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Ministry of Employment and the Economy, Finland

Government Degree on the Safety of Nuclear Power Plants

717/2013

Chapter 1 Scope and definitions

Section 1 **Scope**

This Decree lays down provisions on the safety of nuclear power plants. Moreover the Decree shall apply to other nuclear facilities equipped with a nuclear reactor.

Section 2 **Definitions**

For the purposes of this Decree:

1) *annual dose* shall refer to the sum of the effective dose arising from external radiation within the period of one year, and of the committed effective dose from the intake of radioactive substances within the same period of time;

2) *criticality* shall refer to a state where the output and loss of neutrons, created in nuclear fission and maintaining a chain reaction, are in equilibrium so that a steady chain reaction continues;

3) *criticality accident* shall refer to an accident caused by an uncontrolled chain reaction of nuclear fissions;

4) *anticipated operational occurrence* shall refer to such a deviation from normal operation that can be expected to occur once or several times during any period of a hundred operating years;

5) *accident* shall refer to postulated accidents, design extension conditions and severe accidents;

6) *postulated accident* shall refer to a deviation from normal operation which is assumed to occur less frequently than once over a span of one hundred operating years, excluding design extension conditions; and which the nuclear power plant is required to withstand without sustaining severe fuel failure, even if individual components of systems important to safety are rendered out of operation due to servicing or faults. Postulated accidents are grouped into two classes on the basis of the frequency of their initiating events:

a) Class 1 postulated accidents which can be assumed to occur less frequently than once over a span of one hundred operating years, but at least once over a span of one thousand operating years;

b) Class 2 postulated accidents which can be assumed to occur less frequently than once during any one thousand operating years;

7) *design extension condition* shall refer to:

a) an accident where an anticipated operational occurrence or class 1 postulated accident involves a common cause failure in a system required to execute a safety function;

b) an accident caused by a combination of failures identified as significant on the basis of a probabilistic risk assessment; or

c) an accident caused by a rare external event and which the facility is required to withstand without severe fuel failure.

8) *severe accident* shall refer to an accident in which a considerable part of the fuel in a reactor or in a spent fuel pool loses its original structure;

9) *severe reactor accident* shall refer to an accident in which a considerable part of the fuel in a reactor loses its original structure;

10) *probabilistic risk assessment* shall refer to a quantitative assessment of hazards, probabilities of event sequences and adverse effects influencing the safety of a nuclear power plant;

11) *safety functions* shall refer to functions important from the point of view of safety, the purpose of which is to control disturbances or prevent the generation or propagation of accidents or to mitigate the consequences of accidents;

12) *redundancy principle* shall refer to the use of several parallel subsystems, so that the system can perform the required function even though individual subsystems are out of operation e.g. due to maintenance or failures;

13) *diversity principle* shall refer to ensuring of functions through systems or components having different operating principles or differing from each other in some other manner, with all systems or components able to implement a function separately;

14) *functional isolation* shall refer to the isolation of systems from one another so that the operation or failure of one system does not adversely affect another system; functional isolation also covers electrical isolation and isolation of the processing of information between systems;

15) *separation principle* shall refer to physical separation and functional isolation;

16) *controlled state* shall refer to a state where a reactor has been shut down and the removal of its decay heat has been secured;

17) *safe state* shall refer to a state where the reactor has been shut down and is non-pressurised, and removal of its decay heat has been secured;

18) *controlled state following a severe reactor accident* shall refer to a state where the removal of decay heat from the reactor core debris and the containment has been secured, the temperature of the reactor core debris is stable or decreasing, the reactor core debris is in a form that poses no risk of re-criticality, and no significant volumes of fission products are any longer being released from the reactor core debris;

19) *safe state following a severe reactor accident* shall refer to a state where the conditions for the controlled state of a severe reactor accident are met and, in addition, the pressure inside the containment is low enough that leak from the containment is minor, even if the containment is not leak-tight;

20) *physical separation* shall refer to the separation of systems or components from one another by means of adequate barriers, distance or placement, or combinations thereof and

21) *normal operating conditions* shall refer to the planned operation of a nuclear power plant according to the Operational Limits and Conditions and operational procedures in place. These also include testing, plant start-up and shutdown, maintenance and refuelling.

