

Translation of:

Vessels and piping classified as important to safety: Engineering, manufacture and installation

Edition February 2009, Revision 2 of 1st June 2013 [Date of translation: 31.03.2014]

Guideline for Swiss Nuclear Installations

ENSI-G11/e

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List of Contents

Guideline for Swiss Nuclear Installations

ENSI-G11/e

1. Introduction	1
2. Subject matter and scope of application	1
3. Legal basis	1
4. Basic Requirements	2
4.1 Construction Specification	2
4.2 Design Specification	3
4.3 Categorisation of Components' Parts	3
4.4 Hazard Analysis	3
4.5 Supervision by the Safety Authority	4
4.6 Supervision by the authorised inspector	4
5. Engineering	5
5.1 Principles	5
5.2 Materials Semi-Finished Products and Weld Filler Metal	5
5.3 Provisions for Operation and Handling	6
6. Design approval	7
6.1 Fabrication of material, semi-finished materials and welding filler metals	7
6.2 Design and construction	7
6.3 Manufacture of components	8
6.4 Installation of components and systems	8
7. Manufacture and installation	9
7.1 Qualification in Manufacturing	9
7.2 Material Certifications	10
7.3 Tests of Manufacturing	10
7.4 Deviations	11
7.5 Reworks	11
7.6 Marking	11
7.7 Construction Supervision	11
8. Documentation	13
8.1 Construction documentation	13
8.2 Operating instructions	14
9. List of References	14
Annex 1: Definitions (according to ENSI glossary)	16
Annex 2: Design Specification	19

Disclaimer: This translation is provided for information purposes only and has no legal force!

Guideline for Swiss Nuclear Installations ENSI-G11/e

Vessels and piping classified as important to safety: Engineering, manufacture and installation

Edition February 2009, Revision 2 of 1st June 2013 [Date of translation: 31.03.2014]

Annex 3:	Hazard Analysis	22
Annex 4:	Design approval documents	23
Annex 5:	Qualification and Monitoring of Construction	26

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Guideline for Swiss Nuclear Installations ENSI-G11/e

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1. Introduction

The Swiss Federal Nuclear Safety Inspectorate (ENSI) is the safety authority for nuclear safety and security of nuclear facilities in Switzerland. In its capacity as safety authority, or based on a mandate in regulations, it issues guidelines. Guidelines are enforcement documents that substantiate the implementation of legal requirements and facilitate a uniformity of implementation practice. They further concretise the state-of-the-art in science and technology. ENSI may allow deviations from the guidelines in individual cases, provided that the suggested solution ensures at least an equivalent level of nuclear safety and security.

2. Subject matter and scope of application

This guideline regulates the detailed requirements for planning, manufacturing, and installation of safety classified vessels and piping, their supports, and pressure-retaining component parts for use in Swiss nuclear facilities (BRK) [Verordnung über sicherheitstechnisch klassierte Behälter und Rohrleitungen in Kernanlagen, (VBRK)]. It also applies to nuclear internals as well as for component parts with a safety function. The regulations relate to, modifications, and corrective maintenance.

Safety classified vessels and piping in nuclear facilities and nuclear internals belong to both, the main mechanical components according to art. 26, para. 1, sec. b of the Swiss Federal Nuclear Energy Regulations (KEV) and also to the mechanical components MA and MB according to Annex 4 (KEV).

The detailed requirements for maintenance of safety classified vessels and piping in nuclear facilities are the subject of the guideline ENSI-B06, and those for ageing management are regulated by the guideline ENSI-B01. The requirements for the transport and storage containers are included in the guideline ENSI-G05.

3. Legal basis

This guideline implements the following legal basis:

Art. 3, para. 2 of the Regulation on Safety Classified Vessels and Piping in Nuclear Facilities (VBRK, SR 732.13).

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Guideline for Swiss Nuclear Installations ENSI-G11/e

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4. Basic Requirements

The elimination or reduction of hazards arising from the operation of the components must basically be achieved by a good design and layout, safety analysis and by a careful selection of materials and components. Quality must be comprehensively monitored and verified by means of specific testings and inspections during engineering, manufacture and installation. Suppliers as well as manufacturers must work in accordance with a quality management system that fulfils the nuclear requirements.

Protective measures have to be designed such that the operation and the maintenance of the components are ensured without restrictions. Shielding, isolations, equipment with safety function and mechanical protection devices are particularly considered as protective measures.

4.1 Construction Specification¹

Following standards have been approved for engineering, manufacture and installation

- a. ASME Boiler and Pressure Vessel Code, Section III, Division 1;
- b. KTA Safety Standards.

In particular the specifications in ASME III, Subsection NB to NG and KTA 3201, 3211, 3301 and 3401 apply.

Within one system, only one of the above mentioned standards a or b may be applied for components of the safety classes SC 1 to SC 3. Exempt from this regulation are components of safety class SC 3 that have to this date been designed and built according to codes and standards from non-nuclear applications. For these components and for components of SC 4, accepted non-nuclear standards may be used.

For DWR-installations, the requirements of the construction code for components of SC 1 apply to the secondary side of the steam generator with the connected main steam piping and feed water lines up to, and including, the first isolation appliances as well as their supports and mounts.

The present guideline specifies additional requirements to the construction code. If the above construction code does not contain any regulations, the specific requirements in the design specification have to be defined accordingly.

¹ Version according to revision 2 dated 1st June 2013

4.2 Design Specification²

The license holder of a nuclear facility is responsible for drawing up the design specification as well as for keeping it up to date. He may assign the preparation of the specification to third parties. Any modification to components and parts and the procurement of spare parts has to be verified on the design specification. If necessary, the design specification has to be brought in line with the latest technical standard.

