

# IAEA Safety Standards

Style Definition: Heading 1

Status: Step 110

Approval by the relevant review Committees.

~~Approved by the Coordination Committee  
after addressing MS comments.~~

~~Reviewed in NSOC SGDS (Asfaw) (Technical Editorial review)  
For submission to SSCs and NSGC~~

## Site Evaluation for Nuclear Installations

### Specific Safety Requirements DS484

~~April~~March 428, 2018







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## 1. INTRODUCTION

### BACKGROUND

1.1. This Safety Requirements publication supersedes the edition of Site Evaluation for Nuclear Installations ~~which that~~ was issued in 2016 as IAEA Safety Standards Series No. NS-R-3 (Rev. 1)<sup>1</sup>. ~~This NS-R-3 (Rev. 1) was a partial revision of IAEA Safety Standards Series No. NS-R-3<sup>2</sup> issued in 2003 and it took into account issues highlighted after the Fukushima Daiichi accident. This Safety Requirements~~ publication takes into account and incorporates developments ~~related~~relating to site evaluations for nuclear installations since ~~the publication of IAEA Safety Standards Series No. NS R 3 in 2003 and the partially revised publication NS R 3 (Rev. 1) in 2016, which addressed overarching issues highlighted after the Fukushima Daiichi accident.~~ It applies ~~the~~ IAEA Safety Standards Series No. SF-1, Fundamental Safety Principles [1]. Requirements for site evaluation are intended to contribute to ~~the adequate~~the adequate protection of site personnel and the public and protection of the environment from harmful effects of ionizing radiation arising from nuclear installations. It is recognized that there are steady advances in technology and scientific knowledge, in nuclear safety and in what is considered adequate protection. Safety requirements ~~evolve~~change with these advances and this publication reflects the present consensus among ~~Member~~ States.

1.2. This Safety Requirements publication establishes requirements and provides criteria for ~~ensuring safety in~~ site evaluation in order to ensure meet the site fundamental safety objectives for nuclear installations [1] ~~defined by Requirement number 2. Several~~ related Safety Guides<sup>3</sup> ~~on site evaluation~~ provide guidelines recommendations on how to meet the requirements established in this ~~Safety Requirements~~ publication [2-8].

### OBJECTIVE

1.3. The objective of this publication is to establish appropriate requirements and criteria for:

- a) Defining the information to be used in the site evaluation process;
- b) Evaluating a site ~~to ensure such that that~~ the site related hazardous phenomena and characteristics are adequately taken into account, so that the ~~site related hazards are~~

<sup>1</sup> INTERNATIONAL ATOMIC ENERGY AGENCY, Site Evaluation for Nuclear Installations, IAEA Safety Standards Series No. NS-R-3 (Rev. 1), IAEA Vienna, (2016).

<sup>2</sup> INTERNATIONAL ATOMIC ENERGY AGENCY, Site Evaluation for Nuclear Installations, IAEA Safety Standards Series No. NS-R-3, IAEA Vienna, (2003).

~~properly assessed and that the~~ corresponding site specific design parameters are appropriate;

- c) Analysing the characteristics of the population and the ~~area-region~~ surrounding the site ~~aimed so as~~ to determine ~~if whether there~~ would be significant difficulties ~~in planning for~~ ~~to implementation of~~ emergency response actions effectively.

The criteria described above are to be applied:

- i. ~~To~~ identify the ~~external~~ natural and human induced events ~~external to the installation~~ that could challenge the safety of the nuclear installation;
- ii. ~~to assess~~ ~~To assess the interactions between the site and site and site~~ ~~the nuclear installation~~ ~~installation interactions in for~~ operational states and accident conditions, over the ~~projected~~ lifetime ~~of the nuclear installation, of the nuclear installation,~~ including those ~~interactions~~ ~~accidents~~ that ~~require~~ ~~could necessitate~~ ~~guaranteed~~ proper implementation of emergency response plans.

1.4. This publication is intended for use by regulatory bodies ~~responsible for in~~ establishing regulatory requirements, and ~~for by~~ operating organizations ~~or their contractors~~ ~~directly~~ ~~responsible for in~~ conducting site evaluation ~~of for~~ nuclear installations.