Chapter 2 General safety

Section 3 Assessment and verification of safety

The safety of a nuclear power plant shall be assessed when applying for a construction license and operating license, in connection with plant modifications, and at Periodic Safety Reviews during the operation of the plant. It shall be demonstrated in connection with the safety assessment that the nuclear power plant has been designed and implemented in a manner that meets the safety requirements. The safety assessment shall cover all the nuclear power plant states. The safety of a nuclear power plant shall be assessed also after occurred accident and, whenever necessary, on the basis of the safety research results.

The safety of a nuclear power plant and the technical solutions of its safety systems shall be assessed and substantiated analytically and, if necessary, experimentally. Analytical methods include transient and accident analyses, analysis of internal and external hazards, strength analyses, failure tolerance analyses, failure mode and effects analyses, and probabilistic risk assessments. The analyses shall be maintained and revised as necessary, taking into account operating experience from the plant itself and from other nuclear power plants, the results of safety research, plant modifications, and the advancement of calculation methods.

The analytical methods employed to demonstrate compliance with safety requirements shall be reliable and well qualified for the purpose. The analyses shall demonstrate the conformity with the safety requirements with high certainty. Any uncertainty in the results shall be assessed and taken into account in determining safety margins.

Section 4 Safety classification

The safety functions of a nuclear power plant shall be defined and the related systems, structures and components classified on the basis of their safety significance.

Systems, structures and components important to safety shall be designed, manufactured, installed and used so that their quality level, and the assessments, inspections and tests, including environmental qualification, required to verify their quality level, are sufficient considering the safety significance of the item in question.

Safety classification shall be applied in determining the quality requirements for systems, structures and components.

Section 5 **Ageing management**

The design, construction, operation, condition monitoring and maintenance of a nuclear power plant shall provide for the ageing of systems, structures and components important to safety in order to ensure that they meet the design-basis requirements with necessary safety margins throughout the service life of the facility. Systematic procedures shall be in place for preventing the ageing of systems, structures and components which may deteriorate their availability, and for the early detection of the need for their repair, modification and replacement. Safety requirements and applicability of new technology shall be periodically assessed, in order to ensure that the technology applied is up to date, and the availability of the spare parts and the system support shall be monitored.

Section 6 **Management of human factors**

Special attention shall be paid to the avoidance, detection and correction of any human error at any life cycle phase of the nuclear power plant. The possibility of human error shall be taken into account in the design of the nuclear power plant and in the planning of its operation and maintenance, so that human errors and deviations from normal plant operations due to human error do not endanger plant safety. The possibility of common cause failures due to human error shall be reduced. The effects of human errors shall be limited by applying a functional defense in depth safety principle.

Chapter 3 Limitation of radiation exposure and releases of radioactive substances

Section 7 **Radiation safety of nuclear power plant workers and environment**

Occupational radiation exposure of nuclear power plant workers shall be kept as low as reasonably achievable. The design and operation of nuclear power plants shall be implemented so that the radiation exposure of workers can be restricted as specified in Section 2 and Chapter 9 of the Radiation Act (592/1991). The maximum values for workers' exposure to radiation are stipulated in Chapter 2 of the Radiation Decree (1512/1991).

Radiation exposure of the surrounding population resulting from nuclear power plant operations shall also be kept as low as reasonably achievable. The design and operation of nuclear power plants shall be implemented so that the radiation exposure of the population can be restricted as specified in Section 2 of the Radiation Act. The maximum values for radiation exposure of the public from the operation of a nuclear power plant, operational occurrences and accidents are specified in Sections 8 – 10 of this Decree.

Section 8 **Limit for normal operation**

The limit for the annual dose of an individual in the population, arising from the normal operation of a nuclear power plant, is 0.1 millisievert (mSv).

Section 9 **Limit for an anticipated operational occurrence**

The limit for the annual dose of an individual in the population arising as a result of an anticipated operational occurrence is 0.1 mSv.

