STUK

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STORAGE AND HANDLING OF NUCLEAR FUEL

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Authorisation

By virtue of the below acts and regulations, the Radiation and Nuclear Safety Authority (STUK) issues detailed regulations that apply to the safe use of nuclear energy and to physical protection, emergency preparedness and safeguards:

- Section 55 of the Nuclear Energy Act (990/1987)
- Section 29 of the Government Decision (395/1991) on the Safety of Nuclear Power Plants
- Section 13 of the Government Decision (396/1991) on the Physical Protection of Nuclear Power Plants
- Section 11 of the Government Decision (397/1991) on the Emergency Preparedness of Nuclear Power Plants
- Section 8 of the Government Decision (398/1991) on the Safety of a Disposal Facility for Reactor Waste
- Section 30 of the Government Decision (478/1999) on the Safety of Disposal of Spent Nuclear Fuel.

Rules for application

The publication of a YVL Guide does not, as such, alter any previous decisions made by STUK. After having heard those concerned, STUK makes a separate decision on how a new or revised YVL Guide applies to operating nuclear power plants, or to those under construction, and to licensees' operational activities. The guides apply as such to new nuclear facilities.

When considering how new safety requirements presented in YVL Guides apply to operating nuclear power plants, or to those under construction, STUK takes into account Section 27 of the Government Decision (395/1991), which prescribes that *for further safety enhancement, action shall be taken which can be regarded as justified considering operating experience and the results of safety research as well as the advancement of science and technology.*

If deviations are made from the requirements of the YVL Guides, STUK shall be presented with some other acceptable procedure or solution by which the safety level set forth in the YVL Guides is achieved.

Translation. Original text in Finnish.

1 General

In storing and handling nuclear fuel (hereinafter referred to as 'fuel'), the primary safety objectives are to prevent criticality and damage to the fuel, as well as to ensure adequate cooling and radiation protection. Furthermore, it is important from the point of view of safety to ensure that the loads to be lifted during fuel handling and transfer do not drop and that the operability of safety-related systems, components and structures of the nuclear power plant is not jeopardized.

Tried and tested, high-quality technical solutions, competent personnel, well-tried procedures and appropriate instructions are prerequisites for achieving the safety objectives.

This Guide defines the safety requirements and the control procedure for the storage and handling of fresh and spent fuel of a nuclear power plant. The control procedure applies to all those structures and components of the storage and handling systems that may affect fuel safety. The Guide does not deal with the control of any process-related technical systems (e.g. cooling and purification systems), including their structures and components, connected with fuel storage. With regard to the storage of spent fuel, this Guide only deals with storage in a water pool.

Guide YVL 6.1 describes the regulatory control of nuclear fuel by the Radiation and Nuclear Safety Authority (STUK) in general. The detailed requirements for fuel control are given in Guide YVL 6.3. The regulatory control of nuclear power plants by STUK on the whole is discussed in Guide YVL 1.1.

2 Safety requirements for storage and handling

2.1 General requirements

Guide YVL 1.0 defines the safety principles for the storage and handling of fuel. The requirements given below shall be taken into account when applying these principles.

The fuel storage and handling systems and the related structures and components shall be classified in accordance with Guide YVL 2.1.

The fuel inspections carried out during an outage shall be taken into account when designing the reactor building.

In addition to the requirements for nuclear and radiation safety given below, the regulations, guides and standards pertaining to occupational safety and structural design shall be taken into account. The guides stated in References 1 to 8 deal with criticality and thermal analyses and the detailed design of components. If necessary, STUK will give detailed instructions on how to apply them.

2.2 Storage systems for fresh fuel

The storage facilities shall be designed such that the facility remains subcritical when filled with fuel and that the effective multiplication factor k_{eff} does not exceed the value of 0.95 even in postulated accidents, although it is assumed that water or another possible moderator enters the storage facility. Any accumulation of moderator in the storage facility shall be prevented.

The possibility of fuel damage during storage shall be minimized. Any lifting or transfer of heavy objects above the fuel shall be avoided.

Appropriate rooms and equipment shall be provided for fuel inspections.

2.3 Storage systems for spent fuel

The storage facilities shall be designed such that the facility remains subcritical when filled with fuel having the maximum reactivity and that the effective multiplication factor k_{eff} does not exceed the value of 0.95 even in postulated accidents.

