GUIDE YVL B.8

FIRE PROTECTION AT A NUCLEAR FACILITY

Definitions

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.8 (15.11.2013).

Translation. Original text in Finnish.

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1 Introduction

101. The task of the Radiation and Nuclear Safety Authority (STUK) as the national authority responsible for oversight of the safety of the use of nuclear energy is based on the Nuclear Energy Act (990/1987) [1] and the Nuclear Energy Decree (161/1988) [2]. STUK's general oversight procedures in regulating nuclear facilities are given in Guide YVL A.1 "Regulatory oversight of safety in the use of nuclear energy". STUK’s oversight includes the oversight of the fire protection arrangements of nuclear facilities in so far as they affect the nuclear and radiation safety of the facilities. **[**2019-12-15 **]**

102. The Radiation and Nuclear Safety Authority Regulation on the Safety of a Nuclear Power Plant (STUK Y/1/2018) [3] presents requirements for the safety design of nuclear power plants: Section 9 requires implementation of the defence in depth principles to prevent accidents and to mitigate their consequences; Section 15 requires that the internal events to be considered include at least fire, floods, explosions and component failures; Section 16 presents requirements for the nuclear power plant’s control room arrangements; Sections 18–23 present requirements for the nuclear power plant’s construction, commissioning, operation, processing of operational experiences, safety research, the Operational Limits and Conditions, condition monitoring and maintenance; Section 25 presents requirements for the organisation and personnel of a nuclear facility. **[**2019-12-15 **]**

103. The Radiation and Nuclear Safety Authority Regulation on the Safety of Disposal of Nuclear Waste (STUK Y/4/2018) [4] presents requirements for the safety design of the final disposal of nuclear waste: Section 13 requires that a principle of defence in depth be applied in order to prevent accidents and mitigate their consequences; Section 18 requires that fires, floods, explosions, rock falls and any other internal events be taken into account as internal events; Sections 22–24 present requirements for the construction, commissioning and operation of a nuclear facility; Section 38 present requirements for the management, organisation and personnel. **[**2019-12-15 **]**

104. The Ministry of the Environment issues technical regulations and guidelines on construction and structural fire protection [7]. The building inspection authority in each municipality sees to it that the regulations and guidelines issued by the Ministry are complied with in all construction activities. **[**2013-11-15 **]**

105. Leadership and control of fire and rescue services, as well as the availability and quality of its services, rests with the Ministry of the Interior; the Ministry is also responsible for the preparation and arrangement of fire and rescue services at national level; and for co-ordination

of the performance of different ministries involved in the fire and rescue services under the Rescue Act (379/2011) [8] and the Government Decree (407/2011) on fire and rescue services [9]. Regional State Administrative Agencies are responsible for the duties of rescue services in their sphere of activity. Municipalities are responsible in co-operation for fire and rescue services in a region determined by the Government (regional fire and rescue services). As regards the requirements, design, installation, maintenance, inspection and demonstration of conformity of the equipment of the rescue services, the Rescue Equipment Act (10/2007) [10] shall be observed. **[**2019-12-15 **]**

106. The Government Decree (1439/2016) [11] and the Ministry of Trade and Industry Decision (918/1996) [12] present the requirements for equipment and protective systems intended for potentially explosive atmospheres. The Government Decree (576/2003) [13] presents the requirements for prevention of personnel hazards caused by potentially explosive atmospheres. The Finnish Safety and Chemicals Agency (Tukes) provides guidelines on the application of the ATEX legislation in Finland [14]. **[**2019-12-15 **]**

107. STUK's activities do not affect any oversight activities required in the Land Use and Building Act (132/1999) [5], the Land Use and Building Decree (895/1999) [6], the Rescue Act (379/2011) [8] and the Government Decree on Rescue Services (407/2011) [9], unless otherwise agreed between the authorities. **[**2013-11-15 **]**

2 Scope of application

201. When this Guide sets requirements for nuclear facilities, reference is made, under the Nuclear Energy Act, to facilities necessary for producing nuclear energy (nuclear power plants), including research reactors, facilities performing extensive final disposal of nuclear wastes, and facilities used for extensive fabrication, production, use, handling, storage of nuclear materials or nuclear wastes. Requirements for nuclear facilities always apply to nuclear power plants unless a requirement separately says they only apply to other nuclear facilities. **[**2019-12-15 **]**

202. This Guide applies to the planning and implementation of fire protection during the design, construction and operation of the nuclear facility. The Guide shall be applied to the decommissioning of nuclear facilities. This guide shall be complied with at the entire plant area and in all its buildings. **[**2019-12-15 **]**

203. As regards fire protection at a nuclear facility construction site, this guide shall apply whenever fire protection is significant for the safety of nearby nuclear facilities and to ensure fulfilment of the design criteria of the nuclear facility under construction. **[**2013-11-15 **]**

204. This Guide describes fire protection inspections performed by STUK during the design, construction and operation of the nuclear facility. Furthermore, it presents the requirements for fire protection documents to be submitted to STUK. **[**2013-11-15 **]**

205. In addition to the fire protection requirements of this Guide, the following Guides also contain fire protection related requirements to be followed:
a. Guide YVL A.1 “Regulatory oversight of safety in the use of nuclear energy” sets forth requirements for nuclear facility design and oversight.
b. Guide YVL A.3 “Leadership and management for safety” sets forth detailed requirements related to the management system and quality management.
c. Guide YVL A.5 “Construction and commissioning of a nuclear facility” sets forth requirements for the management and oversight of the construction project at different stages of a nuclear facility's construction.
d. Guide YVL A.6 “Conduct of operations at a nuclear power plant” sets forth requirements for the operation of a nuclear power plant, such as for outages.
e. Guide YVL A.7 “Probabilistic risk assessment and risk management of a nuclear power plant” sets forth requirements for probabilistic fire risk assessments.
f. Guide YVL A.11 “Security of a nuclear facility” sets forth requirements for physical protection at a nuclear facility and its planning.
g. Guide YVL B.1 “Safety design of a nuclear power plant” sets forth requirements for the

nuclear power plant's safety design and the design of systems important to safety.

h. Guide YVL B.7 “Provisions for internal and external hazards at a nuclear facility” sets forth requirements for nuclear facility layout design and the design to protect against internal and external threats.

i. Guide YVL E.6 “Buildings and structures of a nuclear facility” sets forth requirements for the design of civil structures.

j. Guide YVL E.7 “Electrical and I&C equipment of a nuclear facility” sets forth electrical equipment-specific requirements for protection against fire load-induced explosions.

[2019-12-15 **]**

3 Design requirements

3.1 General design requirements

301. Under Section 15 of the Radiation and Nuclear Safety Authority Regulation on the Safety of a Nuclear Power Plant (STUK Y/1/2018) [3] and Section 18 of the Radiation and Nuclear Safety Authority Regulation on the Safety of Disposal of Nuclear Waste (STUK Y/4/2018) [4], structures, systems and components important to safety of a nuclear facility and a nuclear waste facility shall be designed and located as well as protected in a way to make the likelihood of internal events (such as fires) small and their effect on facility safety insignificant. **[**2019-12-15 **]**

302. A basis for the quality management of the nuclear facility's construction and operation is provided in Section 25 of the Radiation and Nuclear Safety Authority Regulation on the Safety of a Nuclear Power Plant (STUK Y/1/2018) and Section 38 of the Radiation and Nuclear Safety Authority Regulation on the Safety of Disposal of Nuclear Waste (STUK Y/4/2018); they stipulate that organisations participating in the design, construction, operation, and decommissioning of a nuclear power plant and a nuclear waste facility shall employ a management system for ensuring the management of safety and quality. **[**2019-12-15 **]**

303. The fire protection for the nuclear facility shall be so planned that during and after a potential fire situation the nuclear facility can be brought to a controlled state and this state can be maintained for as long as the prerequisites for a transfer to a safe state can be guaranteed and the release of radioactive substances into the environment can be prevented. **[**2019-12-15 **]**

304. The licensee can propose that also foreign regulations and guides be applied in designing the nuclear facility's fire protection arrangements. It shall then be demonstrated, however, that they form a feasible entity. The application of foreign regulations and guides is subject to STUK's approval. **[**2013-11-15 **]**

305. An organisation carrying out the fire protection design of buildings shall have an SFS-EN ISO 9001 compliant or equivalent management system that is suitable for this purpose and has been successfully certified or independently assessed by a third party. **[**2019-12-15 **]**

306. For the inclusion of all aspects of fire protection, an expert responsible for fire protection design shall be nominated for the duration of the nuclear facility's design and construction. The expert shall have sufficient qualifications and experience in nuclear, radiation and fire safety. Management of the entirety of the nuclear facility's fire protection arrangements places specific

requirements on the combination of several design areas, such as facility layout, structural, heating/ventilation/air-conditioning, as well as electrical and I&C design. **[**2019-12-15 **]**

307. In addition to the design requirements of this Guide, to be complied with in the design of nuclear facilities are
a. the fire and building legislation in force in Finland
b. for applicable parts, the practices of risk-informed fire protection planning for nuclear power plants described in the IAEA Guides [15–21] as well as in a technical report [22]
c. the practices of the WENRA reference requirement area S, “protection against internal fires” [23]. **[**2019-12-15 **]**

3.2 Defence in depth approach to fire protection

3.2.1 General

308. The nuclear facility’s fire protection shall be based on the defence in depth approach to fire protection, which aims to
a. prevent the ignition of a fire
b. rapidly detect and extinguish ignited fires
c. prevent fire growth and spreading of a fire
d. contain a fire so that the facility’s safety functions can be reliably performed irrespective of the effects of the fire. **[**2019-12-15 **]**

