GUIDE YVL B.7

PROVISIONS FOR INTERNAL AND EXTERNAL HAZARDS AT A NUCLEAR FACILITY

Authorisation

According to Section 7 r of the Nuclear Energy Act (990/1987), *the Radiation and Nuclear Safety Authority (STUK) shall specify detailed safety requirements for the implementation of the safety level in accordance with the Nuclear Energy Act.*

Rules for application

The publication of a YVL Guide shall not, as such, alter any previous decisions made by STUK. After having heard the parties concerned STUK will issue a separate decision as to how a new or revised YVL Guide is to be applied to operating nuclear facilities or those under construction, and to licensees' operational activities. The Guide shall apply as it stands to new nuclear facilities.

When considering how the new safety requirements presented in the YVL Guides shall be applied to the operating nuclear facilities, or to those under construction, STUK will take due account of the principles laid down in Section 7 a of the Nuclear Energy Act (990/1987): *The safety of nuclear energy use shall be maintained at as high a level as practically possible. For the further development of safety, measures shall be implemented that can be considered justified considering operating experience and safety research and advances in science and technology.*

According to Section 7 r(3) of the Nuclear Energy Act, *the safety requirements of the Radiation and Nuclear Safety Authority are binding on the licence holder, while preserving the licence holder's right to propose an alternative procedure or solution to that provided for in the regulations. If the licence holder can convincingly demonstrate that the proposed procedure or solution will implement safety standards in accordance with this Act, the Radiation and Nuclear Safety Authority may approve the procedure or solution.*

With regard to new nuclear facilities, this Guide shall apply as of 1 January 2020 until further notice. With regard to operating nuclear facilities and those under construction, this Guide shall be enforced through a separate decision to be taken by STUK. This Guide replaces Guide YVL B.7 (15.11.2013).

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1 Introduction

101. This Guide presents how internal and external hazards shall be taken into account in the design of a nuclear facility. **[**2013-11-15 **]**

102. General requirements for the protection of a nuclear power plant against external hazards are given in Section 14 of Radiation and Nuclear Safety Authority Regulation on the Safety of a Nuclear Power Plant (STUK Y/1/2018):

1. The design of a nuclear facility shall take account of external hazards that may endanger safety. Systems, structures, components and access shall be designed, located and protected so that the impacts of external hazards deemed possible on nuclear facility safety remain minor. The operability of systems, structures and components shall be demonstrated in their design basis external environmental conditions.

2. External hazards shall include exceptional weather conditions, seismic events, the effects of accidents that take place in the environment of the facility, and other factors resulting from the environment or human activity. The design shall also consider unlawful and other unauthorised activities compromising nuclear safety and a large commercial aircraft crash. **[**2019-12-15 **]**

103. General requirements for the protection of a nuclear waste facility against external hazards are given in Section 17 of Radiation and Nuclear Safety Authority Regulation on the Safety of Disposal of Nuclear Waste (STUK Y/4/2018):

1. The design of a nuclear facility shall take account of external hazards that may endanger operational safety. Systems, structures and components as well as access routes shall be designed, located and protected so that the impacts of external hazards deemed possible on nuclear facility safety remain minor. The operability of systems, structures and components important to safety shall be demonstrated in the external environmental conditions used as their design bases.

2. External hazards shall include exceptional weather conditions, seismic events, the effects of accidents that take place in the environment of the facility, and other factors resulting from the environment or human activity. The design shall also consider unlawful and other unauthorised activities compromising nuclear safety, as well as aircraft crashes. **[**2019-12-15 **]**

104. General requirements for the protection of a nuclear power plant against internal hazards are given in Section 15 of Radiation and Nuclear Safety Authority Regulation on the Safety of a Nuclear Power Plant (STUK Y/1/2018):

1. The design of a nuclear facility shall take account of any internal hazards that may endanger safety. Systems, structures and components shall be designed, located and protected so that

the probability of internal hazards remains low and impacts on nuclear facility safety minor. The operability of systems, structures and components shall be demonstrated in the room specific environmental conditions used as their design bases.
2. Internal hazards to be considered include at least fire, flood, explosion, electromagnetic radiation, pipe breaks, container ruptures, drop of heavy objects, missiles due to explosions or component failures, and other possible internal hazards. The design shall also consider unlawful and other unauthorised activities compromising nuclear safety. **[**2019-12-15 **]**

105. General requirements for the protection of a nuclear waste facility against internal hazards are given in Section 18 of the Radiation and Nuclear Safety Authority Regulation on the Safety of Disposal of Nuclear Waste (STUK Y/4/2018):
1. The design of a nuclear facility shall take account of internal hazards that may endanger safety. 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 environmental conditions used as their design bases.
2. Internal hazards to be considered shall include fire, flood, explosion, electromagnetic radiation, drop of heavy objects, different types of rock slides, and other possible internal events. The design shall also consider unlawful and other unauthorised activities compromising nuclear safety. **[**2019-12-15 **]**

106. Under Section 3 of Radiation and Nuclear Safety Authority Regulation on the Emergency Arrangements of a Nuclear Power Plant (Y/2/2018):
1. Emergency arrangements shall be planned to ensure that emergency situations are quickly brought under control, the safety of the individuals in the site area is assured, and timely action is taken to prevent or limit radiation exposure to the public in the emergency planning zone.
2. Planning shall take account of a simultaneous threat to nuclear safety occurring in all nuclear facilities in the site area and their potential consequences, especially the radiation situation on the site and in the surrounding area and the opportunities to access the area.
3. Planning shall take account of the fact that the emergency situation could continue for a prolonged period.
4. Planning shall be based on analyses of the time-behaviour progress of severe accident scenarios resulting in a potential release. In such a case, variations in the state of the plant, the development of events as a function of time, the radiation situation at the plant, radioactive releases, radioactive release routes and weather conditions shall be taken into account.
5. Planning shall take account of events deteriorating safety, their controllability and the severity

of consequences, and threats related to unlawful action and the potential consequences thereof. **[**2019-12-15 **]**

107. Protection against internal and external hazards is provided by the nuclear facility's layout design, application of the redundancy, separation and diversity principles, structural dimensioning of components and structures, the environmental qualification of the components and documented procedures for protection against internal and external hazards. Layout design is important in protecting the nuclear facility against internal and external hazards. **[**2019-12-15 **]**

108. The following general principles apply to solutions implemented for protection against internal and external hazards [21]:

- The design is performed conservatively in order to ensure sufficient safety margins.
- If possible, the protection is implemented so that it does not require actions from the operating personnel.
- It is ensured that the management of assumed operational occurrences and postulated accidents is possible during and after internal and external design basis events.
- The predictability of external events and the available warning time is taken into account in the provisions.
- The possibilities and procedures to control the plant's status during and after internal and external events are ensured.
- The possible simultaneous effect of external events on parallel and diverse (sub)systems, several systems, structures and components, several nuclear power plant units and other nuclear facilities located on the same site, the regional infrastructure, material deliveries from outside the plant site and the implementation of countermeasures is taken into account.
- The sufficiency of personnel and other resources is ensured considering the use of shared equipment and personnel at several nuclear power plant units and other nuclear facilities located on the same site.
- It is ensured that protection against internal and external hazards does not adversely affect the management of initiating events caused by other reasons.

The above general principles have been followed in the requirements of the Guide, and they are also a good starting point in assessing questions related to external hazards for which there are no detailed requirements in the regulations or guides. **[**2019-12-15 **]**

2 Scope of application

201. This Guide applies to provisions for internal and external hazards at a nuclear facility during the different phases of its life cycle. Certain requirements separately mentioned in this Guide only apply to a nuclear power plant. **[**2013-11-15 **]**

202. This Guide applies to an applicant for and the holder of a Government decision-in-principle in accordance with the Nuclear Energy Act (990/1987), an applicant for and the holder of a construction licence for a nuclear facility, as well as an applicant for and the holder of an operating licence for a nuclear facility. **[**2019-12-15 **]**

203. During a nuclear facility's construction, before nuclear fuel or nuclear waste has been brought to the facility, this Guide shall apply in the scope necessary to ensure the integrity and operability of systems, structures and components important to safety during facility operation. **[**2019-12-15 **]**

204. This Guide applies to a nuclear facility undergoing decommissioning in the scope justifiable considering the amount of radioactive substances contained in the nuclear facility and the risk of their release. **[**2019-12-15 **]**

205. This Guide does not apply to underground rooms for final disposal of nuclear waste or to a research reactor. **[**2013-11-15 **]**

206. This Guide applies to hazards arising from natural phenomena and external hazards pertaining to human activities, such as explosions and chemical spills not intended for harming the nuclear facility on purpose. Requirements pertaining to protection against unlawful action are given in Guide YVL A.11. **[**2013-11-15 **]**

207. This Guide concerns hazards that may occur at the current or planned Finnish nuclear facility sites or similar sites during a facility's life cycle. The Radiation and Nuclear Safety Authority imposes, where necessary, additional requirements that might be needed for sites essentially deviating from the current facility sites. **[**2019-12-15 **]**

208. Requirements for the nuclear facility's layout design as well as protection against internal and external hazards are given also in the following Guides:

- YVL A.1 "Regulatory oversight of safety in the use of nuclear energy", submission of documents to STUK
- YVL A.2 "Site for a nuclear facility", including assessments of external conditions
- YVL A.7 "Probabilistic risk assessment and risk management of a nuclear power plant",

including seismic PRA and fragilities as well as the PRA of other external events

- YVL A.10 “Operating experience feedback of a nuclear facility”, including reporting of internal and external events
- YVL A.11 “Security of a nuclear facility”, including the use of security zones for the placement and protection of systems and equipment important to safety
- YVL B.1 “Safety design of a nuclear power plant”, including general separation requirements, protection against electromagnetic disturbances, the design criteria for air conditioning systems, the design documents to be submitted to STUK and keeping them up to date
- YVL B.2 “Classification of systems, structures and components of a nuclear facility”, including seismic classification
- YVL B.8 “Fire protection at a nuclear facility”
- YVL C.1 “Structural radiation safety at a nuclear facility”, radiation protection considerations in layout design
- YVL C.5 “Emergency arrangements of a nuclear power plant”, consideration of external events in the planning of emergency arrangements
- YVL E.13 “Ventilation and air-conditioning equipment of a nuclear facility”.

