall be defined using a risk-informed selection process that first determines the risk categories and from them selects the inspection areas.

422. The selection process shall apply an expert panel procedure according to ASME Code, Section XI, Appendix R, Supplement 1 [4] and the ENIQ Recommended Practice, ENIQ RP 11 [12]. The procedure shall represent independent assessment in the selection process. The panel process is a method that analyses and combines deterministic and probabilistic information to support the decision-making. The expert panel shall extensively represent expertise and have representatives from various fields of nuclear power plant technology. The panel's duties include assessing the degradation mechanisms of piping and the consequential effects of a break by piping segment, and the appropriateness of the inspection areas and their selection.

4.9 Assessment of risk effects posed by updates to the inspection programme

423. A numeric risk comparison between the old and new inspection programme shall be drawn up when updates to the programme are made. It shall contain an assessment of the change to the radiation doses to which the inspection personnel are exposed. The assessed risk caused by pipe fractures on the basis of the new programme shall be lower than the risk assessed in the previous programme.

4.10 Long-term management of the risk-informed in-service inspection programme

424. The results of the inspections shall be taken into consideration when assessing the failure potential of the piping in the in-service inspection programme and drawing up future inspection programmes. In this case, the inspection scope or intervals may be changed as required.

425. The risk-informed in-service inspection programme shall be updated if the risk classification has changed during the inspection interval. The risk classification shall be updated if the failure potential has essentially grown due to, for example, flaw indications exceeding the threshold of the acceptance standards detected at an inspection area, plant modifications implemented, or essential changes in probabilistic risk assessment results.

Maintaining and updating risk-informed in-service inspection programmes is discussed in ENIQ's report Discussion Document, Updating of Risk-Informed Inspection Programmes. [9].

5 General requirements for inspection system qualifications, organisation, strategy plans and qualification body

5.1 General qualification requirements

501. According to Section 113 b of the Nuclear Energy Decree (161/1988) [2], *non-destructive testing of a nuclear facility's structures and components relevant to nuclear safety during in-service inspections may only be carried out by using testing systems that have been qualified by a qualification body approved by the Radiation and Nuclear Safety Authority (STUK). The Radiation and Nuclear Safety Authority defines the structures and components referred to in Subsection 1 above that are considered relevant to nuclear safety, and the testing systems used for them. The licensee shall apply in writing for the approval of the qualification body for its duties.*

502. An inspection system shall refer to all those elements of non-destructive testing that can influence the quality and outcome of an inspection, such as inspection equipment and their software, inspection procedures and inspection personnel who calibrate the inspection equipment, record inspection data, detect defects and characterise and size them.

503. The qualifications of inspection systems shall be used to demonstrate that the inspection objectives set in the qualification input information are met.

504. The licensee shall be responsible for arranging the qualifications of the inspection systems, and it shall employ a qualification body and testing organisation for assistance.

505. An inspection system shall be qualified by means of systematic assessment, using all the methods that are needed to provide reliable confirmation of an inspection system to ensure it is capable of achieving the required performance under real inspection conditions. Each inspection system shall be qualified for pre-service and in-service inspections by demonstrating that it reliably detects, characterises and/or defines defects endangering structural integrity and nuclear safety in a manner that enables the meeting of the inspection objectives set forth in the input information.

506. The systems used for surface inspections and volumetric inspections during the pre-service and in-service inspections shall be qualified according to the qualification requirements set forth in this Guide. The same principles may also be applied to the qualification of visual inspection systems that utilise optical tools.

507. The minimum requirement level for the qualification of inspection systems used for in-service inspections shall be the European Qualification Methodology Document (EQMD) [14] drawn up and published by the European Network for Inspection and Qualification (ENIQ), supplemented by ENIQ's Recommended Practices (ENIQ RP) RP 1, RP 2, RP 4, RP 5, RP 6, RP 7, RP 8 and RP 10 [15, 16, 17, 18, 19, 20, 21, 22].

508. Qualification shall take into account the following:

- The link between nuclear safety and the qualification input information
- The link between the radiation safety principles (ALARA) required during practical inspections and the qualifications

509. The qualification shall consist of practical trials that shall be performed using test pieces that represent the inspection area, and/or a technical justification used to assess the performance of the inspection system. The technical justification may be based, for instance, on physical reasoning, parametric studies, experimental evidence or predictive models; see ENIQ's qualification methodology document EQMD [14].

5.2 Organisation of qualifications, strategy plan and procedures

510. The licensee shall ensure the continuity of qualification and establish a qualification management group whose members are appointed from expert organisations. The management group shall appoint a support group consisting of experts from various organisations to work under it, with the task of guiding practical qualification work and support the qualification body. The members of the group shall have sufficient expertise in the field. Procedures shall be provided for the responsibilities, authorities and tasks of the groups.

511. The licensee shall include in the qualification strategy plan the guidelines on key qualification requirements and procedures. The guidelines shall precisely define the operation of the qualification organisation.

512. The licensee shall submit to STUK a plant unit-specific strategy plan for the organisation, methods and implementation of the qualifications, with related guidelines. The strategy plan shall include the following:

- General procedures presenting the basic requirements and methods for the qualification and the qualification organisation: management group, support group and qualification body, and the organisation's quality management system (for approval)
- A nuclear plant unit-specific overall qualification plan containing, among other things, information on forthcoming objects of qualification, their qualification grouping (for approval) and a schedule for the implementation of qualification (for information)
- The instructions for the different parts of qualification: operation of the qualification body, collection and assessment of input information, planning of the qualifications, technical justification and practical trials, collection and assessment of the qualification documents and granting qualification certificates, references to the European Qualification Methodology Document (EQMD) [14] and Recommended Practices (ENIQ RP) RP 1, RP 2, RP 4, RP 5, RP 6, RP 7, RP 8 and RP 10 [15, 16, 17, 18, 19, 20, 21, 22] (for information)
- The basic documents for the accreditation and approval of the qualification body required in subsection 5.3 (for approval).

513. The strategy plan shall be updated. At the start of the construction stage of a nuclear power plant, the overall grouping and schedule of the qualifications may be preliminary. They shall be submitted to STUK for information; the overall grouping of qualifications shall be submitted through the qualification body. The final grouping of qualifications shall be approved by the qualification body and submitted to STUK for approval.

5.3 Qualification body

5.3.1 Fundamental requirements and tasks of qualification body

514. According to Section 60 a of the Nuclear Energy Act (990/1987), *the Radiation and Nuclear Safety Authority (STUK) approves manufacturers of nuclear pressure equipment for their duties and inspection organisations, testing organisations and qualification body for duties pertaining to the control of pressure equipment, steel and concrete structures, and mechanical components at nuclear facilities within the scope determined by the Radiation and Nuclear Safety Authority. The Radiation and Nuclear Safety Authority supervises the operation of such an inspection organisation, testing organisation, and qualification body.*

515. According to Section 117 b of the Nuclear Energy Decree (161/1988), *when the Radiation and Nuclear Safety Authority (STUK) approves an authorised inspection body for its duties, it shall define the body's inspection rights and establish the requirements and conditions pertaining to its operations. In the decisions of approval, the period of validity of the decision, the body's obligation to report to the Radiation and Nuclear Safety Authority (STUK) as well as its obligation to observe secrecy under the law shall be stated. What is established in Subsection 1 above shall also be applied to the testing organisation and qualification body referred to in Section 60 a of the Nuclear Energy Act.*

516. The licensee shall have available a qualification body that has been assessed by an accreditation body for inspection system qualification management, planning, implementation, control and assessment as well as the issuing of qualification certificates. Pursuant to Section 60 a of the Nuclear Energy Act (870/1999) [1], the licensee shall have the qualification body approved by STUK. The tasks of the qualification body are described in Annex D.

517. Removed; same text as in requirement 516.

518. The qualification body shall be competent, impartial and independent of design, construction and operation, as well as of any financial factors that could affect its work and decisions. It shall have the necessary technical competence and resources.

519. According to Section 1 of the Act on the accreditation of conformity assessment services (920/2005) [23], this act defines a national accreditation service that is intended to ensure the reliability and international acceptability of conformity assessment services.

520. According to Section 5 of the Act (920/2005) [23], an assessment body applying to become a qualification body shall seek accreditation from FINAS, the Finnish Accreditation Service.

521. The qualification body and its activities shall meet the minimum requirements for a type 1 independent third party organisation presented in ENIQ RP 7 [20]. In this case it shall also meet, at a minimum, the general independency requirements for a type A inspection organisation presented in standard SFS-EN ISO/IEC 17020 [24]. Alternatively, it shall meet the requirements for a personnel certification body presented in standard SFS- EN ISO/IEC 17024 [25].

522. The accreditation of a qualification body shall use the following as the assessment basis:

- This Guide YVL E.5
- Standard SFS-EN 17020, General criteria for the operation of various types of bodies performing inspection [24], or
- Standard SFS-EN ISO/IEC 17024, Conformity assessment. General requirements for bodies operating certification of persons [25]
- The European Qualification Methodology Document (EQMD) [14] drawn up by the European Network for Inspection and Qualification (ENIQ), supplemented by ENIQ's Recommended Practices ENIQ RP 1, RP 2, RP 4, RP 5, RP 6, RP 7, RP 8 and RP 10 [15, 16, 17, 18, 19, 20, 21, 22]
- Of the above, ENIQ Recommended Practice 7: Recommended General Requirements for a Body Operating Qualification of a Non-Destructive Test [20] is especially important.

523. The purpose of ENIQ RP 7 [20] is to assist those wishing to establish a qualification body and develop it, and those who assess the competence of a qualification body.

524. The qualification body shall be impartial in its activities. The services of the qualification body shall be made available to all operators in the field of nuclear facilities.

5.3.2 Personnel of the qualification body

525. The qualification body shall appoint a technical director who is versed and experienced in NDT inspection methods; he/she has the overall responsibility for performing qualification according to the applicable guidelines. A substitute shall also be appointed for the technical director.

526. The personnel of the qualification body shall be competent for their tasks. They shall have the suitable qualifications, experience, training and sufficient knowledge of the qualification requirements. The qualification body shall have available personnel with diverse expertise and experience in the technical fields required to assess the capability of inspection systems to reliably detect, characterise and size flaws, as described in recommended practice ENIQ RP 7 [20].

527. At least one member of the personnel of the qualification body monitoring and assessing qualifications from the inspection technical point of view shall have Level 3 basic qualification for the inspection method in question under a qualification system that complies with Standard SFS-EN ISO 9712 [26] or a corresponding system; in addition, extensive practical experience is required of factors that may affect inspection reliability in the in-service inspection of a nuclear facility's components and structures.