In general, a specific design specification is required. For similar components (e.g. valves), a basic specification (standard specification) may be complemented by component-specific detail specifications (data sheets).

The design specification contains all the information on technical, quality-related and organisational requirements for the respective component. This is necessary for the component manufacturer to execute the order and for defining his responsibilities. The requirements of this guideline have to be considered in the design specification for regulatory oversight and supervision by the authorised inspector. The design specification belongs to the application documents of hierarchy M2 in accordance with Annex 4 NEO.

Annex 2 shows the structure and content of a typical design specification.

4.3 Categorisation of Components' Parts³

The parts of the components are to be categorized in the context of the design as follows:

- a. safety related, pressure-retaining parts
- b. safety related, functionally important parts
- c. non-safety related parts

4.4 Hazard Analysis⁴

A hazard analysis for all components must be prepared for the planning. Legal requirements for operational safety, protection against radiation, protection of health, and industrial safety must be considered in all phases of installation, commissioning and operation of the components until their decommissioning.

Along with use according to instructions, possible human errors by the operating and maintenance personnel shall be taken into account in the hazard analysis. Local conditions during operation and maintenance of the components are to be considered. Safety measures such as shielding, filters, accessibility, radiation protection zones, lifting gear and platforms are to be defined and are to be taken into account in the planning so that the safety of the personnel is ensured at all times.

² Version according to revision 2 dated 1st June 2013

³ Version according to revision 2 dated 1st June 2013

⁴ Version according to revision 2 dated 1st June 2013

Safety measures for the identified hazards are to be defined and incorporated in the manufacture and assembly of components. Any remaining hazards for any of the operational states of the components are to be identified in the operating instructions and targeted countermeasures and rules for procedure are to be described.

Annex 3 shows the structure of a typical hazard analysis.

4.5 Supervision by the Safety Authority⁵

Design specifications, categorization of components' parts as well as hazard analysis are part of the application documentation of hierarchy M2. These documents can be submitted separately to the authority for review.

For minor modifications according to art. 5.1.3 ENSI-A04 and hence for a simplified form of acceptance only the design specification as well as the categorization of components' parts are to be submitted to the safety authority. For comprehensive modifications art. 5.1.3 ENSI-A04 and hence for an acceptance within four hierarchy levels (M1 up to M4) the design specification, the categorisation of components' parts and the hazard analysis are to be submitted to the safety authority.

4.6 Supervision by the Authorised Inspector⁶

In addition to the monitoring by the safety authority, the engineering, manufacture and installation of the VPN (BRK) are subject to supervision by an accredited type A inspection agency in accordance with ISO / IEC 17020 (expert) that has been designated by the safety authority. Supervision includes the review of the design documents (design approval), the supervision of manufacturing and installation as well as the review of the construction documentation.

The expert is responsible for the inspection of:

- Piping of SC 1 > DN 25 (1“), SC 2 > DN 50 (2“) and SC 3 > DN 100 (4“) including all connected components
- vessels of SC 1 up to SC 3 insofar as $p \cdot V > 1$ (p: design overpressure in bar, V: volume in m³)
In that, the criterion $p \cdot V$ shall be applied for heat exchangers separately on the primary and secondary side. Once the criterion has been met on one side, then the entire heat exchanger is under the technical expert's supervision.
- Safety valves of the controlled piping and vessels of SC 1 up to SC 3
-

⁵ New chapter according to revision 2 dated 1st June 2013

⁶ Version according to revision 2 dated 1st June 2013

5. Engineering⁷

5.1 Principles

The minimum allowance required is to be extracted from the applicable construction specification. Allowances which consider the influence of corrosion, erosion, embrittlement and material fatigue are to be chosen so that the safety of the components is ensured at all times until their decommissioning.

5.2 Materials Semi-Finished Products and Weld Filler Metal

Materials, semi-finished products as well as weld filler metals are to be acquired in accordance with the applicable construction code and fulfil the supplementary requirements stated in this guideline. Along with materials permitted by the construction code, other materials specified in the technical standards and suitable for nuclear applications can also be used to the extent that they meet the requirements of the applicable construction code and the design specification. In addition to the requirements set forth in the construction codes, the following requirements apply for procurement of materials.

5.2.1 Limitation of the Cobalt Content

In austenitic materials and weld filler metals that come in contact with the primary water, the cobalt content is to be limited as follows:

- a. materials in the neutron field of the reactor core:
cobalt content ≤ 500 ppm (0,05 %)
- b. tubes of the steam generator, resuperheater, preheater (BWR):
cobalt content $\leq 1\ 000$ ppm (0,1 %)
- c. other parts of the system:
cobalt content $\leq 2\ 000$ ppm (0,2 %).

⁷ Version according to revision 2 dated 1st June 2013

5.2.2 Contents of trace elements

The content of trace elements that promote embrittlement or corrosion (phosphorus, sulphur, copper) of vessels and piping of the safety classes SC 1 and SC 2 are to be limited in accordance with the Supplementary Requirements of the ASME Code (section II, parts A to D). When using European standard materials, the KTA requirements (3201.1, section 3.2.4.2 or 3211.1, table A 1-1) must be met.

5.2.3 Testability

The material quality must be chosen so that the prescribed manufacturing and in-service inspection can be carried out without any restrictions.

