

## **Regulation**

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# **Regulation for the Siting of Nuclear Facilities (FANR-REG-02)**

## **Version 0**

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## Definitions

### Article (1)

For purposes of this regulation, the following terms shall have the meanings set forth below. Other capitalised terms used but not defined herein shall have the meaning ascribed to them in Article 1 of the Federal Law by Decree No. 6 of 2009 Concerning the Peaceful Uses of Nuclear Energy (the Law):

|  |  |
|--|--|
| <b>External Events</b>                           | Events unconnected with the Operation of a Facility or the conduct of an Activity which could have an effect on the Safety of the Facility or Activity.  |
| <b>Emergency Measures</b>                        | Plans, procedures, checklists and any other measures prepared and implemented to prevent or minimise the occurrence or impact of an Emergency, including an Emergency Plan.  |
| <b>External Zone</b>                             | The area immediately surrounding a proposed Site Area in which population distribution and density, and land and water uses, are considered with respect to their effects on the possible implementation of Emergency Measures.  |
| <b>Site Area</b>                                 | A geographical area that contains an authorised Facility, authorised Activity or source and within which the management of the authorised Facility or authorised Activity may directly initiate Emergency Actions.   |
| <b>Siting</b>                                    | The process of selecting a suitable site for a Facility, including appropriate assessment and definition of the related design basis.  |
| <b>Structures, Systems and Components (SSCs)</b> | A general term encompassing all the elements of a Facility or Activity which contributes to protection and Safety, except human factors. Structures are the passive elements such as building vessels and shielding. A System comprises several components assembled in such a way as to perform a specific active function and a Component is a discrete element of a system. |

## Objective and Scope

### Article (2)

1. The objective of this regulation is to establish the requirements for applicants and licensees to follow when evaluating sites for one or more Nuclear Facilities.

2. This regulation establishes the requirements for the evaluation of a proposed site and defines the extent of information relating to a proposed site to be presented by the applicant. This information includes (but is not limited to the following):
  - a) evaluating a proposed site to ensure that the site-related phenomena and characteristics are adequately taken into account;
  - b) analyzing the characteristics of the population of the region and the capability of implementing an Emergency Plan over the projected lifetime of the plant;
  - c) defining site-related hazards; and
  - d) quantifying the input parameters related to seismic, meteorological, hydraulic, geotechnical areas and human induced conditions used in the Design of the Nuclear Facility SSCs.
3. The approach to meeting these requirements will be to use traditional deterministic defence-in-depth methods complemented by risk-informed performance-based methodology to address site characteristics and emergency planning issues.

### **Article (3)**

The scope of this regulation encompasses site related factors and site installation interaction factors relating to plant operational states and accident conditions, including those that could lead to Emergency Measures, and natural and human induced events external to the installation that are important to Safety. The external human induced events considered in this regulation are all of accidental origin. Considerations relating to the Physical Protection of the Nuclear Facility against willful actions by third parties are outside the scope of this regulation and are addressed in other Authority regulations. This regulation does not address underground or offshore facilities.

## **General Requirements**

### **Article (4)**

The main purpose of the site evaluation is to protect the public and environment from the radiological consequences of radioactive releases due to normal Operation and Accidents. In the evaluation of the suitability of a site for a Nuclear Facility, the following aspects shall be considered:

1. effects of External Events (natural in origin or human induced) occurring in the region of the particular site;
2. characteristics of the site and its environment that could influence the transfer of released Radioactive Material to Persons and the environment;
3. population density, population distribution and other characteristics of the External Zone and how these characteristics may risk members of the public and affect the implementation of Emergency Measures;