528. If necessary, the qualification body shall employ external experts for qualifications, especially inspection personnel with Level 3 qualifications and experts in the manufacture of test pieces. The qualification body shall familiarise the external persons with its own operating procedures and ensure that they are familiar with this Guide YVL E.5, ENIQ's qualification methodology document EQMD [14] and related supplementary recommended practices ENIQ RP 1, RP 2, RP 4, RP 5, RP 6, RP 7, RP 8 and RP 10 [15, 16, 17, 18, 19, 20, 21, 22].

529. The qualification body shall maintain a document management system as part of its qualification activities. The system shall be able to separate between two types of document:

- Documents describing the mode of operation of the qualification body
- Qualification dossiers of individual inspection systems.

530. A documented training system shall be in place for the personnel. Information regarding the qualifications, training and experience of the personnel shall be archived and kept up-to-date. The system shall be used to ensure that the familiarisation of the personnel for the technical and administrative requirements of their work is kept up-to-date and that it follows the policy laid down by the qualification body.

531. The management of the qualification body shall appoint an independent quality management representative.

532. The personnel shall have available clearly documented guidelines concerning their responsibilities and duties. The guidelines shall be kept up-to-date.

5.3.3 Qualification body's quality manual

533. The qualification body shall draw up a fully documented quality management system that it shall maintain and for which it is responsible. It shall include procedures that cover the qualification's organisation and control requirements. Instructions shall be provided for the procedure of issuing qualification certificates.

534. The quality management system shall ensure the effective overall management of the qualification activities, and it shall include the following:

- An explanation of the quality policy
- A description of the legal position of the qualification body
- A description of the organisation of the qualification body
- The names, competences, experience and work certificates of the organisation's internal and external executive qualification personnel and other qualification personnel
- The detailed training arrangements for the qualification body's personnel
- An organisation chart for the qualification body, presenting responsibilities, authorities, and tasks
- Task descriptions of the qualification body's personnel
- Detailed procedures for the practical trials for qualification
- Control and assessment instructions for the manufacture of the test pieces
- A list of subcontractors and detailed procedures for the competence assessment and supervision of the subcontractors
- Detailed instructions for the complaints process
- Assessment instructions for the qualification results
- Instructions for issuing certificates, issuing criteria
- Confidentiality instructions for the manufacture of test pieces and practical trials, among other things
- Instructions for internal audits
- Instructions for processing feedback and taking corrective action
- Document management instructions
- Management instructions for a quality management system review.

5.3.4 Approval of a qualification body

535. For the approval of a qualification body, the licensee shall submit an application to STUK with the following enclosures:

- An accreditation decision from the national accreditation body FINAS

- The qualification body's documents on which the accreditation decision is founded:
  – The quality manual
  – A description of the operations and technical competence areas of the qualification body
  – A description of the expertise available to the qualification body
  – Use of external resources
  – A description of the organisation
  – A description of the document management system
  – Descriptions of the processing of records, the data security applied to qualifications, the methods for solving disagreements, audit methods, and the issuing of qualification certificates.

6 Qualification activities

6.1 Qualification process

601. Inspection systems shall be qualified using the qualification process illustrated in Annex C. The diagram in the Annex contains the tasks of all parties to the qualification process and the qualification system's most important elements. It also shows how the inspection system can be developed by means of a feedback system, and presents the interaction involved in the technical justification within the framework of the entire qualification process.

602. Inspection areas with similar input information may be grouped into qualification groups such that qualification is conducted for all of them at the same time, thus reducing the number of individual qualifications. The grouping, as well as a group's practical trials, is to be justified by means of a technical justification containing an analysis of any differences in essential input parameters. The essential input parameters shall be within the same range in the qualification group.

603. If a preliminary overall grouping of qualifications is used during the construction stage, it shall be submitted to STUK for information via the qualification body at the beginning of the construction stage; the final grouping shall first be approved by the qualification body and then submitted to STUK for approval.

6.2 Qualification dossier

604. The qualification body and the licensee shall gather inspection system specific qualification documents into a systematic dossier covering the entire qualification. Detailed recommendations for the qualification dossier are provided in ENIQ Recommended Practice 4 [17].

605. According to Section 7 e of the Nuclear Energy Act (990/1987) [1], *compliance with requirements concerning the safety of a nuclear facility shall be proven reliably.*

606. According to Section 9 of the Nuclear Energy Act (990/1987) [1], *it shall be the licensee's obligation to assure safe use of nuclear energy. This obligation cannot be delegated or transferred to another party.*

607. It shall be the licensee's obligation to draw up a summary of justifications for each in-service inspection document submitted to STUK for approval, and enclose it with the document.

608. The licensee shall draw up the summary of justifications for the document in a manner where it is a good and convincing argument and answers the question of why the licensee expects STUK to approve the document; see "Argumentti ja kritiikki" [8].

609. The licensee shall demonstrate the acceptability of the document and the actions presented therein by means of the argumentative summary.

610. The licensee shall demonstrate the scope and thoroughness of its own inspection proceedings with the summary of justifications.

611. The licensee shall present the following issues as part of its argumentation in the summary of justifications:
- A summary of the matter submitted for approval, the planned actions and any deadlines.
- Procedures to approve issues that are outside the scope of application of the document but that are essential for the approval of the matter.
- The connections of the document to other in-service inspection and qualification docu-

ments, the history and future of in-service inspections, and references to letters from the licensee and STUK.
- References to other issues that are essential for the processing of the matter.
- As part of the argumentation, factual justifications and references to statutes and standards as justification of the acceptability of the document and the actions presented therein.

612. Any references to statutes, standards, and recommendations used in the preparation shall be unambiguous; references to names and chapters of standards are acceptable, for example.

613. The qualification dossier shall include the following essential parts:
- Information on the qualification personnel appointed for each task
- The qualification input information
- The qualification procedure
- The technical justification
- A description of the test pieces and practical trials
- The inspection procedure
- A description of the inspection equipment and software
- A qualification assessment report and the qualification certificates.

614. During the qualification process, the licensee shall submit the following information to STUK concerning a single qualification:
- Information on the qualification personnel appointed for each task (for information)
- Input information with justifications in good time prior to the drawing up of the qualification procedure and the start of qualification (for approval via the qualification body)
- Qualification procedure compiled by the qualification body (for information).

615. For the purpose of approving the qualification of the inspection procedure and equipment, the licensee shall submit to STUK the final qualification dossier no later than three months prior to the date of commissioning of the inspection system.

616. The final qualification dossier shall include the following information:
- The qualification assessment report,
- The qualification certificates,
- Other final documents listed in this subsection 6.2.

617. An assessment report drawn up by the qualification body shall be submitted to STUK for approval. Other result documentation shall be sent to STUK for information together with the assessment report.

618. When STUK has approved the qualification dossier's assessment report and noted that it has processed the other parts of the qualification dossier as received for information, it may determine in a decision that the inspection procedure and equipment have now been qualified.

6.3 Qualification input information

619. The licensee shall define the input information required for an inspection qualification prior to the drawing up of the qualification procedure and the start of the qualification process, and submit it to STUK for approval.

620. The input information shall be approved by the qualification body before being submitted to STUK for approval. The qualification body shall assess the sufficiency of the data from a qualification technical point of view in order to ensure that the prerequisites for starting qualifications are met.

621. All of the qualification input information shall be available before the planning of the practical trials begins.

622. Various qualification levels shall be used, if the intention is to focus the qualification process on safety-significant components. The choice of the qualification level shall be made by assessing the nuclear risk significance of a defective structure and the role of the inspection in reducing the probability of failure.

623. A high qualification level shall be used for the qualification of inspection systems for components and structures that have high failure potential and severe consequential effects, resulting in high risk significance. The starting point shall always be to use a high qualification level.

624. Qualification levels lower than the highest level shall be defined and justified using risk-informed methods for the qualification of in-service inspections for piping and other components. The definition and justifications shall take into account the risk significance of the inspection area, ENIQ RP 8 [21].

625. The definitions and justifications of qualification levels shall consider component design, such as strength calculations, materials and manufacturing, operating conditions, potential degradation mechanisms, their probability and consequences. It is then required that organisational units responsible for plant safety and experts in these technical fields define the qualification level and provide justification for it.

626. Defects processed in the input information shall be divided into three groups as follows, based on the predictability and probability of their nature:

- Specific defect; specific defects have already been found in structures of this type
- Postulated defect; the initiation of defects of particular types is postulated in a particular structure
- Unspecified defect; no specific degradation mechanisms exist for the structure and the nature of potential defects is thus unknown.

627. The target defect sizes that shall be detected and defined correctly during in-service inspections shall be defined for each inspection area. If the items qualified have been grouped into qualification groups, the defects shall be defined for each wall thickness according to the most stressed component. Of these, the defects most difficult to detect because of their size shall be chosen as target defects. Target defect size shall be primarily based on defects allowed during the nuclear facility's operation by the standard applied in the design of the component or structure in question. A calculation method that complies with ASME Code, Section XI [4] Subarticle IWB-3600 shall be used to calculate pressure equipment crack growth during the inspection interval or during its remaining service life. The standards list the service-loading safety factors in question.

628. The data presented for the input information defects shall be as detailed as possible, ENIQ RP 1 [15]. The following typical input information parameters for different degradation mechanisms shall be evaluated whenever possible, and the uncertainty factors of the assessment shall be reported:

- Defect group (specific defect, postulated defect or unspecified defect)
- Defect type (degradation mechanism)
- Location and orientation of crack
- Geometry (crack opening and tip)
- Roughness and branching of crack surface
- Crack contents: water, air, and oxides
- Residual stresses.

The report by J. Wåle [27] may be used to determine the input information parameters. It characterises statistically the morphology parameters of real cracks created by various degradation mechanisms. The report was prepared upon the request of Sweden's former nuclear safety authority (Statens Kärnkraftinspektion, SKI).

629. Essential input information includes the following:

1. Information on the item inspected
   - Dimensioning and geometry
   - Materials and manufacturing techniques
   - Dimensioning and geometry of welded joints as well as the welding processes
   - Surface conditions and claddings
   - Structural repairs
   - Environmental conditions e.g. accessibility and radiation level
   - Potential compression stresses in the inspected area during inspection
   - Previously detected defects
2. Safety class
3. The qualification level
4. Objectives of the in-service inspection
   - Detection target
   - Type, size, location and orientation of defects to be detected and defined
   - Required accuracy of sizing and positioning

- Inspection volume
- Allowable number of false calls.

630. The inspection system shall reach a detection capability that allows for detecting all defects that are equal to or larger than the inspection detection target. If other targets are set for the detection capability, they shall be justified.

631. If false calls are allowed in the inspections, their number shall be justified by assessing the consequences of false calls.

