

Safety Standards

of the
Nuclear Safety Standards Commission (KTA)

KTA 3211.4 (2017-11)

**Pressure and Activity Retaining Components of Systems
Outside the Primary Circuit;**

Part 4: Inservice Inspections and Operational Monitoring

(Druck- und aktivitätsführende Komponenten von Systemen au-
ßerhalb des Primärkreises;

Teil 4: Wiederkehrende Prüfungen und Betriebsüberwachung)

Previous versions of this Safety Standard
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If there is any doubt regarding the information contained in this translation, the German wording shall apply.

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Pressure and Activity Retaining Components of Systems Outside the Primary Circuit; Part 4: Inservice Inspections and Operational Monitoring

KTA 3211.4

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PLEASE NOTE: Only the original German version of this safety standard represents the joint resolution of the 35-member Nuclear Safety Standards Commission (Kerntechnischer Ausschuss, KTA). The German version was made public in the Federal Gazette (Bundesanzeiger) on May 17th, 2018. Copies of the German versions of the KTA safety standards may be mail-ordered through the Wolters Kluwer Deutschland GmbH (info@wolterskluwer.de). Downloads of the English translations are available at the KTA website (<http://www.kta-gs.de>).

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Comments by the editor:

Taking into account the meaning and usage of auxiliary verbs in the German language, in this translation the following agreements are effective:

shall	indicates a mandatory requirement,
shall basically	is used in the case of mandatory requirements to which specific exceptions (and only those!) are permitted. It is a requirement of the KTA that these exceptions - other than those in the case of shall normally - are specified in the text of the safety standard,
shall normally	indicates a requirement to which exceptions are allowed. However, the exceptions used, shall be substantiated during the licensing procedure,
should	indicates a recommendation or an example of good practice,
may	indicates an acceptable or permissible method within the scope of this safety standard.

Fundamentals

(1) The safety standards of the Nuclear Safety Standards Commission (KTA) have the objective to specify safety-related requirements, compliance of which provides the necessary precautions in accordance with the state of the art in science and technology against damage arising from the construction and operation of the facility (Sec. 7 para. 2 subpara. 3 Atomic Energy Act - AtG) in order to achieve the fundamental safety functions specified in the Atomic Energy Act and the Radiological Protection Ordinance (StrlSchV) and further detailed in the Safety Requirements for Nuclear Power Plants as well as in the Interpretations on the Safety Requirements for Nuclear Power Plants.

(2) No. 3.1 of the Safety Requirements for Nuclear Power Plants, among other things, sets high requirements for the quality assurance and reliability of fabrication, the use of qualified materials, the safeguarding and maintenance of quality features during fabrication as well as the performance of in-service inspections to the extent of safety required. Requirement no. 3.4 requires, among other things, that a concept to maintain component integrity shall be put up to assure and evaluate the requisite quality of the pressure-retaining walls of components of the external systems with nominal diameters of more than DN 50 in operation. The safety requirements no. 3.2 "Requirements for the reactor core and the shutdown systems", no. 3.3 "Requirements for the equipment for fuel cooling in the reactor core" and no. 3.10 "Requirements for the handling and storage of the fuel assemblies" specify further requirements regarding the design and quality of the safety systems. The Safety Standard KTA 3211.4 is intended to specify detailed measures which shall be taken to meet these requirements within the scope of its application. For this purpose, a large number of standards from conventional engineering, in particular DIN standards, are also used. For the pressure and activity retaining components of systems outside the primary circuit the stipulations of the aforementioned safety requirements are further and comprehensively substantiated in conjunction with the following Safety Standards

KTA 3211.1 Materials and Product Forms,

KTA 3211.2 Design and Analysis,

KTA 3211.3 Manufacture.

(3) The task of this Safety Standard with respect to operational monitoring is to determine measures regarding the monitoring of causes and consequences of damage mechanisms. These measures consist of:

- a) Monitoring of causes:
 - aa) monitoring of the parameters and data relevant to component integrity,
 - ab) monitoring of the quality of water and steam.
- b) Monitoring of consequences by:
 - ba) in-service inspections,
 - bb) leakage monitoring,
- c) Documentation and continuous recording of the monitoring results along with a foresighted evaluation in order to limit operational damage mechanisms.