[2019-12-15 **]**

209. Detailed layout design requirements as well as requirements for protection against internal and external hazards are also provided in other YVL Guides. Chapter-specific reference to the most important YVL Guides is made later in the text. **[**2013-11-15 **]**

210. Acts, decrees and regulations in force in Finland that pertain to construction and fire and rescue services also apply to the construction and design of the nuclear facility. The Decree of the Ministry of the Environment on the Fire Safety of Buildings (848/2017), in particular, presents requirements affecting layout design [13]. Fire protection requirements for the nuclear facility are provided in Guide YVL B.8. **[**2019-12-15 **]**

211. The requirements of this Guide apply to systems, structures and components important to the nuclear facility’s safety, unless a requirement separately specifies its scope of application. A system, structure or component important to safety shall refer to systems, structures and components in safety classes 1, 2 and 3 and systems in class EYT/STUK. In addition, the requirements of chapter 4 concerning seismic design are applied to seismic category S2A equipment and structures to the extent necessary to protect systems important to safety. However, the requirements of the Guide are not applied to systems that belong to class

EYT/STUK solely on the grounds that the system monitors radiation, surface contamination or radioactivity of the plant, tools, workers or the environment (e.g. the environmental radiation monitoring network) or it is used to produce essential information for the radiation safety of the population in an emergency situation (meteorological measuring system). **[**2019-12-15 **]**

3 Layout design of the nuclear facility

3.1 Layout design of the site area

301. Design of the site area layout shall be appropriate considering the facility's nuclear and radiation safety, preparedness and rescue arrangements as well as nuclear security. **[**2013-11-15 **]**

302. The site area layout design shall take into account the possibility of simultaneous accidents at several facility units. **[**2013-11-15 **]**

303. To be taken into account in planning traffic and access arrangements at the site area are rare meteorological conditions, floods and other rare external conditions as well as radiation conditions during an accident. The site area layout design shall take into account accessibility of buildings and structures in the event of fires and accidents as well as rare external conditions. **[**2013-11-15 **]**

304. Traffic and access arrangements at the site area, taking into account transports of dangerous materials, shall be so planned that a transport accident does not endanger the safety of the facility or the emergency preparedness arrangements. **[**2013-11-15 **]**

305. Buildings and rooms containing explosive materials shall be so located that a potential explosion does not endanger systems, structures or components important to safety. **[**2013-11-15 **]**

306. The site area layout design shall be implemented in such a way that the possibility of the spreading of the effects of fires, floods and other hazards from one building to another is low. **[**2019-12-15 **]**

307. The site area layout shall be designed in such a way that the danger caused by missiles generated by the failure of a turbine, generator or other heavy rotating machines to safety functions implemented by systems, structures and components important to safety is very low. Hazard assessment shall include all facilities at the same site area or in its immediate vicinity. **[**2019-12-15 **]**

308. The placement of sea water intake and outlet channels shall be so designed as to make the possibility of the simultaneous loss of alternative water intakes from external causes low. **[**2019-12-15 **]**

309. The design of external power grid connections shall take into account phenomena simultaneously endangering different grid connections. **[**2019-12-15 **]**

310. If several nuclear power plant units or other nuclear facilities are intended to be located at the same site area or in its immediate vicinity, the layout design of the site shall take into account the potential effects of construction and transport on the operating nuclear facilities. **[**2013-11-15 **]**

3.2 Protection of the nuclear facility against internal hazards

311. Provisions shall be made in the design of the nuclear facility to protect the facility against internal hazards. This can be done by means of layout design, for example. Internal hazards to be taken into account in design shall be determined on a facility-specific basis. At least the following phenomena shall be analysed as internal hazards:

- fires and the spread of smoke and hazardous gases as well as explosions generated in consequence of a fire
- explosions and chemical reactions of materials handled at the facility
- release of dangerous gases and liquids
- arcing
- electromagnetic interference that can be caused by equipment, including GSM, defective equipment, cabling, enclosure and earthing
- consequent effects of the failure of components, piping and tanks containing liquids or gases (missiles, jet forces, pipe whips, pressure waves)
- missiles caused by the failure of rotating machines and other equipment
- falling of heavy loads
- floods
- unnecessary operation of the fire water and extinguishing system
- loss of the cooling, heating and ventilation of rooms as well as their unnecessary operation.

[2019-12-15 **]**

312. Rooms where temperatures can be exceptionally high or low and could endanger the operability of equipment important to safety housed in them, shall be equipped with temperature monitoring from which alarm signals shall be led to the main control room. Guide YVL B.1 presents requirements for assessing the consequences of any loss of the ventilation, heating and cooling of the rooms and analysing the temperature-related behaviour of the rooms. **[**2019-12-15 **]**

313. When designing the location and protection of components, impacts, water jets, steam discharges and possible missiles caused by the breaking of piping and equipment, as well as water-induced hydrostatic pressure, shall be taken into account. **[**2013-11-15 **]**

314. Floods shall be taken into account in the layout design. The design shall, at minimum, take account of internal flooding due to the following causes: pipe, component, container and pool leakages due to breaking or functional reasons, automatic actuation of systems as designed or erroneously, failure of automatic pump trips, and operator errors. Sea water pipe breaks during design-basis sea water levels shall also be examined. External floods are addressed in chapter 5.4. **[**2019-12-15 **]**

315. Design relating to protection against floods shall take into account conditions where process systems, penetrations or doors or hatches that are normally kept closed have been opened for maintenance or repair work. **[**2019-12-15 **]**

316. Structural dimensioning shall take into account hydrostatic pressure, buoyancy and possible other loads caused by floods or blockage of subsurface drains. The requirements on how floods shall be taken into consideration in the separation of safety divisions are addressed in more detail in chapters 3.3. and 3.4. **[**2019-12-15 **]**

317. Safety division compartments containing flood sources shall be provided with leakage monitoring. Leakage monitoring alarm signals shall be led to the main control room. **[**2019-12-15 **]**

317a. Any leak water in safety division compartments containing flood sources shall be directed to the drainage system or rooms from which it can be removed. **[**2019-12-15 **]**

318. Lifting of heavy loads shall be taken into account in the nuclear facility's layout design. The hoisting routes and the structures beneath them shall be so designed that the falling of heavy loads does not lead to the loss of the cooling of the nuclear fuel or reactivity control. Detailed requirements concerning hoisting devices, load-lifting attachments, functions and routes are presented in Guide YVL E.11. **[**2019-12-15 **]**

319. Layout design requirements pertaining to the following matters, among other things, are presented in other YVL Guides:

- YVL A.8: requirements concerning the possibilities of conducting inspections and ageing management
- YVL A.11: requirements concerning nuclear security and airplane crash
- YVL B.1: general requirements concerning environmental conditions in facility rooms, air

conditioning and ventilation requirements, protection against electromagnetic interference
- YVL B.2: requirements concerning seismic classification of systems, structures and components
- YVL B.5: pipe whips
- YVL B.6: requirements concerning containment design
- YVL B.8: requirements concerning fire compartmentation, emergency exits and protection against fire-load induced explosions
- YVL C.1: requirements concerning structural radiation protection and protection against the release of radioactive substances into facility rooms, including leakage management in rooms housing systems containing radioactive liquid
- YVL C.5: rooms required for emergency operations
- YVL D.1: requirements concerning nuclear safeguards
- YVL D.3 and YVL D.4: requirements concerning the handling and storage of nuclear fuel and nuclear waste management
- YVL E.4: leakage control requirements pertaining to the leak-before-break principle to be complied with to assure primary circuit integrity and requirements for shielding to protect against pipe breaks
- YVL E.6: design principles for pool structures housing radioactive fuel including their technical verification and monitoring.
- YVL E.11: hoisting routes, falling of heavy loads, fuel handling.