632. If the preliminary data on the inspection system being qualified, such as the equipment, procedures and personnel, are available, they may be submitted to STUK for information but shall not be binding on the qualifications.

6.4 Qualification procedure

633. The licensee shall submit the qualification procedure drawn up by the qualification body to STUK for information.

634. A qualification procedure is an inspection system-specific document which systematically describes how a system is qualified in practice. The qualification procedure shall be drawn up such that the results of qualification may be assessed against it. The procedure shall include at least the following matters:

- Effect of the qualification level
- Balance between the technical justification and practical trials
- Information required from the testing organisation
- The method of assessment of the technical justification, inspection procedure and inspection equipment
- Additional qualifications of personnel
- Instructions for conducting the practical trials
- Information on the test pieces
- Assessment criteria for the entire inspection system.

The information to be included in the qualification procedure is set forth in Annex E.

635. The qualification procedure shall present the qualification approach according to ENIQ RP 8 [21] in a transparent manner.

636. The qualification procedure shall discuss the representative nature of the defects in the test pieces compared to the postulated defects or specific defects of the assumed degradation mechanisms. J. Wåle's report on the characterisation of morphological parameters of real cracks caused by various degradation mechanisms [27] may be used to assist the evaluation. The assessment shall be linked to the assessment of the technical justification.

637. The qualification of equipment and procedure shall be primarily performed separately from the qualification of personnel, because otherwise it will be difficult to differentiate any weaknesses of the inspection system.

638. The minimum requirement level for the drawing up of the qualification procedure shall be ENIQ's qualification methodology document EQMD [14].

639. The qualification procedure shall be prepared on the basis of the input information presented by the licensee and approved by STUK.

640. The diagram in Annex C presents the qualification procedure as part of the qualification process in terms of time and performance.

6.5 Technical justification

6.5.1 General

641. A technical justification shall refer to information collected by a testing organisation which provides evidence that the inspection objectives set for the inspection system in the qualification input information can be achieved. A technical justification is most commonly used to justify the inspection procedure, present the selection criteria for inspection equipment and to justify test pieces and their defects in practical trials.

642. Where applicable, the technical justification shall include physical reasoning, prediction

models, and experimental evidence. These may include results from other qualifications and round robin trials, or authenticated practical experience and parametric studies. The physical reasoning shall be drawn up during the early stages of the qualification process in order to define the test pieces for the practical trials.

643. The purpose, contents and drawing up of a technical justification are all discussed in detail in ENIQ's Recommended Practices 1 and 2 [15, 16], which shall be applied as the minimum level of requirements.

644. To facilitate the assessment work of the qualification body, the technical justification shall be structured in the manner presented in Annex F, see ENIQ RP 2 [16]. The diagrams in Annexes C and F illustrate the structure of a technical justification, the mutual interactions of different sections, and the interaction with the entire qualification process.

645. The technical justification shall be drawn up for the following purposes, ENIQ RP 2 [16]:

- To complement the qualification conducted by practical trials, which is limited by the statistically limited number of test pieces
- To generalise and complement the results of a practical trial by demonstrating that, if the test results of the defects of the individual test pieces meet the set targets, corresponding results may be achieved under other inspection conditions
- To provide good technical foundation for the planning of efficient practical trials
- To justify the test pieces and defect groups
- To justify the inspection equipment
- To extend existing qualification
- To extend qualification from one inspection area to another, similar inspection area
- To extend qualification to new material structures
- To cover the changes to and modernisation of the inspection equipment or software

646. The definition of the level of technical justification shall take into account the qualification level, ENIQ RP 8 [21].

647. The balancing of the technical justification and practical trials shall take into account the following:

- The qualification level
- The availability of evidence
- Special inspection technology issues, such as the effects of manufacturing technology on the details of the inspection area.

648. The evidence for technical justification may often have a restricted scope of validity, and this shall be borne in mind and brought up when drawing up and applying a technical justification.

6.5.2 Essential parameters

649. The influential and essential parameters of an inspection system shall be defined. The definition and analysis of essential parameters are vital parts of a technical justification. Parameters are discussed in detail in ENIQ's Recommended Procedure RP 1 [15].

650. The factors which have an influence on the quality and outcome of an individual inspection are called influential parameters. The degree of their influence shall be assessed and, based on the assessment, some of the parameters shall be classified as essential parameters. These are parameters whose changes may prevent the inspection objectives from being met. Parameters are either fixed parameters with a fixed value and tolerance or parameters covering a range. Essential parameters shall be analysed in the early phases of the drawing up of the technical justification. They shall be divided into two groups:

- Input information parameters, including component materials, dimensions and other characteristics; types, sizes, location and orientation of defects that shall be detected, and the inspection environment
- Inspection system parameters
  - Inspection procedure parameters, including beam angles and frequencies as well as recording levels and personnel requirements
  - Equipment parameters, including the degree of digitalisation, linearity of display, and the positioning and repeatability accuracy of the scanner.

651. The parameters of an inspection procedure shall be chosen based on input information parameters in a manner ensuring the accurate detection and determination of a component's defects. Technical justification shall demonstrate the applicability of the choices made and provide evidence of inspection system capability obtained by means of the parameters chosen.

652. The inspection equipment parameters shall be determined based on the entire inspection, meaning that their choice is influenced by the input information parameters and inspection procedure parameters.

653. The influential and essential parameters with their values shall be analysed and justified in the technical justification in the following stages:

- Division of influential parameters into two groups: input information parameters and inspection system parameters
- Division of parameters into essential and non-essential parameters
- Division of essential parameters into parameters fixed within a tolerance and those covering a range
- Definition of the tolerances and ranges of the essential parameters pertaining to the component and the defects to be detected
- Definition of the acceptable tolerances and ranges of the essential inspection procedure parameters and equipment parameters, considering the essential parameters of the input information group.

654. The conclusions of the technical justification shall contain a list of the essential parameters covering a range and essential parameters whose value has to be fixed within a tolerance with their ranges and tolerances, the adherence to which is a requirement for the validity of the qualification.

655. The analysed and justified essential parameters of an inspection procedure with their tolerances or ranges shall be included in the procedure.

6.6 Practical trials

656. The qualification body shall plan, conduct, supervise and assess the practical trials and report their results in detail.

657. Before the practical trials, the qualification body shall assess the qualification defects in the test pieces starting from designs, and supervise the manufacture of the defects.

658. The qualification body shall ensure the confidentiality of the blind trial test pieces and test arrangements in accordance with its own quality management systems.

659. Practical trials are discussed in reference ENIQ RP 5 [18], which shall be applied as the minimum level of requirements.

6.6.1 Test pieces

660. The licensee shall ensure that the approved qualification input information is presented to the designers and manufacturers of the test pieces and defects.

661. The test pieces and their defects shall be designed on the basis of the essential parameters of the input information and the physical reasoning. The test pieces and defects may have to be updated on the basis of the qualification procedure and/or supplemented technical justification.

662. If the inspection system is qualified for an inspection area that does not have identified structural degradation mechanisms, in which case the input information defect is unspecified, the test pieces shall be designed on the basis of suitable postulated defects.

663. If the qualification uses test pieces that have originally been manufactured for other purposes, their suitability for the qualification in question shall be demonstrated by analysing the essential parameters of the input information in the technical justification. Any restrictions and the potential need for other complementary justifications, test pieces and tests shall be investigated.

664. In the design of the test pieces, special attention shall be paid to such input information and inspection system essential parameters as cannot be sufficiently covered in the technical justification due to insufficient evidence. These essential parameters as well as the inspection procedure and equipment parameters determine the requirements to be set for the test pieces and practical trials.

665. The limited nature of practical trials shall be balanced by applying in design the cases that are worst from the point of view of inspections. Worst cases refer to such defects and component geometries, or other essential parameters, as are likely to represent the greatest challenges for the detection and accurate sizing within a specific inspection qualification situation defined by the input information and considering the specific inspection system used.

666. If the inspection objectives are achieved for worst cases within the range of essential parameters, other defects shall nevertheless be manufactured in the test pieces, or it shall be proven by means of the technical justification that the objectives will be achieved within the tolerances or ranges of all the essential parameters. The defects of the test pieces shall simulate postulated or specific types of defects to an extent sufficient from the point of view of the inspection method.

667. The defects in the test pieces may be
- real defects,
- realistic defects, or
- artificial defects.

668. When realistic defects are used, the test piece designs shall justify the representative nature of the defects by comparing them to the postulated defects or specific defects based on the assumed degradation mechanisms. A corresponding approach shall be applied to specific defects. If the inspection method being qualified is an ultrasonic inspection method, the justification shall assess the following parameters of the crack and present the uncertainty factors of the assessment:
- Defect group (specific defect, postulated defect or unspecified defect)
- Defect type (degradation mechanism)
- Location and orientation of crack
- Geometry (crack opening and tip)
- Roughness and branching of crack surface
- Crack contents: water, air, and oxides
- Residual stresses.

669. The manufacturer of the test piece defects shall demonstrate to the qualification body that the defects manufactured correspond to the postulated defects or specific defects in terms of the properties described above. J. Wåle's report on the characterisation of morphological parameters of real cracks caused by various degradation mechanisms [27] may be used as the basis of the demonstration.

670. The qualification body shall assess the qualification defects in the test pieces used for practical trials starting from designs, and supervise their manufacture. If the qualification body bases its supervision of manufacture on documents, it shall assess the reliability of the documents. The suitability of the qualification defects of the test pieces for the inspection objectives of the qualification in question shall be assessed by comparing the pros and cons of the qualification defects and their manufacture procedures. A summary of the assessments shall be presented in the qualification assessment report.

671. The blind trial test pieces shall be kept confidential.

672. The tasks of a qualification body in the design and manufacturing of test pieces are set forth in Annexes C and D.

6.6.2 Implementation of practical trials

673. Prior to the start of the qualification process, the licensee shall ensure that the qualification body is acquainted with the use of the inspection system, where necessary. The qualification body, for its part, shall guide the inspection personnel in the test arrangements of an open trial. The qualification body shall witness the trials and log all essential activities and events.

674. In the qualification tests of inspection equipment, either mock-ups or open or blind test pieces may be used. The operator of the equipment shall closely follow the instructions for use of the equipment during functional testing. Special care shall be taken to keep the accuracy of positioning and repeatability of the equipment within its tolerance range between the disassembly and installation. A list shall be made of the inspection equipment components that are qualified.

675. The practical trial part of the qualification of inspection personnel shall be conducted by blind trials, separately of the qualification of inspection procedures and equipment, so that, in the case of a potential rejection, the unqualified part of an inspection system can be accurately defined for further development. Previously qualified inspection procedures and equipment shall be used in the trials. Whenever automated data acquisition and processing are used in mechanised inspections, an analysis of previously recorded defect data may serve as a blind trial. Inspection personnel can be qualified for data acquisition, defect detection, characterisation and sizing all in one, or separately. Defect length and height may be separately sized as well.