## **Required Design Characteristics**

### **Article (5)**

1. Site characteristics that may affect the Safety of the Nuclear Facility shall be investigated and assessed, as well as characteristics of the natural environment in the region that may be affected by potential radiological impacts in operational states and accident conditions. The applicant/Licensee shall establish measures to monitor and verify all site characteristics remain within the assumptions used in the Design and the final Safety analysis report throughout the life of the Nuclear Facility.
2. Proposed sites for Nuclear Facilities shall be examined in relation to the frequency and severity of external natural and human induced events and phenomena that could affect the Safety of the Nuclear Facility.
3. The foreseeable evolution of natural and human induced factors in the region that may have a bearing on Safety shall be evaluated for a time period that encompasses the projected lifetime of the Nuclear Facility. These factors, particularly population growth and population distribution, shall be monitored over the lifetime of the Nuclear Facility. If necessary, appropriate measures shall be taken to ensure that the overall risk remains acceptably low.
4. The site characteristics, in combination with the reactor's safety characteristics shall provide high level of protection of public health and Safety.
5. The hazards associated with External Events that are to be considered in the Design of the Nuclear Facility shall be determined. For an External Event (or a combination of events) the parameters that are used to characterise the hazards shall be chosen in such a way as to facilitate the Design of the Nuclear Facility.
6. In assessing the risks associated with External Events, the potential consequences of combining these hazards with the ambient site conditions (e.g. hydrological, hydrogeological and meteorological conditions) shall be considered.
7. The analysis shall take into account any additional matters relating to Safety such as the transport and Storage of input and output materials, fresh and Spent Nuclear Fuel, and Radioactive Waste, which could influence the suitability of the site.
8. The potential for interactions between nuclear and non-nuclear effluents, such as the combination of heat or chemicals with Radioactive Material in liquid effluents, shall be considered.
9. The potential radiological impacts on people in the region, including impacts that could lead to Emergency Measures, of the Nuclear Facility in its operational states and in accident conditions shall be evaluated. Due consideration shall be given to all relevant factors, including population distribution, dietary habits, use of land and water, and the radiological impacts of any other releases of Radioactive Material in the region.
10. If it is proposed to increase the installed nuclear capacity to a level significantly greater than that previously determined to be acceptable, the suitability of the site shall be re-evaluated accordingly.

## **Requirements for Hazards Associated with External Natural and Human Induced Events**

### **Article (6)**

1. Proposed sites shall be investigated with regard to all the site characteristics that could be significant with respect to Safety as a result of external natural and human induced events.
2. Possible natural phenomena and human induced situations and activities in the region of a proposed site shall be identified and evaluated to determine their significance to the safe Operation of the Nuclear Facility.
3. Parameters for describing the hazards associated with natural and human induced phenomena shall be selected or developed.
4. In the determination of hazards, site specific data shall be used. In the event that such data are not obtainable, data from other regions that are relevant to the region of interest or acceptable simulation techniques may be used.
5. Foreseeable significant changes in land use shall be considered, such as changes to existing installations or human activities, or the Construction of high-risk installations.
6. All relevant available information and records of the occurrences and severity of important natural phenomena or human induced situations and activities shall be collected for the region and shall be analyzed for reliability, accuracy and completeness.
7. Appropriate methods shall be adopted for establishing the hazards that are associated with major external phenomena. The methods shall be up-to-date and compatible with the characteristics of the region. Special consideration shall be given to applicable probabilistic methodologies including uncertainties.
8. When applying a method to establish the hazards associated with major external phenomena the size of the region needs to be chosen carefully. It shall be large enough to include all the features and areas that could be of significance in determining the natural and human induced phenomena under consideration and for the characteristics of the event.

## **Requirements for Determining the Potential Effects of the Nuclear Facility in the Region**

### **Article (7)**

1. In the evaluation of a site to determine the potential radiological impact on the region of the Nuclear Facility in its operational states and accident conditions that could lead to Emergency Measures, appropriate estimates shall be made of expected or potential releases of Radioactive Material. In doing this, the Design of the Nuclear Facility and its safety features shall be taken into account.

2. The direct and indirect pathways by which Radioactive Material released from the Nuclear Facility could potentially reach and affect people and the environment shall be identified and evaluated. In such an evaluation, specific regional and site characteristics shall be taken into account, with special attention paid to the function of the biosphere in the accumulation and transport of radionuclides.
3. The site characteristics and Design of the Nuclear Facility shall be examined concurrently, and such examination must demonstrate that the radiological risks to the public and to the environment associated with radioactive releases from the site are acceptably low as determined by the Authority pursuant to the Law and applicable regulations.
4. The Design of the Nuclear Facility shall be such as to compensate for any unacceptable potential effects of the Nuclear Facility on the region as determined by the Authority pursuant to the Law and applicable regulations.