(4) The task of this Safety Standard with respect to in-service inspections is to determine the relevant measures as listed in a) to d) hereinafter in order to ascertain and evaluate the actual component condition at the date of testing by:

- a) non-destructive tests and examinations of the external and internal surfaces of pressure and activity retaining components,
- b) evaluation of the general condition during regular plant inspection,
- c) pressure tests as integral loading test,

- d) functional tests addressing the safeguards against excessive pressure.

All above tests and examinations shall be documented in a so-called "test and inspection manual" which takes into consideration the requirements for the individual component and contains the entire extent of in-service inspections.

(5) During in-service inspections, test and examination procedures are used to detect defects due to operation in due time prior to reaching the acceptance level. When determining the extent of tests and examinations as well as the items to be examined, the design, material properties, fabrication processes and loading of the respective component as well as experience gained with already performed inspections shall be taken into consideration.

(6) The quality of the component with regard to materials, design and manufacture shall be documented and be evaluated by continuously recording the accumulated operational loadings including commissioning, and the results of the in-service inspections.

1 Scope

(1) This Safety Standard shall apply to in-service inspections of the pressure retaining walls of pressure and activity retaining systems and components of light water reactors which are not part of its reactor coolant pressure boundary but do have a certain significance with respect to reactor safety. This is given in the case where one of the following criteria applies:

- a) The plant facility is required for the mitigation of design basis accidents with regard to shutdown, long-term maintenance of subcriticality and with regard to residual heat removal. Requirements regarding components of systems which only indirectly serve in residual heat removal – these are the non-radioactivity retaining closed cooling water systems and service water systems – shall be specified on a plant-specific basis taking the design redundancy (e.g. redundancy, diversity) into consideration.
- b) Large energies are released in case of failure of the plant facilities and no mitigating measures such as structural measures, spatial separation or other safety measures are available to keep the effects of failure to an acceptable limit with respect to nuclear safety.
- c) A failure of the plant facilities could either directly, or indirectly through a chain of assumed sequential events, lead to a design basis accident in accordance with Sec. 49 para. 1 of the Radiation Protection Ordinance (StrlSchV).
- d) Systems and components to which none of the criteria a) through c) apply, the failure of which, however, would lead to major plant internal damages – these are the components of Group II from Appendix to Sec. 4.2 of the RSK Guidelines for PWR and the corresponding components for BWR. With regard to the intensity of testing and documentation graduated levels may apply.

(2) The scope of this Safety Standard extends to the following components:

- a) pressure vessels,
 - b) piping and piping products including small-bore pipes,
 - c) pumps,
 - d) valves,
 - e) heat exchangers
- including the integral parts of the component support structures.

Note:

The secondary shell of the steam generators including the feedwater inlet and main steam outlet nozzles, but not the minor nozzles and nipples are covered by the scope of KTA 3201.4. The pipe connecting welds themselves are within the scope of KTA 3211.4.

(3) This Safety Standard does not apply to

- internals of components (that are not constituent part of the pressure retaining wall) and accessories,
- systems and plant facilities performing auxiliary functions for the systems dealt with in this Safety Standard,
- those system parts where the system pressure is determined solely by the geodetic pressure level in the suction regime,
- component parts of the power transmission in pumps and valves nor to the tests with respect to proof of functional capability,
- tests of functional capability within the framework of in-service inspections, except functional tests addressing the safeguards against excessive pressure,

Note:

Functional tests of shutdown systems are laid down in KTA 3103, functional tests of residual heat removal systems in KTA 3301 and functional tests of heat removal systems for fuel assembly storage pools in KTA 3303.

(4) This Safety Standard shall apply to systems and components which have been designed and manufactured in accordance with KTA 3211.1, KTA 3211.2 and KTA 3211.3.

(5) This Safety Standard may also be applied to those components or component parts where an evaluation performed in due consideration of the state of science and technology showed that the principles of basic safety are complied with and that no additional requirements for in-service inspections and operational monitoring are required.

(6) In the case of components that do not meet the requirements under paragraph (4) or (5), increased requirements regarding in-service inspections and operational monitoring may have to be specified on the basis of the special situations.

Note:

Besides the requirements possibly to be met regarding in-service inspection and operational monitoring further measures to be taken may be taken into account.

(7) In the case of components and systems outside the reactor coolant pressure boundary for which restricted design-basis leak and break assumptions are made, the component integrity shall be ensured during the total operational lifetime by means of a consistent concept in accordance with KTA 3201.4, Section 3 (integrity concept). The requirements of **Table 5-3** in section 5 "Extent of testing and test intervals" of Safety Standard KTA 3211.4 taking into consideration the footnote regarding the use of restricted leak and break postulates shall apply to the in-service tests and inspections required to monitor the consequences of possible operational damage mechanisms.