6.6.3 Assessment of the results of practical trials

676. The qualification body shall assess the conducting and results of practical trials and justify its assessment in a report. A detailed description of the practical trials and a report on their outcome with the assessment criteria shall be included in the qualification dossier. Any deviations from the inspection procedure and practical problems in trials shall be reported and their impact on the qualification outcome assessed.

677. The results shall meet the assessment criteria presented in the qualification procedure, derived from the inspection objectives set forth in the input information. The performance variables defined as the objectives of the inspection in the input information may be as follows: defect detection, false calls, accuracy of defect height determination, accuracy of length determination and accuracy of positioning defects. Each performance parameter shall be separately assessed.

678. The qualification of inspection procedures or equipment by practical trials aims to demonstrate that the qualification objectives are achieved by closely following the procedure. When interpreting the outcome of the trials, the team of inspectors involved shall report their entire chain of argumentation in order to give evidence that the results were not obtained by justification external to the inspection procedure. The minimum amount of information that the qualification body needs to make its assessment shall include all the documentation on which indications are based and which explain and justify the interpretation of indication signals.

679. In the qualification of inspection personnel by practical trials, an inspector shall demonstrate to the qualification body that she/he is capable of using the qualified inspection procedure and equipment correctly and in a repeatable manner. The inspector shall also be able to justify, if necessary, the various phases of the inspection process. By witnessing the inspection and reviewing the results, the qualification body shall gain adequate confidence that the inspection procedure is fully adhered to in personnel qualification.

The general principles of inspection personnel qualification are given in subsection 6.7.

680. The qualification of an inspection system shall be rejected in practical trials in the following cases, for example:

- The stated objectives of the qualification are not achieved.
- The stated objectives of the qualification are achieved, but the chain of argumentation to interpret the results is inadequate.
- The stated objectives of the qualification are achieved but a written inspection procedure has been deviated from.

In some cases, the qualification may be approved by limiting the scope of qualification.

6.7 Qualification of inspection personnel

681. Inspectors shall have been qualified under a qualification system that complies with level 2 or 3 of SFS-EN ISO 9712 [26], or they shall have an equivalent basic qualification for the inspection method in question. Basic qualifications shall usually be supplemented with additional qualifications for in-service inspections. Additional qualifications are inspection system-specific and may require special training and experience, a written examination and practical blind trials. A general basic requirement is that inspection equipment and procedures have already been qualified to meet the inspection objectives, as the qualification of the personnel cannot be focused otherwise. Guide YVL E.12 discusses the approval of inspection personnel by STUK.

682. The requirements for additional inspector qualification shall be presented in the inspection procedure. They shall be separately justified in the technical justification of each inspection procedure. The additional qualification and its assessment criteria depend on the inspection area procedure and equipment as well as the nature of the inspection task.

683. The qualification body shall assess the additional qualification requirements set forth in the technical justification, take care of the qualifications, assess the results and draw up the qualification certificates.

684. The qualification of inspection personnel is discussed in ENIQ's Recommended Practice ENIQ RP 10 [22], which shall be applied as the minimum level of requirements.

685. Practical blind trials are discussed in subsection 6.6.

6.8 Qualification assessment report

686. The qualification body shall draw up a qualification assessment report. The report shall be based on the input information, qualification procedure, technical justification and results of the practical trials as well as the witnessing of the qualification. The report shall describe how, in accordance with the assessment criteria presented in the qualification procedure, the inspection system meets the stated objectives for defect detection as well as characterisation of defect type, size, position and orientation.

687. The qualification assessment report shall contain

1. an assessment of the adequacy and restrictions of the technical justification in providing evidence of the fulfilment of an inspection system's stated objectives,
2. an assessment of the adequacy and restrictions of the practical trials in demonstrating the fulfilment of an inspection system's stated objectives,
   - an assessment of the test pieces, the correlation between the defects and postulated or specific defects and data relating to the control of the manufacture of the test pieces,
   - data on the practical trials,
   - an assessment of how far the objectives of the in-service inspection system have been achieved
3. an assessment of the mutual complementarity of the technical justification and the practical trials
   - applicability of an inspection system's scope within the range of the essential parameters,
   - the scope of the range of essential parameters in both the technical justification and the practical trials
4. summary of the outcome of the practical trials
5. deviations from the qualification procedure and recommendations for future qualifications
6. factors potentially restricting the scope of qualification and their causes
7. conclusions concerning the achievement of the stated objectives and grounds for the issuance of qualification certificates as well as recommended actions to develop the inspection system.

Qualification reporting is discussed in ENIQ's qualification methodology document EQMD and in the ENIQ Recommended Practice document RP 4 [14, 17].

6.9 Qualification certificates

6.9.1 Issue of qualification certificates

688. A qualification body shall draw up qualification certificates for all qualifications it has approved in such a way that the qualified inspectors, inspection procedures and equipment as well as their scope and restrictions are identifiable. The certificate shall bear the qualification body's signature.

689. Qualification certificates of inspection equipment and procedures shall give the following information:

- identification of equipment and software,
- identification of procedure, its revision identification, name and date,
- scopes of qualification with their restrictions,
- references to input information documents,
- references to an assessment report,
- date,
- signatures.

The qualification certificates issued for inspection procedures and equipment are valid until further notice, taking into account the restriction requirements mentioned in subsection 6.9.2.

690. After the conducting of a qualification, the qualification body shall draw up personal qualification certificates for the inspection personnel, which state the qualifications in detail and give the scopes of qualification with their restrictions and inspection procedure references. The qualification certificates shall state the components inspected and the inspection tasks qualified for them, as well as the essential information on the inspection equipment used in the qualification.

691. The qualification certificates of inspection personnel shall give the following information:

- name of person,
- identification of inspection procedure, its revision identification, name and date,
- identification of inspection equipment and software,
- scopes of qualification with their restrictions,
- references to an assessment report,
- the inspector's basic qualification,
- validity of the certificate,
- date,
- signatures.

692. The qualification certificates for inspection personnel are valid for five years on the following conditions:

- The inspector has a valid level 2 or 3 basic qualification under a qualification system that complies with standard SFS-EN ISO 9712 [26] or equivalent.
- The inspector verifiably works regularly using in-service inspection procedures and equipment.
- The inspector annually receives relevant training, including training in his or her specific field of qualification prior to the start of the inspections.

6.9.2 Withdrawal or review of qualification certificates

693. The qualification body shall withdraw the qualification certificates for an inspection procedure or inspection equipment, if the procedure or equipment qualified is found to be unreliable, or such other serious shortcomings are detected in the inspections that the inspection system is incapable of detecting or evaluating in practice the defects for which it is qualified.

694. The qualification body shall assess whether the actual inspection areas correspond to the qualification test pieces and defects and whether the inspection conditions match the qualification conditions.

695. If a qualified inspection system is modified so that the tolerances or ranges of essential qualification parameters are exceeded, the qualification body shall assess the prerequisites for modification of the qualification scope and the qualification certificates. Technical justification or additional practical trials may then be required.

696. The qualification body shall report in writing to the licensee and the testing organisation any changes made to a certificate and any grounds for the changes.

6.9.3 Licensee's obligations

697. The licensee shall update the lists of inspectors. The lists shall refer to the inspection system qualification certificates by inspector and to the decisions on the relevant qualifications given by STUK.

698. The licensee shall report in writing to the qualification body in cases where the scope of qualification is exceeded, as mentioned in subsection 6.9.2, where the inspection system is found to be unreliable, or where other shortcomings could lead to the withdrawal or revision of qualification certificates.

6.10 Archiving of qualification documentation and storage of test pieces

699. The licensee shall be responsible for archiving the qualification documents and storing the test pieces. The qualification body shall determine the confidentiality of the storage of the qualification documents and the test pieces. The qualification documents shall be stored until the decommissioning of the nuclear facility. The documents shall be updated to reflect feedback received on practical inspections or additional qualifications. Under Section 63 of the Nuclear Energy Act (990/1987) [1], STUK shall have access to the filed copies of qualification documents and test pieces for supervisory purposes. The licensee shall ensure that STUK has the proper access arrangements available to it and shall also arrange for similar rights to extend to the qualification body separately for the qualification in question.

7 Regulatory oversight by the Radiation and Nuclear Safety Authority

7.1 Control in general

701. STUK oversees in-service inspections by reviewing documents relating to programmes and results. It will commence its review of the in-service inspection document with an assessment of whether the licensee has, in the summary of justifications it has drawn up, convincingly argued in favour of the acceptability of the document and the measures proposed in it. STUK will use argumentation analysis in its own evaluation [8].

702. STUK will make an assessment of whether or not the summary of justifications, as an argument, clearly and convincingly answers the question as to why the document should be approved.

If STUK, in its preliminary investigation, should, with reference to the summary of justifications, find the scope and depth of the licensee's argumentation and its own review and approval procedure inadequate, it will halt the processing of the document at this stage and requires the licensee to add more content to its summary of justifications for the process to continue.

If the licensee's argumentation and approval procedure are adequate, STUK will continue the process by first comparing the summary of justifications to the content of the rest of the document, finally evaluating the acceptability of the entire document.

703. When in-service inspections are performed during outages, STUK will pay monitoring visits to the plant site to the extent it considers appropriate. The purpose of these visits is to witness the general inspection arrangements, the process for reporting on the results and the flow of information between the various parties involved and to make a preliminary assessment of the results of the inspections.

STUK will designate, with reference to the inspection schedule it has received, those areas of inspection for which the precise starting time must be given.

704. Under the periodic inspection programme for operation, STUK will monitor the data systems used in the in-service inspections.

7.2 Plan for principles of in-service inspections

705. STUK will process and give a decision on the plan for principles of in-service inspections.

706. STUK will consider whether the plan for principles is adequate for a construction licence to be issued. When evaluating the construction licence application, STUK will consider, with reference to the preliminary safety analysis report and the plan for principles of in-service inspections it receives together with the application, as to whether they indicate that the preconditions for comprehensive qualified in-service inspections have been planned in all phases of the service life of the nuclear facility, from design to decommissioning.

707. STUK will particularly assess whether the plan for principles, in order to indicate the existence of the preconditions for construction, includes the following:

- an indication that there is readiness to prepare the pre-service inspection plan,
- an indication that there is readiness to commence the qualification process,
- a description of the in-service inspection document system.

7.3 Control of pre-service inspections

708. The completion of the pre-service inspections is required before STUK can ascertain under Section 20(2)(1) of the Nuclear Energy Act (990/1987) [1] that the nuclear facility meets the set safety requirements. STUK will assess this on the basis of its own monitoring process and the summary reports of the pre-service inspection results submitted for approval by the licensee.