### **Requirements Derived from Considerations of Population and Emergency Planning**

#### **Article (8)**

1. The proposed region shall be studied to evaluate the present and foreseeable future characteristics and the distribution of the population of the region. The study shall include an evaluation of present and future uses of land and water in the region. Any special characteristics that may affect the potential consequences of radioactive releases on individuals and the population as a whole shall be taken into account.
2. In relation to the characteristics and distribution of the population, the combined effects of the site and the Nuclear Facility shall be such that:
  - a) for operational states of the Nuclear Facility the radiological exposure of the population remains as low as reasonably achievable and in conformance with the regulatory requirements set forth in FANR Regulation for Radiation Dose Limits and Optimisation of Radiation Protection for Nuclear Facilities (FANR-REG-04); and
  - b) the radiological risk to the population associated with accident conditions, including those that could lead to Emergency Measures being taken, is acceptably low.
3. The External Zone for a proposed site shall be established by taking into account the potential for radiological consequences for people and the feasibility of implementing Emergency Plans, and of any External Events or phenomena that may hinder their implementation. Before Construction of the Nuclear Facility is started, it shall be confirmed that there will be no insurmountable difficulties in establishing an Emergency Plan for the External Zone before the start of Operation of the Nuclear Facility.



## **Specific Requirements for Evaluation of External Events**

### **Earthquakes**

#### **Article (9)**

1. The seismological and geological conditions in the region and the engineering geological aspects and geotechnical aspects of the proposed Site Area shall be evaluated.
2. All relevant information on earthquakes and volcanism, if any, in the region shall be collected and documented.
3. The hazards associated with earthquakes shall be determined by means of seismotectonic evaluation of the region.
4. Hazards due to earthquake induced ground motion shall be assessed for the site taking into account the seismotectonic characteristics of the region and specific site conditions. A thorough uncertainty analysis shall be performed as part of the evaluation of seismic hazards.
5. Seismic and geological input parameters necessary to support Design of the Nuclear Facility SSCs shall be quantified based on the results of the site characterisation.

### **Surface Faulting**

#### **Article (10)**

1. The potential for surface faulting (i.e. the fault capability) shall be assessed for the site. A fault shall be considered capable (on the basis of geological, geophysical, geodetic or seismological data) if one or more of the following conditions applies:
  - a) it shows evidence of past movement or movements (significant deformations and/or dislocations) of a recurring nature within such a period that it is reasonable to infer that further movements at or near the surface could occur. In highly active areas, where both earthquake data and geological data consistently reveal short earthquake recurrence intervals, periods of the order of tens of thousands of years may be appropriate for the Assessment of capable faults. In less active areas, it is likely that much longer periods may be required;
  - b) a structural relationship with a known capable fault has been demonstrated such that movement of one fault may cause movement of the other fault at or near the surface;  
or
  - c) the maximum potential earthquake associated with a seismogenic structure is sufficiently large and at such a depth that it is reasonable to infer that in the geodynamic setting of the site movement at or near the surface could occur.
2. Where reliable evidence shows the existence of a capable fault that has the potential to affect the Safety of the Nuclear Facility, an alternative site shall be considered.

## **Meteorological Events**

### **Article (11)**

The extreme values of meteorological variables and phenomena including wind, precipitation, temperature, storm surges and the other meteorological events listed below shall be investigated for the site of any Nuclear Facility to evaluate their possible consequences.

#### 1. Lightning

- a) The potential for the occurrence, the frequency and severity of lightning shall be evaluated for the site on the basis of all relevant, available information.

#### 2. Tornadoes

- a) The potential for the occurrence, the frequency and severity of tornadoes in the region of interest shall be assessed on the basis of all relevant available information.
- b) The hazards associated with tornadoes shall be derived and expressed in terms of parameters such as rotational wind speed, translational wind speed, radius of maximum rotational wind speed, pressure differentials and rate of change of pressure.
- c) In the Assessment of the hazards, consideration shall be given to potential missiles that could be associated with tornadoes.

