

Guide YVL E.2, Procurement and operation of nuclear fuel and control rods

1 Scope of application

Guide YVL E.2 sets forth the requirements for the acceptance of the design, manufacture, receiving and operation of nuclear fuel and control rods, as well as for the requirements for their inspections and repairs to be carried out during and after operation.

2 Justifications of the requirements

Guide YVL A.3 “Leadership and management for safety” specifies the requirements and basis for all activities related to the safety of a nuclear facility. Putting emphasis on the licensee’s responsibility has been one of the starting points of the entire guide series reform. The scope of application of Guide YVL A.3 states that its requirements, where applicable, apply to organisations contributing to the fuel manufacture and thereby also to the quality management of fuel design and manufacture and its surveillance. In accordance with STUK’s policy on YVL guides, general requirements for quality management do not need to be separately repeated in component-level instructions.

The requirements on the selection and assessment of the suppliers of nuclear fuel and control rods in Guide YVL E.2 are based on Guide YVL A.3. subsection “Purchasing and control of the supply chain”. Guide YVL A.3 specifies detailed requirements e.g. for the procedures for purchasing the structures and components of the nuclear facility.

In accordance with the previous procedures, subsection 3.1 “Quality management of design and manufacture” of Guide YVL E.2 specifies requirements for assessment of the supplier’s quality management system. Furthermore, requirement 309 of Guide YVL E.2 states that the licensee shall submit to STUK applications regarding the acceptability of the quality management of the design and manufacture of nuclear fuel and control rods, which include assessments of the quality management systems of the supplier and its subcontractors.

The licensee shall also draw up and submit to STUK for information a long-term programme used by the licensee to regularly assess the performance of the quality management systems of the supplier and its subcontractors. A revised programme, which summarises the realisation of the assessments, shall be submitted to STUK for information annually.

Subsection 3.2 of Guide YVL E.2 states that the acceptability of the designs of nuclear fuel and control rods shall be demonstrated by a suitability study in accordance with Guide YVL B.4. The licensee shall draw up a memorandum assessing the acceptability of the suitability study documentation. The memorandum along with the documentation of the suitability study shall be submitted to STUK for approval.

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Guide YVL E.2 specifies the division of fuel assembly components into products specific to a fuel delivery batch and to products not specific to such a batch. The most important products (part, component) of a fuel assembly shall be assigned to a fuel delivery batch from the beginning of their manufacture, whereas this does not apply to other fuel assembly components. The manufacture of the components not specific to the batch may have taken place even before the licensee has ordered the fuel delivery batch in question. In such cases, the supplier shall ensure that the properties and quality of components not specific to the batch correspond to the approved construction plan of the delivery batch in question.

In control rod manufacture, there is no need for this kind of division of products since control rod parts shall be classified as components not specific to a batch. Therefore, manufacture of control rods is considered to be started when the first qualified manufacturing step of a control rod is commenced.

A list of the products specific and non-specific to a fuel delivery batch shall be submitted to STUK for approval, at the latest when the licensee submits the quality assessment plan for the supplier and its subcontractors, as described in requirement 307. The safety significance of the product shall be taken into account in the scope of the assessment procedures along with the role of supplier as a manufacturer of products specific or non-specific to a delivery batch. For products not specific to a batch, assessment of the manufacturer's quality management practices are emphasised. This is important because it is not required to submit a construction plan before the commencement of the manufacture of the products not specific to a delivery batch and, thus it may not be possible to react to changes in advance. Secondly, the licensee may not have an opportunity to supervise the manufacture of their products not specific to the delivery batch.

Requirements 305–309 of Guide YVL E.2 primarily apply to a new supplier or a situation, in which significant changes have taken place in an supplier's organisation or in a subcontracting chain or when licencing a new fuel type.

Requirement 310 refers to the long-term assessment programme according to which the licensee regularly assesses the performance of the quality management systems of its suppliers and their subcontractors. The programme shall also include information about realised and planned assessments, assessment intervals and procedures.

Subsection 3.3 "Construction plan" of Guide YVL E.2 specifies requirements for the documents for each individual delivery batch of nuclear fuel and control rods, to be submitted to STUK for approval. The construction plan shall include all drawings, specifications and manufacturing and inspection plans concerning the delivery batch in question. A memorandum prepared by the licensee demonstrating the acceptability of the construction shall show that the properties and parameters of the nuclear fuel and control rods to be manufactured comply with the approved suitability study.

STUK's review of the application concerning the quality management of the design and manufacture of the nuclear fuel and control rods can be concurrent with the review of the suitability study. As a rule, both of them have to be approved by STUK

before STUK commences the review of the construction plan for the reload batch in question.