5.2.4 Evidence of Proof Stress Properties at Elevated Temperature

For safety related, pressure retaining component parts of SC 1 and SC 2, an additional tensile test at elevated temperature at or above 150°C (for heat-treated bolting at or above 300°C) for each required tension test at room temperature T_0 is required. A hot yield point $R_{p0.2}(T_A)$ and a tensile test at elevated temperature $R_m(T_A)$ must be confirmed.

Either S_u -values according to ASME, section II-D, table U or modified specific minimum values shall be used as specified minimum values for the tensile test at elevated temperature, which are to be calculated as follows (this also applies for heat-resisting materials according to EN-codes).

$$R_m(T_A) = 1.1 \times R_m(T_0) \times R_{p0.2}(T_A) / R_{p0.2}(T_0)$$

5.3 Provisions for Operation and Handling

The in-service inspections according to Annex 2 of the Swiss Federal Regulations Concerning Safety Classified Vessels and Piping in Nuclear Facilities (VBRK) are considered as a required inspection. Shielding, insulation, or mechanical safeguards are to be designed so that they can be removed and re-installed in order to carry out the maintenance work without unacceptable exposure to radiation. The components are to be configured so that they can be cleaned and decontaminated.

For welds in vessels and piping of the safety classes SC 1 and SC 2, which in the framework of operation are required to be tested volumetrically (ultrasonic and radiographic testing), a scratch-free, flat grinding of the top layer and the weld transitions is required. These welds are to be designed so that they can be tested with handling devices.

Fittings, nozzles, and valves of the mechanical safety classes SC 1 and SC 2 have to be provided with cylindrical testing surfaces as an extension for welds for which testing using ultrasonic methods is mandatory. The width of the testing surfaces is dependent on the testing technology provided.

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6. Design approval

Design approval means the review of technical documents (application documents of the hierarchy M3 according to Annex 4 KEV (Swiss Federal Nuclear Energy Regulations) that precedes the manufacturing or installation of components. A Design approval review is required for modifications and repairs and is done on the basis of the hierarchy M2 application documents approved by the Nuclear Inspectorate and taking into account the regulatory requirements, the regulatory framework, the construction codes, the standards, and the specifications.

Design approval documents (VPU = Vorprüfunterlagen) are to be prepared for:

- a. the manufacturing of materials, semi-finished products and weld filler metals
- b. design and construction
- c. the manufacturing of components
- d. the Installation of components and systems

Requirements for form and content of specific design approval documents (VPU) are found in Annex 4. The design approval documents (VPU) are to be presented in due time to the technical expert appointed by the safety or review. The license holder is responsible for the pre-qualification for the components and processes for which there is no obligation for approval or surveillance according to Annex 5.

6.1 Fabrication of material, semi-finished materials and welding filler metals

The following documents are required, where applicable, and shall be submitted to the expert:

- a. material specification for materials and semi-finished products
- b. heat treatment plan
- c. specifications for non-destructive examinations
- d. sampling plans
- e. specification for heat treatment as well as special forming and shaping operations
- f. specification for rework
- g. drawings as well as manufacturing and test sequence plans

6.2 Design and construction

The following documents are required, where applicable, and shall be submitted to the expert:

- a. design drawing and parts lists with information on materials and semi-finished products for vessels, heat exchangers, pumps and valves

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- b. system circuit diagram, design drawings and parts lists with information on materials and semi-finished products for piping (type of pipes and fittings)
- c. design report on the dimensioning, stress and fatigue analysis, verification of earthquake resistance.

6.3 Manufacture of components

The following documents are required, where applicable, and shall be submitted to the expert:

- a. assembly drawing, supplementing drawings and isometric drawings
- b. materials list, weld location list
- c. inspection plan (manufacturing and test sequence plan)
- d. specification for heat treatment and special shaping or forming processes
- e. pickle and cleaning specification
- f. specification for pressure tests
- g. specification for function tests, adjustment experiments, flow measurements
- h. specification for welding, procedure qualifications, batch tests of the welding filler metals
- i. specification for non-destructive examinations
- j. specification for rework

6.4 Installation of components and systems

The following documents are required, where applicable, and shall be submitted to the expert:

- a. drawing with parts list
- b. bill of material, weld location list
- c. installation and test sequence plan (assembly instruction)
- d. specification for welding, procedure qualifications, batch tests of the welding filler metals
- e. specification for pressure tests, functional tests, adjustment experiments, measurements of flow
- f. specification for non-destructive examinations
- g. specification for rework
- h. installation specification

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Guideline for Swiss Nuclear Installations ENSI-G11/e

7. Manufacture and installation⁸

The license holder of a nuclear facility is responsible for the quality of both, the raw material as well as the manufactured and installed components, including the compliance of the corresponding rules as well as the completeness and technical accuracy of the documentation. The expert designated by the safety authority is mainly responsible for the supervision of special manufacturing operations as well as examination of the documentation. The scope of supervision by the designated expert within manufacturing and installation of parts for use in Swiss nuclear facilities the BRK and RPV internals refers to the supervision range according to chapter 4.6 and defined in Annex 5. The necessary documents have to be submitted to the authorised inspector to be reviewed prior to executing any work.

7.1 Qualification in Manufacturing

Qualifications of shaping process as well as welding process, welder and manual skill tests are subject to the technical expert's supervision according to table no. 5-1. Qualifications are to be performed on the basis of certified specifications and test plans.