309. Advanced and reliable technical designs and methods shall be used to prevent fire ignition, including e.g.
a. minimisation of the danger of ignition by the use, in accordance with the Decree of the Ministry of the Environment (848/2017), of construction materials allowable for Class P1 buildings as stated on the classification of buildings in requirement 338
b. protection and monitoring of equipment causing the risk of a fire, e.g. monitoring of vibration and oil leaks of rotating apparatuses (turbine generators, diesel generators and large pumps), transformer gas analysers and arc fault protection
c. ensuring fire protection relating to temporary fire loads and fire-hazardous components, supervision of work and administrative procedures as well as work-related personnel training. **[**2019-12-15 **]**

310. A fire shall be detected and promptly extinguished by active fire protection arrangements including e.g.
a. an automatic fire detection system covering the entire facility

b. protection of components containing significant fire hazards by fixed extinguishing systems
c. fire protection during fire-hazardous work
d. operative fire fighting in accordance with chapter 3.5.3. **[**2019-12-15 **]**

311. Fire growth and spread shall be prevented and the effects mitigated by reliable technical means including
a. fire separation of buildings and safety divisions
b. fire compartmentation and local fire protection
c. stopping or rerouting of ventilation to restrict the supply of oxygen and prevent smoke spread
d. spread prevention and extraction of smoke and combustion gases. **[**2019-12-15 **]**

311a. The principles of the fire protection arrangements of the entire nuclear facility shall be described in the design procedure for fire protection (fire protection concept) of the facility. Fire protection arrangements located in buildings or closely linked to systems shall be described in the system descriptions of the buildings or systems in question. **[**2019-12-15 **]**

311b. The fire protection arrangements of areas identified based on requirements 312 and A203 as requiring more detailed assessment shall be presented in system descriptions so that the function of each factor relative to the fire protection concept is clear. The influencing methods of fire protection arrangements shall be specified, and they shall be placed at the levels of the defence in depth concept of fire protection. Fire protection arrangements are assessed qualitatively for each area, and they shall meet the following criteria:

- The main focus of the fire protection concept shall be on structural fire protection measures.
- The fire protection concept shall be based on several defence in depth levels of fire protection.
- Fire protection arrangements that secure the fire safety of a single area shall be based on several influencing methods.

[2019-12-15 **]**

312. Implementation of the defence in depth approach to fire protection shall be assessed by analyses in accordance with chapter 3.3 and Appendix A, which focus at least on the following:
a. Rooms where the fire separation of safety divisions cannot be implemented by means of a fire wall according to standards.
b. The containment, annulus and control room as well as areas where the zone affected by a design basis fire is contained within a fire cell smaller than the fire compartment.

c. Rooms where the fire load contributing to a fire is, in a design basis fire, assumed to be smaller than the fire load of the entire fire compartment or a single component. Such fire compartments may contain, for example, large cable concentrations, a large transformer and oil systems that do not inherently burn completely due to layout and/or structural protection.
d. The turbine generator.
e. Diesel generators.
f. Switchboards in case of an arc accident. **[**2019-12-15 **]**

313. The significance of the results of fire hazard analyses used as the basis of risk-informed design shall be assessed by approved accident modelling methods such as
a. cause-effect diagrams
b. fault tree and event tree methods
c. failure mode and effect analyses and consequence analyses.
The more detailed requirement A308 is presented on the application of the methods as part of the fire hazard analysis entity. **[**2019-12-15 **]**

3.2.2 Failure criteria during fire situations

314. In evaluating the implementation of the defence in depth approach to fire protection, failures or impairments in the nuclear facility's fire protection shall be assumed. It shall be demonstrated that a single failure or deviation in fire protection does not lead to uncontrolled fire spread and endanger the facility's safety. Situations such as those involving an open fire door, or fire dampers that fail to close, shall be analysed as impairments of fire compartmentation. As common cause failures of active fire protection systems, situations shall be analysed where a fire detection system is inoperational, the fire extinguishing system does not start or the operation of the plant fire brigade is delayed. Requirements 325 and A306 present more detailed requirements for the handling of faults and impairments in fire hazard analyses. **[**2019-12-15 **]**

315. Nuclear power plant design shall make provision for fire-induced initiating events and safety functions whose actuation is required during fire situations. A fire may cause an initiating event as well as consequential failures. Even if a fire at the nuclear power plant does not directly lead to an initiating event involving an automatic initiation of safety functions, it shall always be possible to promptly bring the facility to a controlled state in accordance with the emergency and abnormal operation procedures regardless of consequential failures resulting from the fire situation. **[**2019-12-15 **]**

316. All equipment in the fire compartment shall normally be assumed to fail due to a fire. In interpreting the failure criteria, the effects of fire can be considered to be limited to the area of one fire compartment. A fire can cause the failure of several redundant subsystems of systems in the same safety division within one fire compartment. **[**2019-12-15 **]**

317. When a fire in the fire compartment under analysis causes an initiating event at the nuclear power plant, the failure criteria in Guide YVL B.1 are valid as such. **[**2019-12-15 **]**

318. When a fire in the fire compartment under analysis cannot cause an initiating event at the nuclear power plant but causes the failure of a redundant subsystem important to safety, the failure is then considered a single failure/common cause failure as referred to in Guide YVL B.1. **[**2013-11-15 **]**

319. In addition to an initiating event possibly caused by a fire, to be taken into account during fire situations are fire-induced consequential failures irrespective of which the accomplishment of safety functions must be possible in accordance with the failure criteria of Guide YVL B.1. In analysing the scope of consequential failures, the effects of smoke and other combustion gases shall be taken into account. **[**2019-12-15 **]**

320. Fire situations where a transformer fire or a switchgear fire potentially causes the simultaneous loss of all connections to the national grid shall be analysed and the results of the analysis taken into account in the design of grid connections. Guide YVL B.1 presents design requirements for the national grid connections of nuclear power plants. **[**2019-12-15 **]**

3.3 Fire hazard analyses

3.3.1 General

321. Fire-induced failure is assessed by deterministic design methods in the first place and its significance for the nuclear power plant's safety is verified by a probabilistic fire risk assessment (Fire PRA) in accordance with Guide YVL A.7. **[**2019-12-15 **]**

322. To verify the adequate implementation of the defence in depth approach to fire protection, the following fire hazard analyses shall be conducted:
a. fire hazard analyses of the nuclear facility by deterministic, generally approved and experimentally verified methods such as

- structural and functional fire hazard analyses
- fire simulation analyses to evaluate fire development and the ambient effects of fire, temperature increase in particular

- analyses of heating, load-bearing capacity and integrity of load-bearing and separating structures
- analyses or calculations of temperature increase in the room or object of study, such as component temperature increase

b. in addition to the above, for a nuclear power plant, a probabilistic fire risk assessment, a fire PRA (Guide YVL A.7).
More precise requirements for the contents of the analyses are presented in appendix A. **[**2019-12-15 **]**

323. In risk-informed fire protection planning and assessment, the results of deterministic fire hazard analyses shall be collected on a case-by-case basis and the adequacy of the nuclear facility's defence in depth ensured by accident modelling methods. The methods shall be used to assess the significance of fire protection impairments for fire safety at the nuclear facility. **[**2013-11-15 **]**

324. Appendices to Guide YVL A.11 present procedures for providing protection against an airplane crash. Guide YVL B.7 presents requirements for layout design in accidents. In regards to the related fire consequences, the adequacy of fire protection shall be demonstrated by risk-informed design and fire hazard analyses. **[**2013-11-15 **]**

3.3.2 Deterministic fire hazard analyses

325. The adequacy of fire protection shall be demonstrated by deterministic fire hazard analyses. It is especially important to demonstrate that the safety functions of the facility can be reliably accomplished during any potential fire situation. Fire hazard analyses shall also examine design basis extension events (common cause failures in systems related to fire protection). The reliable implementation of the safety functions of the facility shall not be endangered by any single failure or deviation in fire protection arrangements. The results of deterministic fire hazards analyses are used as input data in drawing up a fire PRA. More precise requirements for the contents of the fire hazard analyses are presented in appendix A. **[**2019-12-15 **]**

326. It shall be demonstrated by means of the containment fire hazard analysis that, despite containment fires, the reactor can be shut down and cooled, and residual heat can be removed without compromising containment integrity. **[**2013-11-15 **]**

327. It shall be demonstrated by a fire hazard analysis of the control room that control of the necessary safety functions can be executed in the event of a fire in the control room or in any

other fire compartment. [2013-11-15]

328. In connection with the design of the I&C systems of the nuclear facility, the influence of fires on the functioning of safety significant I&C systems shall be analysed, including the effects of fire-induced temperature rise and combustion gases on equipment and the reflection of disturbances and failures thereof on the execution of safety functions. [2019-12-15]

329. The load-bearing capacity of the building frame (R) as well as the integrity (E) and insulation (I) of the separating structural elements shall be demonstrated in accordance with the fire resistance class requirements specified in the Decree of the Ministry of the Environment (848/2017) or by fire simulation and structural analysis. Standard ISO 18195 [35] specifies methodology to assess the fire resistance rating of structural elements by using calculation formulas, fire simulation and test results. [2019-12-15]

3.3.3 Probabilistic fire risk assessment (fire PRA)

330. The PRA shall also analyse fires as initiating events. Guide YVL A.7 applies to fire risk analyses conducted during design, construction and operation of the nuclear power plant in order to assess the adequacy of fire protection and to identify fire-induced risk factors. [2019-12-15]

331. To be analysed as internal and external events by the PRA are fires that could induce an initiating event. The analyses shall be conducted in the same way as assessments of facility internal failures, disturbances, human error and loss of off-site power. [2019-12-15]

332. The effects of malfunctioning fire-water and fire extinguishing systems on the reliability of fire protection as well as the flood risk caused by the malfunctions shall be assessed in accordance with Guide YVL A.7. [2013-11-15]

333. The adequacy of the testing methods of the fire detection and fire extinguishing systems shall be evaluated so that the fire risk significance of the areas protected by them is taken into account. [2019-12-15]

334. Requirements for the design stage Level 1 and Level 2 probabilistic risk assessment to be drawn up for the review of the nuclear power plant’s construction licence application are presented in Guide YVL A.7. [2019-12-15]