[2019-12-15 **]**

320. Removed. **[**2019-12-15 **]**

3.3 Requirements for the separation and protection of safety divisions

321. The technical requirements to be set for structures between safety divisions and other separating structures as well as for separation by distance shall be determined on the basis of the internal or external hazards examined as well as the Finnish Building Code RakMK [13] and applicable standards. **[**2019-12-15 **]**

322. Doors, hatches and penetrations between safety divisions shall be avoided. **[**2013-11-15 **]**

323. Openings in structures between safety divisions shall be kept closed and leak tight during the nuclear facility's normal operation. **[**2013-11-15 **]**

324. In rooms where safety divisions cannot be constructed as separate compartments, they shall be separated by partly separating structures or by distance. The methods of separation to

be used in these cases shall take into account the defence-in-depth concept of fire protection (Guide YVL B.8) and they shall be justified by analyses. Examples of such cases include the containment as well as the control room and the cable spaces below it. **[**2019-12-15 **]**

325. If cables that do not functionally belong to the systems of a safety division must be routed through the safety division, the cables shall be placed in separate cable ducts that fulfil the requirements for separation between safety divisions. **[**2019-12-15 **]**

326. Systems and fire loads in the safety divisions and in rooms adjacent to them and a fire considered possible in the said rooms, the release of poisonous gases, flooding and the related hydrostatic pressure, as well as other internal or external hazards considered possible shall be taken into account in the design of the separation of the safety divisions, separating structures and the boundary between a safety division and other rooms or outside areas. **[**2019-12-15 **]**

326a. In designing parts of buildings below ground level, the pressure difference between safety divisions as a result of the water level reaching ground level shall be taken into account. **[**2019-12-15 **]**

327. The effects of the failure of pipes and pressure equipment on other systems, structures or components in the safety division shall be analysed. Vapour spread as well as the effects of humidity and heat shall also be analysed. Analysis, design and protection requirements related to the consequences of pipe breaks are presented in Guide YVL E.4 “Strength analyses of nuclear power plant pressure equipment”. **[**2019-12-15 **]**

328. Protection against pressure increases caused by fractures and bursts of pipes and pressure equipment shall be provided in the rooms in question by controlled pressure relief routes, such as discharge hatches, that open on pressure increase to prevent structural damage. **[**2013-11-15 **]**

329. Technical means shall be used to prevent the spreading of internal floods, to manage water leaks and to limit leak volumes. **[**2019-12-15 **]**

329a. Flooding and the spreading of floods through the basement and ground water drainage systems of buildings shall be prevented by appropriate design solutions. **[**2019-12-15 **]**

330. The principles for separating the redundant subsystems of safety-classified systems into separate safety divisions are provided in Guide YVL B.1. **[**2013-11-15 **]**

331. Fire resistance requirements on the separating structures between safety divisions are presented in Guide YVL B.8. **[**2019-12-15 **]**

3.4 Requirements for penetrations and openings in the boundaries of safety divisions

332. The functional need for doors, hatches and penetrations in structures between safety divisions shall be justified, and they shall be designed to fulfil the leak tightness, pressure resistance, fire resistance and other environmental requirements set for structures between safety divisions. **[**2013-11-15 **]**

333. The number of doors, hatches and penetrations shall be kept to a minimum between a safety division and any other compartment containing heavy fire loads or substantial flood sources. The functional need for these doors, hatches and penetrations shall be justified. **[**2019-12-15 **]**

334. The doors between safety divisions as well as between safety divisions and other rooms or outdoor areas shall be provided with a monitoring and alarm system for relaying status information to the control room or alarm centre. Ordinary access doors shall be self-closing and self-locking. **[**2013-11-15 **]**

335. In case access is provided between safety divisions in rooms below ground level (door step level of buildings) there shall be two successive doors in place (a double door or passage via a neutral room). Both doors shall be designed to withstand the design basis water pressure for the separating structures between safety divisions. **[**2013-11-15 **]**

336. The possibility of floods spreading from one safety division to another in rooms above ground level shall be assessed. If spreading is estimated possible, there shall be two successive doors in place in access routes between safety divisions (a double door or passage via a neutral room). The hydrostatic pressure assumed in the design of the separation between safety divisions shall be taken into account in the design of both doors. **[**2019-12-15 **]**

337. Fire compartmentation-related requirements for doors, penetrations and fire dampers between safety divisions are provided in Guide YVL B.8. **[**2013-11-15 **]**

338. The nuclear security related requirements for doors and the locking system are provided in Guide YVL A.11. **[**2013-11-15 **]**

339. The requirements on how an airplane crash shall be taken into consideration in the layout design of the nuclear facility are provided in Appendix B to Guide YVL A.11. **[**2013-11-15 **]**

3.5 Demonstration of the implementation of requirements, and the documents to be submitted to STUK

3.5.1 Application for a decision-in-principle

340. The licence applicant shall submit to STUK for the review of the application for a decision-in-principle, as part of the plant description, a preliminary layout design of the site area. To be presented in connection with the preliminary layout design is a plot plan on a grid map presenting the geographical location of the facility and its various structural elements, power grid connections and sea water intake and discharge openings. A preliminary traffic plan for the site area shall be presented in connection with the preliminary layout design of the site area. **[**2019-12-15 **]**

341. The licensee shall submit to STUK for the review of the application for a decision-in-principle, as part of the plant description, the facility's preliminary layout design plan describing the location of the main components and rooms reserved for the systems, structures and components important to safety. **[**2013-11-15 **]**

3.5.2 Application for a construction licence and the construction stage

342. The licensee shall submit to STUK for the review of the construction licence application an updated layout design plan for the site area and the associated plot plan and traffic plan. **[**2013-11-15 **]**

343. The licence applicant shall submit to STUK for the review of the construction licence application a layout design plan including layout drawings. They can be presented in the system descriptions of the structures. Appendix A of Guide YVL B.1 presents the requirements for describing layout design in the system descriptions of the structures. **[**2019-12-15 **]**

343a. The licence applicant shall submit to STUK for the review of the construction licence application a 3D computer model (building information model). It shall include a preliminary presentation of buildings, and systems, structures and components to the extent necessary for assessing the layout design of the plant, space reservations, the implementation of separation requirements and protection against internal hazards. Systems, structures and components in Class ETY shall be presented extensively enough so that the significance of their positioning to systems, structures and components important to safety can be assessed. A description of the 3D computer model (information model description) shall be submitted as an appendix to the model. **[**2019-12-15 **]**

344. The licence applicant shall submit to STUK, in connection with the Preliminary Safety Analysis Report, descriptions of protection against internal hazards. [2019-12-15]

344a. The adequacy of physical separation shall be justified by analyses to be submitted to STUK in connection with the Preliminary Safety Analysis Report. [2019-12-15]

345. The licensee shall submit to STUK, with the documents submitted for the review of the construction licence application, the standards to be applied in the separation of safety divisions. [2013-11-15]

345a. The licence applicant shall maintain the documents, analyses and 3D computer model presented in requirements 342–345 during the construction of the nuclear facility. The updates to the 3D computer model shall be delivered to STUK sufficiently often in order to implement regulatory oversight. [2019-12-15]

3.5.3 Operating licence application and operation

346. The licence applicant shall submit to STUK for the review of the operating licence application the updated documents, analyses concerning the layout design as well as protection against internal hazards and the 3D computer model mentioned in requirements 342–345. [2019-12-15]

347. The adequate scope and implementation of the protection against internal hazards shall be ensured by means of facility walkdowns prior to the nuclear facility's commissioning. The requirements on facility walkdowns are given in connection with external hazards in chapter 5.10. [2019-12-15]

348. The licence applicant shall maintain the documents and analyses presented in requirements 342–345 during the operation of the nuclear facility. [2019-12-15]

349. The 3D computer model shall be updated during the operation of the nuclear facility to the extent needed for the manner of using the model, and the updates shall be submitted to STUK sufficiently often in order to implement monitoring. [2019-12-15]

4 Earthquakes

4.1 Design basis earthquake

401. A design basis earthquake shall be determined for the nuclear facility. A design basis earthquake refers to facility site bedrock surface motion used as the basis for the nuclear facility's design. The design basis earthquake shall be so defined that in the current geological conditions the anticipated frequency of occurrence of stronger bedrock motions is less than once in a hundred thousand years ($1 \cdot 10^{-5}$/year) at a median confidence level. **[**2019-12-15 **]**

401a. The methods used in the determination of the design basis earthquake shall be described and justified. The area's seismic history, regional and local geology and tectonics shall be considered in the determination. **[**2019-12-15 **]**

402. The external impact of the design basis earthquake on the nuclear facility shall be presented as a ground response spectrum. The ground response spectrum represents the maximum vibrations of a family of idealised single-degree-of-freedom damped oscillators anchored in site bedrock as a function of the natural frequencies for a given damping ratio. **[**2013-11-15 **]**

403. A ground response spectrum shall be determined for the nuclear facility site using information and measurement results describing the site as well as possible. In determining the ground response spectrum, data on earthquake locations and magnitudes collected in Finland and, if necessary, in nearby areas shall be used. Instrumental observation data and historical data obtained by sensory observations shall be used. Analyses shall take into account the various observation thresholds of different types of observation and the location-related uncertainty factors of historical observations. **[**2019-12-15 **]**

404. Acceleration induced at a facility site by an earthquake of a certain magnitude at a certain distance is evaluated by means of a ground motion prediction equation. The ground motion prediction equation shall be based on data measured in an area corresponding as well as possible to the geological conditions in the area of the facility site. The selection of the ground motion prediction equations used to determine the ground response spectrum shall be justified. **[**2019-12-15 **]**

405. The ground response spectrum used in the design shall be based on the ground response spectrum determined for the site. The ground response spectrum shall be scaled to correspond to vertical and horizontal peak ground acceleration (PGA) values at rock surfaces and, if necessary, a separate spectrum for both directions of vibration shall be given. **[**2019-12-15 **]**