## SCOPE

1.5. ~~These is Safety Requirements~~ ~~Requirements in this~~ publication ~~addresses apply to a~~ ~~broad range of~~ ~~the following~~ ~~all~~ nuclear installations ~~as defined in the IAEA Safety Glossary [2].92];~~

- Nuclear power plants;
- Research reactors (including subcritical and critical assemblies) and any adjoining radioisotope production facilities;
- Storage facilities for spent fuel;
- Facilities for the enrichment of uranium;
- Nuclear fuel fabrication facilities;
- Conversion facilities;
- Facilities for the reprocessing of spent fuel;
- Facilities for the predisposal management of radioactive waste arising from nuclear fuel cycle facilities;
- Nuclear fuel cycle related research and development facilities.

1.5.1.6. This Safety Requirements publication covers site evaluation for both new and existing nuclear installations. ~~Requirements for hazard evaluation are also applicable to both categories new and existing nuclear installations categories.~~

1.7. The 'site ~~area~~area' is the geographical area that contains an authorized facility, authorized activity or source, and within which the management of the authorized facility or authorized activity or first responders may directly initiate an emergency response, ~~as defined in IAEA Safety Standards Series No. GSR Part 7, Preparedness and Response for a Nuclear or Radiological Emergency [103]. This~~ The site area is typically the area within the security perimeter fence or other designated property marker.

1.8. The 'external zone' is the area immediately surrounding a proposed site area in which population distribution and density, and ~~and~~ land and water uses, are considered with respect to their effects on the possible implementation of emergency response actions [9].

1.9. The ~~'region surrounding the site'~~'region' in the context of this publication ~~is~~ the region surrounding the site and is generally intended to include more than the external zone. The region~~It~~ is to be determined for investigation of specific hazards. ~~It~~ is also known as the 'geographical area of interest'.

1.10. The external human induced events considered in this Safety Requirements publication are of accidental origin. Considerations relating to ~~the~~ physical protection of the nuclear installation against sabotage, and to physical protection against unauthorized removal or sabotage of the nuclear material, wilful actions by third parties are outside ~~its~~ the scope of this publication although ~~they~~ such considerations may bear significant safety implications for site evaluation. This publication does not address the threats assessment of human activities of malevolent origin. Recommendations fFor the establishment of the design basis threats effer SSCsstructures, systems and components important to nuclear security ; recommendations are provided in Ref-IAEA Nuclear Security Series No. 13 [114] and in supporting publications in the IAEA Nuclear Security Series.

1.6.1.11. However, there is an interface between safety and nuclear security; has to be considered. when it comes to sSite specific design parameters external natural and human induced hazards parameters requiredused for the qualification of structures, systems and components (SSCs) that are important to nuclear safety against external natural and human induced hazards, as and those that are important to nuclear security. Derivation of site specific external hazards design parameters required byin this publication, can also be used for the establishment of qualification of structures, systems and components important to nuclear security requirements against relevant external hazards (e.g. earthquakes, flood, high

wind, etc.) of SSCs important to nuclear security. ~~This publication does not address the threats assessment of human activities of malevolent origin.~~ However there is an interface between safety and security, when it comes to site specific design parameters for structures systems and components (SSCs) that are important to nuclear safety and those that are important to nuclear security. Derivation of site specific design parameters recommended by this publication can be used for the establishment of design basis hazards of SSCs important to nuclear security.

1.7.1.12. The site selection process, also called 'siting processes', for a nuclear installation is divided into two stages<sup>4</sup>:

- a) Site survey, in which when potential candidate sites are identified after the investigation of a large region and the rejection of unsuitable sites; on the basis of existing data
- b) Site Selection, in which the candidate sites are assessed by screening, and evaluation, comparison and ranking comparing them on the basis of safety and other considerations to select one or more aims to arrive at the 'preferred candidate site(s)'. In this second stage the candidate sites are assessed by screening and ranking.