335. Requirements for the Level 1 and Level 2 probabilistic risk assessment compliant with requirement 334 to be updated for the review of the nuclear power plant’s operating licence application are presented in Guide YVL A.7. [2019-12-15]

3.4 Structural fire protection

3.4.1 General

336. The nuclear facility shall be designed in such a way that structural fire protection together with the facility´s functional design and layout design ensure the safety of the facility during fire situations as far as possible without active fire fighting operations. **[**2013-11-15 **]**

337. Incombustible construction materials or materials with extremely limited combustion shall be used in structural elements. **[**2013-11-15 **]**

3.4.2 Fire resistance classes and separation of buildings

338. Buildings are divided into four fire classes P0, P1, P2 and P3 [7]. Buildings containing systems important to the nuclear power plant's safety shall be designed as Class P1 or P0 buildings on the following conditions:
a. The buildings must primarily comply with the requirements of Class P1.
b. Performance based design solutions (P0 procedure) that do not comply with Class P1 requirements shall be justified by analyses that are conservative in terms of the assumptions on fire loads, fire development and structural operation, or based on experimental information.
c. The minimal requirements related to the fire resistance of structures (requirements 340, 341, 343, 345 and 352 established in this Guide) shall also be complied with when using methods based on postulated fire development. **[**2019-12-15 **]**

339. The fire class of buildings containing systems other than those important to safety is determined according to the Decree of the Ministry of the Environment (848/2017). **[**2019-12-15 **]**

340. The minimum fire requirement for the outer walls and roof of safety-classified buildings is the fire resistance class EI-M 120 of the Decree of the Ministry of the Environment (848/2017). **[**2019-12-15 **]**

341. If systems important to safety are located in one or both of two conjoined buildings, the buildings shall be separated by a fire wall that complies with the class requirements of the Decree of the Ministry of the Environment (848/2017) and has a minimum fire resistance class of EI-M 120. **[**2019-12-15 **]**

342. The fire resistance rating of doors and hatches located between buildings shall be at least equal to the fire resistance rating required for the penetrated firewall. **[**2013-11-15 **]**

343. The load-bearing structures of the buildings of nuclear facilities shall be constructed in compliance with the regulations of the Decree of the Ministry of the Environment (848/2017) in accordance with the fire resistance class and fire load category of the building. Load-bearing structures shall at least meet the fire resistance rating R 60. The fire resistance rating (R) of a fire compartment's load-bearing structures shall, however, be at least equal to the fire resistance rating of the walls enclosing the fire compartment, in terms of fire insulation (I) and integrity (E). **[**2019-12-15 **]**

3.4.3 Fire separation of safety divisions

344. Requirements for fire separation between safety divisions are given in Guides YVL B.1 and YVL B.7. This Guide sets forth the requirements for the fire separation of safety divisions. **[**2013-11-15 **]**

345. Safety divisions shall be separated from each other by structures having a fire resistance rating of at least EI-M 120. If the safety division separation requirement of EI-M 120 is inadequate due to heavy fire loads, the rating of the structures shall fulfil the requirements accordant with fire loads, or their fire resistance rating shall be justified by fire hazard analyses. Requirement applies also to the case presented in YVL B.7 requirement 325. **[**2019-12-15 **]**

346. A safety division shall be divided into fire compartments based on compartmentation by storey and compartmentation by use, as well as based on fire load. **[**2019-12-15 **]**

347. In the separating structural elements between safety divisions, any elements reducing fire safety, such as doors, hatches and penetrations for ventilation, pipes and cables, shall be avoided as much as possible. In case these must be installed in structural elements between safety divisions, they shall fulfil the same fire resistance class requirement as the separating structural element. **[**2019-12-15 **]**

348. Doors and hatches between safety divisions shall be kept closed during normal operation of the plant and they shall be equipped with continuous position monitoring. Separating fire doors shall be self-closing and self-bolting. **[**2019-12-15 **]**

3.4.4 Fire compartmentation

349. Fire compartmentation is based on compartmentation by storey and compartmentation by use. Rooms with varying purposes of use, such as control rooms, process rooms, computer rooms, electrical and switch rooms, cable spaces, battery rooms and active carbon filter rooms, shall be separated as their own fire compartments. **[**2019-12-15 **]**

350. A fire compartment shall not, in terms of radiation protection, have rooms belonging to both the controlled area and the clean area. The interconnecting spaces intended for personnel traffic at the boundary between the controlled and clean area shall be separated into individual fire compartments. **[**2013-11-15 **]**

351. Heavy fire load concentrations or compartments where the risk of fire is high shall be separated into individual fire compartments. The amount of combustible liquids, gases and other fire loads placed in the areas and rooms of the plant that are important to safety shall be minimised. **[**2019-12-15 **]**

352. The separating structural elements of compartments shall fulfil the fire resistance class requirements of the Decree of the Ministry of the Environment (848/2017). The minimum fire resistance class shall be EI 60. **[**2019-12-15 **]**

353. The fire resistance rating of doors and hatches in separating structural elements other than those between safety divisions shall be at least half of that required for the structural element (wall, floor or roof).

a. The fire resistance class of separating doors and hatches shall be at least equal to EI 60.

b. Separating fire doors shall be self-closing and self-bolting. **[**2013-11-15 **]**

354. Dampers as well as cable, ventilation and piping penetrations shall fulfil the integrity and insulation requirements (EI) for the penetrated separating structural element. **[**2019-12-15 **]**

3.4.5 Protection against fire-load induced explosions

355. Explosions and arcs as well as their consequent effects such as missiles shall be taken into account in designing fire protection arrangements at nuclear facilities. Protection shall be provided against explosions occurring in consequence of fires. **[**2019-12-15 **]**

356. The nuclear facility’s design shall provide protection against the risk of explosions and arcs in accordance with the defence in depth approach to fire protection so as to

a. prevent explosions and arcs by monitoring and protection systems

b. minimise the risk for plant safety from explosions and arcs

c. limit the spread of the effects of an explosion and arc. **[**2019-12-15 **]**

357. Combustible liquids or gases, which are not part of the facility's processes and could cause explosions, shall not be permanently or temporarily located in rooms important to plant safety, or in their immediate vicinity. The design of the facility and its fire protection shall take into account the spread of gases, gas mixtures and liquids far from the leak point before they ignite or explode. **[**2019-12-15 **]**

358. The generation of conditions prone to explosions and arcs in the tanks, piping and electrical rooms important to safety (switchgears and battery rooms) of the plant's process systems shall be primarily prevented by means of design solutions. **[**2013-11-15 **]**

359. Pressure relief along controlled routes (e.g. pressure relief hatches of rooms) to prevent structural failures and collapse of buildings and rooms involving the risk of explosion shall be ensured in the design of buildings and rooms. **[**2019-12-15 **]**

360. The possibility of arcing shall be taken into account in the design of rooms containing electrical equipment and in the choice of the equipment (instrumentation, circuit-breakers).
a. Switch cabinets important to safety shall be provided with arc barriers, which limit the duration of arcs and the amount of total energy generated and released.
b. Design shall consider the possibility of smoke causing an arc flash in the switchgear room. **[**2013-11-15 **]**

361. In addition to fires, to be taken into account in transformer positioning and protection is the possibility of an arc or a rapid, explosive energy discharge.
a. During a high energy discharge, the rapid release of gas as well as the mixing and expansion of air and gas could cause a powerful fire and explosion.
b. Large oil-cooled transformers shall be equipped with monitoring and protection systems (gas analyzers, gas relays) to prevent fires and arcs (arc flashes).
c. Transformers containing large amounts of oil shall be placed sufficiently far from buildings and protected with structures and fire extinguishing systems. **[**2019-12-15 **]**

362. Rooms shall be provided with adequate air-conditioning and ventilation if the risk of explosive concentrations of gas or dust exists.
a. Hydrogen may form in batteries, which shall be considered in the design of battery room ventilation.
b. The risk of a fire and an explosion of dust or gas mixtures in ventilation ducts shall be considered. **[**2019-12-15 **]**

363. Hydrogen stations that cool generators, for example, shall be located sufficiently far from buildings important to safety and their design shall consider explosion pressure waves. Other gas cylinders shall be located and stored in rooms specially designed for them. **[**2013-11-15 **]**

364. Process systems containing combustible gas mixtures (e.g. the off-gas system) shall be placed far from systems implementing safety functions. The separation can be made to another fire compartment, or alternatively, sufficient separation can be justified with analyses. **[**2019-12-15 **]**

3.4.6 The containment and annulus

365. Safety divisions (redundant subsystems) inside the containment and in the annulus shall be housed in separate fire compartments whenever possible. **[**2013-11-15 **]**

366. Whenever the fire compartmentation between safety divisions is not possible inside the containment of the nuclear power plant, the operability of components important to safety as well as redundant subsystems shall be ensured by protective structures, separation by distance, fire-resistant materials and fire insulation. The design concepts shall be analysed in accordance with the defence in depth approach to fire protection utilising a risk-informed approach and also taking into account the airplane crash resistance requirements of Guide YVL A.11. **[**2019-12-15 **]**

367. The fire load inside the containment shall be minimised. Safety system equipment including cables and impulse lines shall be so located and protected that the effects of a potential fire are limited to one safety division only. **[**2013-11-15 **]**

368. Protection and fire protection of the lubrication oil system of the primary circulation pump/motor shall be so designed in accordance with the defence-in-depth approach that a potential fire does not endanger the facility's safety functions. Provision shall be made for oil leaks by means of oil collection and drainage systems whereby leaked oil is extracted to sealed, fire-suppressing collection tanks. **[**2013-11-15 **]**

3.4.7 Control room and emergency control room

369. Control rooms shall be placed in plant area locations safe from fire risks. Guidelines and requirements for control rooms are given in Guides YVL B.1 and YVL A.11. [2013-11-15]

