Radiation and Nuclear Safety Authority

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Guide YVL E.8, Valves of a nuclear facility

1 Scope of application

Guide YVL E.8 applies to nuclear facilities' valves belonging to safety classes 1, 2 and 3 throughout their service lifetime. The Guide's requirements apply to licensees as well as parties involved in the valve supply chain.

2 Justifications of the requirements

The justifications of the requirements presented in the Guide are presented for each chapter and in so far as licensees have requested justifications when commenting the Guide or the requirements are otherwise presumed to need a more detailed examination.

2.1 Chapter 1 Introduction

The chapter presents the grounds for Guide YVL E.8 "Valves of a nuclear facility". The introduction makes references to the Nuclear Energy Act (990/1987) and STUK regulations on the safety of nuclear facilities and final disposal of nuclear waste and justifies the significance of valves in the safe operation of nuclear facilities.

The Guide allows for serially manufactured valves procedures deviating from those of built-to-order valves to demonstrate their acceptability for nuclear facility use. For this reason, the requirements pertaining to procurement of a serially manufactured valve are presented separately in a dedicated chapter.

The Guide has adopted the concept of "low-energy valves". When the criteria of the definition[1] are met, the valves belong to the scope of inspection of the authorised inspection organisation (AIO) and the technical requirements of Safety Class 3 may be applied to them, even though the valves would belong to Safety Class 2. Over-dimensioning of a low-energy valve at the service place in view of the load or stress targeting the component can be proven so great that relieving the requirements regarding design, dimensioning and quality control of manufacturing will not cause an additional risk of losing valve operability during operation. The valves' degree of utilisation in relation to the allowed stress, fatigue or some other strain impacting their operability is assumed to be small in which case minor undetected manufacturing faults do not probably cause the loss of valve integrity, tightness or performance. In addition, due to the low process parameters, consequences to the environment in a potential loss of component integrity are smaller than those of a high-energy component. On these grounds, there is room for flexibility in the requirements of low-energy valves according to the Graded Approach principle (consideration of the safety significance).

[1] Low-energy equipment shall refer to Safety Class 2 equipment with a design pressure of up to 20 bar(g) and a design temperature of up to 120 °C and to which the design, dimensioning and quality-control requirements of a corresponding equipment from Safety Class 3 can be applied with technical justifications without having a risk to lose the operability of the equipment.

2.2 Chapter 2 Scope of application

The chapter presents the scope of the Guide and its interfaces with other guides. The Guide applies to safety-classified valves throughout their service lifetime. This shall refer to the valve design, manufacture, installation, commissioning and operation. Where applicable, the requirements apply to the licensee and operators in the valve supply chain.

2.3 Chapter 3 Licensee's general equipment requirement specification

The chapter presents a requirement to the licensee on the valves' general equipment requirement specification[2]. The requirement does not take a stand on who prepares the general equipment requirement specification. Key factors in a general equipment requirement specification are the "general" data sheet and quality control plan. The data sheet presents the design bases and values that are typically specified in valve procurements. The data sheet also includes the requirements that the actuator sets for the valve and the valve for the actuator. Correspondingly, the general quality control plan (general inspection plan) specifies at a principle level the inspections and tests to take place from the material procurement to the test run of the valve. The general requirements are supplemented in connection with procurement with requirements specific to the service place both in normal operation and possibly in transient and accident conditions. If a valve has, e.g., seismic requirements, the data sheet template presents the acceleration values and, if there are not any, the field is marked with N/A or in a similar manner. The principle is that similar specifications are prepared for all mechanical components that are procured to the nuclear facility in large volumes during the construction process or operation for repairs and modifications. These components typically include tanks, piping, pumps and lifting equipment in addition to valves. In the case of components to be procured once-only or very rarely, such as the diesel generator serving as the emergency power supply, the general equipment requirement specification serves no actual purpose and STUK does not require one for approval.

The requirement is justified as follows:

- the licensee's "component standard" harmonises the requirements to a level that is more detailed than the YVL guides and, thereby, reduces the interpretation needs of the requirements
- the part-specific classification of the requirements is possible according to the "Graded Approach" (requirements are set in proportion based on the significance of the component in fulfilling the design bases and implementing the safety function required of the component)
- it serves as a clear requirement basis for the AIO inspections
- the construction plan can be approved also after starting manufacture (for now, only in Safety Class 3), because the equipment requirement specification serves

[2] The general equipment requirement specification shall refer to a document that includes the component group-specific general design and quality control requirements for safety classes 1, 2 and 3 set by the licensee. In component procurement, the requirements set out in this document shall be supplemented by requirements specific to the service place.

already as the component's partial advance approval, while the location-specific suitability shall be assessed later, however, before the construction inspection.