The qualification required according to Annex 1, number 3.1 of the VBRK (Swiss Federal Regulations Concerning Safety Classified Vessels and Piping in Nuclear Facilities) for personnel, equipment and working, work procedures required according to number 3.1 of Annex 1 OVPN for the manufacture of welded joints is usually accomplished through:

- a. the assignment of qualified welders who meet the requirements of the applicable construction code or have been qualified and certified ASME IX, according to European Standard EN 287, ISO 9606 or European Standard EN 1418.
Additional requirements from the construction code have to be considered
- b. the use of welding equipment that has been calibrated and periodically checked
- c. the use of welding processes that have been qualified according to the applicable construction code or according to ASME IX or European Standard EN ISO 15614
Additional requirements from the construction code have to be considered
- d. the use of welding filler material permitted by the applicable construction code
- e. the use of reviewed specifications, welding plans, and operating instructions

In addition to the current welder qualification in effect, the welder must pass a test of manual skill for installation welds of parts relevant to safety.

The test piece to be welded must represent the most difficult weld and weld position that can occur. The test of manual skill is to be passed under surveillance by the technical

⁸ Version according to revision 2 dated 1st June 2013

expert. The criteria for passing a test of manual skill are to be determined in advance and in writing.

Welders who do not pass the test of manual skill are to be barred from producing welded joints of safety related components.

7.2 Material Certifications

The necessary examinations according to manufacturing code and delivery standard must be certified as stated in table no. 5-2 and 5-3.

Manufacturing operations and examination certified by 3.2 certificates and issued in accordance with EN 10204 must be supervised on site by the technical expert designated by the supervision authority and must bear his personal stamp.

The technical expert designated by the supervision authority generally examines the documentation for the 3.1 certificates, issued in accordance with EN 10204, for manufacturing operations and examination.

Certified Material Test Reports (CMTR) according to the ASME III NCA 3860 requirements are recognized in place of a material certificate 3.1 according to European Standard EN 10204.

Material properties are to be documented by lot in so far as and not otherwise specified in the supplier or material standard.

7.3 Tests of Manufacturing

The necessary tests and inspections during manufacturing that are required per the construction code and the additional requirements of this guideline according to chapter 5.2 are to be carried out, documented and certified.

The performance and time of the testing are determined by the construction code. In so far as there are no other specifications in the construction code, the testing is to be carried out in delivery condition or alternatively after the last heat treatment. Non-destructive testing and dimensional inspections that are carried in the course of the manufacturing of larger components may be replaced by intermediate testing during manufacturing.

Only test and measurement equipment are to be used that are subject to periodic inspections by testing and calibration laboratories that are accredited according to ISO/IEC 17025.

The qualification required according to Annex 1, number 3.2 of the Swiss Federal Regulations concerning safety classified vessels and piping in Nuclear Facilities for personnel, equipment, and testing procedures is basically to be carried out and documented according to the requirements of the applicable construction code.

Alternatively, testing personnel qualified and certified level 2 according to EN ISO 9712 can be deployed.

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7.4 Deviations

If setpoints or specified requirements are not met or deviations are found during manufacturing or installation, then this is to be documented in the form of complete deviation reports. The deviation report is to be submitted to the technical expert for examination. This examination has to be registered and recorded for traceability in the Fabrication and Inspection plan. If a deviation is left uncorrected, justification must be given as to why this is permissible.

7.5 Reworks

Reworks on components and parts and during manufacture and installation of parts of the categories a and b are to be carried out on the basis of reviewed deviation reports and are subject to the examination through the technical expert designated by the supervision authority. For important reworks a Fabrication and Inspection plan is to be prepared and submitted to the technical expert for examination. Repeated reworks require the consent of the technical expert.

7.6 Marking

In order to ensure traceability between the raw material up to the finished part, material, semi-finished product, sample pieces, parts, and components have to be permanently marked. Thereby the requirements of Annex 1, number 3.3 VBRK and of the construction code apply.

7.7 Construction Supervision

The basic requirements of Annex 1 number 3.2 VBRK have to be fulfilled.

Table 5-4 in Annex 5 shows the extent of the construction supervision by the technical expert designated by the supervision authority. These acceptance tests have to be included as hold points in the inspection plan. The technical expert confirms the supervision of the acceptance test with his personal stamp and signature in protocols and inspection plans.

7.7.1 Final Inspections

The final inspections necessary for acceptance have to be described in the test and inspection plan and carried out accordingly. The final inspections have to be supervised by the technical expert.

After the pressure test, visual examinations have to be performed together with the technical expert as internal and external examinations.

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The design of components and parts has to be verified on the objects on the basis of acceptance drawings in the presence of the technical expert. By means of dimensional checks, the design dimensions (e.g. wall and weld seam thicknesses, nozzle positions) as well as important installation dimensions have to be checked and documented. Any deviations found have to be documented („as-built” drawing), checked for validity, and assessed.

For piping, „as-built” isometric drawings have to be recorded after the installation. The stress analyses provided for the piping systems have to be examined on the basis of the „as-built” isometric drawing and, if necessary, supplemented.

7.7.2 Pressure Testing

Pressure testing is to be carried out in accordance with a testing procedure approved by the technical expert. Prior to pressure testing, all the required non-destructive tests of welds must be carried out and documented.

The testing procedure shall contain not less than the following elements:

- a. the requirements from the construction code and the Swiss Federal Regulations concerning safety classified vessels and piping in nuclear facilities
- b. a system diagram including the testing program with the sections of the piping system covered by the pressure testing with a list of the vessels, heat exchangers, pumps, and valves installed, and specifying the identification numbers, the manufacturer, and the manufacturing number
- c. the requirements for the testing medium, the test pressure, the testing temperature, and the holding time
- d. the instructions with regard to filling and venting, and pressure gauge connections
- e. the criteria for evaluating the testing
- f. the type of certificate.