406. Moved to para. 415b. **[**2019-12-15 **]**

407. The vertical and horizontal PGA values used shall be justified on a site-specific basis. The horizontal component minimum value shall be 0.1·g as prescribed in the Guides IAEA NS-G-1.6 [9] and IAEA SSG-9 [8]. The relation between the horizontal and vertical components at different acceleration and frequency levels can be determined, for example, in accordance with the Guide IAEA SSG-9 or report NUREG/CR-6728 [18]. **[**2019-12-15 **]**

408. In connection with the design basis earthquake, a hazard curve for the peak ground acceleration (PGA) of the rock surface shall be presented at least up to the recurrence time of 10^7 years for the assessment of design extension conditions (DEC) in accordance with Guide YVL B.1 and for seismic PRA. **[**2019-12-15 **]**

408a. The uncertainties of the ground response spectrum and the hazard curve determined shall be evaluated, and the uncertainties shall be taken into account in determining the ground response spectrum used in the design. **[**2019-12-15 **]**

409. The source information and methods used in determining the design basis earthquake shall be assessed and the design basis earthquake updated, as necessary, in connection with periodic safety reviews. **[**2013-11-15 **]**

4.2 Seismic design of structures and components

4.2.1 General

410. The licence applicant shall prepare a design procedure presenting the seismic design bases for seismic category S1 and S2A structures and components. **[**2019-12-15 **]**

410a. The design standards to be used shall be presented as part of the design bases – for example, ASCE/SEI 4-16 [14] and ASCE/SEI 43-05 [15] and, for complementary data, NUREG/CR-6919 [19] and NUREG/CR-6926 [17]. The design standards shall be conservatively applied in evaluating the vibrations transferred to the components by the structural framework with regard to the corresponding design criteria concerning acceleration, speed and/or displacement amplitudes. **[**2019-12-15 **]**

411. For calculations made for structures and components, the impact of the design basis earthquake can also be presented with an acceleration-time diagram constructed using the ground response spectrum. The acceleration values used and the method of their derivation shall be presented and justified. **[**2019-12-15 **]**

412. The acceleration-time diagram shall be verified by comparing the acceleration-frequency curve derived from it with the initial ground response spectrum. [2019-12-15]

413. In case the loading caused by the design basis earthquake is to be modelled by other methods than those referred to in requirements 411–412, a separate approval for the method in question shall be obtained from STUK. [2019-12-15]

414. In designing earthquake resistant nuclear facility structures and components, proven general design principles shall be considered, such as the following:

- Structures shall be designed and components located in such a way that the loads propagated by them on buildings occur as close to ground level as possible. Sharp changes in the profile of horizontal accelerations between floor levels shall be avoided.
- The shape of load-bearing structures shall be as regular and simple as possible.
- With regard to bracing structures, a building's different parts shall be so located as to avoid structural eccentricity.
- Massive buildings and equipment foundations important to safety shall be preferably founded directly on bedrock. In case of deviations from this, soil-structure interaction studies between bedrock, soil and buildings shall be required, in addition to the ground response spectrum.
- Detailed design principles provided in Guide IAEA SG NS-G-1.6 [9].

[2013-11-15]

4.2.2 Loads

415. The seismic design of structures and components assigned to seismic category S1 and S2A in accordance with Guide YVL B.2 shall consider loads generated by the design basis earthquake. To determine the loads, the floor response spectra or acceleration-time diagrams corresponding to the ground response spectrum shall be derived by dynamic analyses for the building levels housing the structures and components under examination. [2019-12-15]

415a. The design of systems, structures and components in seismic categories S1 and S2A in accordance with Guide YVL B.2 shall also take into account vibration-induced loadings following a large commercial airliner crash as well as explosion/burst pressure waves, unless it can be demonstrated, based on the failure criteria applicable, that it is unnecessary for some systems, structures and components. [2019-12-15]

415b. The floor response spectrum (spectrum and zero period acceleration of the floor) can be determined as an envelope spectrum, which in addition to seismic earthquake induced vibrations covers vibrations caused by other reasons, such as an airplane crash or explosion/burst pressure wave. **[**2019-12-15 **]**

416. In the dynamic analysis of buildings, mass, damping and stiffness characteristics essentially affecting vibration behaviour shall be modelled. The damping ratio values selected shall be justified taking into account the corresponding utilisation rate of the structural capacity (the matter is addressed in the report NUREG/CR-6919 [19]). **[**2019-12-15 **]**

416a. In the justification of the values of damping ratios, the corresponding requirement level of the structural design of the frame structure, such as the utilisation rate of the capacity and the cracking status of concrete, shall be taken into account. In the justification of the used values, the response levels presented in standards ASCE/SEI 4-16 [14] and ASCE/SEI 43-05 [15] can be followed so that requirement 410a is taken into account. Recommendations relating to the matter are also presented in report NUREG/CR-6919 [19]. **[**2019-12-15 **]**

416b. The relative damping of systems and components in seismic categories S1 and S2A that are attached to frame structures shall be assessed under the same principle as in requirement 416a, taking into account the design criteria concerning their acceleration, speed and/or displacement amplitudes. Recommendations relating to the matter are also presented in report NUREG/CR-6919 [19]. **[**2019-12-15 **]**

416c. When the standard ASCE/SEI 4-16 [14] is applied in the analysis of the effects of a design basis earthquake and other design basis external vibrations, response level 1 shall primarily be used in presumed damping values. Using response level 2 shall be separately justified. **[**2019-12-15 **]**

416d. When the standard ASCE/SEI 4-16 [14] is applied in the analysis of the effects of a DEC C earthquake and other DEC C external vibrations, response level 2 shall primarily be used in presumed damping values. Using response level 3 shall be separately justified. **[**2019-12-15 **]**

416e. No analysis of the dynamic interaction between buildings and the bedrock is required when massive buildings and equipment foundations important to seismic safety are founded directly on bedrock in accordance with requirement 414. Otherwise, the analysis in question shall be performed. **[**2019-12-15 **]**

417. Uncertainty factors relating to source information and spectral peaks at natural frequencies shall be considered. Applicable instructions are provided in Guide YVL E.4 and the Guide IAEA NS-G-1.6 [9]. **[**2013-11-15 **]**

418. Removed. **[**2019-12-15 **]**

419. The highest horizontal and vertical acceleration values arising at the component locations shall be used in the dimensioning of individual structures and components. Displacement amplitudes between buildings or building sections shall be considered in case they generate significant loads. The horizontal acceleration component of each object is chosen according to its structurally weakest direction, whenever this can be established. In other cases, components will be chosen for two orthogonal horizontal directions (the object's principal directions). These components can be combined in accordance with the standard ASCE 4-16 [14] or EN 1998 [16], for example. **[**2019-12-15 **]**

420. Other simultaneous loads shall be added to the loads generated by the design basis earthquake. They include loads from normal operation and loads simultaneously generated by possible anticipated operational occurrences caused by an earthquake. The design basis earthquake need not be considered simultaneously with the loading generated by a postulated accident condition when an earthquake’s consequent effects have been prevented by corresponding earthquake resistance of structures and components. **[**2013-11-15 **]**

421. In so far as the failure of S2B seismic category structures and components is acceptable in such a way that additional loads are exerted on structures and components in a higher seismic category during an earthquake, the additional loads in question can be taken into account in corresponding floor response spectra. Seismically induced hydraulic burst pressures generated by S2B category pressure vessels, for example, can be included in the floor response spectra of the affected area. **[**2019-12-15 **]**

422. Combinations of earthquake loads and other loads shall be examined in dimensioning and strength calculations. Load combinations shall be determined in the requirement specifications in such a way that extreme load combinations are addressed. Guide YVL B.1 sets forth general requirements for requirement specifications. Guidance on requirement specifications for structures and components concerning various fields of technology are presented in the E series of the YVL Guides. **[**2019-12-15 **]**

423. The partial safety coefficients of loads and materials shall be determined in accordance with approved requirement specifications for structures and components. As the partial safety

coefficient of earthquake loads, the value 1.0 shall be used, unless another justified value is presented case-specifically. **[**2019-12-15 **]**

4.2.3 Dimensioning principles

424. In the design procedure in accordance with requirement 410, the licensee shall present the dimensioning principles for implementation of the earthquake resistance of different types of structures and components including their methods of support, fixing and protection. In addition, a plan shall be presented for demonstration of compliance with the requirements as regards the functioning of different types of structures and components during earthquake conditions. **[**2019-12-15 **]**

425. System, structure and component-specific seismic design as well as the dimensioning calculations required to take into account seismic loads in compliance with chapter 4.2.2 shall be presented in the design documents of structures and components. **[**2013-11-15 **]**

426. The dimensioning calculations of seismic category S1 and S2A pressure equipment, other mechanical structures and components, and particularly any related supports and fixings shall examine the loads caused by the design basis earthquake. Requirements for pipe supports and fixings are presented in Guide YVL E.3 "Pressure vessels and piping of a nuclear facility". **[**2019-12-15 **]**

427. In the suitability analyses of seismic category S1 and S2A electrical and I&C equipment, dimensioning calculations for supports and fixings subjected to substantial loads during earthquakes shall be presented. **[**2013-11-15 **]**