Note:

The procedures for break preclusion are laid down in KTA 3206.

2 Definitions

(1) Pipe attachment weld

The pipe attachment weld is a weld seam that connects the nozzle of a component with the corresponding pipe section.

(2) Indications and types of flaws

The correlation between indications and flaws are shown in **Figure 2-1**.

(3) Relevant indication

Relevant indication is an indication reaching or exceeding the evaluation limit.

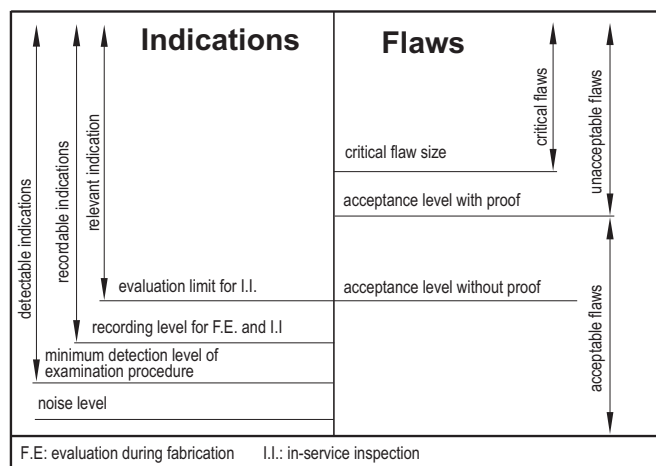


Figure 2-1: Indications and types of flaws

(4) Echo height evaluation

Echo height evaluation means the evaluation of indications by comparing the echo amplitude (signal amplitude of the ultrasonic signal generated at the reflector) with the recording level and the evaluation limit as shown in **Fig. 2-1**. Echo height evaluation does not include the sizing of reflectors.

(5) Operational flaws

Operational flaws are flaws due to operational damage mechanisms.

(6) Higher stress locations

Higher stress locations are such locations of a component or component part that

- compared to the general level of stress intensity are more highly stressed taking the frequency additionally into account

or

- are more susceptible to corrosive action.

(7) Integrity

Integrity is the condition of a component or barrier, at which the required safety criteria with regard to strength, resistance to fracture and leak tightness are met.

(8) Reference standard

Reference standards to adjust and examine the test system or to examine the detection medium are

- in the case of ultrasonic testing: unclad test blocks of a known material, with predetermined surface quality and geometry, e.g. calibration block no. 1 to DIN EN ISO 2400 or calibration block no. 2 to DIN EN ISO 7963,
- in the case of penetrant testing: reference block 2 to DIN EN ISO 3452-3,
- in the case of magnetic particle testing: flux indicator for controlling the detection medium (reference block 1 to DIN EN ISO 9934-2 Annex B),
- in the case of visual testing: test pattern to DIN 25435-4,
- in the case of radiographic testing: image quality indicator to DIN EN ISO 19232-1,
- in the case of eddy current testing: reference block adapted to the task, made of a known material and with a specific surface quality and geometry.

(9) Measured values

Measured values are documented and stored values (e.g. pressure, temperature, amplitude, time of flight, position).

(10) Detection threshold

Detection threshold is the lowest limit of detection of indications.

(11) Types of tests, testing procedures and techniques

The terms, their acronyms and correlation of the types of tests, testing procedures and techniques are shown in **Table 2-1**.

(12) Surface inspection

Surface inspection is the non-destructive testing of surfaces using techniques which allow detecting indications on the surface and near-surface regions in which case the depth examined depends on the method used.

(13) Quality required

The required quality means the condition of a part, component or system with respect to their capability of meeting the specified requirements.

(14) Noise

Depending on the test conditions, randomly distributed additional signals due to noise of the test system, reflections from the structure of the material or its surface condition.

(15) Noise level

Noise level means the 95 % value of the cumulative frequency of the heights of the noise signals in the examined volume free from defects.

(16) Recording level

Recording level means the specified threshold at which, when being reached or exceeded, indications from the test object are recorded.

(17) Representative locations, components or component parts

Such locations, components or component parts are considered to be representative where the in-service inspection will lead to sufficiently comparable safety related results for other locations, components or component parts, taking into consideration the material composition, design and manufacturing quality as well as the stress type, level and frequency.