The construction plan for products specific and not specific to a fuel delivery batch must be approved by the licensee and STUK before the commencement of the manufacture of the products specific to the delivery batch in question. The manufacturer must ensure and compile documents demonstrating that products not specific to a delivery batch have been manufactured in accordance with an approved construction plan. However, significant changes to manufacturing and inspection methods must be reported to STUK in advance.

The construction plan for control rods must be approved by STUK before the construction inspection of the control rods takes place.

The licensee must submit to STUK for information their plans for the manufacturing surveillance of each delivery batch of nuclear fuel and control rods. They must indicate the scope and objectives of the surveillance and the attendees of the surveillance visits. Memorandums of surveillance visits and inspections in accordance with the plans must be submitted to STUK for information, at the latest in connection with the operation permit application of the delivery batch in question.

3 International provisions concerning the scope of the Guide

There is a historical basis for the preparation of guides concerning the design, manufacture and quality management of nuclear fuel and control rods, as a part of Finnish provisions. Finland adopted a very detailed and demanding level related to the construction and operation of nuclear power plants, which also applies to all safety-related activities and the associated control of quality management. This level was also extended to the manufacturing surveillance of nuclear fuel. Because suitable and sufficiently detailed guides fit to serve as models could not be found in international provisions, guides serving our particular basis was drawn up for Finland.

Oversight in accordance with the detailed regulation can be considered to contribute to both understanding and application of the special requirements for the design, manufacture and operation of nuclear fuel, especially in a country that has neither fuel manufacture of its own nor the development of the associated technology.

Guide YVL E.2 has been compared to IAEA safety instructions [1–4] and to the WENRA requirements. The ISO TC 85 (Nuclear energy, nuclear technologies, and radiological protection) list of standards has also been reviewed; it does not include a standard with a subject area corresponding to the contents of Guide YVL E.2.

4 Impacts of the Tepco Fukushima Dai-ichi accident

The consequences of the Fukushima accident for nuclear fuel could not have been prevented by any factor related to the design and manufacture of the currently used fuel types. Nevertheless, since the accident, research projects have been started with the aim of developing accident-tolerant fuels (ATF) better able to withstand the conditions caused by loss of coolant accidents (LOCA) and postulated accidents. However, the development of such fuel types, laboratory tests and test irradiations as

well as the gathering of operating experience in power reactors postpone a commercial product far into the future.

Guide YVL E.2 sets forth the requirements for the acceptance of the design, manufacture, receiving and operation of nuclear fuel, as well as for the inspections and repairs of the fuel to be carried out during and after operation. The Guide also contains quality management requirements for the procurement, design and manufacture of nuclear fuel. These requirements could not have affected the occurrence, progression or management of the Fukushima accident.

5 Needs for changes taken into account in the update

When updating the requirements of Guide YVL E.2, the need for changes due to amendments of international and Finnish laws and regulations was analysed. The change proposals made in connection with the YVL Guide implementation decisions (SYLVI) together with others recorded in STUK's change proposal database were also considered. Opportunities for reduction of the administrative burden were also considered.

One need for change to be considered in the update of Guide YVL E.2 was to adapt the requirements of control rods to the Guide. Most of the requirements conform to the Guide as such for both fuel and control rods. Therefore, it is not necessary to write e.g. a new annex or chapter applicable only to control rods and repeat the same requirements again. The name of the Guide has been changed by adding to it control rods: "Procurement and operation of nuclear fuel and control rods".

Previously, most requirements of Guide YVL E.2 only referred to fuel, and requirement 202 in chapter 2 "Scope of application" stated that the Guide, when applicable, should also be complied with the procurement of control rods used in reactors. The Guide has now been updated by adding control rods to all requirements applicable to both control rods and nuclear fuel. A few requirements have been divided into separate requirements that apply to either nuclear fuel or control rods if the requirement is inapplicable to both of them.

The term 'quality management guidelines' of requirement 302 has been changed to 'quality plan' in accordance with ISO 9000:2015 "Quality management systems – Fundamentals and vocabulary". The quality plan required by requirement 302 of Guide YVL E.2 does not refer to the quality plan of Guide YVL A.3, which supplements the supplier's management system (e.g. requirements 629a, 630 and A01 of YVL A.3). The quality plan of Guide YVL E.2 describes the quality management procedures by which the licensee ensures the quality management processes and quality objectives of the design and manufacture of nuclear fuel and control rod procurement.

The reduction of administrative burden has been taken into account in requirement 328. The requirement has been specified with regard to updated versions of construction plan documents and their delivery schedules submitted for approval or for information.