4.3 Demonstration of earthquake resistance

4.3.1 General

428. The licence applicant shall demonstrate that seismic category S1 and S2A structures and components meet the requirements for earthquake resistance established in chapter 4.2. Demonstration may be in the form of analyses, tests, up-to-date empirical assessments or combinations thereof. Such demonstrations or corresponding result documentation are to be presented in connection with STUK’s inspections required for the types of structure or component in question before commissioning. The specification of a seismic category-dependent requirement level for the functionality and integrity of systems, structures and components is discussed in Guide YVL B.2. Analyses and experimental methods are addressed in more detail in the Guide IAEA SG NS-G-1.6 [9]. **[**2019-12-15 **]**

428a. Earthquakes stronger than the design basis earthquake shall be considered design extension conditions (DEC C) in accordance with Guide YVL B.1. This can be done using the seismic fragility curves of equipment needed for bringing the plant to a safe state. **[**2019-12-15 **]**

429. Guide YVL A.8 “Ageing management of a nuclear facility” presents requirements for the handling of earthquake resistance in ageing management. **[**2019-12-15 **]**

430. The probabilistic risk assessment (PRA) shall be applied to demonstrate that the implementation of seismic design is acceptable from the viewpoint of the nuclear facility’s overall safety. **[**2013-11-15 **]**

4.3.2 Analyses

431. Guides YVL E.4 “Strength analyses of nuclear power plant pressure equipment”, YVL E.6 “Buildings and structures of a nuclear facility”, YVL E.8 “Valves of a nuclear facility”, YVL E.9 “Pumps of a nuclear facility” and YVL E.10 “Emergency power supplies of a nuclear facility” describe analyses that demonstrate the earthquake resistance of pressure equipment and the steel containment structure for design basis earthquake induced loads. **[**2019-12-15 **]**

4.3.3 Tests and combining tests with analyses

432. The earthquake resistance of components and/or their parts that cannot be analysed with adequate reliability shall be experimentally demonstrated. **[**2019-12-15 **]**

433. In combining analyses and tests it shall be presented how the testing combinations to be determined correspond to the design assumptions and how the fulfilment of seismic resistance requirements is demonstrated. **[**2013-11-15 **]**

4.3.4 Empirical assessments

434. The earthquake resistance of a component or structure can be assessed based on an earlier report prepared for a corresponding item in conformity with chapter 4.3.2 or 4.3.3. Commensurate up-to-date experiences of earthquakes that have occurred may also be utilised. **[**2013-11-15 **]**

4.3.5 Electrical and I&C equipment

435. The type tests of electrical and I&C equipment shall include sufficient requirements for endurance of mechanical stress in comparison to the design basis earthquake. The durability of inter-component cabling and connections shall be demonstrated by analyses and/or tests. **[**2013-11-15 **]**

4.3.6 Equipment aggregates

436. Aggregates comprising electrical and I&C equipment, mechanical components, piping and equipment foundations shall be evaluated in such a way that, in addition to the seismic qualification of individual parts of the equipment aggregate, interactions between these parts are also taken into account. **[**2019-12-15 **]**

437.Reports on equipment aggregates shall be prepared describing how their seismic resistance has been demonstrated by qualification of its individual parts and analysis and/or evaluation of the aggregate. **[**2019-12-15 **]**

4.3.7 Safe shutdown of the nuclear power plant

438. The nuclear power plant's safe shutdown after an earthquake shall be based on unambiguous procedures. The pre-shutdown vibration acceleration level and the method of its establishment are presented in the procedures. Shutdown procedures shall be based on appropriately qualified category S1 systems, structures and components. **[**2019-12-15 **]**

438a. The nuclear facility shall have instructions describing the inspections and other measures to be carried out after an earthquake, their dependency on the intensity of the earthquake (acceleration levels at the site) and the conditions for continued operation after the earthquake. **[**2019-12-15 **]**

439. Seismic monitoring shall be performed at the nuclear power plant based on dynamic frame structure properties corresponding to design basis earthquake acceleration levels, as well as the planned location at the facility of systems and components used for a safe shutdown. Requirements for sensors are given in requirements 445–449. **[**2019-12-15 **]**

4.3.8 The use of PRA to support earthquake resistance design

440. The most important initiating events due to earthquake-induced failures and component malfunctions shall be incorporated in the PRA to be drawn up in accordance with Guide YVL A.7. The seismic PRA shall, irrespective of seismic classification, consider components plus their supports, as well as experiences of the susceptibility to failure of different types of structures and components in actual earthquakes of varying intensities. Failure sequences attributable to the simultaneous dynamic loading of large equipment aggregates and the possibility of common cause failures shall be analysed. **[**2013-11-15 **]**

441. PRA analyses shall demonstrate systems significant for safe shutdown and determine the HCLPF estimates for corresponding fragilities of components and structures. The fragility estimates shall be based on 3D analyses of structural framework and actual fixing methods in such a way that all directions of vibration have been appropriately evaluated. **[**2019-12-15 **]**

4.4 Earthquake resistance control during construction and operation

442. Earthquake induced loads shall be considered in the construction plans of seismic category S1 and S2A structures and components. Earthquake resistance related requirements are provided in chapters 4.2 and 4.3. **[**2013-11-15 **]**

443. The scope and implementation of the seismic design of structures and components shall be ensured by facility walkdowns prior to the nuclear facility's commissioning. The inspections shall be carried out by competent technical experts and under STUK's oversight. Experts participating in the facility walkdowns shall acquaint themselves with the seismic design documents. The facility walkdowns include verification of the appropriateness of seismic support and fixing solutions as well as identification and assessment of potential seismic risk factors requiring further measures. **[**2019-12-15 **]**

443a. The need for a walkdown and its necessary extent shall be assessed. If necessary, the walkdown shall also be carried out after extensive modifications and in connection with the periodic safety review, the seismic PRA and its updates. **[**2019-12-15 **]**

444. A plan for facility walkdowns shall be drawn up. Approved construction plans as well as the seismic PRA and fragilities shall be taken into account in the planning, among other documents and information. A facility walkdown report shall be drawn up describing walkdown implementation and any detected non-conformances detected affecting safety. **[**2013-11-15 **]**

445. An essential part of the seismic monitoring system is composed of sensors. The appropriateness of the seismic sensors shall be demonstrated in connection with the procedures for safe shutdown specified in chapter 4.3.7. **[**2019-12-15 **]**

446. Seismic sensors shall be located in the bedrock of the nuclear facility site to verify the vibration data and assumptions used in defining the design basis earthquake. Furthermore, at least one reactor building of each type having similar seismic characteristics shall have at least two sensors one of which is attached to the base plate and the other above the building level housing seismic category S1 structures and components. **[**2013-11-15 **]**

447. The sensors shall be suitable for design-basis acceleration and frequency values. The sensors shall be capable of recording reliably and at sufficiently short intervals the accelerations of earthquakes in vertical direction and in two mutually perpendicular horizontal directions. **[**2013-11-15 **]**

448. After a significant earthquake, sensor recordings shall be available when assessing the necessary scope of inspections of seismic category S1 and S2A structures and components as well as the prerequisites for continued plant operation. **[**2013-11-15 **]**

449. Records yielded by seismic sensors and the availability of components shall be regularly checked during plant operation. Observations exceeding the set threshold values shall be recorded as time series in such a way that they can be used to conduct the appropriate analyses later on. Procedures shall be specified for operations and they shall be included in periodic inspection programmes. **[**2013-11-15 **]**

4.5 Demonstration of the implementation of requirements, and the documents to be submitted to STUK

450. The licence applicant shall present in the nuclear facility’s Preliminary and Final Safety Analysis Reports the design basis earthquake to be used for seismic design. The Preliminary and Final Safety Analysis Reports or related topical reports shall include a description of methods and input data used in the determination of the design basis earthquake as well as the general principles to be followed in the seismic design of the facility. **[**2019-12-15 **]**

451. Research and analyses to determine and reassess the design basis earthquake shall be traceable, and the related source information, result documentation and reference material shall be archived. The methods and procedures of research and analysis as well as the organisations and persons involved and their tasks shall be described. The documentation in question shall be archived for the entire life cycle of the nuclear facility and be accessible to

STUK, when necessary. **[**2013-11-15 **]**

452. The licensee shall, in the documents submitted to STUK for the review of the nuclear facility's construction licence application, present for approval the design procedure and the information concerning the seismic design bases referred to in requirement 410. **[**2019-12-15 **]**

453. Plans, analyses and test plans to demonstrate the seismic resistance of structures and components, as well as result documentation, shall be presented to STUK in documents to be submitted in accordance with Guides YVL E.6, YVL E.7, YVL E.8, YVL E.9, YVL E.10 and YVL E.11. **[**2013-11-15 **]**

454. Seismic test plans shall be submitted to STUK sufficiently early for STUK to be able to oversee the tests. Test reports shall be submitted to STUK for information for the approval review of a corresponding final suitability assessment or construction plan. **[**2019-12-15 **]**

455. The effects of non-conformances occurring during manufacturing, construction and installation on seismic safety shall be presented in summaries of justification or final suitability analyses in accordance with the E series YVL Guides. **[**2019-12-15 **]**

456. The licence applicant/licensee shall submit to STUK for approval the facility walkdown plan referred to in requirement 444 before the facility walkdowns and the facility walkdown report before the commissioning of the facility or a plant modification. The reports pertaining to the equipment aggregates referred to in requirement 437 shall be submitted to STUK for approval before the facility walkdown. **[**2019-12-15 **]**

457. The requirements for the submission of a seismic PRA during the different licensing phases are given in Guide YVL A.7. **[**2013-11-15 **]**