370. Separation of the control room and the emergency control room from the rest of the facility and from each other shall be implemented in compliance with the requirements set for the separation of safety divisions. The control room and the emergency control room shall be their own fire compartments in accordance with the Decree of the Ministry of the Environment (848/2017), however their fire resistance shall be not less than EI-M120. The control rooms shall have separate ventilation and air conditioning systems whose structural separation is equivalent to that between safety divisions. [2019-12-15]

371. Control systems in the emergency control room shall be separated from the control systems of the control room and made into separate fire compartments in such a way that loss of equipment in the control room, or in any single fire compartment, does not prevent the functioning of controls in both the control room and the emergency control room. A corresponding requirement applies to emergency control posts outside the control rooms, which complement the vital functions of the emergency control rooms. [2013-11-15]

372. Cables important to safety that run from different safety divisions to the control room shall be routed through separate fire compartments. In case cables from different redundant systems must exceptionally be located in the same fire compartment, they shall be separated inside the compartment by means of distance, fire-resistant materials and fire insulation. The fire compartment shall be equipped with effective and reliable fire detection systems and fire-extinguishing systems. An example of such a compartment is the cable space under the control desk. [2013-11-15]

373. The control room and the emergency control room shall be provided with overpressure ventilation to prevent smoke from entering the control room or the emergency control room in case of a fire outside the room in question. Overpressure ventilation of the emergency control room can be replaced by locating the supply air centre of the control room and the emergency control room in such a way that their independence as regards smoke risk is reliably ensured. Overpressure ventilation shall be separate from other ventilation systems. [2019-12-15]

374. In case of a fire situation in a control room, the control room personnel shall be able to quickly and safely move from the control room to the emergency control room. [2013-11-15]

3.4.8 Access and escape routes

375. The nuclear facility shall feature an adequate number of appropriate, sufficiently spacious and easy-to-use access routes to enable safe exit from the facility. Access and escape route design shall comply with the Decrees of the Ministry of the Environment (848/2017) and (1007/2017). **[**2019-12-15 **]**

376. The fire brigade shall be able to operate effectively at the plant during a fire situation. The design of attack routes for fire brigades shall be in compliance with the regulations of the Decree of the Ministry of the Environment (848/2017). **[**2019-12-15 **]**

377. The personnel shall be able to move within the plant to ensure the necessary safety functions during a fire or other accident. Emergency response operations shall be ensured by appropriate training. **[**2013-11-15 **]**

378. Requirements set by physical protection for the design of access and escape routes are given in Guide YVL A.11. Requirements imposed by passage within the plant area and transport are given in Guide YVL B.7. **[**2019-12-15 **]**

3.5 Active fire protection

3.5.1 Automatic fire detection systems

379. To detect and locate a fire as quickly as possible, the nuclear facility buildings shall have extensive, sufficiently effective and reliable automatic fire detection systems. They shall be so designed that the location of a fire can be identified at least to any individual room. In large rooms containing systems important to safety it shall be possible to identify the location of the alarm with sufficient accuracy, even to a single detector within the room, if necessary. **[**2013-11-15 **]**

380. The alarms of fire detection systems shall always be relayed to the facility unit's control room and to the plant fire brigade. **[**2013-11-15 **]**

381. The selection and placement of fire detection equipment shall take into account the characteristic features of the compartment including ambient conditions, fire loads, ventilation, air conditioning and the significance of the compartment to the safety of the facility. If necessary, the fire detection systems can be supplemented with other appropriate monitoring systems. **[**2019-12-15 **]**

3.5.2 Fire extinguishing water systems and fire extinguishing systems

382. There may be several nuclear power plants at the site as well as other nuclear facilities, such as an interim storage for spent nuclear fuel, nuclear waste processing utilities and storages. If the on-site fire extinguishing water system serves several nuclear facilities, its capacity and significance in terms of safety during events threatening the entire facility site shall be assessed. **[**2019-12-15 **]**

383. The nuclear power plant and other nuclear facilities at the site shall be equipped with fire water tanks, a fire water pumping station and fire water mains. Fire water volumes and the capacities of the fire water pumping stations shall be designed in accordance with sprinkler rules to supply water to the most extensive area requiring protection and taking into account potential fire spread. Furthermore, an adequate amount of fire water must be available for operative use by fire brigades. Requirements concerning fire extinguishing systems are set forth in the Ministry of the Interior Decree SM-1999-967/Tu-33 [25] on automatic fire extinguishing equipment. Guidelines regarding fire extinguishing systems are provided in standards [26–30, 33]. **[**2019-12-15 **]**

384. The fire water systems of the nuclear power plant and other nuclear facilities shall be implemented in such a way that in case of the potential failure of a system part, the leak point can be isolated to limit fire water loss to the vicinity of the failure point. **[**2013-11-15 **]**

385. To facilitate fast suppression of fires and to minimise damage and hazards, the nuclear power plant and other nuclear facilities shall be equipped with a fire water system and effective and reliable fire extinguishing systems. The location of the facilities, the structural fire protection solutions, the prerequisites for the operation of the equipment in the rooms and the type and amount of fire loads shall be taken into account in the design of the fire extinguishing systems of different fire compartments. **[**2019-12-15 **]**

386. Irrespective of the layout design of the nuclear facility or the amount of existing fire loads, at least the following rooms and systems shall be provided with fixed, sufficiently reliable and, if necessary, automatic fire extinguishing systems:
a. cable spreading rooms where compartmentation between safety divisions (redundant subsystems important to safety) is not realised
b. cable rooms containing large cable concentrations with a fire load of > 1,200 MJ/m^2, unless it can be demonstrated by the defence in depth approach to fire protection that the development of a continuous cable fire in them is highly unlikely
c. rooms and systems containing radioactive substances from which considerable amounts of

radioactive substances can be released into rooms or the environment due to a fire, unless the risk is otherwise demonstrated to be insignificant
d. where necessary, components featuring heavy fire loads, such diesel generators, large transformers and other systems containing large amounts of oil. **[**2019-12-15 **]**

387. Fire protection systems shall be so designed that their breaking or inadvertent operation cannot endanger the implementation of the facility’s safety functions. Guides YVL B.1 and B.7 describe how the breaking or inadvertent operation of fire protection systems shall be prepared for as an internal hazard. **[**2019-12-15 **]**

388. The removal of fire water shall be arranged from rooms equipped with fixed water extinguishing systems or from rooms where large quantities of fire water are presumably needed in a fire situation. The effects of extinguishing water induced flooding shall be taken into account in the design and placement of these rooms. Loose parts shall also be taken into account in the removal of fire water. **[**2013-11-15 **]**

389. Guide YVL B.2 presents requirements for the seismic classification of fire water and extinguishing systems and their components. Guide YVL B.7 presents requirements for demonstrating the earthquake resistance of components. **[**2019-12-15 **]**

3.5.3 Operative fire fighting

390. The nuclear power plant shall have an operative fire fighting readiness consisting of fire protection performed by the plant fire brigade, plant personnel and off-site fire brigades. This includes the on-site movable fire fighting equipment. **[**2013-11-15 **]**

391. On the nuclear power plant area, or in its immediate vicinity there shall be a plant fire brigade whose adequate manning shall be justified. The brigade shall consist of at least one full-time fire foreman and three full-time fire fighters (1+3). The plant fire brigade shall be at a five-minute (5) response preparedness at all times (7/24). The fire fighters shall be qualified in smoke diving in terms of training, experience, physical condition, suitability and equipment [24]. The plant fire brigade shall be equipped with a sufficient amount of suitable and efficient equipment. **[**2013-11-15 **]**

392. Operation with the plant fire brigade and the regional fire and rescue services shall be planned, instructions provided and co-operation exercises conducted. **[**2013-11-15 **]**

393. The control room and the fire brigade shall be equipped with displays and printers for the fire detection system to speed up and facilitate identification of the fire locations and guidance to the scene of the incident. **[**2013-11-15 **]**

394. Where command responsibility is concerned, the provisions of the Rescue Act [8] and the Government Decree on Rescue Services [9] apply. **[**2013-11-15 **]**

395. Nuclear facilities shall be provided with equipment facilitating the use of a communication system generally in use by the authorities. It shall be possible to use the communication system at least along access routes and attack routes and in areas necessary for fire-extinguishing activities. **[**2019-12-15 **]**

3.5.4 Overpressure ventilation and smoke extraction

396. The use of access routes between the control room and the emergency control room during fires shall be analysed and, where necessary, their reliability assured by special arrangements and taking into account the requirements of Guide YVL A.11. **[**2013-11-15 **]**

397. Nuclear facilities shall be equipped with smoke extraction systems that remove the hot, possibly corrosive and toxic combustion gases generated by a fire.
a. Rooms with heavy fire loads, such as the turbine hall and cable rooms, shall be provided with sufficiently efficient smoke extraction systems.
b. The personnel carrying out fire extinguishing must be able to safely locate the fire.
[2013-11-15 **]**

3.6 Emergency lighting

398. Emergency lighting shall be designed and installed at the nuclear facility comprising escape lighting as well as stand-by lighting for the control room, emergency control room, local control centres and command centre. The emergency lighting shall enable safe passage inside the plant and escape from the buildings when normal lighting is out of order due to a disturbance in electricity supply, a fire or some other event. **[**2019-12-15 **]**

3.7 Provision for outages/annual maintenance

399. The nuclear power plant's design shall take into account plant servicing and maintenance. Guide YVL B.7 provides guidelines for the plant layout design.
a. Fire protection shall make provision for fires occurring during outages by employing the defence in depth approach in accordance with this Guide.
b. Appropriate storage space, routes and instructions shall be in place for the storage and transport of temporary fire loads. **[**2013-11-15 **]**

4 Documents of the design stage and the construction stage

4.1 General

401. Guide YVL B.1 presents the design documents of the nuclear facility to be submitted to STUK. Regulatory oversight of the nuclear power plant's design and construction comprises four stages: decision-in-principle stage, construction licence stage, construction stage and operating licence stage. Guide YVL A.1 sets forth requirements for the documents to be submitted in the different licensing stages. This chapter describes the fire protection documents to be submitted during the aforementioned stages and the essential requirements for their contents. **[**2019-12-15 **]**