The possibility of fuel damage during storage shall be minimized. Any lifting or transfer of heavy objects above the fuel shall be avoided.

The storage facility shall be equipped with

- a fuel cooling system, which is capable of keeping the temperature of the coolant below 60°C under operating conditions (taking single failures into account) and below 100°C in postulated accidents
- a coolant purification system
- a coolant makeup system, which is capable of replacing coolant losses caused by postulated accidents; the system shall be capable of maintaining a water level that ensures sufficient radiation protection and fuel cooling

- systems for detecting and locating leaking fuel assemblies or provisions for installing such systems in the storage facility, if necessary
- systems for detecting and collecting fuel pool leakages
- a ventilation system, which is capable of limiting the releases of radioactive materials into the environment in accordance with Government Decision 395/1991.

Adequate handling, decontamination and inspection facilities shall be provided for the fuel handling and transport packages. Appropriate rooms and equipment shall likewise be provided for fuel inspections and damaged fuel assemblies.

The storage conditions shall be such that corrosion of the fuel and storage equipment is reduced to a minimum. The chemical condition and activity of the coolant shall be monitored and, furthermore, it shall be ensured that the coolant stays sufficiently pure and clear, for example in order to check the identification markings on fuel assemblies.

The gates of the pools shall be designed in such a way that they remain leakproof even if one of the pools in the storage system concerned is drained of water.

When designing the pools, any drops of heavy loads, earthquakes and the boiling of the coolant, as well as any load combinations deemed possible shall be taken into account, in addition to the loads owing to the structures and operation.

It shall be possible to continuously monitor the water temperature and level of the pool, and under normal operating conditions the water level shall be kept high enough above the fuel level in order to ensure adequate radiation protection.

The fuel pools must not contain any nozzles through which the water level could drop to such an extent that the cooling and adequate radiation protection would be jeopardized.

The storage facilities shall be designed such that any single pool or the reactor may be emptied completely of fuel to other storage pools located at the plant site.

2.4 Storage racks

The fuel storage racks shall be designed in such a way that all safety requirements are fulfilled. In addition, the racks and their attachments shall be designed such that lifting operations cannot endanger their structural integrity. It shall be possible to inspect the storage racks and any neutron absorbers contained in them at regular intervals.

The storage racks shall be designed and located in the storage pool in such a way that the cooling of fuel takes place in the form of natural circulation. The possibility of fuel becoming stuck, scratched or otherwise damaged shall be minimized.

The possibility of positioning fuel at wrong locations in the storage racks shall be minimized.

The materials of the storage racks shall be such that they do not release any substances into the fuel assemblies that might cause fuel damage during operation.

2.5 Fuel handling systems

The design of the fuel handling systems shall be based on a risk assessment. The assessment shall particularly analyse any events that could result in fuel criticality, inadequate cooling or radiation protection, or fuel damage. The design shall ensure that criticality is prevented, adequate cooling and radiation protection are ensured, and that the probability of fuel damage is minimal.

The handling procedures shall be designed in such a way that

- the handling of heavy objects above the fuel is avoided
- the handling of heavy objects is avoided above areas in which the dropping of objects might endanger safety-related components
- they do not endanger the integrity of the storage pools and fuel
- the water cover required for radiation protection remains sufficient even in the event of a single failure.

The fuel handling equipment shall fulfil the applicable general requirements for hoisting appliances (see YVL 5.8). Handling movements shall

stop automatically upon occurrence of a power cut and in the event of overload or overspeed. The equipment shall not become incapable of carrying the load safely in the event of a single failure.

The fuel handling machine shall be equipped with the protective devices and functions required on the basis of the risk analysis report, including at least the following:

- limit switches to stop the movement as soon as the load becomes considerably lighter
- limit switches to interrupt the lifting or rotation upon occurrence of a power cut and in the event of overload or overspeed
- disconnecting switches to restrict the handling operations to permissible areas
- mechanical limit stops for the handling, lifting and lowering operations
- a mode for slow lifting, lowering and handling operations
- a stopper for simultaneous horizontal and vertical movements
- limit switches for predefined limits of the bridge and trolley movements
- stopping of the movement in the event of a slack hoisting cable
- detection of the load attachment and detachment
- a load size indicator
- an emergency stop device, which enables all operations to be stopped at the same time
- instrumentation for determining the exact position of the fuel
- an adequate lighting and TV system.