Section 10 **Limits for accident**

The limit for the annual dose of an individual in the population arising as a result of a Class 1 postulated accident is 1 mSv;

a Class 2 postulated accident is 5 mSv; and

a design extension condition is 20 mSv.

The release of radioactive substances arising from a severe accident shall not necessitate large scale protective measures for the public nor any long-term restrictions on the use of extensive areas of land and water.

In order to restrict long-term effects the limit for the atmospheric release of cesium-137 is 100 terabecquerel (TBq). The possibility of exceeding the set limit shall be extremely small.

The possibility of a release in the early stages of the accident requiring measures to protect the public shall be extremely small.

Chapter 4 Nuclear safety

Section 11 **Siting of a nuclear power plant**

The impact of local conditions on safety and on the implementation of the security and emergency arrangements, shall be considered when selecting the site of a nuclear power plant. The site shall be such that the impediments and threats posed by the plant to its environment remain extremely low and heat removal from the plant to the environment can be reliably implemented.

Section 12 **Prevention of accidents and mitigation of consequences**

In order to prevent anticipated operational occurrences and accidents, and to mitigate the consequences thereof, the functional defence-in-depth principle shall be implemented in the design, construction and operation of a nuclear power plant.

In accordance with the functional defence-in-depth safety principle, the design must include the following levels of defence:

1) prevention to ensure that the operation of the plant is reliable and deviations from normal operating conditions are rare;

2) control of deviations from the plant’s normal operating conditions so that the plant is equipped with systems which are able to limit the development of operational occurrences into accidents and if required can bring the plant into a managed state;

3) control of accident situations so that the nuclear plant is equipped with systems that function automatically and reliably to prevent severe fuel damage in postulated accidents and in design extension conditions; manually actuated systems can also be used to manage accident situations if it can be justified from a safety perspective;

4) confinement of a release of radioactive substances in severe reactor accidents by equipping the nuclear power plant with systems which ensure the leaktightness of the containment in severe reactor accidents so that the limits for releases in severe reactor accidents are not exceeded;

5) mitigation of the consequences by means of emergency arrangements to limit the public's exposure to radiation in situations where radioactive substances are released from the plant into the environment.

The levels of defence required under the defence-in-depth principle shall be as independent of one another as is reasonably achievable. High quality proven technology that has been thoroughly researched and tested is to be used for the different levels of the defence-in-depth. The necessary measures to bring a situation under control or to prevent harmful effects of radiation must be planned in advance. When organising licensee's operations, it must be ensured that operational occurrences and accidents are reliably prevented. There shall be effective technical and administrative provisions to ensure staff's ability to operate in these situations.

Section 13 **Engineered barriers for preventing the dispersion of radioactive substances**

In order to prevent the dispersion of radioactive substances, the structural defence-in-depth safety principle shall be implemented.

Structural defence-in-depth design shall prevent dispersion of radioactive substances into the environment by means of successive barriers which are the fuel and its cladding, the reactor cooling circuit (primary circuit) and the containment.

The fuel, reactor, reactor primary circuit and the cooling circuit for removing heat from the pressurised water reactor's primary circuit (secondary circuit), the primary and secondary circuits' water chemistry, the containment and safety functions are to be designed in such a manner that they fulfil the safety requirements specified in Subsections 4-6.

In order to ensure the fuel integrity:

1) the probability of fuel failure shall be low during normal operational conditions and anticipated operational occurrences;

2) in postulated accidents, the amount of fuel failures shall be kept small and fuel coolability shall not be compromised; and

3) the possibility of a criticality accident shall be extremely small.

In order to ensure primary and secondary circuit integrity:

1) the primary circuit of a nuclear power plant shall be designed and manufactured in compliance with high quality standards so that the probability of hazardous faults in structures and that of mechanisms threatening their integrity remains extremely low and any faults which occur can be detected reliably through inspections;

2) the primary circuit of a nuclear power plant shall, with sufficient margins, withstand the stresses arising in normal operational conditions, anticipated operational occurrences, postulated accidents and design extension conditions;

3) the primary circuit of a nuclear power plant and systems immediately connected to it, and components important to the safety of the secondary circuit of a pressurised water reactor, shall be

reliably protected during anticipated operational occurrences and all accident scenarios, in order to prevent damage caused by over-pressurisation;

4) the water chemistry conditions of a nuclear power plant's primary circuit and a pressurised water reactor's secondary circuit shall not cause mechanisms that threaten their integrity; and

5) in order to detect leakages, the facility shall be equipped with sufficient monitoring systems.