#### 3. Tropical cyclones

- a) The potential for the occurrence, the frequency and the severity of tropical cyclones in the region of the site shall be evaluated on the basis of all relevant available information.
- b) If appropriate, the hazards associated with tropical cyclones shall be determined in relation to the site. Hazards for tropical cyclones include factors such as extreme wind speed, pressure and precipitation.
- c) In the Assessment of the hazards, consideration shall be given to potential missiles that could be associated with tropical cyclones.

#### 4. Sandstorms

The potential for the occurrence, frequency and severity of sandstorms shall be evaluated for the site on the basis of all relevant, available information.

## **Flooding**

### **Article (12)**

1. Floods due to precipitation and other causes
  - a) The region shall be assessed to determine the potential for the occurrence, the frequency and severity of flooding due to one or more natural causes such as runoff resulting from precipitation or high tide, storm surge, seiche and wind waves that may affect the Safety of the Nuclear Facility. If there is a potential for flooding, then all relevant data, including historical data, both meteorological and hydrological, shall be collected and critically examined.
  - b) A suitable meteorological and hydrological model shall be developed taking into account the limits on the accuracy and quantity of the data, the length of the historical period over which the data were accumulated, and all known past changes in relevant characteristics of the region.
  - c) The possible combinations of the effects of several causes shall be examined. For example, for coastal sites and sites on estuaries, the potential for flooding by a combination of high tide, wind effects on bodies of water and wave actions such as those due to cyclones shall be assessed.
  - d) The hazards for the site due to flooding shall be assessed and input parameters necessary to support Design of Nuclear Facility SSCs against the adverse effects of flooding quantified.
  - e) The potential for instability of the coastal area or water channel due to erosion or sedimentation shall be investigated.
2. Water waves induced by earthquakes or other geological phenomena
  - a) The region shall be evaluated to determine the potential for tsunamis or seiches that could affect the Safety of a Nuclear Facility on the site.
  - b) If there is found to be such a potential, all relevant available data relating to tsunamis or seiches affecting the shore region around the site shall be collected and critically evaluated for their relevance to the evaluation of the site.
  - c) On the basis of the available data for the region and comparison with similar regions that have been well studied with regard to these phenomena, the frequency of occurrence, magnitude and height of regional tsunamis or seiches shall be estimated and used to determine the hazards associated with tsunamis or seiches taking into account any amplification due to the coastal configuration at the site.
  - d) The potential for tsunamis or seiches to be generated by regional offshore seismic events shall be evaluated on the basis of known seismic records and seismotectonic characteristics.

- e) The hazards associated with tsunamis or seiches shall be derived from known seismic records and seismotectonic characteristics as well as from physical and/or analytical modelling. These include potential drawdown and run-up that may result in physical effects on the site.
3. Floods and waves caused by failure of water control structures
- a) Where appropriate, information relating to any upstream water control structures shall be analysed to determine whether the Nuclear Facility would be able to withstand the effects of the failure of one or more of the upstream structures.
  - b) The possibility of storage of water as a result of the temporary blockage of rivers upstream or downstream (e.g. caused by landslides) so as to cause flooding and associated phenomena at the proposed site shall be examined.

## **Geotechnical Hazards**

### **Article (13)**

1. Slope instability
- a) The site and its vicinity shall be evaluated to determine the potential for slope instability (such as land and rock slides) that could affect the Safety of the Nuclear Facility.
  - b) If there is found to be a potential for slope instability that could affect the Safety of the Nuclear Facility, the hazard shall be evaluated by using parameters and values for the site specific ground motion.
2. Collapse, subsidence or uplift of the site surface
- a) Geological maps and other appropriate information for the region shall be examined for the existence of natural features such as caverns, karstic formations and human made features such as mines, water wells and oil wells. The potential for collapse, subsidence or uplift of the site surface shall be evaluated.
  - b) If the evaluation shows that there is a potential for collapse, subsidence or uplift of the surface that could affect the Safety of the Nuclear Facility, practicable engineering solutions shall be provided otherwise the site shall be deemed unsuitable.
  - c) If practicable engineering solutions appear available, a detailed description of subsurface conditions obtained by reliable methods of investigation shall be developed for the purposes of determination of the hazards. The practicability of the proposed engineering solutions shall be confirmed before the site is deemed to be suitable.

### 3. Soil liquefaction

The potential for liquefaction of the subsurface materials of the proposed site shall be evaluated by using parameters and values for the site specific ground motion and proven analytical methods.