709. STUK will consider and give decisions on the pre-service inspection plan for pressure equipment and the summary report of the pre-service inspection results.

7.4 Summary programme for in-service inspections

710. STUK will consider and give a decision on the summary programme for in-service inspections.

711. STUK will consider whether the summary programme is adequate for the operating licence to be granted.

712. STUK will consider the summary programme and make an assessment of whether the programme sets out from the start of the construction phase the general principles and evaluation criteria for the pre-service inspection plan, as well as the subsequent in-service inspection programmes for an inspection interval and the inspection plans for operation period.

713. STUK will consider whether the summary programme sets out the principles for selecting the inspection areas, methods and intervals, the procedures for reporting and evaluating the inspection results and flaw indications, and the qualification procedures of inspection systems in all phases of the service life of the nuclear facility, from design to decommissioning.

7.5 Control of individual in-service inspections

714. The completion of individual in-service inspections is required before STUK can ascertain, by virtue of Section 20(2)(1) of the Nuclear Energy Act (990/1987) [1], that the nuclear facility meets the set safety requirements. STUK will assess this on the basis of its own monitoring process and the notification of the completion of inspections submitted by the licensee.

715. STUK will consider and give decisions on the programmes for an inspection interval, in-service inspection plans for operation period, and the summary reports of in-service inspection results.

716. On application, STUK will consider the analyses and other action plans prior to reactor start-up after an outage, if the intention is to leave flaw indications in the structure exceeding the thresholds set in the acceptance standards on the basis of fracture mechanical analyses.

717. An inspector from STUK will check the results of all individual in-service inspections of the reactor pressure vessel internal structures and its interior before the permission to close the reactor pressure vessel head is granted. STUK will finally process the results as part of the summary reports of the results of the individual in-service inspections.

718. An inspector from STUK will assess the results of the individual in-service inspections for the purpose of preparation a start-up decision after an outage. STUK will finally process the results as part of the summary reports of the results of the individual in-service inspections.

719. STUK will process, for its monitoring purposes, as received for information the nuclear plant unit-specific summaries of in-service inspections and progress reports for the current inspection interval.

7.6 Control of the risk-informed selection process

720. Before a construction licence is granted, STUK will assess the licensee's preparedness to draw up a risk-informed in-service inspection programme for piping. For that purpose, STUK will consider the document submitted with the construction licence application documents that sets out the principles governing the preparation of the risk-informed in-service inspection programme for piping and the preliminary risk-informed selection process method description and indicates source materials.

721. STUK will assess the updated risk-informed selection process methodology description for piping submitted for approval during the construction of a nuclear power plant, and which is supplied for the purpose of the pre-service inspection plan.

722. STUK will evaluate the results of the risk-informed selection process submitted for information when the pre-service inspection plan and programme for an inspection interval are being processed.

723. When a deterministic in-service inspection programme for an operating nuclear facility is changed to a risk-informed programme, STUK will process the methodology description of the risk-informed selection process.

724. STUK will process the updates to the risk-informed in-service inspection programme for piping.

STUK will use the following aid in its processing: ENIQ's report Discussion Document, Updating of Risk-Informed Inspection Programmes [9].

7.7 Control of qualifications

725. STUK oversees qualifications by reviewing qualification documents. It will commence its review of a qualification document with an assessment of whether the licensee has convincingly argued, in the summary of justifications it has drawn up, in favour of the acceptability of the document and the measures proposed in it. STUK will use argumentation analysis in its own evaluation [8].

726. STUK will make an assessment of whether or not the summary of justifications, as an argument, clearly and convincingly answers the question as to why the document should be approved.

If STUK, in its preliminary investigation, should, with reference to the summary of justifications, find the scope and depth of the licensee's argumentation and its own review and approval procedure inadequate, it will halt the processing of the document at this stage and requires the licensee to add more content to its summary of justifications for the process to continue.

If the licensee's arguments and approval procedure are adequate, STUK will continue the process by first comparing the summary of justifications to the content of the rest of the document and eventually evaluate the acceptability of the entire document.

727. STUK will consider the plant unit-specific strategy plan for the organisation and implementation of qualification, and the procedures employed, submitted for approval or information, along with related guidelines, in accordance with subsection 5.2.

728. STUK will consider the qualification body's approval application with reference to the accreditation decision issued by FINAS and the qualification body's documents supporting that decision.

729. Representatives of STUK may participate in the qualification body's accreditation process together with FINAS representatives.

730. STUK will process the design documents of an individual qualification as follows:

- the composition of the qualification body and any deviations from the qualification organi-

sation presented in the strategy plan (for information),
- input information with justification (for approval),
- qualification procedure compiled by the qualification body (for information).

731. In overseeing and evaluating qualifications, STUK will use as assessment criteria the European Qualification Methodology Document (EQMD) [14], produced and published by the European Network for Inspection Qualification (ENIQ), supplemented with ENIQ's recommended practices ENIQ RP 1, RP 2, RP 4, RP 5, RP 6, RP 7, RP 8 and RP 10 [15, 16, 18, 19, 20, 21, 22].

732. When overseeing and inspecting qualifications, STUK will also use as assessment criteria the Common Views report by the European Nuclear Safety Authorities [28], with special emphasis on
- the link between nuclear safety and the qualification input information
- the link between the radiation safety principles (ALARA) required during practical inspections and the qualifications.

733. When evaluating qualification results, STUK will process the following documents:
- The qualification assessment report,
- The qualification certificates,
- the other final documents listed in subsection 6.2.

734. STUK will process the qualification body's assessment report as received for approval and the other sections of the result documentation as received for information.

When STUK has approved the qualification dossier's assessment report and noted that it has processed the other parts of the qualification dossier as received for information, it may determine in a decision that the inspection procedure and equipment have now been qualified.

735. STUK will take action on the basis of the reports, if the qualification body reports administrative and organisational shortcomings that compromise the independence and reliability of qualification.

736. STUK may pay monitoring visits to the places where the qualification documentation is archived and test pieces stored. It has rights of access for this purpose under Section 63 of the Nuclear Energy Act (990/1987) [1].

7.8 Control of document updates

737. STUK will oversee document updates, for which the licensee shall apply for STUK's approval in the same way as for the original documents.

Definitions

Expert panel

Expert panel, in the context of in-service inspections, shall refer to a special workgroup consisting of experts of various fields of nuclear facility technology that evaluates risk-informed methods.

Open trial

Open trial shall, in the context of qualification, refer to a practical trial conducted using the inspection system under qualification which is witnessed by a qualification body and where the inspectors have been given advance knowledge of the defects of the test piece inspected.

Conditional Core Damage Probability

Conditional core damage probability (CCDP) shall refer to the probability of core damage as a result of an initiating event such as a pipe break ($CCDP = CDF/f_{\text{pipe break}}$).

Physical reasoning

Physical reasoning shall, in the context of qualification, refer to a part of the technical justification that summarises the detailed selection justifications of the qualification approach expressed in qualitative terms. The design of test pieces may be started using physical reasoning.

Acceptance standard

Acceptance standards shall, in the context of in-service inspections, refer to flaw indication acceptance standards presented in ASME Code XI, or to other flaw indication acceptance evaluation methods approved by STUK containing threshold values generally valid for a certain type of components, or parts thereof, not considering the actual stresses present in the item in question.

Artificial defect

Artificial defect shall refer to an intentional defect created in the test piece for the purpose of qualification that differs from an actual defect in terms of physical properties. It is usually a groove, indentation or something similar manufactured by means of machining.

Recording level

Recording level shall refer to an indication threshold, above which indications shall be recorded in the inspection record.

Practical trials

Practical trials shall, in the context of qualification, refer to the assessment of non-destructive inspection, applying the inspection to test pieces containing defects.

Geometrical indication

Geometrical indication shall refer to an indication of the geometrical or metallurgical structure of the component that is obtained by using non-destructive testing methods.

Parametric studies

Parametric studies shall, in the context of qualification, refer to experimental laboratory studies to establish the impact of various separate essential parameters.

In-service inspection plan for the operation period

In-service inspection plan for the operation period shall refer to an inspection plan presenting the inspections performed during an operation period. The inspections are performed during the refuelling and service outages that determine the length of the operation period.

In-service inspection programme for an inspection interval

In-service inspection programme for an inspection interval shall refer to an inspection programme with a scope of one inspection interval, such as ten years. The programme for each inspection interval presents the inspections selected for performance during the inspection interval in question, and the inspection procedures and other documents to which changes have been introduced after the previous interval.

Plan for principles of in-service inspections

Plan for principles of in-service inspections shall refer to a plan for principles required under Section 35 of the Nuclear Energy Decree (161/1988). It refers to a document describing the in-service inspections performed using non-destructive inspection methods throughout the entire life cycle of a nuclear facility, from design to decommissioning. The plan for principles of in-service inspections contains a preliminary description of the risk-informed selection processes of inspection items, the selection criteria for inspection intervals, the inspection systems and their qualifications, and the methods used to report and assess inspection results and flaw indications.

Pre-service inspection plan

Pre-service inspection plan shall refer to an inspection plan the purpose of inspections of which is to provide basic comparative data for in-service inspections and obtain data supplementing manufacture and installation quality control about the original condition of the inspection items inspected within the in-service inspection scope.

Pass/fail criterion for in-service inspection qualification

Pass/fail criteria for in-service inspection qualification shall refer to the qualification assessment criteria relating to the number of defects detected in a test piece, the number of false calls, the accuracy of determining defect size and position, and other factors that are reported in an inspection qualification and that determine the acceptability of the inspection system.

Qualification approach of in-service inspections

Qualification approach of in-service inspections shall refer to a combination of qualification measures that is required to achieve the required level of qualification. The level of difficulty and novelty of the inspections and the level of qualification required are considered when defining the approach.

Input information for qualification of in-service inspection

Input information for qualification of in-service inspection shall refer to the information, such as the essential parameters describing an item inspected and the objectives of the inspection, that must be available before inspection qualification is started.

Qualification dossier of in-service inspection

Qualification dossier of in-service inspection shall refer to a collection of all relevant information concerning the definition and implementation of inspection qualification. The qualification dossier includes information on defects, items inspected, inspection conditions and the inspection procedure. It also covers the qualification procedure, technical justification, and the results of the qualification.

Summary programme for in-service inspections

Summary programme for in-service inspections shall refer to a summary programme required under Section 36 of the Nuclear Energy Decree (161/1988).

Indication

Indication shall, in the context of in-service inspections, refer to flaw indications and geometrical indications.