5 Other hazards external to the nuclear facility

5.1 General requirements for protection against external hazards

501. To be taken into account in the design of the nuclear facility's systems, components and structures are natural phenomena assessed as possible at the facility site, as well as other external hazards affecting at the facility. **[**2013-11-15 **]**

502. The licence applicant shall draw up a report on the external hazards considered in the facility design and the methods of preparing against them. The report shall describe the external conditions and events postulated in connection with normal operation and anticipated operational occurrences and accidents. **[**2019-12-15 **]**

503. The following general principles shall be followed in selecting design values for systems, structures and components important to safety that pertain to external events and conditions:
a. Design values shall include an adequate margin in relation to the peak values measured at the facility site and in its vicinity.
b. In determining design values, at least phenomena whose estimated probability of occurrence at the site over one year is higher than 10^{-5} at a median confidence level shall be considered.
c. If it can be reliably demonstrated that an external event or condition does not affect the probability of occurrence of a certain postulated accident, the design value regarding the external event or condition in question can be chosen for the systems required for the management of the postulated accident so that its maximum probability of exceedance in one year is 10^{-4}.
d. The safety significance of systems, structures and components important to safety shall be considered in selecting their design values, and the adequacy of the design values shall be justified. **[**2019-12-15 **]**

504. In addition to the above, to be ensured in selecting the sea water level design value is that the design value is higher than
a. the water level estimated possible at the site at a median confidence level once in a hundred years added with two metres and a site-specifically evaluated wave margin, and
b. the extreme level equivalent to the least favourable combination of factors evaluated in accordance with requirement 515 added with a site-specifically evaluated wave margin.
[2013-11-15 **]**

505. To be taken into account in selecting design values as well as in applying the redundancy and separation principles (YVL B.1) are dependencies affecting the simultaneous occurrence of

external events. A hazard arising from unlawful action need not be taken into account as a load simultaneously with external hazards caused by exceptional natural phenomena or regular human activities. [2013-11-15]

506. Exceptional external events and conditions with an estimated frequency of occurrence less than 10^{-5}/year shall be considered design extension conditions (DEC C events). The licence applicant/licensee shall present and justify external phenomena considered as DEC C events. In selecting the phenomena and their magnitude, the limit values for core damage and large release frequency presented in Guide YVL A.7 shall be taken into account. To be incorporated in the DEC C design values is a justified marginal in relation to the observed maximum values of the phenomena analysed. [2019-12-15]

506a. The nuclear facility shall have the necessary measurement instruments for monitoring weather phenomena, the sea water level and the temperature. The measurement results shall be recorded so that they can later be used for assessing events and external hazards at the plant site. [2019-12-15]

507. The nuclear facility shall have in place procedures for the monitoring of external hazards affecting the safety of the facility, and for operation during events involving a clearly increased hazard of an external event affecting the safety functions, and in conditions where an external event that has compromised implementation of the safety functions. [2013-11-15]

507a. The nuclear facility shall have instructions describing the inspections and other measures to be carried out after exceptional weather phenomena and other external events that affect safety and the conditions for continued operation. [2019-12-15]

508. The adequacy of design values for external events and conditions shall be verified by means of probabilistic risk assessment. The probabilistic studies shall take into account interdependencies between natural phenomena. Guide YVL A.7 presents the limits for core damage frequency and large release frequency, which also include the external hazard contribution. [2019-12-15]

5.2 Hazard curve

509. To determine the nuclear facility's design bases, the occurrence frequencies of external events affecting plant safety shall be assessed. A hazard curve shall be drawn up for phenomena for which measurements time series are available; the curve shall present the exceedance frequency of the parameter value representing the phenomenon. **[**2013-11-15 **]**

510. If a hazard curve needs to be determined for a recurrence period exceeding the period covered by the measurement results, fitting of an extreme value distribution to the time series shall be employed. The mathematical form of the extreme value distribution shall be selected with the aim that the final outcome will not be non-conservatively sensitive to the effects of individual measurement results. **[**2013-11-15 **]**

511. The uncertainties of hazard curves determined for the nuclear facility site shall be evaluated and uncertainties shall be taken into account in determining design values. For evaluation of uncertainties, hazard curves based on time series measured in several localities in the vicinity of the nuclear facility site shall be analysed. Adequate utilisation of national measurement data and expertise shall be ensured in determining hazard curves and estimating uncertainties. **[**2013-11-15 **]**

5.3 Meteorological phenomena

512. The design of the nuclear facility shall take into consideration the exceptional meteorological phenomena and comparable natural phenomena assessed as possible at the facility site. At least the following phenomena shall be considered in the design:

- high and low atmospheric temperature
- high winds including tornadoes and downbursts
- high and low air pressure as well as fluctuations of air pressure
- rain, snow, hail
- freezing rain and splashes from sea or watercourses
- atmospheric moisture, fog, mist, rime ice
- lightning
- drought
- electromagnetic interference caused by solar flares.

[2019-12-15 **]**

513. Design solutions shall ensure that freezing, snow or other events causing clogging do not prevent cooling air supply to systems important to safety or combustion air supply to emergency power engines. [2013-11-15]

5.4 High and low sea water level and external floods

514. Provisions for abnormally high and low sea water levels shall be taken in the design of a nuclear facility located by the sea. The wave height evaluated as possible at the site shall be taken into account in the design. Furthermore, the hazard to the nuclear facility from the flooding of rivers, lakes and other potential sources of flooding in the nuclear facility's vicinity shall be examined and, where necessary, taken into account in the facility design. [2013-11-15]

515. Hazard curves in accordance with chapter 5.2 shall be drawn up for high and low sea water levels. In addition to a statistical approach, factors affecting sea water level shall be specified, and the maximum impact of every identified factor shall be evaluated, along with the extreme level corresponding to the least favourable combination of factors. As factors affecting sea water level, at least the total volume of water in the Baltic Sea, air pressure, wind, seiche and tide shall be examined. The analysis shall include the estimated change in the water level of oceans and the uncertainties arising from it during the nuclear facility's design lifetime. [2019-12-15]

516. The design of the nuclear facility's buildings and systems shall reliably prevent sea water from flooding the facility via drainage or open systems located below door step level. The design shall also cover conditions during maintenance as well as sea water pipe breaks during exceptionally high sea water levels. [2013-11-15]

517. The flooding of facility rooms due to exceptionally high water level of sea or other waterbody as well as exceptional precipitation shall be analysed as external floods. Flooding due to external sources in consequence of pipe breaks, malfunctions and human error shall be included in the examination. Potential flood routes shall be identified. The analyses shall include at least doors, hatches, penetrations, drainage systems as well as sea water pumping station pools and sea water discharge routes. [2019-12-15]

5.5 Ice and frazil ice

518. Ice conditions at the nuclear facility site shall be established – in particular, the loadings caused by ice movement and pack ice to water intake structures and other structures near the shoreline. The design shall take into account ice-induced loadings. **[**2019-12-15 **]**

519. The hazard posed by the blockage of sea water intakes by frazil ice and other forms of ice shall be evaluated and reduced as far as possible by appropriate design solutions. The solutions chosen shall be presented and their adequacy justified in the Preliminary and Final Safety Analysis Reports. **[**2013-11-15 **]**

520. The nuclear facility's sea water systems shall be equipped with suitable temperature measurements to identify the hazard posed by frazil ice. During the nuclear facility's operation, the sea water freezing point shall be determined at regular intervals under conditions favourable for the formation of frazil ice (low atmospheric temperature and sea without ice cover). **[**2013-11-15 **]**

5.6 Other external events endangering seawater and raw water supply

521. The design of sea water intake and outlet structures as well as sea water systems shall apply design solutions where the possibility of a blockage is low. Guide YVL B.1 also presents requirements for preparing for the loss of the final heat sink. **[**2019-12-15 **]**

522. The following matters, among others, shall be examined as events causing the danger of a blockage: water-carried impurities entering the sea water systems, such as algae, other plant life and organisms and their remains, as well as oil and other fouling chemicals. In the design and operation of the sea water systems provisions shall also be taken to protect against growth of plant life and organisms, such as mussels, in the seawater systems. **[**2013-11-15 **]**

523. The sea water systems shall be equipped with suitable cleaning systems to handle impurities. **[**2013-11-15 **]**

524. The cleanliness of the nuclear facility's sea water supply at intake shall be monitored. Monitoring shall be enhanced during conditions involving a higher than normal risk of impurities entering the sea water systems. **[**2013-11-15 **]**

525. The safety significance of disturbances in the supply of fresh raw water and the water treatment system shall be assessed. Protection shall be provided against disturbances in the supply of raw and treated water to ensure that the accomplishment of safety functions is not endangered **[**2013-11-15 **]**

5.7 External fires and explosions

526. Nuclear facility design shall take into account explosion pressure waves external to the facility buildings induced by a chemical explosion pressure wave or a burst pressure wave. The design bases for a pressure wave caused by the bursting of pressure equipment belonging to the facility shall be based on analyses. The requirements pertaining to the magnitude of a design basis external explosion/burst pressure wave attributable to other reasons are given in Guide YVL A.11. **[**2019-12-15 **]**

527. The effects of heat and smoke arising from forest fires and wildfires as well as other fires external to the facility shall be taken into account in the nuclear facility's design. **[**2013-11-15 **]**