### 4. Behaviour of foundation materials

- a) The geotechnical characteristics of the subsurface materials shall be investigated and a soil profile for the site determined in a form suitable for Design purposes.
- b) The stability of the foundation material under static and seismic loading shall be assessed.
- c) The groundwater regime and the chemical properties of the groundwater shall be studied.

## **External Human Induced Events**

### **Article (14)**

#### 1. Accidental aircraft crashes

- a) The potential frequency and severity of aircraft crashes on the site shall be assessed taking into account, to the extent practicable, characteristics of future air traffic and aircraft.
- b) If the Assessment shows that there is a potential for an aircraft crash on the site that could affect the Safety of the Nuclear Facility, then an assessment of the hazards shall be made taking into account all relevant plant engineered safety features such as the containment building.

#### 2. Chemical hazards

- a) Activities in the region that involve the handling, Processing, transport and storage of chemicals having a potential for explosions or for the production of gas clouds capable of deflagration, detonation or causing human fatality or illness due to toxicity shall be identified. The frequency and severity of such events shall be specified.
- b) Hazards associated with chemical explosions shall be expressed in terms of overpressure and toxicity (if applicable) taking into account the effect of distance.

#### 3. Other important human induced events

- a) The region shall be investigated for installations (including installations within the site boundary) in which flammable, explosive, asphyxiant, toxic, corrosive or Radioactive Materials are stored, processed, transported and otherwise handled and that if released under normal or accident conditions could jeopardise the Safety of the Nuclear Facility. This investigation shall also include installations that may give rise to missiles of any type that could affect the Safety of the Nuclear Facility. The potential effects of electromagnetic interference, eddy currents in the ground and the clogging of air or water inlets by debris shall also be evaluated.

- b) For nuclear power plant sites located on navigable waterways, the evaluation shall consider the probability and potential effects of impact on the Nuclear Facility cooling water intake structure and enclosed pumps by the various sizes, weights and types of barges or ships that normally pass the site, including any explosions incident to the collision. Applicants shall use this analysis to determine whether an additional source of cooling water is required.

### **Electrical Grid Availability**

#### **Article (15)**

The site assessment shall account for interaction of the Nuclear Facility with the electrical grid and other generators on the system including potential load growth and effects of additional transmission lines.

### **Water Availability**

#### **Article (16)**

1. Consumption of water shall be evaluated for existing and future water use scenarios in the area to ensure adequate water supplies during droughts for both station Operation and other regional water users.
2. The availability of water during periods of low flow or low water level is an important initial consideration for identifying potential sites. The frequency and duration of low flow or low-level periods shall be determined from the historical records.
3. Potential natural and human induced events that could cause a loss of function of systems required for the long-term removal of heat from the core shall be identified. Such events include the blockage or diversion of a cooling water supply, depletion of a reservoir by siting, an excessive amount of marine organisms, ship collisions, oil spills fires. If the probabilities and consequences of such events cannot be reduced to acceptable levels, then the hazards for the Nuclear Facility associated with such events shall be established.
4. An assessment and analysis of the potential impact of the various External Events shall be performed by using the collected data and information in a suitable model.

### **Site Characteristics and the Potential Effects of the Nuclear Facility in the Region**

#### **Atmospheric Dispersion of Radioactive Material**

#### **Article (17)**

1. A meteorological description of the region shall be developed, including descriptions of the basic meteorological parameters, regional topography and phenomena such as wind speed and direction, air temperature, precipitation, humidity, atmospheric stability parameters, and prolonged inversions.

2. A programme for meteorological measurements shall be prepared and carried out at or near the site with the use of instrumentation capable of measuring and recording the main meteorological parameters at appropriate elevations and locations. Data from at least one full year shall be collected, together with any other relevant data that may be available from other sources.
3. On the basis of the data obtained from the investigation of the region, the atmospheric dispersion of released Radioactive Material shall be assessed with the use of appropriate models. These models shall include all significant site specific and regional topographic features and characteristics of the Nuclear Facility that may affect atmospheric dispersion.