In order to ensure the containment integrity:

1) the containment shall be designed to maintain its integrity during anticipated operational occurrences and, with a high degree of certainty, during all accident conditions;

2) pressure, radiation and temperature loads, radiation levels inside the plant, combustible gases, impacts of missiles and short-term high-energy phenomena resulting from an accident shall be considered in the design of the containment; and

3) the possibility of failure of the reactor pressure vessel in a severe accident so that the leaktightness of the containment would be endangered shall be extremely small.

A nuclear power plant shall be equipped with systems to ensure the stabilisation and cooling of molten core material generated during a severe accident. Direct interaction of molten core material with the load bearing containment structure shall be reliably prevented.

Section 14 **Safety functions and provisions for ensuring them**

In ensuring safety functions, inherent safety features attainable by design shall be primarily utilised. In particular, the combined effect of a nuclear reactor's physical feedback characteristics shall be such that it mitigates the increase in reactor power.

If inherent safety features cannot be utilised in ensuring a safety function, priority shall be given to systems and components which do not require a power supply or which, in consequence of a loss of power supply, will settle in a state preferable from the safety point of view.

In order to prevent accidents and mitigate the consequences thereof, a nuclear power plant shall be provided with systems for shutting down the reactor and maintaining it in a subcritical state, for removing decay heat generated in the reactor, and for retaining radioactive materials within the plant. Design of such systems shall apply redundancy, separation and diversity principles that ensure implementation of a safety function even in the event of a malfunctions.

The most important safety functions necessary to bring the plant to a controlled state and to maintain it must be ensured even if any individual component of a system providing the safety function is inoperable and even if any other component of a system providing the same safety function or of a supporting or auxiliary system necessary for its operation is simultaneously inoperable due to the necessity for its repair or maintenance.

Common cause failures shall only have minor impacts on plant safety.

A nuclear power plant shall have off-site and on-site electrical power supply systems to cope with anticipated operational occurrences and accidents. It shall be possible to supply the electrical power needed for safety functions using either of the two electrical power supply systems.

Nuclear power plants must have equipment and procedures to ensure that decay heat from nuclear fuel in the reactor and in spent fuel pools can be removed for a period of three days independent of external electricity and external water supplies in situations which are caused by rare external events or by a malfunction in the plant's internal electricity distribution system.

The plant shall be designed with systems, structures and components for controlling and monitoring severe accidents. These systems shall be independent of the systems designed for normal operational conditions, anticipated operational occurrences and postulated accidents. Systems necessary for ensuring the integrity of the containment in a severe accident shall be capable of performing their safety functions, even in the case of a single failure.

The plant shall be designed so that it can be brought into a safe state after a severe accident.

Section 15 **Fuel handling and storage**

Adequate fuel cooling and radiation protection shall be ensured when handling and storing nuclear fuel. Damage to fuel cladding during handling and storage must be prevented with a high degree of confidence. The possibility of a criticality accident shall be extremely low. Fuel storage conditions shall be maintained such that the leak-tightness or mechanical endurance of a fuel assembly is not substantially degraded during the planned storage period.

Section 16 **Management and storage of radioactive waste**

Waste generated during the operation of a nuclear power plant, the activity concentration of which exceeds the limits set by the Radiation and Nuclear Safety Authority shall be treated as radioactive waste. Waste shall be sorted, categorised and handled in an appropriate manner in terms of its storage and disposal, and stored safely.

Section 17 **Protection against external hazards**

External hazards that may endanger safety functions shall be taken into account in the design of a nuclear power plant. Systems, structures and components shall be designed, located and protected so that the impacts of external hazards deemed possible have only a minor impact on plant safety. The operability of systems, structures and components shall be demonstrated in their design basis external environmental conditions.