(18) Authorized inspector

The authorized inspector for the tests and inspections to be conducted in accordance with this Safety Standard is the authorized inspector called in by the licensing or supervisory authority in accordance with Section 20 of the Atomic Energy Act.

(19) Damage mechanisms

Damage mechanisms are all physical, chemical and biological processes which may impair the integrity or function of a component.

(20) Standard instrumentation

The standard instrumentation serves to monitor the parameters and data relevant to the integrity of components within the scope of this Safety Standard and comprises measuring equipment to monitor global loadings and - if required - measuring equipment to monitor local loadings.

(21) Nozzle weld

A nozzle weld is a weld seam that connects the nozzle with the vessel wall or the pipe wall.

(22) Welded joint

A welded joint is a weld seam that joins component parts the cross-sections of which have been adapted in the connecting area.

(23) Reference block

A reference block is a block corresponding to the test object with respect to test-relevant characteristics (e.g. material, weld design, shape, wall thickness) and that contains reference flaws (e.g. notches, bores) adapted to the individual testing task.

(24) Acceptance level with proof

The acceptance level with proof relates to a defect size that can be accepted when being proved (e.g. by fracture mechanics verification) to be less than rejectable.

(25) Acceptance level without proof

The acceptance level without proof relates to a defect condition that is left unchanged and can be accepted without further proof.

Serial Number	Type of Test	Test Procedure	Testing Technique
1	Surface inspection	Magnetic particle testing (MT)	e.g. field magnetization by magnetomotive force
		Penetrant testing (PT)	e.g. colour contrast penetrant testing
		Ultrasonic testing (UT)	e.g. single transducer probetechnique, dual-element probetechnique, wave conversion technique, phased-array technique
		Eddy-current testing (ET)	Single frequency, multiple frequency
		Radiographic testing (RT)	X-ray, Radioisotope
		Visual testing (VT)	Selective or integral visual testing with or without optical means
2	Examination for wall thinning	Ultrasonic testing (UT)	E.g. wall thickness measurement with measuring techniques 1 to 3 acc. to DIN EN 14127
		Radiographic testing (RT)	Wall thickness measurement with projection technique, e.g. computerised radiography with imaging plates
3	Evaluation of the general condition	Regular plant inspection	
4	Pressure test	Hydrostatic test	
5	Functional test		

Table 2-1: Type of tests, testing procedures and techniques

3 Safeguarding of required component quality

(1) The principles laid down in this Section serve to safeguard the required component or system quality with respect to the functional capability of plant components acc. to sub-clause 1 (1) a) and with respect to the prevention of failure of plant facilities, systems or components involving serious consequences as indicated in sub-clauses 1 (1) b) to d) (see also **Figure 3-1**).

(2) Temporary disturbance of individual component integrity shall neither lead to

- a) a loss of functional capability of plant facilities as indicated in sub-clause 1 (1) a) nor
- b) to plant facilities failure involving serious consequences as indicated in sub-clauses 1 (1) b) to d).

(3) The required quality as regards proper design and manufacture shall be the result of meeting the requirements of KTA 3211.1, KTA 3211.2 and KTA 3211.3 or the principles of basic safety.

Note:

See related sub-clauses 1 (4) and 1 (5).

(4) Where components deviate from the requirements of the Safety Standards KTA 3211.1, KTA 3211.2 and KTA 3211.3 or from the principles of basic safety such deviations shall be evaluated as to what extent increased requirements for in-service inspections and operational monitoring have to be laid down.

(5) For components for which a changed state of knowledge regarding possible damage mechanisms is available, additional requirements shall be laid down, where required, with regard to

in-service inspections and operational monitoring with due respect of the specific conditions prevailing.

Note:

Besides possible requirements for standard instrumentation and in-service inspections further measures, e.g. preventive maintenance, may be taken into account.

(6) To safeguard the required quality during operation

- a) operational monitoring measures,
 - b) monitoring of the consequences of operational damage mechanisms,
- and
- c) preventive maintenance measures

shall be taken and be evaluated in accordance with **Figure 3-1** (8).

(7) Where the required quality is no more available, respective measures shall be taken (**Figure 3-1** (9)).

(8) The effectiveness of the measures taken with respect to safeguarding against operational damage mechanisms shall be assessed (**Figure 3-1** (10)).