528. The requirements for protection against flammable, toxic and asphyxiating gases are provided in Guides YVL B.1 and YVL A.11. **[**2013-11-15 **]**

529. Requirements for the facility's fire protection systems and operative fire fighting and rescue preparedness are provided in Guide YVL B.8. **[**2013-11-15 **]**

5.8 Electromagnetic interference

530. The requirements for protection against electromagnetic interferences are provided in Guides YVL B.1, YVL E.7 and YVL A.11. **[**2013-11-15 **]**

5.9 Hazards caused by flora and fauna

531. Access into equipment rooms of rodents and other animals endangering cables and electrical equipment shall be reliably prevented. **[**2013-11-15 **]**

532. Access of birds, swarms of insects and other animals into ventilation and air-conditioning systems, as well as into the combustion and cooling air systems of emergency power engines, shall be prevented. **[**2013-11-15 **]**

5.10 Demonstration of the implementation of requirements, and the documents to be submitted to STUK

533. Research and analyses to determine and reassess the design bases for external events shall be traceable, and the related source information, test results and reference material shall be archived. The methods and procedures of research and analysis as well as the organisations and persons involved, along with their tasks, shall be described to the extent practicable. The documentation in question shall be archived for the entire life cycle of the nuclear facility and be accessible to STUK, where necessary. **[**2019-12-15 **]**

5.10.1 Application for a decision-in-principle

534. The documents to be submitted to STUK for review of a decision-in-principle application shall include an overview of the meteorological, hydrological and geological conditions at the plant site, as well as of human actions that may affect the safety of the facility and the implementation of emergency preparedness measures. [2013-11-15]

535. The documents to be submitted to STUK for the review of a decision-in-principle application shall include an overview of the intended protection against external events that are assessed as possible at the facility site. [2013-11-15]

5.10.2 Application for a construction licence, construction stage and plant modifications

536. The documents to be submitted to STUK for the review of a construction licence application shall include detailed information of the meteorological, hydrological and geological conditions and ice conditions at the plant site, as well as of human actions that may affect the safety of the facility and the implementation of emergency preparedness. [2019-12-15]

537. The licensee shall submit to STUK for the review of the construction licence application a description in accordance with requirement 502 of the protection provided against external hazards. It may be included in the Preliminary Safety Analysis Report or in a separate document (topical report). [2013-11-15]

538. The design values pertaining to external events and other design bases shall be given and the design solutions to protect against external events shall be presented in the system descriptions, conceptual design plans of plant modifications and pre-inspection documents. [2019-12-15]

539. The adequacy of design solutions to protect against external events shall be justified by analyses or tests if the reliability of the analysis methods cannot be demonstrated. STUK shall be afforded the possibility of overseeing the tests. Test plans shall be submitted to STUK for information sufficiently early on before the tests. Analyses of electrical and I&C equipment as well as test reports shall be submitted to STUK for the approval review of final suitability assessments. Analyses of mechanical components and structures shall be submitted with construction plans to STUK or an authorised inspection body in accordance with the division of inspection responsibilities set forth in the E Series of the YVL Guides, and the test reports shall be submitted to STUK or an authorised inspection body before the commissioning inspections of the components or structures. [2019-12-15]

5.10.3 Application for an operating licence and commissioning of plant modifications

540. The documents to be submitted to STUK for the operating licence review shall include the data referred to in requirement 536 in updated form, and the report on protection against external hazards referred to in requirement 502 in updated form. **[**2013-11-15 **]**

541. The adequate scope and implementation of the protection against internal and external hazards shall be ensured by means of facility walkdowns prior to the nuclear facility's commissioning. The need for a facility walkdown shall be assessed in connection with plant modifications. If necessary, the facility walkdown shall be carried out before the commissioning of the plant modification. Facility walkdowns shall be carried out by competent technical experts, and STUK shall be afforded the possibility of overseeing them. The experts participating in facility walkdowns shall familiarise themselves with the design documents. The requirements for facility walkdowns carried out to assess seismic design are provided in chapter 4. **[**2019-12-15 **]**

542. A facility walkdown plan shall be prepared and submitted to STUK for information for the review of the nuclear facility's first operating licence application and before the commissioning of the plant modifications of an operating nuclear facility. A facility walkdown report shall be drawn up describing walkdown implementation and observations affecting safety. The report shall be submitted to STUK for information sufficiently early on before the commissioning of the nuclear facility or the plant modification. An assessment of the necessary measures based on the observations made during the walkdown shall be presented in the report. **[**2019-12-15 **]**

542a. The design values and other design bases pertaining to external events and the design solutions to protect against external events shall be presented in the conceptual design plans concerning plant modifications and the pre-inspection documents. The requirements for updating the Final Safety Analysis Report after implementing changes are presented in Guides YVL A.1 and YVL B.1. **[**2019-12-15 **]**

6 Regulatory oversight by the Radiation and Nuclear Safety Authority

601. During the decision-in-principle phase, STUK reviews the reports attached to the application for a decision-in-principle in accordance with Section 24(2) of the Nuclear Energy Decree (161/1988) as regards internal and external hazards, as well as the layout design reports referred to in requirements 340 and 341. The review's main results are presented in STUK's preliminary safety assessment pertaining to the application. **[**2019-12-15 **]**

602. In reviewing the construction licence application, STUK reviews, as regards internal and external hazards as well as layout design, the Preliminary Safety Analysis Report, reports on protection against internal and external hazards, as well as the reports on layout design referred to in requirements 342–345. The review's main results are presented in STUK's safety assessment pertaining to the application. Detailed review findings and remarks are presented to the construction licence applicant in a STUK decision. **[**2019-12-15 **]**

603. During the nuclear facility's construction, STUK conducts inspections in accordance with a pre-determined programme (construction inspection programme RTO) and ensures in connection with the review of plans for systems, structures and components that the requirements for protection against internal and external hazards and layout design have been taken into account in the plans. **[**2013-11-15 **]**

604. At the licensee's request, STUK reviews facility site-specific PGA values and ground response spectra for the design basis earthquake. The approval justifications include corresponding sensitivity analyses depicting the design criteria assessment methods and their essential computation parameters with uncertainties. **[**2019-12-15 **]**

605. Removed. **[**2019-12-15 **]**

606. When reviewing the construction plans and suitability analyses, STUK also reviews the provisions for internal and external hazards and the fulfilment of the requirements concerning layout design. **[**2019-12-15 **]**

607. STUK oversees, to the necessary extent, the tests to demonstrate the resistance of the nuclear facility's systems, structures and components against internal hazards, earthquakes and other external hazards. **[**2013-11-15 **]**

608. When reviewing the operating licence application, STUK reviews, as regards internal and external hazards as well as layout design, the Final safety Analysis Report submitted as an attachment to the operating licence application, the final reports on layout design and provisions against internal hazards, as mentioned in requirement 346, and the documents in accordance

with requirement 540. The review's main results are presented in STUK's safety assessment pertaining to the application. Detailed review findings and remarks are presented to the operating licence applicant in a STUK decision. **[**2019-12-15 **]**

609. During the nuclear facility's operation, STUK reviews and, based on the review, accepts conceptual design plans, pre-inspection documents and changes to the Final Safety Analysis Report that are prepared for system modifications. During the reviews, provisions against internal and external hazards as well as layout design are also reviewed. **[**2013-11-15 **]**

610. During the nuclear facility's operation, STUK conducts plant operation-related inspections in accordance with a pre-determined programme (operational inspection programme KTO). STUK also assesses the sufficiency of the provisions for internal and external hazards in connection with the inspection of the probabilistic risk assessment. **[**2019-12-15 **]**

611. Requirements pertaining to operating licence applications, as set forth in Guide YVL A.1, apply to periodic safety assessment implemented during an operating licence period. **[**2019-12-15 **]**

7 Removed (Appendix An example of an acceptable spectrum)

A01. Removed. **[**2019-12-15 **]**

8 References

1. Nuclear Energy Act (990/1987). **[**2013-11-15 **]**

2. Nuclear Energy Decree (161/1988). **[**2013-11-15 **]**

3. Radiation and Nuclear Safety Authority Regulation on the Safety of a Nuclear Power Plant (STUK Y/1/2018). **[**2019-12-15 **]**

4.Radiation and Nuclear Safety Authority Regulation on Security in the Use of Nuclear Energy (STUK Y/3/2016). **[**2019-12-15 **]**

5.Radiation and Nuclear Safety Authority Regulation on the Emergency Arrangements of a Nuclear Power Plant (STUK Y/2/2018). **[**2019-12-15 **]**

6. Radiation and Nuclear Safety Authority Regulation on the Safety of Disposal of Nuclear Waste (STUK Y/4/2018). **[**2019-12-15 **]**

7. Protection against Internal Hazards other than Fires and Explosions in the Design of Nuclear Power Plants, Safety Guide, Safety Standards Series No. NS-G-1.11, IAEA, 2004. **[**2019-12-15 **]**

8. Seismic Hazards in Site Evaluation for Nuclear Installations, SSG-9, IAEA, 2010. **[**2013-11-15 **]**

9. Seismic Design and Qualification for Nuclear Power Plants, Safety Standards Series No. NS-G-1.6, IAEA, 2003. **[**2013-11-15 **]**

10. Evaluation of Seismic Safety for Existing Nuclear Installations, Safety Standards Series No. NS-G-2.13, IAEA, 2009. **[**2013-11-15 **]**