External hazards shall include exceptional weather conditions, seismic events, impact of accidents taking place in the plant's vicinity and other factors resulting from the environment or human activity. The design shall also consider unlawful actions with the aim of damaging the plant and a large commercial aircraft crash.

Section 18 **Protection against internal hazards**

The design of a nuclear power plant shall take account of any internal hazards that may endanger safety functions. Systems, structures and components shall be designed, located and protected so that the probability of internal hazards remains low and impacts on plant safety minor. The

operability of systems, structures and components shall be demonstrated in the room specific environmental conditions used as their design bases.

Internal hazards to be considered include at least fire, flood, explosion, electromagnetic radiation, pipe breaks, container breakages, drop of heavy objects, missiles due to explosions or component failures, and other possible internal hazards.

Section 19 **Monitoring and control of a nuclear power plant**

The control room of a nuclear power plant shall contain equipment that provides information on the state of the nuclear reactor and any deviations from normal operation. A nuclear power plant shall be equipped with automatic systems that actuate safety functions as required, and that control and supervise their functioning during operational occurrences to prevent accidents and during accidents to mitigate their consequences.

These automatic systems shall be capable of maintaining the plant in a controlled state long enough to provide the operators with sufficient time to consider and implement the correct actions.

The nuclear power plant shall have a supplementary control room independent of the main control room, and the necessary local control systems for shutting down and cooling the nuclear reactor, and for removing decay heat from the nuclear reactor and spent fuel stored at the plant.

Section 20 **Decommissioning**

The design of a nuclear power plant shall take account of the decommissioning of plant units so as to restrict the volume of waste destined for final disposal, accumulating during their dismantling, and the radiation exposure of workers due to the dismantling of the plant, and to prevent radioactive substances from spreading into the environment during decommissioning and when the waste is processed.

Chapter 5 Construction and commissioning of a nuclear power plant

Section 21 **Construction**

The holder of the nuclear power plant unit’s construction license shall ensure during construction that the plant is constructed and implemented in conformity with the safety requirements and using approved plans and procedures.

The licensee shall ensure that the plant supplier and subcontractors providing safety-significant services and products are operating in compliance with the safety requirements.

Section 22 **Commissioning**

In connection with the commissioning of a nuclear power plant, the licensee shall ensure that the systems, structures and components and the plant as a whole operate as designed.

At the commissioning stage, the licensee shall ensure that an expedient organisation is in place for the future operation of the nuclear power plant, alongside a sufficient number of qualified personnel and appropriate procedures.

Chapter 6 Operation of a nuclear power plant

Section 23 **Operation**

The organisation operating a nuclear power plant shall be responsible for the plant's safe operation under all operational states and accident conditions.

The control room of the nuclear power plant shall be constantly manned by a sufficient number of operators aware of the status of the plant, systems and components. The control and supervision of a nuclear power plant shall utilise written procedures that correspond to the existing structure and the operational state of the plant. Written orders and related procedures shall be provided for the maintenance and repair of components.

For operational occurrences and accidents, appropriate procedures for the identification and control of incidents shall be available.

Operational measures concerning the nuclear power plant, as well as events having an impact on safety, shall be documented so that they can be analysed afterwards.

Section 24 **Operational experience feedback and safety research**

Safety-significant operational events shall be investigated for the purpose of identifying the root causes as well as defining and implementing the corrective measures. For further safety enhancement, operating experience from the plant and from other nuclear power plants, the results of safety research and technical developments must be regularly monitored and assessed. Opportunities for improvements in technical and organisational safety, identified from operating experience, safety research and technical developments shall be assessed and implemented to the extent regarded as justified on the basis of the principles laid down in Section 7 a of the Nuclear Energy Act (990/1987).

Section 25 **Operational limits and conditions**

The operational limit and conditions of a nuclear power plant shall include the technical and administrative requirements for ensuring the plant's operation in compliance with design bases and safety analyses. The requirements for ensuring the availability of systems, structures and components important to safety, as well as the limitations that are to be complied with when equipment is unavailable, shall also be included in the operational limits and conditions. The plant shall be operated in compliance with the requirements and restrictions set in the operational limits and conditions, and compliance with them shall be monitored and any deviations reported.