The aim of the second stage is to identify suitable sites and to select list of candidate site(s). In this second stage the candidate sites are assessed by screening and ranking to arrive at the 'Site suitability of the preferred candidate sites'. Site suitability site shall be confirmed during in the site evaluation process. The site evaluation process starts with the second stage of the siting process, (namely site selection), following the site survey and shall continue throughout the entire lifetime of the nuclear installation. Detailed site evaluation (for the selected site) provides input to the preliminary safety analysis report and the final safety analysis report. SaAtR. During the operation stage of the nuclear installation, site evaluation continues throughout the operation stage of the nuclear installation with confirmatory and monitoring activities of the site specific design basis parameters as well as any full and comprehensive safety re-evaluation process as required by the based on the outcome of periodic safety reviews.

1.13. This publication addresses the evaluation of those site related factors that have to be taken into account to ensure that the site-installation interactions do not constitute an unacceptable risk to individuals, the population or the environment over the lifetime of the nuclear installation. The non-radiological aspects of the environmental impact of the site and the nuclear installation are not explicitly covered in this publication.

<sup>4</sup> More details about the siting and site evaluation process are presented in the IAEA Safety Standards Series No. SSG-35, Site Survey and Site Selection for Nuclear Installations. [8].

1.8.—

## STRUCTURE

1.9.— This Safety Requirements publication follows the relationship between safety principles and safety objectives in establishing safety requirements and criteria to be used during site evaluation for nuclear installations.

1.10.1.14. Section 2 of this publication ~~describes—sets out~~ the safety principles and ~~objectives~~concepts applicable to site evaluation. Section 3 ~~describes—establishes requirements~~ for the application of the management system for site evaluation. Section 4 establishes ~~the~~ general requirements that are applicable to all types of external hazards and all types of nuclear installations. Section 5 establishes ~~specific—requirements~~ for specific technical aspects~~for the~~related to evaluation of ~~specific—~~natural and human induced external hazards ~~and phenomena~~. Section 6 establishes ~~specific—requirements~~ for specific technical aspects related to site ~~related—~~evaluation of the effects of the nuclear installation on the ~~regional~~ environment; around the nuclear installation (including the atmosphere, the hydrosphere and the biosphere), and on the population. Section 7 establishes requirements for monitoring and periodic ~~re-evaluation—of~~review— of external natural and human induced hazards and site conditions throughout the lifetime of the nuclear installation.

## 2. SAFETY PRINCIPLES AND CONCEPTS

~~2.1. SF-1 [1] establishes one fundamental safety objective and ten safety principles that provide the basis for requirements and measures for the protection of people and the environment against the harmful effects of ionizing radiation and for the safety of facilities and activities that give rise to radiation risk.~~

~~2.2.2.1. As stated in SF-1 [1], “The fundamental safety objective is to protect people and the environment from harmful effects of ionizing radiation.”~~ Paragraph 2.1 of SF-1[1] states that:

“This fundamental safety objective of protecting people - individually and collectively - and the environment has to be achieved without unduly limiting the operation of facilities or the conduct of activities that give rise to radiation risk. To ensure that ~~nuclear installations~~facilities are operated and activities are conducted so as to ~~meet~~achieve the highest standards of safety that can reasonably be achieved, measures have to be taken:

- a) ~~(a)~~———To control the radiation exposure of people and the release of radioactive material to the environment;
- b) ~~(b)~~———To restrict the likelihood of events that might lead to a loss of control over a nuclear reactor core, nuclear chain reaction, radioactive source or any other source of radiation;
- c) ~~(c)~~———To mitigate the consequences of such events if they were to occur.”

~~2.3.2.2. Paragraph 2.2 of SF-1 [1] states that:~~

“The fundamental safety objective applies for all facilities and activities and for all stages over the lifetime of a facility or radiation source, including planning, siting, design, manufacturing, construction, commissioning, and operation, as well as decommissioning and closure. This includes the associated transport of radioactive material and management of radioactive waste.”

~~2.4.2.3. This Safety Requirements publication establishes requirements that apply for implementation of safety Pprinciples 8 and 9 of SF-1 [1] ~~as these two principles are the most relevant for consideration in site evaluation for nuclear installations. In this regard:~~~~

- a) Principle 8 on prevention of accidents states: “All practical efforts must be made to prevent and mitigate nuclear or radiation accidents.” Paragraph 3.31 of SF-1 [1] states: “The primary means of preventing and mitigating the consequences of accidents is ‘defence in depth’. Defence in depth is implemented primarily through the combination

of a number of consecutive and independent levels of protection that would have to fail before harmful effects could be caused to people or to the environment". Paragraph 3.32 of SF-1 [1] states that one of the elements is related to "Adequate site selection and the incorporation of good design and engineering features providing safety margins, diversity and redundancy".