Essential parameters

Essential parameters shall, in the context of qualification, refer to the influential parameters whose value changes may actually influence an inspection in a manner where the goals of the inspection can no longer be achieved. They include input information parameters, inspection procedure parameters, and inspection equipment parameters.

Worst case defect

Worst case defects shall, in the context of qualification, refer to defects, component geometry or other essential parameters that are likely to pose the greatest challenges for defect detection and the accurate determination of size within the framework of a specific situation, as defined by the input information, using a set inspection system.

Piping segment

Piping segment shall refer to a piping section where a breakage or leak caused by a failure of any point of the piping section has the same consequences and where the degradation mechanisms are the same.

Piping structural element

Piping structural element shall refer to a part of a given piping segment, such as a weld joint, straight piping section, pipe bend, fitting, flange connection, or bellows.

Qualification body

Qualification body shall refer to an independent expert body that plans, conducts, assesses and witnesses qualifications of inspection systems.

Qualification system

Qualification system shall refer to a system that includes the procedures and administration to perform qualification tasks.

Qualification procedure

Qualification procedure shall refer to a systematic sequence of rules describing how a certain non-destructive test performed on a particular structure is to be qualified.

Qualification level

Qualification level shall refer to a reference level of inspection reliability set as an objective for an inspection system which will be qualified. The qualification level defined in the input information is dependent on the nuclear-safety risk significance of the failure of the structure and the role of the inspection in the reduction in the probability of failure. The failure potential of the structure and the consequences of the failure affect the nuclear safety risk.

Qualification certificate

Qualification certificate shall refer to a document issued under the rules of an inspection qualification system indicating that there exists an adequate level of confidence that the inspection equipment, procedures and personnel or any combination of these are capable, in a specific inspection, of achieving the inspection objectives set.

Risk category

Risk category shall refer to the magnitude of a risk caused by a pipe leak. The risk category is defined on the basis of the failure and consequence category, in turn defined based on the failure potential and the consequences of a failure.

Risk matrix

Risk matrix shall refer to a diagram consisting of three or more failure categories (Y axis) describing the failure potential, and four or more consequence categories (X axis) describing the conditional core damage probability.

Risk-informed method

Risk-informed methods shall refer to combining the results of a probabilistic risk assessment with the assessment of degradation mechanisms and the consequences of failure of components and structures.

Risk-informed in-service inspection programme

Risk-informed in-service inspection programme shall refer to an inspection programme where the selection process of non-destructive inspections as defined in Guide YVL E.5 is entirely based on the use of risk-informed methods.

Risk-informed selection process

Risk-informed selection process shall, within the context of non-destructive in-service inspections, refer to a selection process whereby the inspection areas, procedures and intervals of pressure-retaining piping segments are selected using risk-informed methods. A risk-informed selection process is applied in the preparation of the pre-service inspection plan, the in-service inspection programme for an inspection interval and the in-service inspection plan for operation period throughout the entire service life of a facility.

Blind trial

Blind trial shall refer to a practical trial conducted under an inspection system to be qualified, witnessed by a qualification body and in which inspectors have not been given advance information about the number, size, orientation or location of defects which the test piece inspected may contain.

Conditional Large Release Probability

Conditional large release probability (CLRP) shall refer to the probability of a large release due to an initiating event such as a pipe break ($CLRP = LRF/f_{\text{pipe damage}}$).

Large Release Frequency

Large release frequency (LRF) shall refer to the expectation value of the frequency of a large release of radioactive substances per unit of time.

Core Damage Frequency

Core damage frequency (CDF) shall refer to the expectation value of a core damage event per unit of time.

Inspection

Inspection shall, in the context of Guide YVL E.5, refer, as defined in the ENIQ glossary, to a process verifying the compliance with written requirements. An inspection may be conducted on several levels:

1. At the highest level, inspection may refer to a third-party inspection that meets the legal requirement for an independent approval.
2. At the medium level, inspection may refer to a verification performed using a range of means to ensure that set specifications, such as component dimensioning, have been met.
3. In the most specialised context, the word is used as a synonym to non-destructive testing, such as in "non-destructive in-service inspections of the components of a nuclear facility".

As the word 'inspection' is generally used in all of these three meanings, no single meaning is defined herein. The applicable meaning must be determined taking the context of the word into consideration.

Inspection system

Inspection system shall refer to all those elements of non-destructive testing that may influence the quality and outcome of an inspection, such as inspection equipment and their software, inspection procedures and personnel.

Qualification of inspection system

Qualification of an inspection system shall, in the context of in-service inspections, refer to the systematic evaluation of a system, using all methods that are needed to provide reliable confirmation that an inspection system is capable of preforming as required under real inspection conditions. An inspection system is qualified by demonstrating that it reliably detects, characterises and/or determines defects endangering structural integrity and nuclear safety so that the inspection goals set forth in the input information are met.

Inspection procedure

Inspection procedure shall, in the context of in-service inspections, refer to a written description and definition of a method of performing an inspection in a particular test situation, specifying all essential parameters and defining the factors to be observed when applying an inspection technique in line with established standards, procedures and regulations.

Inspection reliability

Inspection reliability shall, in the context of in-service inspections, refer to the degree which an inspection system achieves in the detection, characterisation and sizing of defects at an acceptable false call rate.

Modelling of inspections

Modelling of inspection shall refer to the use of mathematical prediction models of non-destructive inspections in order to quantitatively assess the performance of inspection systems as part of the technical justification.

Technical justification

Technical justification as part of qualification for non-destructive in-service inspections shall refer to evidence establishing that an inspection system can meet the objectives set for it. Technical justification may, however, be used for a number of other purposes, such as to justify the selection of test pieces or defects or to justify an upgrade to inspection equipment without the need to repeat the whole qualification.

Testing organisation

Testing organisation shall refer to an organisation performing testing activities requiring special competence. (Nuclear Energy Act 990/1987)

Real defect

Real defect shall, in the context of qualification, refer to a defect that has developed in a structure during its manufacture or use without this having been advanced in any intentional fashion.

Realistic defect

Realistic defect shall, in the context of qualification, refer to a defect that has been intentionally caused in a test piece and that imitates the geometry of a real defect. The most useful realistic defects are defect types that provide similar NDT responses to the real defects studied.

Probabilistic Fracture Mechanics Model

Probabilistic fracture mechanics (PFM) model shall refer to a methodology used to determine the failure probabilities of degraded pressure-retaining structures. When using a deterministic reliability model to calculate the failure time of a degraded pressure-retaining structure, the essential initial parameters (such as loads, fracture strength, original failure frequency, fracture growth pattern and so on) of several single events are input into the model using representative probability distributions of the parameters selected. The time-dependent failure probability is determined by calculating the ratio between the number of failure cases of damaged pressure-retaining structures which have occurred by the time of assessment and the number of calculated cases.

Probabilistic risk assessment (PRA)

Probabilistic risk assessment (PRA) shall refer to a quantitative assessment of hazards, probabilities of event sequences and adverse effects influencing the safety of a nuclear power plant. (Government Decree 717/2013)

Influential parameter

Influential parameters shall, in the context of non-destructive in-service inspections, refer to the parameters that are significant to a specific inspection and may affect the results of the inspection.

False call

False call shall, in the context of in-service inspections, refer to an erroneous assessment of a defect-free area as faulty.

Degradation mechanism

Degradation mechanism shall refer to a phenomenon or process that may cause degradation in a pressure-bearing structure.

Failure potential

Failure potential shall refer to the proneness of a structure to degradation mechanisms. Failure potentials are divided into failure categories.

Consequence of failure

Consequence of failure shall refer to the conditional core damage probability caused by a pipe leak. The consequences of failure are divided into consequence categories.

Flaw indication

Flaw indication shall, in the context of in-service inspections, refer to evidence of a flaw obtained using a non-destructive inspection method.

Leak before break (LBB)

The leak before break (LBB) shall refer to a principle where piping does not have identified failure mechanisms creating the possibility of complete break, and faults that are not detected during inspections may at most create a small, local leak the detection of which allows the plant to be brought into a state where there is no risk of complete break.

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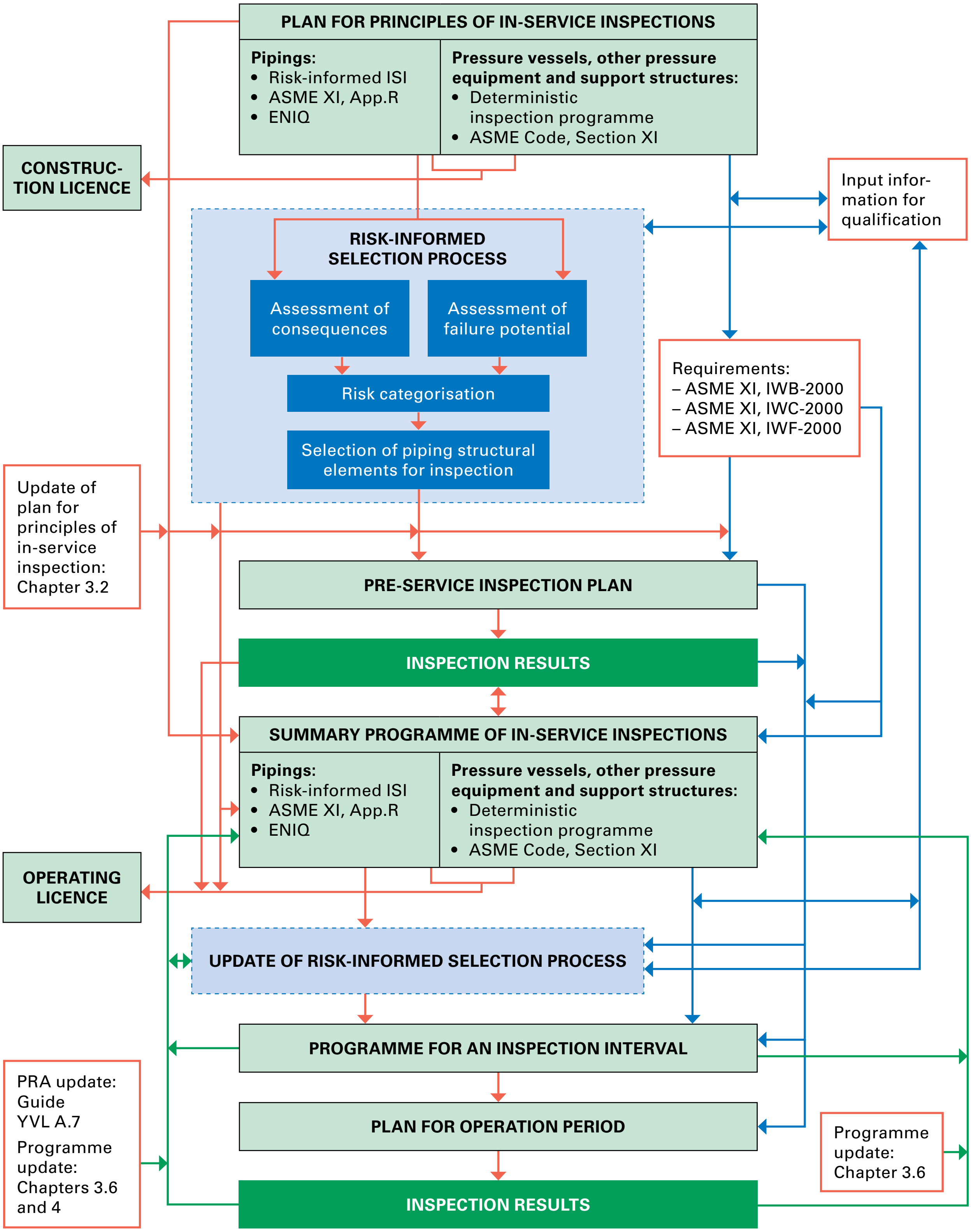
ANNEX A Document diagram for in-service inspections