402. Document related source literature not easily accessible, or their copies, shall be submitted to STUK with the documents in question. **[**2013-11-15 **]**

4.2 Documents to be submitted during the decision-in-principle stage

403. In the decision-in-principle stage, a document shall be submitted presenting the licensee-determined requirements to assure implementation of the Finnish safety requirements in fire protection. The essential contents of this document include

a. applicable regulations, guides and technical standards and their scopes of application
b. defence in depth plan for fire protection and its analysis principles
c. fire separation of safety divisions
d. fire resistance classes and separation of buildings
e. heavy fire loads and their management
f. fire compartmentation layout of the facility. **[**2013-11-15 **]**

4.3 Documents to be submitted during the construction licence stage

4.3.1 General

404. Section 35 of the Nuclear Energy Decree presents the documents to be submitted to STUK with the construction licence application for the nuclear facility. Furthermore, all other analyses considered necessary by STUK shall be submitted to STUK. **[**2019-12-15 **]**

405. The principles of fire protection for the nuclear facility shall be described in the Preliminary Safety Analysis Report (PSAR) and the topical reports complementing it, as well as in the construction quality assurance plans. The PSAR shall give the safety classification and seismic classification of fire protection systems and the fire class of buildings. Safety classification

guidelines are given in Guide YVL B.2. [2013-11-15]

406. Where fire protection is concerned, to be presented in the PSAR are the design criteria; applicable standards; different fire design areas, such as facility layout, including escape routes, implementation of structural fire protection and active fire protection systems, as well as fire hazard analyses to assure implementation of the defence in depth approach to fire protection; and detailed clarifications of the fire loads, fire compartmentation and layout presented in requirement 403. In addition, the Preliminary Safety Analysis Report and the topical reports that complement it shall present the following items:

- fire protection design plan in accordance with chapter 4.3.2
- fire compartmentation drawings and fire hazard analyses to verify fire compartmentation, which cover component location and fire load size assessment in the different fire compartments in accordance with chapter 4.3.3
- system descriptions for fire water systems and fire extinguishing systems in accordance with chapter 4.3.4
- system descriptions for automatic fire detection systems in accordance with chapter 4.3.5
- system description for smoke extraction systems in accordance with chapter 4.3.6
- description of access and escape routes in accordance with chapter 4.3.7
- description of emergency lighting in accordance with chapter 4.3.8.

[2019-12-15]

407. Furthermore, the following documents shall be submitted in the construction licence stage:

- document submission plan and reporting plan including inspections and testing related to fire protection arrangements
- qualifications, tasks and responsibilities of responsible fire protection designer
- conceptual design plan for fire protection inspections during operation
- design solution suitability assessment drawn up by the licensee.

[2019-12-15]

408. The licensee shall submit for the review of the nuclear power plant's construction licence application to STUK for approval a design Level 1 and Level 2 probabilistic risk assessment including the PRA computer model drawn up in accordance with requirement 334 of Guide YVL B.8. [2019-12-15]

4.3.2 Design procedure for fire protection

409. A description of the design organisation shall be presented to demonstrate that adequate competence, resources and co-ordination of the different design areas has been reserved to ensure a comprehensive design of the nuclear facility's fire protection arrangements. **[**2013-11-15 **]**

410. The design procedure presents the final design bases, applicable design standards as well as the classification and testing standards of systems and components. **[**2013-11-15 **]**

4.3.3 Fire compartmentation drawings and verification plans

411. To be presented for buildings are their fire class, fire hazard class, level of protection and density of fire load. **[**2013-11-15 **]**

412. Documents shall include the design bases for structural fire protection, fire compartmentation drawings with every fire compartment marked using a unique symbol and outline, as well as other structural fire protection specifications. The specifications shall include preliminary information on the location of components in the fire compartments, the fire loads and sizes of the fire compartments, as well as the fire resistance ratings of separating structural elements and the fire hazard analyses conducted to verify the fire compartmentation. **[**2013-11-15 **]**

413. Data on any considerable concentrations of combustible materials at the plant shall be presented in a separate description specifying the quality (solid, liquid, gaseous), amount and location of fire loads and the characteristics of smoke and combustion gases released by fires. Furthermore, conceptual design plans shall present principles of collecting oil leakages and other combustible liquids, as well as the methods of limiting the run-off and dispersion of these substances. **[**2013-11-15 **]**

414. Copies of the declarations of performance and CE markings, type approval decisions, verification certificates and manufacturing quality management of separating structural elements pertaining to requirements 342, 347, 353, 354 and 366 shall be submitted to STUK for information. **[**2019-12-15 **]**

4.3.4 Descriptions of fire water and fire extinguishing systems

415. A system description for the fire water system shall be submitted to STUK for approval. The document shall describe how the supply of fire water to extinguishing systems and fire hydrants has been arranged and ensured. **[**2013-11-15 **]**

416. A system description of the fire-extinguishing systems shall be submitted to STUK for approval. The plan for the fire extinguishing systems shall describe the area to be protected, fire loads, system design data, functional description and technical specifications. Furthermore, a demonstration of the suitability of the selected extinguishing systems and substances for their intended use shall be provided. **[**2013-11-15 **]**

417. The descriptions of fire extinguishing systems shall present how the supply of fire water from the fire water system is ensured. To be described is the removal of fire water from rooms equipped with fixed water extinguishing systems or rooms where large quantities of fire water may be needed in a fire situation. **[**2013-11-15 **]**

4.3.5 System description for the automatic fire detection system

418. A system description for the automatic fire detection system shall be submitted to STUK for approval. Detailed detector installation drawings shall be submitted upon separate request by STUK. A statement on the acceptability of the fire detection systems from an inspection body certified by the Finnish Safety and Chemicals Agency (Tukes) and information on the designer and supplier of the systems shall be submitted to STUK for information. **[**2019-12-15 **]**

419. The fire detection system plan shall include:
a. design data, functional descriptions and technical specifications as well as the applicable standards of the system
b. location of the fire alarm control panel and potential control units
c. list of detector types and functional descriptions of detectors
d. principles for installing various types of detectors in different rooms of the plant
e. specifications of the detectors' control functions (smoke vents, ventilation, air conditioning, fire doors, etc.). **[**2019-12-15 **]**

4.3.6 System descriptions for the overpressure ventilation and smoke extraction systems

420. A system description for the smoke extraction systems and overpressure ventilation arrangements shall be submitted to STUK for approval. The system description shall present
a. design bases for the ventilation and smoke extraction systems, and their impact on fire safety
b. plans for preventing the dispersion within the plant of hot, possibly corrosive and toxic gases generated in a fire, as well as smoke
c. method of leading out gases and smoke
d. method of preventing the release of radioactive substances into the environment in a fire situation. **[**2019-12-15 **]**

4.3.7 Plans for access and escape routes as well as attack routes for fire brigades

421. The plans for access and escape routes as well attack routes for fire brigades shall be submitted to STUK for approval. Drawings and descriptions shall present the access and escape routes, exit route length calculations, routes to carry out measures for safely shutting down the facility (see chapter 3.4.8) and the attack routes for fire brigades used for extinguishing fires. **[**2019-12-15 **]**

4.3.8 System descriptions for the emergency lighting

422. System descriptions for the emergency lighting shall be submitted to STUK for approval. The document shall present the functional principles of the system and subsystems, which fulfil the design criteria, as well as the areas equipped with the systems in question. **[**2013-11-15 **]**

4.4 Documents to be submitted during construction

423. During the construction of the nuclear facility, supplemented and detailed documents covering the construction licence stage shall be submitted to STUK.
a. The fire hazard analyses required in chapter 3.3 are updated to correspond to the data of the implementation plans.
b. The construction plans of structures and components, which are required by the structural fire protection detailed in chapter 3.4, shall be submitted to STUK in accordance with Guide YVL E.6.
c. The probabilistic risk assessment submitted in accordance with requirement 408 shall be updated according to Guide YVL A.7 to match the information in the implementation plans, so that STUK can, sufficiently early on during construction, evaluate the significance for fire

protection of the changes that are incorporated between the clarifications necessitated by requirements 334 and 335 of this Guide during construction.
d. Detailed layout drawings for the fire extinguishing systems, as specified in chapter 4.3.4, shall be submitted if separately requested by STUK.
e. As regards chapter 4.3.4, the detailed statements of the inspection body approved by the Finnish Safety and Chemicals Agency on the acceptability of the fire water pumping station, fire water system and the fire extinguishing systems shall be submitted to STUK for information, along with information concerning the parties who designed and implemented the extinguishing systems. **[**2019-12-15 **]**

424. To ensure adequate review time, the plan changes of structural fire protection required after the construction licence application shall be submitted to STUK well in advance of the commencement of construction or installation of the component in question. The nuclear facility's fire compartmentation plans in accordance with chapter 4.3.3 shall be approved before the construction of equivalent structural framework and the concreting of robust concrete structures is initiated. **[**2019-12-15 **]**

4.5 Documents to be submitted during the operating licence stage

4.5.1 Operating licence application

425. Section 36 of the Nuclear Energy Decree lists the documents to be submitted to STUK in connection with the nuclear facility's operating licence application. Furthermore, all other analyses considered necessary by STUK shall be submitted to STUK. The following documents shall be submitted to STUK as regards fire protection arrangements:
a. the Final Safety Analysis Report (FSAR) with the associated detailed reports and analyses including the fire PRA referred to in requirement 334
b. Operational Limits and Conditions (OLC)
c. a description of operative fire fighting preparedness
d. the fire fighting plan
e. an in-service inspection programme for fire protection. **[**2019-12-15 **]**

4.5.2 Final Safety Analysis Report (FSAR)

426. The FSAR shall describe the fire protection arrangements as they are implemented at the nuclear facility. **[**2013-11-15 **]**