Requirement 334 has been revised to reduce administrative burden and to emphasise the licensee's responsibility. The requirement applies to the review of the

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qualifications of special processes related to the manufacture of nuclear fuel and control rods. The timing of the review before the commencement of manufacture in accordance with current requirement 334 is not always possible, because the manufacturing methods of new fuel types are typically qualified along with the manufacturing of the first batches. Therefore, the requirement no longer specifies an exact timing for the review. This emphasises the licensee's responsibility to timely perform the reviews. Moreover, the licensee must justify their procedures to ensure the qualifications of special processes.

According to requirement 335a, the licensee must verify through the manufacturing surveillance and construction inspection of the control rods that the requirements and criteria specified in the construction plan for control rods are fulfilled. The procurement volumes and frequencies of the manufacture of control rods and nuclear fuel differ significantly. The procurement volumes of control rods are lower than those of nuclear fuel. Therefore, it has been considered convenient to adopt a STUK's construction inspection procedure according to Guide YVL E.3 along with the process-oriented and quality management based manufacturing surveillance typical for nuclear fuel. Thus, the focus in oversight shifts from supervision of the quality systems of licensees and manufacturers more to the inspection of products (control rods).

A new requirement 606 added to the Guide YVL E.2 sets the procedure for approval of repaired nuclear fuel or control rods to be reloaded in the reactor. The licensee is not required to apply for a new operation permit for the repaired fuel assemblies or control rods; instead further operation of repaired fuel will be approved by a STUK protocol (YP protocol), with possible restrictions on operation due to the repair. This has been an existing procedure. Previously, the procedure for approving repaired nuclear fuel and possibly repaired control rods for operation was not clearly specified in the guide. There was no actual requirement related to this, but the procedure was mentioned in the chapter "Regulatory oversight by the Radiation and Nuclear Safety Authority".

The description of STUK's activity, formerly requirement 316, has been transferred to paragraph 705a of chapter 7 "Regulatory oversight by the Radiation and Nuclear Safety Authority" and changed status into a description.

Requirement 509a on submitting to STUK the results of the inspections of nuclear fuel and control rods during annual outages for the permission to close the reactor pressure vessel cover has been added as an adjustment to requirement 509. Otherwise, the results of the inspections must be submitted to STUK within six months of the inspection according to requirement 509.

The term "design documentation" used in requirements 601 and 602 is defined at the end of requirement 601. The design documentation refers to the written documentation consisting of the suitability study and construction plan. The term clarifies these requirements.

Requirement 511 has been revised in order to remove overlap between the requirements of guides YVL D.3 and YVL E.2. Now, the requirements concerning fuel inspections have been logically compiled into one guide, Guide YVL E.2.

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Requirement 604, which was previously presented in Guide YVL D.3, has been transferred to requirement 511 of Guide YVL E.2. Requirement 605 of Guide D.3 can be removed because it is identical to requirement 509 of Guide YVL E.2. Furthermore, the reference in requirement 511 of Guide YVL E.2 to requirement 509 concerning the delivery of fuel inspection reports has been removed. Requirement 509 already includes a requirement to submit the results of all fuel inspections to STUK.

Summary of changes:

- Control rods have been added to the title of the guide and to the requirements, which apply as they are to both nuclear fuel and control rods (most of the requirements).
- Three requirements have been divided into separate procedures for nuclear fuel and control rods (309 -> 309, 309a and 309b; 332 -> 332 and 332a; 335 -> 335 and 335a; 337 -> 337, 337a and 337b).
- One new requirement (606) has been added concerning the approval of a repaired fuel assembly/control rod to be reloaded in the reactor. (The requirements lacked this existing procedure.)
- A description of STUK's activity has been transferred to chapter 7 "Regulatory oversight by the Radiation and Nuclear Safety Authority": requirement 316 has been transferred to paragraph 705a as a description.
- A requirement to report the results of the fuel inspections during annual outages to STUK for the permission to close the reactor pressure vessel cover has been added. (509a)
- The term "design documentation" used in requirements 601 and 602 has been defined (601).
- The contents of requirement 604 of Guide YVL D.3 have been moved to requirement 511. Previously, requirement 511 referred to the requirement of YVL D.3 for a condition monitoring programme.

6 References

- [1] IAEA Safety Standards Series, Safety of Nuclear Power Plants: Design, Requirements No. NS-R-1
- [2] IAEA Safety Standards Series, Design of the Reactor Core for Nuclear Power Plants, Safety Guide No. NS-G-1.12
- [3] IAEA Safety Standards Series, Design of Fuel Handling and Storage Systems for Nuclear Power Plants, Safety Guide No. NS-G-1.4
- [4] IAEA Safety Standards Series, Core Management and Fuel Handling for Nuclear Power plants, Safety Guide No. NS-G-2.5.