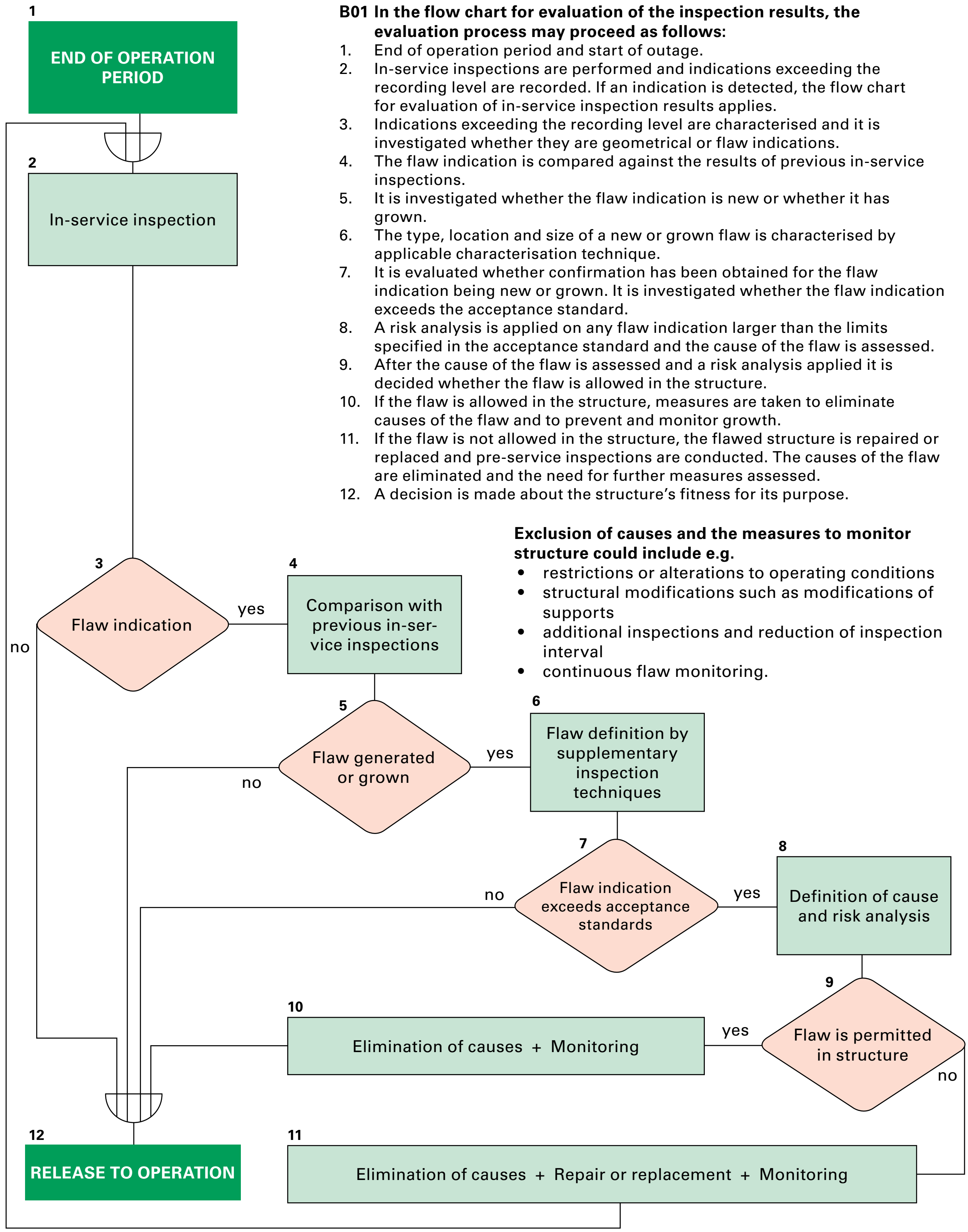
ANNEX B Evaluation of inspection results

B01 In the flow chart for evaluation of the inspection results, the evaluation process may proceed as follows:

1. End of operation period and start of outage.
2. In-service inspections are performed and indications exceeding the recording level are recorded. If an indication is detected, the flow chart for evaluation of in-service inspection results applies.
3. Indications exceeding the recording level are characterised and it is investigated whether they are geometrical or flaw indications.
4. The flaw indication is compared against the results of previous in-service inspections.
5. It is investigated whether the flaw indication is new or whether it has grown.
6. The type, location and size of a new or grown flaw is characterised by applicable characterisation technique.
7. It is evaluated whether confirmation has been obtained for the flaw indication being new or grown. It is investigated whether the flaw indication exceeds the acceptance standard.
8. A risk analysis is applied on any flaw indication larger than the limits specified in the acceptance standard and the cause of the flaw is assessed.
9. After the cause of the flaw is assessed and a risk analysis applied it is decided whether the flaw is allowed in the structure.
10. If the flaw is allowed in the structure, measures are taken to eliminate causes of the flaw and to prevent and monitor growth.
11. If the flaw is not allowed in the structure, the flawed structure is repaired or replaced and pre-service inspections are conducted. The causes of the flaw are eliminated and the need for further measures assessed.
12. A decision is made about the structure's fitness for its purpose.

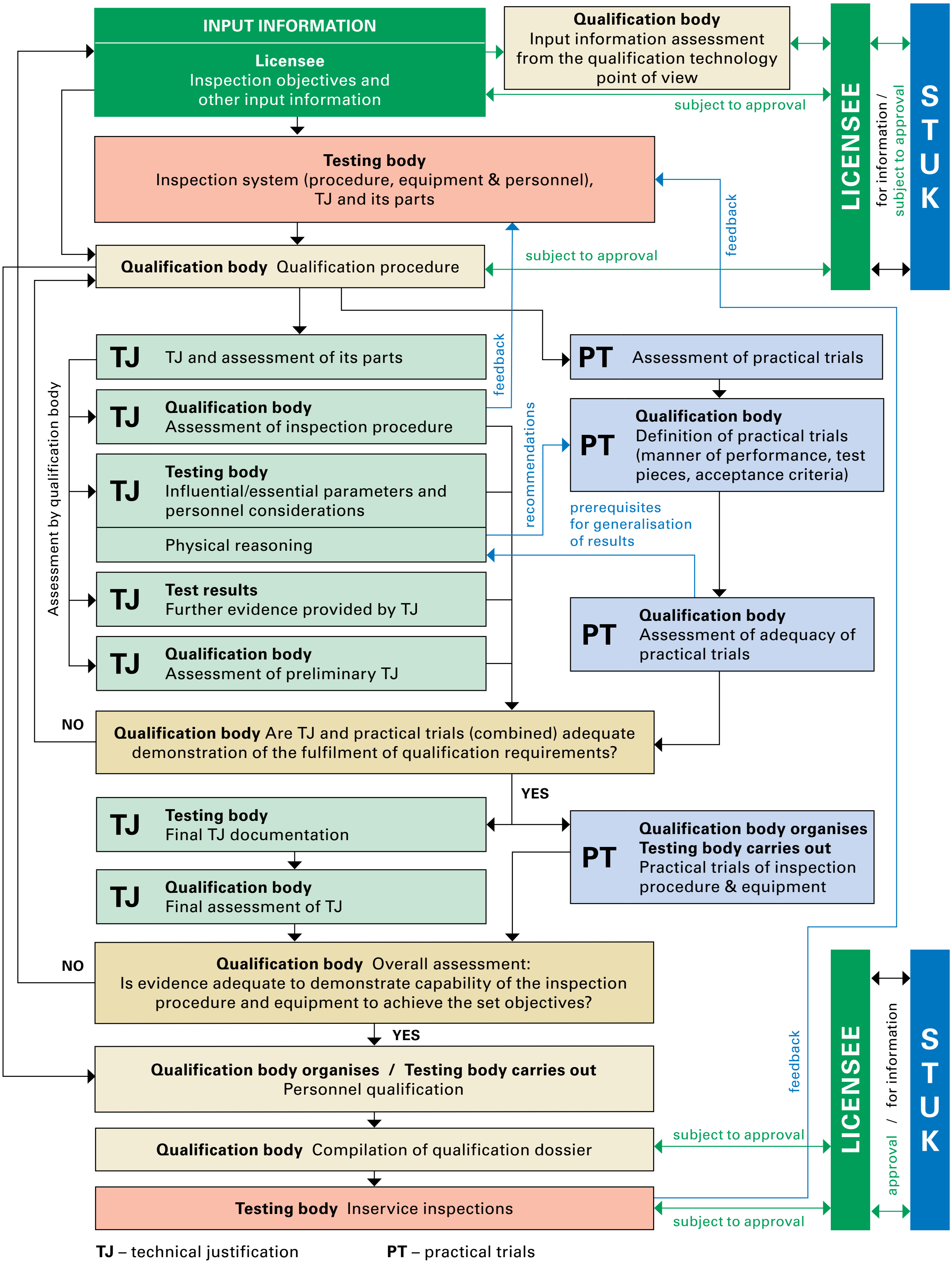
Exclusion of causes and the measures to monitor structure could include e.g.

- restrictions or alterations to operating conditions
- structural modifications such as modifications of supports
- additional inspections and reduction of inspection interval
- continuous flaw monitoring.



Flow chart for the evaluation of inspection results [29].

ANNEX C Qualification process for inspection system



The diagram visualises the qualification process of the inspection system, and presents the interdependencies of the technical justification within the context of the entire qualification. It includes the tasks for the different parties in the qualification, and the key factors in the qualification system. It also visualises the opportunities for developing the inspection system by using a feedback system.

ANNEX D Qualification body

D01. The qualification body shall act competently and independently. Its operation is crucially important for the reliability of qualification.