7.7.3 Functional Testing

The planned functional testings are to be described in the manufacturing/inspection plan. For each test a procedure with all the necessary instructions and requirements is to be developed and reviewed by the technical expert in the course of pre-qualification.

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Guideline for Swiss Nuclear Installations ENSI-G11/e

8. Documentation

The documentation of the engineering, manufacture and installation is part of the construction documentation according to article 27 KEV. The basic requirements according to Annex 1 number 5 VBRK have to be fulfilled.

All documents have to be clearly marked so that they may, at any time and unmistakably, be assigned to each BRK VPN. In particular, the following should be noted:

- a. clear designation with document number, revision index, date of issue and signatures of the quality assurance officers
- b. explanation of abbreviations and symbols used
- c. use of a recognised system of units
- d. identification and justification of modifications
- e. documents must be reproducible and suitable for archiving.

8.1 Construction documentation

The documentation on the engineering, manufacture and installation of components contains at least the clearly marked and reviewed documents specified in the following:

- a. design specification and hazard analysis
- b. documents for review
- c. filled-out inspection plans for each component giving the serial number of the component
- d. deviation reports and certificates of any reworking (to be mentioned in the manufacturing/inspection plan)
- e. certificates of all manufacturing operations and tests mentioned in the manufacturing/inspection plan
- f. material certificates for component parts and welding filler metals (have to be documented in the materials list for each component part)
- g. reports on procedure qualification tests, welder examinations, batch tests of welding filler metals, qualification of manufacturing processes
- h. quality control inspection report.

If individual parts of components are prefabricated, these have to be documented accordingly.

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Guideline for Swiss Nuclear Installations ENSI-G11/e

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8.2 Operating instructions

The fundamental requirements from Annex 1, number 3.4 of the VBRK (Swiss Federal Regulations concerning Safety Classified Vessels and Piping in Nuclear Facilities) must be met. Instructions relating to the contents and preparation of the operation documents can be found in the VDI Guideline 4500 [VDI = Verein Deutscher Ingenieure= Society of German Engineers].

9. List of References

In this guideline reference is made to the following fundamental sources:

- a. **ASME Boiler and Pressure Vessel Code, Section III
Construction code of Nuclear Facility Components, Division 1**
Subsection NB, Class 1 Components
Subsection NC, Class 2 Components
Subsection NCA 3860, Certification Requirements
Subsection ND, Class 3 Components
Subsection NE, Metal Containment Vessels
Subsection NF, Support Structures
Subsection NG, Core Support Structures
- b. **ASME Boiler and Pressure Vessel Code, Section II Materials**
Part A to D
- c. **ASME Boiler and Pressure Vessel Code, Section IX Welding and
Brazing Qualifications**
- d. **KTA Safety Standards**
KTA 3201 Components of the Primary Circuit of Light-water
Reactors Parts 1 to 3, Materials and Forms of
Manufactured Items, Design, Construction and
Calculation, Manufacturing
KTA 3211 Pressure and Activity-conducting Components of
Systems outside of the Primary Circuit, Parts 1 to 3,
Materials and Forms of Manufactured Items, Design,
Construction and Calculation, Manufacturing
KTA 3301 Residual Heat Dissipation System of Light-water
Reactors
KTA 3401 Reactor Safety Containers of Steel, Parts 1 to 3,
Materials and Forms of Manufactured Items, Design,
Construction and Calculation, Manufacturing

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Guideline for Swiss Nuclear Installations ENSI-G11/e

e. Technical Standards

EN 287	Qualification test of welders
EN ISO 9712	Non-destructive testing - Qualification and Certification of Personnel of the NDT Testing
EN 1418	Welding Personnel
EN 10204	Metallic Products- Types of Inspection Documents
EN ISO 9606	Qualification of Welders
EN ISO 15614	Specification and Qualification of Welding Procedures for Metallic Materials- Welding Procedure Test
ISO/IEC 17020	General criteria for the operation of various types of bodies performing inspections
ISO/IEC 17025	General requirements for the competence of testing and calibration laboratories
VDI Guideline 4500	Technical Documentation

The revision 2 of this guideline was issued by the ENSI on 1st June 2013

The Director of the ENSI: sig. U. H. Wanner

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Guideline for Swiss Nuclear Installations ENSI-G11/e

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Annex 1: Definitions (according to ENSI glossary)

Part

A part is an individual part of a component. A group of parts that together meet a goal is considered as a component.

Certificate

A certificate is a document in paper form that contains a positive statement concerning a test or another document. Certificates can consist of credentials, protocols, attestations or certificates.

Manufacture

According to VBRK OVPN, manufacture comprises all measures for the fabrication of materials, semi-finished products and the component parts as well as the assembly of the component at the manufacturer's facility.

Maintenance

Maintenance comprises all measures to reconstitute the nominal condition of technical means of a system as well as measures to restore the functional condition.

Nuclear Internals

Nuclear internals are internals of the reactor pressure vessel that serve to support, guide and hold the elements of the reactor core (fuel elements, control rods, etc.) as well as the guiding the flow of the primary medium.

Component:

A component is a closed part of a system that fulfils a given function. Examples are vessels, pumps, isolation valves, heat exchangers, piping, supports (including steelwork)⁹, suspensions, vibration dampers.

Automated Components¹⁰

Automated components are components with moving parts, whose proper functioning is required during and after an incident. Automated components must be leak tight and functional during the load case. The incidents, in which the operational reliability must be ensured, are specified in the detail specification.