2.4 Chapter 4 Manufacturer

This chapter presents requirements for the valve manufacturer. The general aim of the requirements is to make the manufacturer understand the safety significance of the delivery. Another justification is to reduce the risk of the valve containing manufacturing defects that weaken operability and are not necessarily detected in inspections.

The management system of the valve manufacturer shall be appropriately certified and in Safety Classes 1 and 2 successfully certified for the nuclear industry. Appropriate certification shall refer to a situation where the certification body has been accredited against the requirements of standard EN ISO/IEC 17021 and the accreditation is covered by the Multilateral Agreements (MLA) entered into by FINAS. It is possible to deviate from the particular requirement regarding nuclear industry certification in a case where the management system is supplemented with a delivery-specific quality plan describing the procedures ensuring quality control.

If the valve manufacturer is not appropriately certified in Safety Class 3, the licensee may apply for approval for other management system assessment performed by an independent third party. The third party shall be an organisation independent of the valve delivery, design, manufacture and inspections. The preconditions and qualifications of the third party to assess the manufacturer's management system against the applied standard shall be assessed separately in connection with the processing of the construction plan.

2.5 Chapter 5 Design

The chapter presents the design requirements of valves. The shared justification for all requirements presented in this chapter is the objective of ensuring that valves operate in the required manner in situations where they are expected to operate. The design bases shall be specified to match the valve integrity, leaktightness and performance requirements with the loads, stresses and conditions of the service place during normal operation and transient and accident conditions. Valves still need to be designed and dimensioned so that the requirements set forth as design bases are met. Nuclear design standards take priority, but also other standards may be accepted, if it can be justified that their design yields corresponding operational certainty. Already in the design phase, investments shall be made also to the inspectability and maintainability of valves.

One of the mentioned design requirements regards the failure of the limit switch on a valve equipped with an actuator, in which case the actuator tries to continue the stem movement regardless of the stop limit and, as a result, cause additional loading of the valve structures. In this connection, it is emphasised that only in a case where the failure of the limit switch has been specified as a design basis of the valve in question, the valve shall maintain its required integrity (no leakage outside), leaktightness integrity (no leakage outside and stays tight in the process direction) or performance (no leakage outside, stays tight in the process direction and also

remains fully operational). If a valve has not been specified with such a design basis, it is not necessary for the valve to maintain its integrity, if the stop limit does not work.

With regard to condition monitoring, requirement 508 requires that *condition monitoring of a valve in Safety Class 1 and 2 shall be fixed and produce online data when the valve operates in cases where such condition monitoring substantially enhances the effectiveness of the valve's condition monitoring as compared to condition monitoring conducted periodically*. The valve may be monitored by measuring a parameter yielding information on the performance (or change thereof) either in real time when the valve is operated or with periodic inspections. The requirement primarily applies to new facilities and cases where online condition monitoring is considered to improve nuclear safety. In case "online testing" does not substantially improve the situation in comparison to periodic testing of the valve, the requirement does not need to be applied. This requirement does not apply retroactively to condition monitoring of valves at operating facilities either, for example, in the case of replacement projects. The grounds for the requirement is to promote commissioning of new condition monitoring methods in order to reduce the risk related to technological ageing of nuclear facilities. Different types of condition monitoring system for valves have entered the market with potential to improve operational safety of nuclear facilities.

2.6 Chapter 6 Construction plan

The valve shall be designed and manufactured so that the design basis requirements are met, the demonstration of which is the ultimate purpose of the construction plan. By virtue of the Nuclear Energy Act (990/1987), the licensee is obliged to assure the safe use of nuclear energy and this obligation cannot be delegated or transferred to another party. In order to fulfil this obligation, a statement by the licensee on the acceptability of the valve (summary of justifications) shall always be appended to the construction plan. Based on the data of the construction plan, the licensee shall justify the abilities of the delivery chain and correspondence of the design input data to the service place as well as the conformity of the design and sufficiency of quality control.