The grabs shall be designed in such a way that any loosening or disengagement of the attached load is prevented in two independent ways and that the grabs remain in a safe position in the event of a power cut.

The fuel leak testing devices shall be designed in a way that ensures adequate cooling of the fuel in all situations.

The equipment and component parts that come into contact with pool water shall be designed such that they cannot easily become contaminated and they can be decontaminated.

The fuel transport casks shall fulfil the design requirements laid down in Guide YVL 6.4 where applicable. It shall be possible to continuously monitor the temperature, internal pressure and radiation level of the transport casks or, alternatively, this shall be demonstrated to be unnecessary.

Proper shock absorbers shall be designed to prevent any breakage of the fuel transport casks and transport packages in the event that they are dropped.

2.6 Operation

Instructions shall be drawn up for operation of the storage and handling systems and their components, as well as for operational transients and accidents affecting them. These instructions shall define, e.g., the operations carried out on the fuel, and the functional requirements, actions, responsibilities and records.

Only persons specifically trained for the task are allowed to handle the fuel.

The conditions pertaining to the safety of fuel storage and handling shall be included in the Operational Limits and Conditions of the facility.

The storage and handling systems and related components shall be subjected to in-service inspections in accordance with a system- and component-specific programme. The programme shall define

- the objects and scopes of inspection
- the inspection intervals
- the applicable regulations and standards
- the qualification requirements for the inspection personnel
- preparation of the inspection object
- the inspection methods and equipment to be used
- the calibration requirements for the inspection equipment
- the acceptance criteria for the inspection results
- reporting on the inspections and filing of the inspection records.

3 Regulatory control by the Radiation and Nuclear Safety Authority

Guide YVL 1.0 and Section 2 of this Guide define the safety requirements for fuel storage and handling. It shall be demonstrated in the safety analysis report, in topical reports and in pre-inspection documents of and construction plans for the systems, components and structures that these requirements are fulfilled. Component-specific YVL Guides shall be complied with, where applicable, in the pre-inspection documents.

When drawing up the safety analysis report, Guides YVL 1.1 and YVL 2.0 shall be complied with. The safety analysis report shall contain, e.g., system descriptions, including the design basis, and transient and accident analyses concerning storage and handling, including fuel handling errors and the anticipated operational transients and postulated accidents of the systems in question. The requirements for the analyses are defined in Guide YVL 2.2.

Guide YVL 4.1 shall be complied with for the control of concrete structures, Guide YVL 4.2 for the control of steel structures and Guide YVL 5.8 for the control of hoisting appliances and other fuel handling equipment.

Guide YVL 5.2 pertains to electrical equipment and Guide YVL 5.5 to instrumentation components, where applicable.

Instructions for the test loading and trial run of components and structures shall be given as part of the construction plan for each component or structure.

The procedure defined in Guide YVL 3.7 shall be followed in the commissioning inspection of components and structures.

Testing programmes shall be drawn up for the fuel handling and storage systems and for the related main components to verify that the systems and components fulfil the functional requirements set for them. At the same time, the operability and safety of the combined operations of components and structures shall be verified (e.g. load transfers from one component to another, and operating areas in relation to obstacles, other components and prohibited areas).

General requirements for the testing are defined in Guide YVL 2.5.

The instructions for fuel storage and handling shall be submitted to STUK for information. Likewise, the periodic testing and in-service inspection programmes for the storage and handling systems shall also be submitted to STUK for information.

STUK monitors in-service inspections and maintenance of the fuel storage and handling systems and the related components, as well as the handling and storage of the fuel as part of the control during plant operation.

4 References

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5. Auslegung von Hebezeugen in Kernkraftwerken, Sicherheitstechnische Regel des KTA, KTA 3902, Fassung 6/99.
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7. Design Requirements for Light Water Reactor Fuel Handling Systems, ANSI/ANS-57.1-1992 (Reaffirmed 1998).
8. IAEA Safety Guide, Core Management and Fuel Handling for Nuclear Power Plants, NS-G-2.5, 2002.
9. IAEA Safety Guide, Assessment for Nuclear and Radiation Facilities Other Than Reactors and Waste Repositories, IAEA Draft DS 284, 2002-12-06.