⁹ Version according to revision 2 dated 1st June 2013

¹⁰ Inserted within revision 2 dated 1st June 2013

Mechanical Equipment MA:

Mechanical equipment MA means components with an effect on the 1st approval of construction. Equipment MA comprises of reactor pressure vessels, primary circuits, pressurizer, reactor coolant pumps, steam generators and safety vessels made of steel.

Mechanical equipment MB:

Mechanical equipment MB means the remaining components of the mechanical safety classes SC 1 to SC4.

Installation

Installation refers to the installation of a component in the nuclear installation.

Rework

Rework defect is the elimination of a deviation if the manufacturing was deficient.

Repair

A repair is understood to mean a return to operational condition. Repairs are technical measures that are applied to defective components or parts in order to restore the desired status.

Safety related pressure-retaining parts

Safety related pressure-retaining parts are parts of components that are relevant to integrity and safety. Among these are, in particular, piping, containers, housing of valves and pumps, flanges, covers and bolts.¹¹

Safety related, functionally important parts

Safety related functionally important parts are parts of components that are relevant for function and reliability of the component. Among these are, in particular, the functional parts of pumps, valves, piping, and vessels as well as their internals.

Safety classified vessels and piping in nuclear facilities (BRK)¹²

BRK are vessels and piping, valves and pumps including their pressure-retaining component parts such as flange, nozzle and joints as well as their supports, mounts and carrying elements. Component parts such as safety valves and explosion diaphragms as well as limiting devices such as pressure, temperature and fluid level switch still belong to BRK component parts of safety related functionality.

¹¹ Version according to revision 2 dated 1st June 2013

¹² Inserted within revision 2 dated 1st June 2013

System

A system is a combination of mechanical or electrical components that is required in order to fulfil a certain function.

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Guideline for Swiss Nuclear Installations ENSI-G11/e

Annex 2: Design Specification

The specification must contain information on the following points:

a. Scope of the specification

Detailed component identification, interfaces with other components or building structures;

b. Organisational provisions

Obligations of technical and organisational nature for the clear demarcation of the responsibilities among purchaser, manufacturers or third parties, regarding the specified delivery requirements. Obligations of the parties involved towards the Nuclear Inspectorate and its designated authorised inspection agency.

c. Construction code and supplementing bases

Determination of the mandatory provisions (construction codes, standards) for the design, the materials, the manufacture and the examination of the components.

d. Description of the component

System designation, plant identification, safety classification, earthquake class, tasks and functional mode, modes of operation, designation as active or passive component, designation of the component part categories.

e. Design basis

All information required for the determination of the constructional design and main dimensions of the component, including material selection and the design of the component, such as:

Design and operational data (pressures, temperatures, mass flows, etc.), accident data (pressures, temperatures, pressure and temperature transients, accelerations, etc.), medium data, environmental conditions (pressure, temperature, humidity, radiation, etc.) for normal and accident conditions, expected service life.

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Guideline for Swiss Nuclear Installations ENSI-G11/e

Vessels and piping classified as important to safety: Engineering, manufacture and installation

Edition February 2009, Revision 2 of 1st June 2013 [Date of translation: 31.03.2014]

f. Materials

Requirements regarding the materials, material specifications and material tests such as: material selection, material designations, material acceptance documents (material specifications, sampling plans and lists), tests and test certificates, semi-finished products and welding filler metals, hot tension test specimens and bill of materials).

g. Constructive design

Requirements for the constructive design in relation to maintenance and in- service inspections, ageing management and corrosion protection, data on standard components (flanges, gaskets, bolts, etc.), actuators of valves, de- sign of the wall thickness transitions, supports and anchors.

h. Calculations

Requirements for the design calculations and stress analyses, like information on loads, transients, load case combinations (for normal operation and accident conditions), and influence and consideration of the surrounding medium on the safety margins, especially for the fatigue report.

i. Manufacture

These include inter alia: conditions for the start of production, choice of the manufacturing method, information on the welding, the shaping methods and heat treatment, the marking of semi-finished products, finished parts, weld seams and valves, the execution of rework as well as procedure upon installation.

j. Final inspections

All examinations and tests have to be specified that are performed during the acceptance and the commissioning of the component. These include among others: pressure and leakage and functional tests, trials and endurance tests of active components, other tests with active components such as the determination of characteristics, dynamic behaviour, emergency running characteristics, experiments to demonstrate the integrity and operational performance under seismic loads.

k. Drying, cleaning, conserving and surface protection

Specific requirements regarding drying, cleaning and conserving the component as well as surface protection.

l. Packaging and transport

Specific requirements in relation to the packaging and transport of the component to prevent corrosion, damage and contamination.

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m. Quality assurance

The requirements concerning the quality-assurance measures of the manufacturer and the documents to be prepared have to be specified.

n. Documentation

Requirements for the construction documentation (Art. 27 KEV NEO), the documentation of ensured quality controls as well as of the accomplished acceptance and start-up tests have to be specified.

o. References and Annexs

All references with information of document number, author and title, date of issue and revision index have to be specified in a list.

Annex 3: Hazard Analysis

As a basic principle, the hazard analysis has to address the following points:

- a. definition of the field of use of the component
- b. identification of the hazards
- c. determination of the hazard potential
- d. definition of the safety measures
- e. definition of the test criteria for the safety measures
- f. handling of the remaining hazards (operating instructions).

Annex 4: Design approval documents

Design approval documents are to be prepared for all safety related parts. They are to be identified unambiguously so that they can be assigned unmistakably to the individual components at any time.

In the following, detailed requirements are specified concerning the contents of selected pre-qualification review documents.