In this Guide, a valve refers to a mechanical component which is used to open or close a flow route or to control the flow. The valve is considered to also include integral parts of the valve structure and operation, e.g., possible supports and pilots. The electrical and I&C equipment, such as the valve's electric-motor actuator's preliminary suitability assessment comparable to the construction plan, is processed separately according to the requirements of Guide YVL E.7 "Electrical and I&C equipment of a nuclear facility". The preliminary suitability assessment is not included in the valve's construction plan but it shall have been processed according to the delivery method and schedule presented in Guide YVL E.7. Instead, the mutual compatibility of the valve and its actuator shall be demonstrated with a operability analysis[3] to be appended to the construction plan. It shall be demonstrated, among

[3] A calculation or similar report to ensure that the minimum torque generated by the actuator exceeds the maximum torque conveyed from the frictional force of the valve's obturator, stem seals and other parts in all design basis service. In Safety Classes 1 and 2, it shall be demonstrated that vibrations do not weaken the performance of the valve or its actuator in design basis service. If the valve design bases include limit switch failure, a strength analysis shall also be presented demonstrating the operability required of the valve and actuator also in the situation in question.

other things, that vibrations do not weaken the performance of the valve unit. Vibration-causing internal excitation may be caused by the motion of the actuator and external excitation may be caused by flow turbulences or periodic motion of piping. Often, it is sufficient to justify as to why such excitations are not frequent enough to cause problems. If necessary, the operability analysis can be submitted separately, in which case approval shall be sought before installing the valve.

In Safety Classes 1 and 2, approval for the construction plan shall be sought before the manufacture is started, i.e., before the manufacture of the valve begins from the raw materials (casting, forging or some other structural material) by machining, welding or some other manufacturing method. The grounds for the requirement is to maintain the possibility to impact design solutions in case there are remarks to the conformity of the valve. Modifications are difficult to implement on a finished valve. Here, however, the Graded Approach principle is applied and in Safety Class 3 the construction plan can be approved, if necessary, after the start of manufacturing. This requires that the valve has been designed and manufactured in accordance with the approved general equipment requirement specification of valves. The general equipment requirement specification can be interpreted as the component's "general" advance approval before the start of manufacture, when the complementary location-specific acceptability can be assessed later in Safety Class 3 (before the construction inspection).

In Safety Class 1, an approval for the pressure-retaining parts of the valve's body (material manufacturing) shall be applied for before material procurement starts, if the valve's nominal size is larger than DN50. This requirement is justified by the fact that the body parts' forging (or casting) specifies the valve's structural and, in some cases, functional dimensioning; the acceptability of dimensioning of large valves and valves especially significant to safety should be established as early as possible. In this way, further clarifications and possible rejection of the part can be avoided, if the dimensioning is proven insufficient afterwards.

Requirement 604 allows the submittal of minor revisions to the construction plan for information. In this context, minor revisions refer to revisions that do not have immediate significance to the valve's design basis operability, e.g., replacing one sealing material to another. In any case, STUK and an AIO can take a stand on a revision submitted for information, if necessary.

According to requirement 612 the valve's design bases shall be determined in the scope of the requirements that have been set for the valve's operability in normal operation, during anticipated operational occurrences, postulated accidents, design extension conditions and severe reactor accidents. Regarding valve's aforementioned service beyond normal operation (and conditions), the possible integrity and functionality requirements are determined both during and after such events.

If requirement 615 *in addition to the valve's main dimensions, the construction plans shall show the dimensions used as input data for calculations and the dimensions, part markings, part materials, hard-facings, surface treatments and welded joints essential for operation* cannot be observed, e.g., due to a business secret, alternative methods for indicating the said structural dimensions can be presented. In such a

case, a procedure shall be described that allows the verification of the dimension data indicated in other ways as the actual dimensions of the structure.

The inspection plan to be appended to the construction plan shall define the scope of valve disassembly after functional testing. The requirement aims to exclude possible manufacture and assembly errors from the manufactured valve individuals that could surface only when the valve is already being operated. Even if the valve would require adjusting or setting up for the functional test, the disassembly inspection shall be conducted and the same adjustments or settings reset after assembly. It should be noted that, due to the different structures of valves, the disassembly need is case-specific and that the disassembly is always implemented in the scope accordant with the approved construction plan. Typically, the seal and guiding surfaces shall be visible to the inspector. There is no need for disassembly if the condition of the parts can be inspected without disassembling the valve.