### **Dispersion of Radioactive Material through Surface Water**

#### **Article (18)**

1. A description of the surface hydrological characteristics of the region shall be developed, including descriptions of the main characteristics of both natural and artificial water bodies, the major structures for water control, locations of water intake structures and information on water use in the region.
2. A programme of investigation and measurements of the surface hydrology shall be carried out to determine, to the extent necessary, the dilution and dispersion characteristics for water bodies, the re-concentration ability of sediments and biota, and the determination of transfer mechanisms of radionuclides in the hydrosphere and of exposure pathways.
3. An Assessment of the potential impact of the contamination of surface water on the population shall be performed by using the collected data and information in a suitable model.

### **Dispersion of Radioactive Material through Groundwater**

#### **Article (19)**

1. A description of the groundwater hydrology of the region shall be developed, including descriptions of the main characteristics of the water bearing formations, their interaction with surface waters and data on the uses of groundwater in the region.
2. A programme of hydrogeological investigations shall be carried out to permit the Assessment of radionuclide movement in hydrogeological units. This programme shall include investigations of the migration and retention characteristics of the soils, dilution and dispersion characteristics of the aquifers, and physical and physicochemical properties of underground materials mainly related to transfer mechanisms of radionuclides in groundwater and their exposure pathways.
3. An Assessment of the potential impact of the contamination of groundwater on the population shall be performed by using the data and information collected in a suitable model.

## **Population Distribution**

### **Article (20)**

1. The distribution of the population within the region shall be determined.
2. Information on existing and projected population distributions in the region, including resident populations and to the extent possible transient populations shall be collected and kept up-to-date over the lifetime of the Nuclear Facility. The radius within which data are to be collected shall be chosen on the basis of national practices with account taken of special situations. Special attention shall be paid to the population living in the immediate vicinity of the Nuclear Facility, densely populated areas and population centres in the region, and residential institutions such as schools, hospitals and prisons.
3. The most recent census data for the region, or information obtained by extrapolation of the most recent census data shall be used in obtaining the population distribution. In the absence of reliable data, a special study shall be carried out by the applicant/Licensee.
4. The data shall be analyzed to give the population distribution in terms of the direction and distance from the Nuclear Facility. An evaluation shall be performed of the potential radiological impacts of normal discharges and accidental releases of Radioactive Material, including reasonable consideration of releases due to severe accidents with the use of site specific parameters as appropriate.

## **Uses of Land and Water in the Region**

### **Article (21)**

The uses of land and water shall be characterised in order to assess the potential effects of the Nuclear Facility in the region and particularly for the purposes of preparing Emergency Plans. The investigation shall cover land and water bodies that may be used by the population or may serve as a habitat for organisms in the food chain.

## **Ambient Radioactivity**

### **Article (22)**

Before Commissioning of the Nuclear Facility the ambient radioactivity of the atmosphere, hydrosphere, lithosphere and biota in the region shall be assessed to provide a baseline for establishing the future effects of the Nuclear Facility.

## **Monitoring of Hazards and Industry Experience**

### **Article (23)**

1. The applicant/Licensee shall define and implement performance based measures to monitor site characteristics and ensure they are consistent with the characteristics assumed in the Design of the Nuclear Facility over the lifetime of the Nuclear Facility. The characteristics of the natural and human induced hazards as well as the demographic, meteorological and hydrological conditions of relevance to the nuclear installation shall be monitored. This monitoring shall be commenced no later than the start of Construction and shall be continued through Decommissioning. All the hazards



and conditions that are considered in this regulation and are pertinent to the licensing and safe Operation of the Nuclear Facility shall be monitored.

2. The applicant/Licensee shall review international industry Siting and Construction experience to ensure the site characterisation has appropriately considered the said experience.

### **Management Systems**

#### **Article (24)**

1. As part of the Management System programme for the Nuclear Facility, an adequate Quality Assurance programme shall be established to control the effectiveness of the execution of the site investigations and assessments and engineering activities performed in the different stages of the site evaluation.
2. The Quality Assurance programme implemented for activities that may influence Safety or the derivation of parameters for the design basis for the site may be graded in accordance with the importance to Safety of the individual Siting activity under consideration.
3. Records shall be kept of the work carried out for site evaluation for the Nuclear Facility during the lifetime of the Nuclear Facility.