4.5.3 Operational Limits and Conditions (OLC)

427. The requirements and restrictions to be set for the fire protection arrangements during operation shall be included in the Operational Limits and Conditions (OLC) together with the compensatory safety measures to be applied to maintain a safety level adequate in the event of e.g. a component failure or a planned component disconnection from use. The OLC shall include periodical tests of fire protection systems covered by the OLC and tests to demonstrate the operability of systems and components. The OLC shall include requirements and restrictions for at least the following functions:

a. structural fire protection measures, including fire doors and dampers
b. fire-extinguishing system, water supply, fire water pumps and main pipeline
c. fire detection systems
d. fire extinguishing systems
e. smoke extraction systems
f. equipment for initial extinguishing at the facility
g. operative fire fighting preparedness
h. fire protection during annual outages. **[**2019-12-15 **]**

4.5.4 Operative fire fighting preparedness

428. The requirements concerning the plant fire brigade are presented in chapter 3.5.3. The licensee shall submit specifications on the following to STUK for information:

a. the duties and tasks of the fire brigade leader and the person responsible for the fire fighting organisation and solutions
b. administrative arrangements to alert the plant fire brigade, the emergency response centre and nuclear facility personnel in case of an alarm from the fire detection systems or any other fire alarm
c. command responsibility in a fire situation as well as operative fire fighting procedures
d. overall fire fighting personnel and its competence, including the fire fighting and rescue training of permanent and temporary on-site personnel
e. communication systems to be used in fire and rescue events
f. equipment of the plant fire brigade and the fire fighting and protective equipment at the facility

for fire and rescue events

g. special features of operative fire fighting in spaces belonging to the controlled area based on their radiation conditions

h. special features of fire protection in energised rooms. **[**2019-12-15 **]**

4.5.5 Fire fighting plan

429. A fire fighting plan shall be drawn up and maintained to serve as a tool for the plant personnel, the plant fire brigade and the off-site fire brigades during fire and rescue events. It shall be submitted to STUK for information. **[**2013-11-15 **]**

430. The fire fighting plan shall describe at least the following:

a. plant area and its immediate surroundings

b. plant area buildings, outdoor fire hydrants and building entrances

c. building layouts with markings of fire compartments, most significant fire loads, valve control panel of the fire water system, fire hydrants, equipment for initial extinguishing, attack routes for the fire brigades, access routes, escape routes, smoke extraction equipment, overpressure ventilation, and so on

d. fire alarm system centres, fire detector groups and the locations of manual alarm switches,

e. spaces protected by fire extinguishing systems, valve control panels and the locations of the manual activation switches of the fire extinguishing systems

f. personal protective equipment. **[**2019-12-15 **]**

4.5.6 Principles of fire protection inspections during operation

431. The plant procedure stating the principles of fire protection inspections during operation shall be submitted to STUK for approval. The document shall present the inspection methods, the grounds for assessment of test results, and the recording arrangements of the results. **[**2013-11-15 **]**

4.5.7 Periodic inspection programme

432. The licensee shall draw up an in-service inspection programme for the inspections of fire protection arrangements during operation. This programme shall be annexed to the in-service inspection programme covering the entire facility. The inspections shall pay attention to the prevention of the outbreak of fires, the spreading of fires already ignited and to extinguishing them. Inspection results and potential repair and maintenance measures shall be recorded and the repairs conducted without delay. The effects of the ageing of equipment and materials on fire safety shall be monitored and evaluated. The in-service inspection programme shall be

submitted to STUK for information. **[**2019-12-15 **]**

433. At least the following items shall be included in the in-service inspection programme:

a. fire loads

b. fire compartmentation, including fire doors and structural penetrations

c. access and escape routes and attack routes for fire brigades

d. fire insulation

e. fire detection systems

f. fire water systems

g. fire extinguishing systems

h. overpressure ventilation, smoke extraction ventilation and smoke vents

i. fire dampers

j. fire fighting and rescue equipment

k. personal protective equipment

l. emergency lighting

m. communication systems. **[**2019-12-15 **]**

434. Detailed procedures shall be drawn up for the above inspection items presenting the following for each inspection and test:

a. title of inspection

b. description of inspection

c. person in charge

d. operational state of the facility for the inspection/test

e. inspection and test dates and intervals

f. inspection and test methods

g. approval criteria

h. records to be created

i. repairs and corrections implemented based on the inspections. **[**2013-11-15 **]**

4.6 Commissioning inspection

435. The licensee shall present to STUK the procedures used to assess and approve the fire protection arrangements for commissioning. **[**2013-11-15 **]**

436. The commissioning inspection of fire protection systems shall be conducted by an inspection body certified by TUKES. The commissioning inspection of all fire protection arrangements shall be conducted by the licence applicant (for example, building-specifically). The licence applicant shall then submit to STUK a written commissioning inspection request no

later than a week before the STUK inspection date. [2019-12-15]

437. In the commissioning inspection the licensee shall ensure that

a. fire compartmentation is implemented as described in STUK-approved plans

b. the quality, amount and location of fire loads is as designed

c. fire detection system installations have been approved by an inspection body certified by Tukes

d. fire water system and fire extinguishing system installations have been inspected and approved by an inspection body certified by Tukes

e. initial fire fighting equipment are located as specified in the fire fighting plan (chapter 4.5.5)

f. the communication system is operational

g. operative fire fighting preparedness is as planned. [2019-12-15]

438. An approved commissioning inspection of the fire protection arrangements is a prerequisite for the commissioning of the nuclear facility. [2013-11-15]

5 Fire safety during operation

5.1 General

501. In the inspection and operation of nuclear facilities, the licensee shall take into account the fire safety requirements and aspects whose objective is to

a. prevent ignition of fire

b. rapidly detect and extinguish ignited fires

c. prevent fire spread so that the facility's safety functions can be reliably performed also during a fire situation. **[**2013-11-15 **]**

502. The licensee has overall responsibility for the development of the nuclear facility's fire safety and the maintenance of all fire protection arrangements. Fire safety requirements shall be taken into account in every field of operation. Everyone working at the facility is responsible for ensuring fire safety. For this purpose, there shall be training and instructions for both permanent and temporary facility personnel, and they shall be provided with adequate fire protection instructions. **[**2013-11-15 **]**

5.2 Operational Limits and Conditions (OLC), in-service inspections and maintenance

503. The licensee is responsible for maintaining fire protection arrangements in accordance with the procedures of a valid OLC and of the in-service inspection programme for fire protection. Any revisions by the licensee of the OLC's in-service testing programme are subject to approval by STUK. **[**2013-11-15 **]**

504. If the original functional principles of fire protection systems, structures or components are changed or new systems or parts thereof are built, the plans for the changes shall be submitted to STUK for approval. The plans shall fulfil the requirements of chapter 3. **[**2019-12-15 **]**

505. In disconnecting fire protection systems (fire detection systems, fire water systems or fire extinguishing systems) covered by the OLC for work carried out at the plant, the procedure shall be carried out in accordance with the OLC as well as approved plans and instructions. Guide YVL A.6 presents OLC-related requirements. **[**2013-11-15 **]**

506. STUK shall be informed in advance of any significant/long-term repairs of fire protection systems. At the same time, any compensating measures to maintain the safety level prescribed in the OLC shall be presented. **[**2013-11-15 **]**

507. In making essential changes to operative fire fighting preparedness, STUK's approval shall be obtained for the changes. **[**2013-11-15 **]**

508. Fires and explosion events at the plant site, or situations involving a risk of them, shall be communicated and reported in accordance with Guide YVL A.10. [2019-12-15]

5.3 Nuclear power plant outages

509. According to the OLC, components, structures and systems required for fire protection shall be operable also during nuclear power plant outages. The functionality and adequacy of fire protection arrangements shall be evaluated as part of outage planning. Outage-specific special arrangements shall be undertaken to ensure adequate fire safety, where necessary. [2013-11-15]

510. A general description of refuelling outages and preplanned extensive repair and maintenance outages shall be submitted to STUK for information no later than one month before the commencement of the outage. The description shall include arrangements to intensify fire protection arrangements during outages. [2013-11-15]

511. Operative fire fighting preparedness during outages shall be intensified. During outages, a sufficient number of personnel with fire guard training shall supervise hot work and the fire protection arrangements. [2013-11-15]

512. The opening of separating penetrations and disconnecting of fire detection systems and extinguishing systems shall be done according to clearly defined procedures. Protective measures concerning hot work shall be determined in the work permit. Hot work can only be performed by those having a valid hot work permit in accordance with the work in question. [2013-11-15]

513. Hot work and other work presenting a fire hazard shall be provided with unambiguous instructions and supervision. For this purpose, training shall be provided to permanent and temporary power plant personnel and adequate instructions shall be available. If combustible liquids or gases are temporarily needed in rooms important to safety for the purpose of decontamination or hot work, for example, the amounts in question shall be the smallest possible and they shall be appropriately stored and kept, taking fire safety into account. [2013-11-15]

514. Before the nuclear power plant is restarted after an annual refuelling outage or a maintenance or repair outage of a longer duration, the licensee shall, as regards the fire protection arrangements, ensure that

a. annual inspections required in the OLC have been performed
b. the structural fire protection meets the requirements of the OLC

c. fire detection systems are operable

d. fire extinguishing systems are operable

e. access routes are open and housekeeping is on a high level at the facility

f. temporary fire loads during the outage have been removed or stored safely in accordance with plans

g. the plant fire brigade is in normal preparedness and its equipment is in order. **[**2013-11-15 **]**

5.4 Development of fire safety

515. The maintenance, assessment and continuous enhancement of fire safety shall be part of the safety culture relating to the operation of nuclear power plants. **[**2013-11-15 **]**

516. As part of the maintenance and development of fire safety, the fire PRA described in Guide YVL A.7 shall be kept up-to-date. **[**2013-11-15 **]**