A4.1 Material specifications

In the material specifications all the requirements for the procurement, the manufacturing and the testing of the materials and the semi-finished products are to be listed, such as:

- a. manufacturing method for the item, for example, forged piece, steel bar, casting
- b. scope of applicability as well as the mechanical safety class, the construction code and the guideline
- c. material designation according to the standard
- d. specifications relating to heat treatment and surface finish
- e. requirements for the material designation
- f. handling of the correction of defects and deviations
- g. requirements for packaging
- h. specifications relating to the extent of testing, testing requiring approval and required certificates
- i. detailed specifications related to material testing such as the extent of testing according to the construction code, the design specifications, the characteristics values for the materials (setpoints, among other things, for chemical analysis, tensile strength, hardness, notch impact testing), the material specimen (number, type, direction, position, marking the specimen), and the testing conditions (testing processes, testing temperature, test lot, any testing specifications).

A4.2 Bill of Material

The bill of material has to include all requirements for the documentation and examination of the material certificates and the material identification marking in tabular form:

- a. listing of the parts with specification of position, number, article number, dimension, designation, category of part, material designation, material specifications, material standard, requirements for the form of the manufactured item, required certification and identification of the approval by the manufacturer, the technical expert or the customer
- b. columns for the approval of the documentation with heat and sample numbers, identification of parts and the test certificate/confirmation control by the manufacturer, the customer and the technical expert.

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A4.3 Weld location list

In the weld location list all the information relating to the conclusive identification of the welds is to be specified. Included in this information is listing of the weld locations with specification of position, designation, category of part, welding filler material, material specifications, category of part, required certification and identification of the approval by the manufacturer, the customer, and the technical expert.

A4.4 Construction testing (fabrication and inspection plan)

Construction testing plans are to be prepared separately for the factory manufacturing and construction site manufacturing, listing the manufacturing and testing steps in chronological order. The sequence is binding; any change requires the agreement of the technical expert.

General requirements

- a. manufacturer, nuclear installation, component and/facility designation of the components or parts, if known, component number according to the utility's system of nomenclature
- b. number of the assembly drawing
- c. safety and seismic class
- d. design specifications and the construction code,
- e. number of the corresponding material list

For each step in manufacturing

- a. receiving inspection
- b. numbering of the steps in manufacturing or weld joints
- c. designation and description of the steps in manufacturing
- d. specifications, standards, and drawings to be applied
- e. execution by the manufacturer or the subcontractor
- f. approval by the manufacturer, the technical expert or the customer
- g. review of the documentation by the manufacturer, the technical expert or the customer
- h. for the welding: reference to the procedure qualification, the welder qualification, and the testing of the lot of filler material
- i. hold points for the customer, the manufacturer or the technical expert

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A4.5 Calculation report

The calculation report has to contain the following:

- a. scope of applicability: specification of the components or parts to which the calculation applies
- b. the applicable design specifications and construction code
- c. explanation of process and assumptions made
- d. calculation processes, theoretical foundations, and programs used
- e. load data: the combinations of loading conditions and their classification
- f. geometric data and characteristic values for the material
- g. presentation of the results
- h. evaluation of the results and a comparison with the allowable values
- i. references, references to the literature, source specifications, technical delivery conditions and technical approval conditions of the customer.

Annex 5: Qualification and Monitoring of Construction

Table no. 5-1 Qualifications of the manufacturing procedure

In table no. 5-1 the approvals by the technical experts during the qualification of manufacturing processes for safety related parts are defined. The range of activities refers to the safety-relevant component parts and related components and for their manufacturing which, according to chapter 4.6, the technical expert is responsible for. In special cases the Nuclear Inspectorate can demand additional surveillance steps in the course of approval or pre-qualification review.

Positions marked with an X are to be incorporated in the Fabrication and Inspection Plan as hold points.

Supervision by the authorized inspector	Forming process	Welding Procedure Qualification	Welder Qualification	Testing of manual skills (welder)
receiving inspection for materials, semi-finished products, and welding filler materials	X	X	X	X
material certificates and the marking of the materials	X	X	X	X
transfer of marking/identification of material of the test pieces	X	X	X	X
handling of the welding filler materials		X	X	X
qualification of the welders		X		X ¹³
weld joint preparation		X	X	X
execution of the process	X	X	X	X
heat treatment and monitoring of the temperature	X	X		
non-destructive testing after the processing	X	X	X	X
check of workmanship after the processing	X	X	X	X
marking of the specimen	X	X	X	X
review of the chemical analysis of the materials ¹⁴		X		X
mechanical-technical testing	X	X	X	X
check of documentation for completeness and technical accuracy ¹⁵	X	X	X	X

¹³ new according to revision 2 dated 1st June 2013

¹⁴ Version according to revision 2 dated 1st June 2013

¹⁵ new according to revision 2 dated 1st June 2013

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Guideline for Swiss Nuclear Installations ENSI-G11/e

Table Nr. 5-2 Certificate for the manufacture of Material and semi-finished Products¹⁶