(9) Changes in the state of knowledge, e.g. due to new requirements for incident control, due to damage occurred, in the case of assessment of ageing phenomena or in the case of other safety analyses, shall be considered within the re-evaluation of required component quality during further operation (see **Figure 3-1**).

(10) The procedural steps as per **Figure 3-1** form a consistent concept to ensure the required component and system quality.

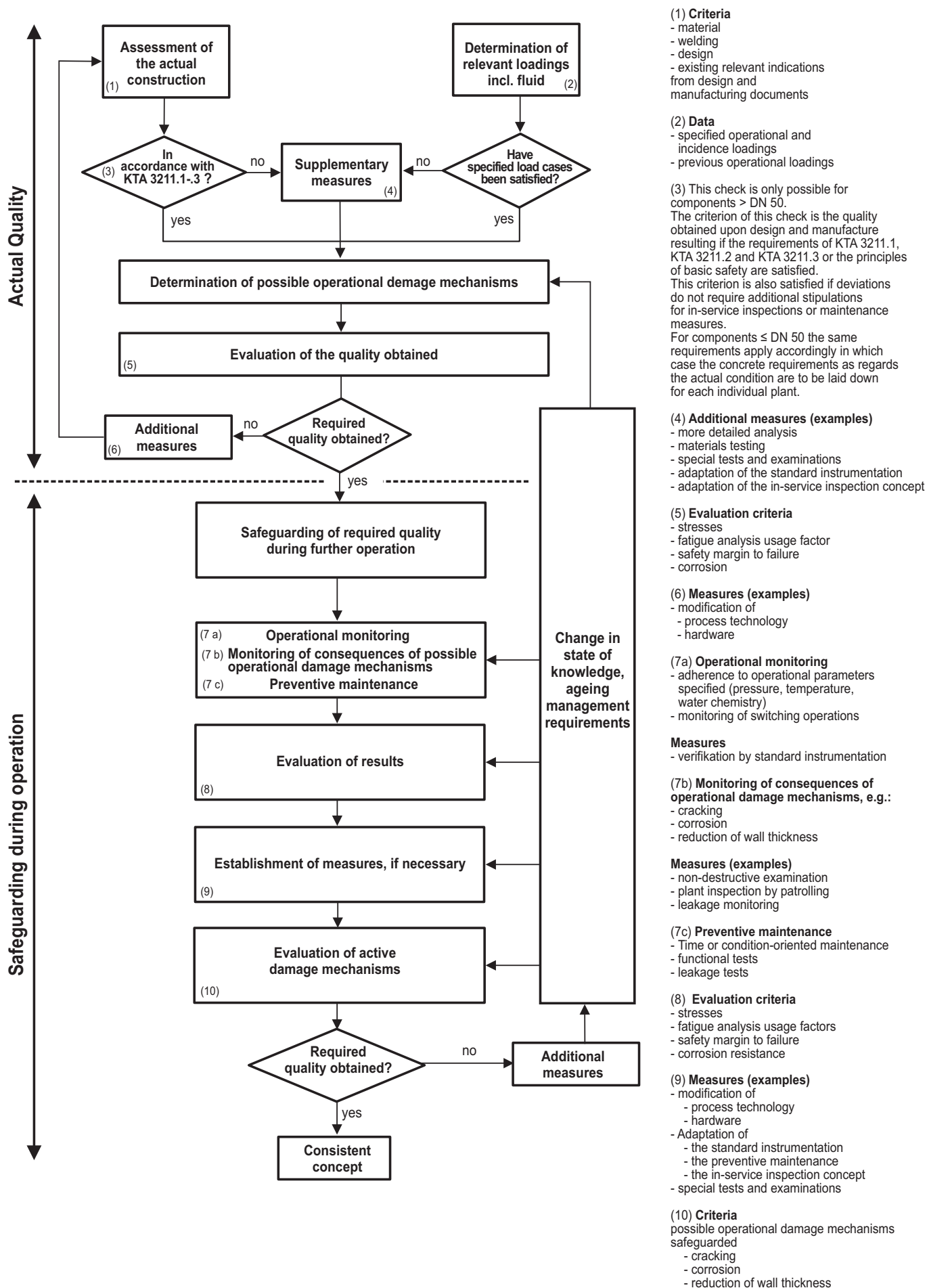


Figure 3-1: Safeguarding of the required component quality