517. Fire hazard analyses and other documents shall be updated if conditions at the plant change or plant modifications are made to the plant's fire protection arrangements. New research results in the fire field, general progress in the field, accumulated knowledge of fire events as well as the ageing effects of components and materials shall be taken into account in fire hazard analyses. The aforementioned matters shall also be taken into account in plant operation and inspections as well as in personnel training. **[**2013-11-15 **]**

6 Regulatory oversight by the Radiation and Nuclear Safety Authority

601. STUK's inspections of fire protection at nuclear power plants and nuclear facilities are timed in accordance with the stages of the licensing process:

a. During the decision-in-principle stage, STUK's statement on an application for a decision-in-principle also covers the principles of fire protection.

b. During the construction licence stage, STUK evaluates the Preliminary Safety Analysis Report (PSAR) and the supplementary topical reports, system descriptions, fire compartmentation drawings as well as the preliminary design and quality assurance procedures. The acceptability and feasibility of implementation of the fire protection principles are verified based on them. During the construction licence phase, STUK also reviews the plant's design phase fire PRA.

c. During construction STUK ensures that the principles presented in the construction licence stage are implemented in the plant's detailed design and implementation. STUK oversees and inspects the plant construction in accordance with the construction inspection programme.

d. During the operating licence stage, STUK inspects the Final Safety Analysis Report, (FSAR) and related system descriptions, the fire PRA and topical reports, including the final analysis reports and commissioning inspection records drawn up by the license applicant and inspection bodies approved by TUKES.

e. STUK conducts the commissioning inspections of fire protection arrangements as part of the commissioning inspections of buildings before the plant's commissioning. The commissioning inspection includes the review of fire protection arrangements (walkdown), the purpose of which is to ensure the implementation of design in accordance with the defence in depth approach to fire protection at the plant.

f. The above stages may also apply to significant design modifications.

g. The licence for dismantling fire protection arrangements in relation to the decommissioning of a nuclear facility is provided by a separate decision based on Section 17 of Regulation STUK Y/1/2018 so that, as a rule, the dismantling of a nuclear facility's fire protection arrangements shall take place at a significantly later stage than the removal of the corresponding protected plant components and significant fire loads. **[**2019-12-15 **]**

602. STUK applies, as necessary, nuclear and radiation safety related fire research. For the purposes of document review, STUK may conduct or commission research work and expert assessments, such as:

a. assessment of the applicability of the whole comprising the design criteria and the applicable regulations and guidelines

b. comparative risk and fire hazard analyses

c. fire experiments. **[**2013-11-15 **]**

603. STUK oversees and inspects the facility's fire protection, condition monitoring and maintenance in conjunction with the inspections included in its in-service inspection programme and other inspections. **[**2013-11-15 **]**

604. At the same time STUK reviews the results of periodic inspections conducted by the licensee and other organisations. Furthermore, STUK oversees on-site as it deems necessary the periodic inspections conducted by the licensee. **[**2013-11-15 **]**

605. In the inspection of modification, maintenance and repair work plans, as well as the actual construction, STUK follows the same process as with the approval of the original work, where applicable. **[**2013-11-15 **]**

606. Where necessary in the handling of matters related to fire protection, STUK co-operates with other authorities, including the regional rescue services and the municipal building inspection authority. Fire protection is also addressed in connection with emergency preparedness matters, where necessary. **[**2013-11-15 **]**

607. STUK exchanges experiences with nuclear facility insurers who comply with Section 23 of the Nuclear Liability Act (484/1972) [34] and arranges joint inspections, where necessary. Organisations that provide insurance cover for nuclear facilities issue international guidelines on fire protection at nuclear power plants [31]. **[**2019-12-15 **]**

7 Appendix A Evaluation of the implementation of the defence in depth approach to fire protection

7.1 General

A101. Appendix A supplements and specifies the requirements of Guide YVL B.8 with regard to fire hazard analyses concerning the defence in depth approach to fire protection. **[**2019-12-15 **]**

7.2 Identification of objects requiring evaluation of the defence in depth approach to fire protection

A201. Evaluation of the defence in depth approach to fire protection begins with the identification of objects requiring evaluation. In the event of fire, the fire compartment is considered completely lost unless fire hazard analyses prove otherwise. Requirement 312 of Guide YVL B.8 presents the minimum requirements for the selection of objects. In addition, the fire compartments located at the interface of safety compartments with a density of fire load exceeding the requirements of the Decree of the Ministry of the Environment (848/2017) for the fire resistance rating of the separating structural elements shall be reviewed in accordance with requirement 345. Major exceeding of the limit value for the highest density of fire load (1,200 MJ/m^2) in fire compartments containing load-bearing structures shall also be taken into account. **[**2019-12-15 **]**

A202. Areas requiring evaluation of defence in depth shall be selected in a risk-informed manner based on fire and nuclear safety aspects, which may also extend the objects of study outside requirement 312. **[**2019-12-15 **]**

A203. The identification of the objects of study shall be performed in a systematic and justified way. The amount of fire load shall be assessed conservatively. In order to identify the objects,
a. buildings, safety divisions and fire compartments of the plant shall be illustrated so that the location of buildings, connections between different buildings and safety divisions and common ventilation systems are identified
b. fire loads shall be listed by fire compartment so that the fire resistance ratings of fire compartments required by the density of fire load (fire class), particularly high fire loads and types of fire load (gas, liquid and solid) are identified
c. the locations of components and controls of systems required for the safe shutdown of the plant shall be specified so that the fire compartments where fire can directly damage safety systems or weaken their usability are identified. **[**2019-12-15 **]**

A204. In the preparation and illustration of the reports required by requirements A201–A203, the 3D computer model (building information model) of the plant shall be utilised, as stated in requirements 343a, 345a, 346 and 349 of Guide YVL B.7. The structure of the building information model shall be consistent for the maintenance of fire protection design information so that the input data, design principles and design solutions of fire protection design can be reviewed using the building information model. **[**2019-12-15 **]**

7.3 Evaluation of the implementation of defence in depth in fire protection

A301. The fire hazard analyses to be performed in order to ensure the sufficient realisation of the defence in depth principle in fire protection are presented in requirement 322 of Guide YVL B.8. In addition, other requirements of the Guide present what shall be demonstrable concerning the safety of different objects (requirements 324–327, 329 and 386). Requirement 313 specifies accident modelling methods to be utilised in analyses. In addition, in evaluating the implementation of the defence in depth approach to fire protection, failures or impairments in the nuclear facility's fire protection shall be assumed, as stated in requirement 314. Using fire class P0 requires additional analyses in accordance with the Decree of the Ministry of the Environment (848/2017). **[**2019-12-15 **]**

A302. Fire hazard analyses shall be made for objects identified in accordance with chapter 7.2. For objects outside safety divisions, a structural fire hazard analysis demonstrating the compliant fire resistance rating of the fire compartment is sufficient. In the case of internal fire in safety divisions, the functionality of the plant shall also be taken into account. A functional fire hazard analysis shall be used to demonstrate that the plant can be brought to a controlled state in a fire situation in accordance with requirement 453 of Guide YVL B.1, the discharge of radioactive substances into the environment has been prevented and the removal of decay heat has been ensured even if one safety division is out of operation because of maintenance measures. Shutdown situations shall also be taken into account in the fire hazard analysis to the extent that they have an effect on fire protection arrangements, temporary fire loads or the implementation of safety functions in a fire situation. **[**2019-12-15 **]**

A303. A design basis fire must be determined in the fire hazard analysis. By default, the design basis fire involves the entire fire load of a fire compartment, but it can be determined as lower if the possibility of the entire fire load being involved in the fire can justifiably be considered negligible. A safety margin shall be added to the design basis fire to be assessed in the design phase in order to prepare for the amount of realised fire load. The exceeding of the design basis fire shall be considered an impairment of fire protection arrangements. **[**2019-12-15 **]**

A304. The fire hazard analysis shall review any ignition sources, including human factors and temporary fire loads, and fire protection arrangements intended to prevent the outbreak of fire. **[**2019-12-15 **]**

A305. A fire hazard analysis shall be used to investigate the conditions prevailing in the fire compartment during fire. These shall be assessed with reliable computational methods or through fire simulation. Simulation is required at least in cases where the design basis fire does not involve the entire fire load of the fire compartment. Matters to be investigated with fire simulation include the temperature field of the fire compartment, heat fluxes to the borders of fire compartments, smoke spreading areas and the operation of extinguishing systems if they are expected to operate in the case to be simulated. **[**2019-12-15 **]**

A306. With regard to defence in depth, impairments of fire protection arrangements shall also be reviewed. They shall be taken into account before carrying out the simulation. Failures and impairments to be taken into account are specified in requirement 314. If other impairments that restrict fire protection arrangements are identified, they shall also be taken into account. In addition to this, temporary fire loads shall be assessed. For example, combustible liquids used in maintenance work (the acceptable amount in accordance with the instructions and any exceeding amount) are taken into account as temporary fire loads. The acceptable procedure is, for example, to utilise an event tree analysis in processing failures and impairments. **[**2019-12-15 **]**

A307. The fire hazard analysis shall contain a consequential effect analysis investigating the consequences of fire in the fire compartment under review and in its immediate vicinity. Consequences to be analysed include

- failures of components and cables in the fire compartment due to temperature, smoke or extinguishing water
- failure mode (silent direction or error signal)
- rise of temperature in adjacent fire compartments and consequent failures
- possibility of the spreading of fire either through open structural elements enclosing the compartment (door, fire damper, etc.) or due to the failure of compartment boundaries
- possibility of the spreading of fire from a safety division or building to another
- disconnections of electrical systems required by fire-extinguishing activities.

[2019-12-15 **]**

A308. After the assessment of failures due to fire, their effect on nuclear safety shall be reviewed. Tools to be utilised may include a fault and effect analysis, a fault tree analysis and a consequence analysis. The fire hazard analysis shall answer at least the following questions:

- Does the fire cause an initiating event?
- Has the safe shutdown of the plant been endangered?
- Have other safety systems failed?