Inspection	SC 1		SC 2		SC 3	
	Component part categories					
	a	b	a	b	a	b
Certificate of melting process of forgings with thicknesses > 100 mm	3.1	3.1	3.1	3.1	3.1	3.1
Confirmation of standardised and of simulated heat treatments according to construction code including mechanical-technological tests	3.2 ¹	3.1	3.2 ¹	3.1	3.1	3.1
Chemical analysis ²	3.1	3.1	3.1	3.1	3.1	2.2
Product analysis of castings and forgings of a completed weight >500kg	3.1	3.1	3.1	3.1	3.1	3.1
Determination of grit size of austenitic materials	3.1	3.1	3.1	3.1	2.2	
Determination of delta-ferrite-content of austenitic materials	3.1	3.1	3.1	3.1	3.1	
Intergranular corrosion test of wetted austenitic materials	3.2		3.2		3.1	
Tensile test ³	3.2 ¹	3.1	3.2 ¹	3.1	3.1	3.1
Tensile test at elevated temperature at design temperature ³	3.2 ¹		3.2 ¹			
Notch-bar impact test ³	3.2 ¹	3.1	3.2 ¹	3.1	3.1	3.1
Hardness test (min. 3 hardness indentations) ³	3.2 ¹	3.1	3.2 ¹	3.1	3.1	3.1
Further mechanical-technological tests on piping	3.2 ¹	3.1	3.2 ¹	3.1	3.1	3.1
Pressure test	3.2 ¹	3.1	3.2 ¹	3.1	3.1	3.1
Volumetric test (UT, RT)	3.2 ¹	3.1	3.2 ¹	3.1	3.1	
Liquid penetrant test (PT, MT)	3.2 ¹	3.1	3.2 ¹	3.1	3.1	
Test for mixed-up components	3.1	2.2	3.1	2.2	2.2	2.2
Visual test and dimensional test	3.2 ¹	3.1	3.2 ¹	3.1	3.1	3.1
Labelling checks	3.2 ¹	3.1	3.2 ¹	3.1	3.1	3.1

¹ acceptance test certificate 3.1 for:

- forgings, piping, fittings and sheet metal for components ≤ DN 50 (2")
- bar stock Ø ≤ 50 mm (2")
- automated test, i.e. ultrasonic testing of sheet metals and piping
- materials and semi-finished products for process qualification and welder tests
- bolts, nuts and other fasteners ≤ M24 (1")

² chemical analysis: minimum one sampling for each heat and quality

³ mechanical-technological tests: minimum one sampling for each heat, heat treatment lot and dimension

¹⁶ new according to revision 2 dated 1st June 2013

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Tests of bolts, nuts and other fasteners \leq M12 (1/2") must not be certified. Every single piece shall be stamped with the sign of the manufacturer and with the quality of the material.

For the component part of category c the following applies:

Tests required by the construction code do not need to be certified. The license holder ensures that the right material quality according to construction code, part list or specification is used. Every single piece must be marked with the sign of the manufacturer, the short-term and the quality of the material.¹⁷

¹⁷ new according to revision 2 dated 1st June 2013

Table no. 5-3 Certificate for the manufacture of filler materials¹⁸

Filler materials for	Tests	SC 1	SC 2	SC 3
- joint weldings on element category a	chemical analysis ¹ for each batch	3.1	3.1	3.1
	mechanical-technological tests ²	3.2 ³	3.2 ³	3.1
- joint weldings on element category b - weld cladding on element category a and b - facing welds on valve lips, slide faces - joint weldings on supports of automated BRK - non-pressure-retaining joint weldings on element category a - process and welder tests of element category a und b	chemical analysis ¹ for each batch	3.1	3.1	3.1
	mechanical-technological tests ²	3.1	3.1	3.1
- joint weldings and weld cladding on element category c - Joint weldings on supports of mechanical inactive BRK - temporary welds	chemical analysis ¹ for each batch	2.2	2.2	2.2
	mechanical-technological tests ²	2.2	2.2	2.2

¹ the delta-ferrite-content of austenitic CrNi-filler materials must be additionally certified

² Notch-bar impact test only ferrite filler materials

³ acceptance test certificate 3.1 of welded joints for:

- forgings, piping, fittings and sheet metal for components ≤ DN 50mm (2")

¹⁸ new according to revision 2 dated 1st June 2013

Table No. 5-4: scope of the surveillance of manufacturing and installation¹⁹

In table no. 5-4 the scope of the technical expert's (designated by the Nuclear Inspectorate) surveillance of manufacturing and installation of safety related parts and components is defined.

Positions marked with an X are to be incorporated in the Fabrication and Inspection Plan as hold points. The technical expert supervises the manufacturing and test steps on site.

<i>manufacturing operation/testing/inspection</i>	SC1	SC2	SC3
<i>testing before the beginning of manufacturing, installation, and correction of defects</i>			
receiving inspection for materials, semi-finished products and welding filler materials	X	X	
transfer of marking at 3.2 certificate	X	X	
<i>testing of validity of processes and qualifications</i>			
testing of heats for welding filler materials	X	X	
welder qualifications	X	X	
qualifications of non-destructive testing personnel	X	X	
<i>forming processes</i>			
surveillance of forming process	X	X	
heat treatment	X	X	
non-destructive testing after forming	X	X	
<i>welding</i>			
non-destructive testing before welding	X	X	
dimensional control of the weld joint preparation	X	X	
surveillance of welding activities	X	X	
heat treatment	X	X	
non-destructive testing after welding	X	X	
<i>non-destructive testing</i>			
execution of non-destructive testing	X	X	

¹⁹ version according to revision 2 dated 1st June 2013

dimensional checks			
dimensional checks and recording of "as-built" condition	X	X	
further inspections and tests			
checks of the tightening torque of bolted joints	X	X	
visual examination of the component parts and components	X	X	
pressure tests	X	X	
functional tests	X	X	
rework			
document review, deviation report, inspection plan, etc.	X	X	X
non-destructive testing of the location following rework	X	X	X
welding	X	X	X
non-destructive testing after welding	X	X	X
review of the documentation after completion of reworks	X	X	X
special inspections			
Special inspections upon the requests of the Nuclear Inspectorate	X	X	X
documentation			
review of documentation	X	X	X

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