Section 26 **Condition monitoring and maintenance**

Systems, structures and components important to the safety of a nuclear power plant shall be available in accordance with the design basis requirements. Their availability and the impact of the operating environment shall be supervised by means of inspections, tests, measurements and analyses Availability shall be confirmed in advance by means of regular maintenance, and preparations shall be made for restoration and repair in case of reduced availability. Condition monitoring and maintenance shall be designed, instructed and implemented in a manner that can reliably ensure the integrity and operability of the systems, structures and components throughout their service life.

Section 27 **Radiation monitoring and control of releases of radioactive substances**

The radiation levels of nuclear power plant rooms and the activity concentrations of indoor air and the gases and liquids in the systems shall be measured as well as releases of radioactive substances from the plant monitored and concentrations in the environment controlled.

Chapter 7 Organisation and personnel

Section 28 **Safety culture**

When designing, constructing, operating and decommissioning a nuclear power plant, a good safety culture shall be maintained. Nuclear safety shall take priority in all operations. The decisions and activities of the management of each organisation participating in the abovementioned activities shall reflect its commitment to operational practices and solutions that promote safety. Personnel shall be encouraged to perform responsible work, and to identify, report, and eliminate factors endangering safety. Personnel shall be given the opportunity to contribute to the continuous improvement of safety.

Section 29 **Safety and quality management**

Organisations participating in the design, construction, operation and decommissioning of a nuclear power plant shall employ a management system for ensuring the management of nuclear and radiation safety and quality. The objective of such a management system is to ensure that safety is prioritised without exception, and that quality management requirements correspond to the safety significance of the activity and function. The management system shall be systematically assessed and further developed.

The management system shall cover all organisational activities impacting the nuclear power plant's nuclear and radiation safety. For each function, requirements significant to safety shall be identified, and the planned measures described in order to ensure conformity with requirements. The organisational processes and operational practices shall be systematic and based on procedures.

Systematic procedures shall be in place for identifying and correcting deviations significant in terms of nuclear and radiation safety. If during construction or operation, it becomes necessary to make changes to approved designs, they shall be implemented in a systematic and controlled manner.

The licensee shall commit and oblige its employees and suppliers, subcontractors and other partners participating in functions affecting safety, to adhere to the systematic management of safety and quality.

Section 30 **Lines of management, responsibilities and expertise**

The lines of management in the licensee's organisation, as well as the positions and related responsibilities of employees, shall be defined and documented. The operation of the organisation shall be evaluated and continuously developed and the risks associated with the organisation's operation are to be evaluated regularly. The safety impacts of significant organisational changes are to be evaluated in advance.

Significant functions with respect to safety shall be designated. Training programmes shall be prepared for developing and maintaining of the professional qualifications of the persons working in such positions, and an adequate command of the functions in question must be verified.

The licensee shall employ adequate and competent personnel for ensuring the safety of the nuclear power plant. The licensee shall have access to the professional expertise and technical knowledge required for the safe construction and operation of the plant, the maintenance of equipment important to safety and the management of accidents.

The licensee shall as support for the responsible manager, have a group of experts, independent of the other parts of the organisation, convening on a regular basis to handle safety-related issues and giving recommendations thereon when necessary.

Chapter 8 Entry into force and transitional provisions

Section 31 **Entry into force**

This Decree will enter into force on 25 October 2013.

The Decree will repeal the Decree of the Council of State on the general regulations for the safety of nuclear power plants (733/2008).

Section 32 **Transitional provision**

The following shall be applicable to a nuclear power plant unit for which an operating licence was issued prior to the entry into force of this Decree: Section 10(2-4), Section 13(6), Sections 14 and 17 and Section 19(3), to the extent required with respect to the technical solutions of the nuclear power plant unit in question, under the principle laid down in Section 7 a of the Nuclear Energy Act.

The following shall be applicable to a nuclear power plant unit for which a construction permit was issued prior to the entry into force of this Decree: Section 14(7) to the extent required with respect to the technical solutions of the nuclear power plant unit in question, under the principle laid down in Section 7 a of the Nuclear Energy Act.