The valve's functional tests shall be instructed in the construction plan to be primarily conducted with the valve's operating parameters. This is justified by the fact that when the valve is operated with the operating parameters it is easier to detect non-conformances that would not otherwise be detected until the valve is already in operation. If the functional tests are not conducted with the operating parameters, an alternative is the possibility of justifying the sufficiency of the presented functional test procedure in the exclusion of manufacturing and assembly errors or that conformity to requirements can be demonstrated, e.g., with type testing conducted on the valve in terms of a specific operating parameter.

2.7 Chapter 7 Type test

The conformity of the valve's design solutions shall be ensured by a once-only type test or other similar functional test. The requirement is based on the fact that a type test is considered to be the most reliable method of demonstrating performance of a functional component (such as a valve) according to its design requirements. The type test is needed because normal factory inspections, which mostly focus on inspecting the acceptability of the manufacture and assembly of an individual valve, do not in every case have the chance or intention of ensuring functional properties required of the valve in all respects. For example, the performance of the valve in accident conditions (if it is a design basis) and capacity are not normally tested as part of the factory inspections constituting a part of the construction inspection.

A new type test is not required, if the type test has been previously performed and it is sufficient for demonstrating the conformity of the valve in question.

The scope of type testing is restricted to such properties required of the valve that cannot be verified reliably with any other means. A separate type test is not necessary, if the valve's design basis performance can be ensured with the help of operating experience or factory tests.

2.8 Chapter 8 Manufacturing

Requirements regarding manufacturing of the valve are presented in this chapter. In practice, it is not possible for STUK or an AIO to monitor the manufacturing of the valves' structural materials or parts excluding exceptions. The requirements of the

chapter are justified generally with the aim of ensuring manufacturing quality, which meets the requirements set for the valve and which simultaneously excludes at least such quality non-conformances that cannot be detected in the final inspections carried out by STUK or an AIO.

2.9 Chapter 9 Construction inspection

The construction inspection serves as the valve's final inspection and this chapter presents the requirements pertaining to it. The construction inspection is an established practice for mechanical components with the aim of getting proof that the materials, manufacture, structures and operation conform to the approved construction plan (manufactured according to its design). In the inspection, the acceptability of the manufacturing result documentation is determined, inspections are carried out and tests are monitored in the scope of the inspection plan submitted together with the construction plan.

STUK and an AIO may use their discretion on whether to monitor a specific inspection or test at the site or to assess the acceptability of the results based on the inspection report appended to the result documentation.

If the valve is repaired or parts (other than single-use wearing parts) are replaced due to faults or some other non-conformances detected during the factory tests, the factory tests shall be repeated. The requirement is justified with the fact that only final and fully successful factory tests provide the most reliable confirmation of the valve's conformity. In the same connection, it becomes clear whether the repaired or replaced part is responsible for the detected issue or is the repair or replacement need a result of some other issue.

2.10 Chapter 10 Installation

The valve installation is comparable to valve manufacturing from the monitoring perspective. A plan (installation construction plan) and final inspection on the finished installation (installation construction inspection) are needed. Necessary instructions, drawings and inspection plan for quality control are appended to the installation construction plan in order to enable the acceptability assessment of the installation work in advance. The installation construction inspection makes sure that the installation work and its quality control have been conducted according to the construction plan.

2.11 Chapter 11 Commissioning

Requirements regarding the two-phase commissioning inspection of the valve are presented in this chapter. In the first phase of the commissioning inspection, the test run preconditions are confirmed by verifying that all the previous valve inspection phases have been successfully completed, the suitability assessments of the actuator have been processed as specified in Guide YVL E.7, the licensee has carried out its own inspections, etc. In this phase, the aim is no longer in performing inspections but only on becoming convinced that the valve is ready, short of a test run.

In the second phase of the commissioning inspection, the operability of the valve and actuator combination is verified with a test run. The test run is carried out according

to a plan, the sufficiency of which has been confirmed in the first phase of the commissioning inspection. At its simplest, the test run procedure may be the licensee's procedure, as long as it fulfils the test procedure criteria, i.e. it includes the test and measurement arrangements, test phases and result acceptance criteria. At the end of a successful test run, the valve is granted either a permanent or fixed-period operating licence. It is granted for a fixed period if, e.g., a test run phase cannot be completed until later and the valve is safe to operate despite this phase preventing the granting of a permanent operating licence.