[2019-12-15 **]**

A309. As the final result of the fire hazard analysis, an assessment of the sufficiency of fire protection arrangements and of fire risk and improvement needs shall be presented.
[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 the Safety of Disposal of Nuclear Waste (STUK Y/4/2018). [2019-12-15]

5. Land Use and Building Act (132/1999). [2013-11-15]

6. Land Use and Building Decree (895/1999). [2013-11-15]

7. Decree of the Ministry of the Environment on Fire Safety of Buildings (848/2017). [2019-12-15]

8. Rescue Act (379/2011). [2013-11-15]

9. Government Decree on Rescue Services (407/2011). [2013-11-15]

10. Rescue Equipment Act (10/2007). [2013-11-15]

11. Government Decree on Equipment and Protection Systems Intended for Use in Potentially Explosive Atmospheres (1439/2016). [2019-12-15]

12. Decision of the Ministry of Trade and Industry on Equipment and Protective Systems Intended for Use in Potentially Explosive Atmospheres (918/1996). [2019-12-15]

13. Government Decree on the Prevention of Danger for Workers Caused by Explosive Atmospheres (576/2003). [2019-12-15]

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15. IAEA SSR-2/1 (Rev. 1), Safety of Nuclear Power Plants: Design, 2016. [2019-12-15]

16. IAEA SSR-2/2 (Rev. 1), Safety of Nuclear Power Plants: Commissioning and Operation, 2016. [2019-12-15]

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21. IAEA NS-G-2.1, Fire Safety in the Operation of Nuclear Power Plants, 2000. **[**2019-12-15 **]**

22. IAEA SRS 10, Treatment of Internal Fires in Probabilistic Safety Assessment for Nuclear Power Plants, 1998. **[**2019-12-15 **]**

23. WENRA, Safety Reference Levels for Existing Reactors (2014). **[**2019-12-15 **]**

24. Directive for Rescue Diving, Publication of the Ministry of the Interior 48/2007. **[**2019-12-15 **]**

25. Ministry of the Interior Decree on Automatic Fire Extinguishing Equipment (SM-1999-967/Tu-33). **[**2019-12-15 **]**

26. SFS-EN 12259, Fixed fire fighting systems. Components for sprinkler and waterspray systems. **[**2013-11-15 **]**

27. CEA 4001, Sprinkler Systems: Planning and Installation. **[**2013-11-15 **]**

28. CEA 4007, CO2 Fire Extinguishing Systems – Planning and Installation. **[**2013-11-15 **]**

29. CEA 4008, CO2 Fire Extinguishing Systems Using Non-Liquefied "Inert" Gases – Planning and Installation. **[**2013-11-15 **]**

30. CEA 4045, Fire Extinguishing Systems Using Liquefied "Halocarbon" Gases. **[**2013-11-15 **]**

31. NNI Pool Guides, International Guidelines for the Fire Protection of Nuclear Power Plants, 2015, 5th Edition. **[**2019-12-15 **]**

32. Decree of the Ministry of the Environment on Safety of use of buildings (1007/2017). **[**2019-12-15 **]**

33. CEN/TS 14972, Fixed firefighting systems. Watermist systems. Design and installation. **[**2019-12-15 **]**

34. Nuclear Liability Act (484/1972). **[**2019-12-15 **]**

35. ISO 18195, Method for the justification of fire partitioning in water cooled nuclear power plants (NPP). **[**2019-12-15 **]**

Definitions

Active fire protection

Active fire protection supplements passive fire protection related to the facility's layout design, fire compartmentation and fire-proof structures. Active fire protection includes fire detection systems and fire extinguishing systems, smoke extraction systems, emergency lighting and operative fire fighting.

Initiating event

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

ATEX

ATEX, atmosphères explosibles, shall refer to a potentially explosive atmosphere; the abbreviation Ex means explosive; an Ex space is an explosive space; an Ex component is a component or protection system used in an explosive space.

Automatic fire detection system

Automatic fire detection system shall refer to a system that automatically and immediately indicates and locates a starting fire. A fire detection system also provides notification of any failures compromising its functional reliability.

Physical separation in connection with fire protection

Physical separation in connection with fire protection shall refer to the separation of spaces or components by means of distance, fire resistance, fire-proof structures, local fire insulation, or a combination thereof.

Appropriate certification

Appropriate certification shall refer to the certification of a quality system based on auditing in which the accreditation of the certification body has been done against the requirements of standard EN ISO/IEC 17021 and the accreditation is covered by the Multilateral Agreements (MLA) or Mutual Recognition Arrangements (MRA) entered into by FINAS.

Plant area

Plant area shall refer to an area that consists of a fenced area containing buildings related to the operation of the facility, and it shall be located within a zone where movement and sojourn are limited (described in subsection 3.4.2 of Guide YVL A.11).

Plant fire brigade

The plant fire brigade shall refer to a fire brigade maintained by the licensee of a nuclear power plant site. Its purpose is to extinguish fires occurring at the nuclear power plant, as well as the plant site and its immediate vicinity, maintain operative fire fighting preparedness, monitor fire and chemical safety, and provide training to plant personnel on fire protection.

Accident modelling method

Accident modelling methods, in risk informed planning and assessment of fire protection, are used to collect the results of fire hazard analyses on a case-by-case basis and ensure the adequacy of the nuclear facility’s defence in depth. The methods are used to assess the significance of any fire protection impairments for fire safety of the nuclear facility.

- A cause-effect diagram can be used to look for the possible consequences of the selected fire situations.
- By applying the failure tree and event tree methods, it is possible to define critical events and sequences of events, and assess their significance with regard to the adequacy of the defence in depth and core damage frequency (CDF) of the plant.
- Fault and effect analyses and consequence analyses (fire and explosion analyses, dispersion analyses) can be used to assess the sufficiency of the structural and functional layout solutions and other fire protection solutions of the buildings at the plant.

Operative fire fighting

Operative fire fighting comprises, for example, the plant fire brigade as well as the fire fighting measures conducted by the plant personnel and other fire brigades in the nearby areas. It covers the fire fighting equipment of the plant fire brigade, as well as the fire fighting equipment at the plant, such as portable fire extinguishers and fire hydrants. Fire fighting plans, rescue diving instructions, training and instructions on fire fighting as well as fire drills are all encompassed by operative fire fighting.

Fire

Fire shall refer to a chemical reaction that produces heat, smoke, or both. The inherent characteristics of a fire include uncontrolled development and spreading.

Fire load

Fire load shall refer to the total thermal energy released by the materials in a space (fire compartment) when the combustible material in that space is fully burned. Fire load density shall refer to the total thermal energy of the fire load per unit of floor area.

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.

Fire compartment

Fire compartment shall refer to a section of a building from which the propagation of fires has been prevented by means of separating, fire resistant structural elements.

Fire protection system

Fire protection systems shall refer to fire detection systems, fire-fighting water pumping stations , the fire water mains, extinguishing systems, smoke extraction systems, and emergency lighting.

Fire hazard analysis

• A structural fire hazard analysis (FHA) is conducted to ensure the sufficient fulfilment of the defence in depth approach to fire protection by means of validated deterministic methods.
• A functional fire hazard analysis (FFHA, FHFA) is conducted to ensure the sufficient fulfilment of the defence in depth principle to fire protection in the functional layout solutions for the implementation of the plant's safety functions.
• Analyses of computational fluid dynamics (CFD) simulate the gas flows in fires, as well as fire development and heat transfer.
• The finite element method (FEM) is used to simulate the conduction of fire-induced heat in solid matter and the development of structural responses as a result of the temperature.

Passive fire protection

Passive fire protection shall refer to structural fire protection arrangements, such as fire compartmentation together with the functional design and layout design of the facility, in order to ensure the facility’s safety during fire situations as far as possible without active fire fighting operations.

Risk-informed fire protection planning and assessment

Risk-informed fire protection planning and assessment is realised when deterministic planning is combined with risk analysis while utilising demonstrative accident management methods.

Explosion

An explosion can be a fast chemical reaction (detonation) that releases a large amount of thermal and kinetic energy. A vapour explosion occurs when liquefied gas is vaporised extremely rapidly, causing a mechanical explosion.

Consequential failure

Consequential failure shall refer to a failure caused by a failure of another system, component or structure or by an internal or external event at the facility.

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.

Suitability assessment

A suitability assessment presents how well a fire protection system meets the requirements placed on it and how the licensee has verified conformity. The suitability assessment also lists changes to the approved documents and their effect on the suitability and acceptability of the system in question.

Design basis fire

Design basis fire shall refer to the worst possible fire situation the probability of which during the design period is not negligible. It is taken into account in the design of fire protection systems, such as fire compartmentation, the fire water mains, and the fire extinguishing systems. A design basis fire must always be determined if the size of a fire load contained by a fire compartment and involved in combustion is assumed to be lower that the fire load of the entire fire compartment. The design basis fire must be justified using hazard, failure and impact analyses.

Ignition

Ignition shall refer to a chemical reaction that can result in a fire. An open flame, sparks, the heating of electrical systems or cables, hot surfaces or static electricity can be sources that cause ignition.

Probabilistic Fire Risk Assessment

Probabilistic fire risk assessment shall refer to a quantitative assessment of the fire-induced hazards, probabilities and negative consequences of sequences of events influencing the safety of a nuclear power plant.

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 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 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)

Emergency lighting

Emergency lighting shall refer to back-up lighting and emergency exit lighting, including lighting for exit routes, open areas and hazardous working areas; emergency lighting functions simultaneously with conventional lighting and independent of it.

Fire protection threat

Fire protection threat shall refer to a situations that can result in the outbreak of a fire or an explosion resulting from a fire load.

Arc

Arc shall refer to a physical phenomenon created when the electrical current between two electrodes is discharged through normally non-conducting material, such as air. In the event of an arc, air, which normally insulates electricity becomes conductive due to smoke, for example.

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.