11. External Events Excluding Earthquakes in the Design of Nuclear Power Plants, Safety Standards Series No. NS-G-1.5, IAEA, 2003. **[**2013-11-15 **]**

12. Meteorological and Hydrological Hazards in Site Evaluation for Nuclear Installations, Safety Standards Series No. SSG-18, IAEA, 2011. **[**2013-11-15 **]**

13. The National Building Code of Finland (RakMK), including i.a. the decrees of the Ministry of the Environment concerning construction, such as the Decree of the Ministry of the Environment on Fire Safety of Buildings (848/2017). **[**2019-12-15 **]**

14. Seismic Analysis of Safety-Related Nuclear Structures, Standard ASCE/SEI 4-16, American Society of Civil Engineers, 2017. (Note, the standard is intended for use in connection with the standard ASCE/SEI 43-05) **[**2019-12-15 **]**

15. Seismic Design Criteria for Structures, Systems, and Components in Nuclear Facilities, Standard ASCE/SEI 43-05, American Society of Civil Engineers, 2005. **[**2013-11-15 **]**

16. Eurocode 8: Design of Structures for Earthquake Resistance, EN 1998, 2004. **[**2013-11-15 **]**

17. Evaluation of the Seismic Design Criteria in ASCE/SEI Standard 43-05 for Application to Nuclear Power Plants (NUREG/CR-6926), U.S. Nuclear Regulatory Commission, Washington, DC, 2007. **[**2013-11-15 **]**

18. Technical Basis for Revision of Regulatory Guidance on Design Ground Motions: Hazard- and Risk-Consistent Ground Motion Spectra Guidelines, NUREG/CR-6728, U.S. Nuclear Regulatory Commission, Washington, DC, 2001. **[**2013-11-15 **]**

19. Recommendations for Revision of Seismic Damping Values in Regulatory Guide 1.61, NUREG/CR-6919, U.S. Nuclear Regulatory Commission, Washington, DC, 2006. **[**2013-11-15 **]**

20. Safety of Nuclear Power plants: design, Specific Safety Requirements. IAEA Safety Standards Series no. SSR-2/1 (Rev. 1), 2016. **[**2019-12-15 **]**

21. WENRA Reactor Safety Reference Levels, Western European Nuclear Regulators' Association, Reactor Harmonization Working Group, January 2014. **[**2019-12-15 **]**

Definitions

Initiating event

Initiating event shall refer to an identified event that leads to anticipated operational occurrences or accidents.

Fragility curve (seismic)

Fragility curve (seismic) shall refer to a curve that describes the probability of component or structure failure as a function of ground acceleration.

Physical separation

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. (STUK Y/1/2018)

Hazard curve

Hazard curve shall refer to a curve that describes the frequency of exceedance (probability per year, for example) of a particular parameter value. A hazard curve can be presented for multiple statistical confidence levels.

HCLPF (High confidence of low probability of failure) capacity

HCLPF (High confidence of low probability of failure) capacity shall refer to a ground acceleration value that results in a component or structure damage probability of 5% at a confidence level of 95%.

Ventilation

Ventilation shall refer to maintaining and improving the quality of indoor air by circulating it; in some rooms of a nuclear facility, ventilation systems are also used to limit the spread of radioactive substances.

Air conditioning systems

Air conditioning systems shall refer to systems designed to manage the purity, temperature, humidity and movement of indoor air by treating supply air or circulating air.

System

System shall refer to a combination of components and structures that performs a specific function.

Floor response spectrum

The floor response spectrum describes the maximum vibrations of single-degree-of-freedom oscillators with various natural frequencies and a particular damping ratio positioned in a certain area of a building. The calculation of the floor response spectrum involves an analysis, based on the dynamic behaviour of the frame structure, of the transfer of the vibration from an earthquake or other external source to the part of the building under examination where it strains systems, structures, and components. Depending on the design basis, the floor response spectrum is an acceleration, velocity or displacement spectrum or an energy response spectrum in accordance with their combination.

Peak ground acceleration (PGA)

Peak ground acceleration (PGA) shall refer to the highest acceleration of ground motion due to an earthquake.

Ground response spectrum

Ground response spectrum shall refer to a method of presentation that describes the maximum vibrations of single-degree-of-freedom oscillators assumed to be anchored in site bedrock at various natural frequencies and using a particular damping ratio.

Redundancy

Redundancy shall refer to the use of alternative (identical or diverse) structures, systems or system components, so that any one of them can perform the required function regardless of the state of operation or failure of any other.

Anticipated operational occurrence

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. (Nuclear Energy Decree 161/1988)

Postulated accident

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 facility 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. (Nuclear Energy Decree 161/1988)

Design extension condition

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.

(Nuclear Energy Decree 161/1988)

Accident

Accident shall refer to postulated accidents, design extension conditions and severe accidents. (Nuclear Energy Decree 161/1988)

Defence in depth approach to fire protection

The aim of the defence in depth approach to fire protection is to prevent the breakout of fires, detect and extinguish fires quickly, prevent the development and spreading of fires, and limit their effects so that the safety functions can be performed reliably irrespective of the effects.

Internal events

Internal events shall refer to events occurring inside a nuclear facility that may have an adverse effect on the safety or operation of the plant.

Damping ratio

Damping ratio shall refer to the ratio of the actual damping coefficient (the ratio of the viscous damping force to velocity) for a single-degree-of-freedom oscillator to the critical damping coefficient (the maximum value of the damping coefficient at which periodically attenuating oscillation is possible). The damping ratio is usually expressed as a percentage.

Design basis earthquake

Design basis earthquake shall refer to facility site ground motion used as the basis for the nuclear facility's design. The design basis earthquake shall be so defined that in the current geological conditions the anticipated frequency of occurrence of stronger ground motions is not more often than once in a hundred thousand years (1×10^{-5}/a) at median confidence level. A design basis earthquakes are represented using peak ground acceleration and ground response spectra.

Probabilistic Risk Assessment, PRA

Probabilistic risk assessment (PRA) shall refer to quantitative assessments of hazards, probabilities of event sequences and adverse effects influencing the safety of a nuclear power plant. (Nuclear Energy Decree 161/1988)

Functional isolation

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. (STUK Y/1/2018)

System/structure/component important to safety

System/structure/component important to safety shall refer to systems, structures or components in safety classes 1, 2 and 3 and systems in class EYT/STUK.

Safety system

Safety system shall refer to a system that has been designed to execute safety functions.

Safety divisions

Safety division shall refer to premises, physically separated from one another, and the components and structures contained therein, where one of the redundant parts of each safety system is placed.

Safety-classified system/structure/component

Safety-classified system/structure/component shall refer to a system, structure or component assigned to safety classes on the basis of its safety significance.

Safety functions

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. (STUK Y/1/2018)

External events

External events shall refer to exceptional situations or incidents occurring in the vicinity of a nuclear facility that could have a detrimental effect on the safety or operation of the plant.

Attenuation function

Attenuation function shall refer to a function presenting the acceleration, speed or displacement of the ground motions caused by an earthquake of a certain magnitude as a function of the distance between earthquake's centre and the point of observation, and the frequency of oscillations. The attenuation function can be presented separately for longitudinal and transversal waves.

Severe reactor accident

Severe reactor accident shall refer to an accident in which a considerable part of the fuel in a reactor loses its original structure. (STUK Y/1/2018)

Failure criterion (N+1)

(N+1) failure criterion shall mean the same as the single failure criterion.
Single failure criterion (N+1) shall mean that it must be possible to perform a safety function even if any single component designed for the function fails.

(N+2) failure criterion

(N+2) failure criterion shall mean that the most important safety functions necessary to bring the plant to a controlled state and to maintain it must be ensured in postulated accidents 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 system necessary for its operation is simultaneously inoperable due to the necessity for its repair, maintenance or testing.

Site area

Site area shall refer to an area in use by nuclear power plant units and other nuclear facilities in the same area, and to the surrounding area, where movement and stay are restricted by the Decree of the Ministry of the Interior issued under Chapter 9, Section 8 of the Police Act (872/2011). (STUK Y/2/2018)

Nuclear facility

Nuclear facility shall refer to the facilities used for the generation of nuclear energy, including research reactors, facilities for the large-scale disposal of nuclear waste, and facilities for the large-scale production, use, processing or storage of nuclear material and nuclear waste.
However, nuclear facility shall not refer to:
a) mines or ore processing plants intended for the production of uranium or thorium, or premises and locations including their precincts where nuclear wastes from such facilities are stored or deposited for final disposal; or
b) facilities and premises that have been permanently closed and where nuclear waste has been disposed in a manner approved as permanent by the Radiation and Nuclear Safety Authority; or
c) premises or parts of a nuclear facility that have been decommissioned in a manner approved by the Radiation and Nuclear Safety Authority. (Nuclear Energy Act 990/1987)

Nuclear power plant

Nuclear power plant shall refer to a nuclear facility for the purpose of electricity or heat production, equipped with a nuclear reactor, or a complex consisting of nuclear power plant units and other related nuclear facilities located at the same plant site. (Nuclear Energy Act 990/1987).

Common cause failure

Common cause failure shall refer to a failure of two or more structures, systems and components due to the same single event or cause.

Single failure

Single failure shall refer to a failure due to which a system, component or structure fails to deliver the required performance.

Single failure criterion

Single failure criterion (N+1) shall mean that it must be possible to perform a safety function even if any single component designed for the function fails.