D02. The qualification body shall
- report any administrative and organisational shortcomings that compromise the independence and reliability of qualification directly to STUK,
- produce checklists for the control and inspection of the input information, inspection procedure, technical justification, practical trials and more,
- assess the input information in terms of the technical aspects of qualification before submitting it to STUK for approval,
- draw up the qualification procedures,
- assess the inspection procedures and technical justification,
- assess what requirements have been set for the competence of inspection personnel,
- determine the balance between the technical justification and practical trials,
- by comparing the advantages and disadvantages of the qualification defects in test pieces and their manufacturing procedures, assess their suitability for achieving the objectives of the inspections in the qualifications concerned,
- assess the detailed plans for each test piece and issue their approval decisions,
- assess and oversee the manufacture of test pieces and prepare an evaluation report for inclusion in the qualification dossier,
- prior to the start of qualification, visually inspect the test pieces and review the result documentation as well as draw up the information for inclusion in the qualification dossier and an approval decision,
- plan, implement, oversee, assess and report on the practical trials and their results,
- ensure that details of the test pieces and practical trials are kept confidential,
- evaluate the extent to which the requirements pertaining to the additional qualification of inspection personnel have been met,
- update the qualification documents with any changes that have been found to be needed,
- assess the qualification documents, draw up a qualification assessment report and issue qualification certificates for inspection equipment, procedures and personnel,
- if necessary, withdraw or amend the qualification certificates.

ANNEX E Contents of the qualification procedure

E01. The qualification procedure shall consist of:

1. a summary of the input information on which the qualification procedure is based in accordance with subsection 6.3.,
2. a preliminary assessment by the qualification body of the inspection procedure,
   - a preliminary assessment of the inspection procedure to ensure that it is unambiguous, systematic and detailed and identifies all essential inspection procedure parameters.
3. Approach to qualification; requirements for its elements at a selected qualification level
   - inspection procedures
   - inspection equipment,
   - inspection personnel,
   - technical justification
   - test pieces.
4. Balance between the technical justification and practical trials in qualification, ENIQ RP 2 [16].
5. Assessment procedures (ENIQ RP 4 [17]) for the
   - technical justification,
   - inspection procedure,
   - inspection equipment,
   - inspection personnel.
6. Plan for implementation of practical trials, EQMD, ENIQ RP 5 [14, 18]
   - determination of the need for open and blind trials,
   - management of blind trials,
   - a description of the test conditions with time limitations,
   - trial implementation plan,
   - qualification schedule and place of practical trials.
7. Detailed information on the test pieces used in the practical trials, ENIQ RP 5 [18]
   - number, types, dimensions, materials,
   - equivalence between the test pieces and the actual components to be inspected,
   - identification of defects in open test pieces.
8. Recording of qualification results, EQMD, ENIQ RP 5 [14, 18]
   - assessment report,
   - qualification certificates.
9. Feedback system to develop the inspection system by qualification and to collect feedback on inspections for qualification purposes.
10. Archiving of the qualification documents,
11. Management and storage of the test pieces.

ANNEX F Contents of the technical justification

F01. The detailed contents of each technical justification depend on the object of qualification and the purpose of the justification. To facilitate the evaluation work by the qualification body, the technical justification shall be structured as follows, ENIQ RP 2 [16]:

Summary
- purpose of the technical justification,
- conclusions of the technical justification on the fulfilment of the objectives of the inspections,
- limitations of the technical justification.

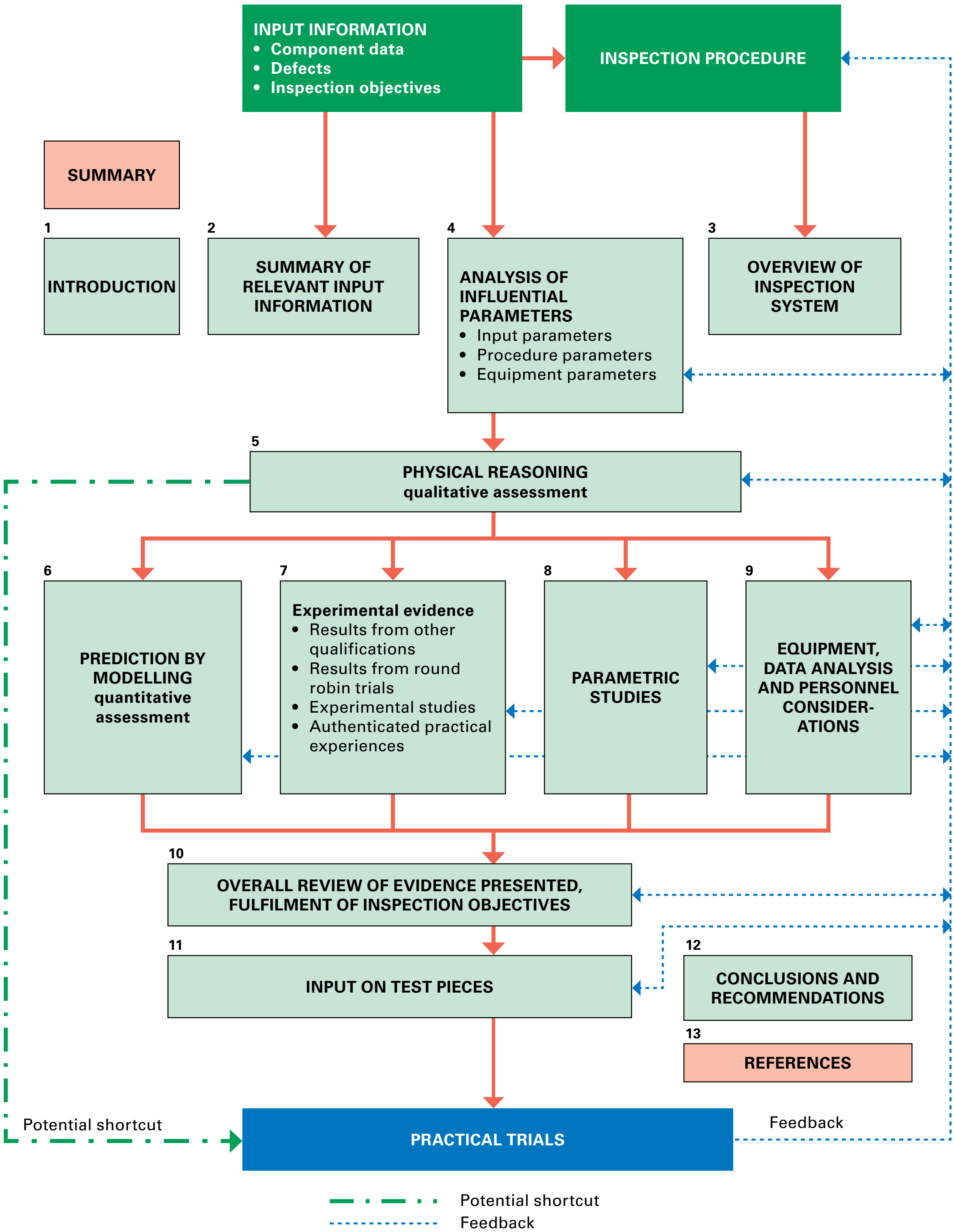
1. Introduction
   - areas inspected covered by the technical justification,
   - defects included,
   - inspection methods included,
   - purpose and scope of application of the technical justification,
   - description of the structure of the technical justification.
2. Summary of significant input information
   - summary of the approved qualification input information.
3. Summary of the inspection system
   - inspection procedure, equipment and personnel to be qualified.
4. Analysis of influential parameters
   - starting point of the technical justification (subsection 6.5.2),
   - selection and identification of essential input, inspection procedure and equipment parameters, ENIQ RP 1 [15],
   - list of the values of essential parameters and their tolerances and ranges.
5. Physical reasoning (qualitative evaluation)
   - qualitative justifications for the choice of the parameters for the inspection procedure/ equipment, where the input information covers the areas for inspection and the objectives of the inspections,
   - worst case defects,
   - needed in the initial phase of qualification as justification for the design and manufacture of test pieces.
6. Prediction models (quantitative evaluation)
   - use of the theoretical prediction modelling, ENIQ RP 6 [19],
   - qualified/unqualified models; assumptions, simplifications and limitations.
7. Experimental evidence
   - applicable results from other qualifications, results of round robin trials, experimental studies,
   - it shall be shown that the experimental evidence is relevant to the qualification concerned,
   - references shall be evaluated and they must be available to the qualification body.
8. Parametric studies
   - identified additional studies for influential parameters, supplementing the prediction models and experimental evidence.
9. Inspection equipment, data processing software and requirements of inspection personnel
   - grounds for the selection of inspection equipment and data processing software containing the justifications for the evaluation and analysis system used to interpret the inspection data,
   - achievement of the objectives of inspections with the selected equipment parameter values,
   - justifications in practical inspections for the achievement and preservation of the performance of qualified inspection equipment,
   - evaluation of, and justifications for, the adequacy of inspection personnel qualification requirements with regard to the equivalence of inspections; necessary specialist experience, training and certification.

10. Overall evaluation of the evidence
- vital part of each technical justification,
- examination of the evidence for previous parts of the technical justification from the perspective of essential parameters,
- summary of the previous parts of the technical justification, taking account of the essential parameters identified, with a justification for the ability of the inspection system to achieve the objectives of the inspections
- the inspection personnel's need for training and experience with reference to essential input information parameters and the previous parts of the technical justification,
- identified additional needs for practical trials,
- adoption of a clear position if the evidence is inadequate,
- adoption of a clear position if the evidence shows that not all the objectives of the inspections set in the input information have been achieved.

11. Input information provided by the technical justification for the test pieces in practical trials
- input information for the design and manufacture of test pieces with reference to previous parts of the technical justification,
- often for practical reasons, the design of test pieces may be begun based on the physical reasoning data,
- a very important application is the balance between the technical justification and the practical trials, so that both of them together make it possible to show that the objectives of the inspections are met,
- geometry, dimensions, materials, defects and accessibility of test pieces.

12. Conclusions and recommendations
- all the important conclusions contained in the technical justification,
- a clear statement concerning the achievement of the objectives of the inspections using the inspection system,
- a clear statement concerning the weaknesses of the technical justification and any limitations in the performance of the inspection system when compared to the objectives of the inspections,
- recommendations to improve the inspection system and even out the weaknesses of the technical justification with practical trials,
- recommendations concerning, for example, the design of the test pieces, inspection personnel qualification requirements or design of the inspection equipment.

13. References
- a list of all the references cited in the text of the technical justification that are available to the qualification body.



Sections of the technical justification and their relationships to the elements of the qualification process, ENIQ RP 2 [19].