2.12 Chapter 12 Operation, condition monitoring and maintenance

This chapter presents the general requirements that apply to the operation, condition monitoring and maintenance of valves. The aim is that the valves are not subjected to unnecessary loading or unfavourable operating conditions during operation. Moreover, the valve is serviced and its condition is monitored to a scope that the loss of the valve or weakening of its operability cannot cause a safety risk at the nuclear facility.

During operation and outages, the valves shall undergo inspections and tests especially in view of the targets and parameters that allow the confirmation of design basis operability. For example, if the valves have a tightness requirement, the seal surfaces shall be inspected and the tightness tested periodically.

A maintenance task not forming a part of the valve's maintenance programme is considered repair work for which approval shall be sought with a repair plan and an inspection following its implementation. The repair plan shall include a procedure description, illustrative drawings and an inspection plan covering manufacturing, installation and commissioning. The repair plan and construction inspection are not required, if the repair work only involves the replacement of parts to approved spare parts without any special processes or if the repair work is minor and targets valve parts insignificant for its operability.

2.13 Chapter 13 Modifications

Requirements regarding possible modifications of the valve are presented in this chapter. Typically, modifications impact the valve performance or operability or the safety of the nuclear facility.

Modifying the structure or operation of a safety-classified valve requires a systematic approach and comprehensive assessment of the impact of the modification. For this reason, a modification with its design bases shall be approved in advance with a construction plan and the implementation of the modification with a construction inspection.

2.14 Chapter 14 Serially manufactured valves

Requirements regarding procurement of a serially manufactured valve[4] are presented in this chapter. It is possible to have a serially manufactured valve approved for nuclear facility use following a procedure deviating from that of a built-to-order valve in Safety Classes 2 and 3. In such a case, it is assumed that a serially manufactured valve can be just as good in terms of quality and suitability or, in some cases, even better due to its manufacture in large series of uniform quality than a built-to-order valve.

The difference to having a built-to-order valve approved is more flexible procedures for demonstrating conformity. A serially manufactured valve can also be approved against design values only without knowing the final service place and have it approved for the service place later before its installation. It is essential that the validity of the design values and acceptability of manufacturing quality can be reliably and unambiguously confirmed. The correctness of the design values can be demonstrated with one or more of the following methods: granted type approval, qualification reports, the manufacturer's dimensioning table or similar, computational analyses, clarifications on the fulfilment of the requirements of the applied dimensioning standard and operating experiences. At the factory, manufacturing quality is monitored at least in the form of random inspections and the licensee is expected to supplement, where necessary, the manufacturer's quality control with its own acceptance inspections. Demonstrating the correctness of the valve's design values is not solely sufficient, the suitability of the valve for its intended service place shall also be confirmed before installing the valve. The service place-specific suitability shall be justified in the construction plan of either manufacture or installation.

2.15 Chapter 15 Regulatory oversight by the Radiation and Nuclear Safety Authority

This chapter presents STUK and an AIO's regulatory activities concerning the valves of a nuclear facility (documents to be submitted and inspections to be carried out in the different phases of the valves' service lifetime).

3 International provisions concerning the scope of the Guide

- IAEA Safety Standards No. SSR-2/1, Safety of Nuclear Power Plants: Design (Vienna 2012)
- IAEA Safety Standards No. SSR-2/2, Safety of Nuclear Power Plants: Commissioning and Operation (Vienna 2011)

4 Impacts of the Tepco Fukushima Dai-ichi accident

The Fukushima accident has no impact on the requirements of the Guide.

[4] A serially manufactured valve has not been designed to meet the requirements of the purchaser, instead it is procured based on the manufacturer's product description. Typically, the valve is manufactured in large batches and it is also suited to other purposes of use. The structure, dimensions and materials of the valve, and the methods and quality of manufacture, do not essentially differ within or across manufacturing batches.

5 Needs for changes taken into account in the update

The needs for changes due to changes made to international and national laws/regulations and the change proposals made in connection with the preparation of the YVL Guide implementation decisions (SYLVI) together with others recorded in STUK's change proposal database have been considered when updating the requirements. In addition, the possibilities to reduce the so-called administrative burden have been considered.

An example of reducing the administrative burden is allowing the use of serially manufactured valves under certain conditions. Another example worth mentioning, which is believed to further clarify the licensing of valves equipped with actuators, is having electrical and I&C equipment now approved solely against the requirements of Guide YVL E.7, i.e., against the preliminary and final suitability assessments. However, the compatibility of the valve and actuator shall be demonstrated with the so-called operability analysis to be appended to the valve's construction plan.