To address Principle 8 ~~Prevention of states that~~ accidents:

~~The site evaluation process for a nuclear installation shall characterize the natural and human induced hazards that may challenge the safety of the nuclear installation identify the reasonably foreseeable relevant external hazards. The site evaluation shall provide Adequate input to the design and safety assessment relating to site specific parameters (see Requirement 2) shall be provided. Paragraph 3.31 [1] Principle 8 why are these requirements in here their status vis a vis the other requirements is not clear; are they kind of over over arching? Paragraph 3.31 [1] states: "The primary means of preventing and mitigating the consequences of accidents is 'defence in depth'. Defence in depth is implemented primarily through the combination of a number of consecutive and independent levels of protection that would have to fail before harmful effects could be caused to people or to the environment". Paragraph 3.32 [1] states that o~~One of the elements is related to "adequate site selection and the incorporation of good design and engineering features providing safety margins, diversity and redundancy."

b) Principle 9 on emergency preparedness and response states: **"Arrangements must be made for emergency preparedness and response for nuclear or radiation incidents."**

To address Principle 9 ~~Emergency preparedness and response:~~

~~the site~~Site evaluation process of ~~identify the reasonably foreseeable external hazards, including those~~ evaluation for a nuclear installation shall provide adequate input for demonstration of protection of very low probability. In addition, in order to ~~of people and the environment from the radiological consequences of radioactive releases due to accidents. The site evaluation shall identify the site characteristics that could impact~~ To assess the feasibility of ~~of to implement planned ation of planning to implement~~

emergency response actions in the external zone<sup>5</sup> region, ~~the site evaluation process shall identify the site characteristics that can affect~~(see Requirement 2).

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<sup>5</sup>~~The External zone is "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 response actions* [9]" defined in Safety Glossary.~~



### 3. APPLICATION OF THE MANAGEMENT SYSTEM FOR SITE EVALUATION

#### Requirement 1: Application of the management system for site evaluation

Site evaluation shall be conducted in a comprehensive, systematic, planned and documented manner ~~and included in the~~ accordance with ~~ana~~ management system.

3.1. ~~A~~ An integrated management system ~~in compliance with IAEA Safety Standards Series No. GSR Part 2, Leadership and Management for Safety [454]~~ shall be established covering the organization, planning, work control, personnel qualification and training, verification and documentation for activities to ensure that the required quality of the work is achieved. ~~[12].~~ The management system shall be ~~established~~ implemented at the earliest possible time ~~to in the conduct of~~ site evaluation activities for the nuclear installations.

3.2. The management system shall ensure the quality and the control of the ~~effective engineering~~ activities performed ~~in at~~ each stages of ~~the~~ site evaluation ~~for the nuclear installation~~.

3.3. ~~The sites~~ Site evaluation ~~process~~ shall include, as part of the management system, proper quality assurance arrangements covering ~~those activities~~ each activity ~~ies~~ that can influence ~~nuclear~~ safety or affect the derivation of the site specific design parameters and other safety related site characteristics for the design basis for the site. The quality assurance arrangements shall be consistent with regulatory requirements and their application shall be graded in accordance with the importance to safety of the ~~individual siting and site evaluation~~ activity under consideration.

3.4. For each site evaluation activity ~~of the site evaluation process~~, including inspection, testing, verification and/or validation, the acceptance criteria and the responsibilities for ~~carrying out~~ performing these ~~activities~~ activity ~~ies~~ shall be specified.

~~3.5. The data collected during in the site evaluation process shall be kept retained and the~~ The results of studies and investigations from the site evaluation ~~process~~ shall be documented in sufficient detail to permit an independent review.

~~3.5.3.6. The~~ An independent review shall be made of ~~of~~ (The evaluation ~~assessments~~ of the site related external natural and human induced hazards and site specific design parameters shall be independently reviewed by a third party.

#### 4. GENERAL REQUIREMENTS FOR SITE EVALUATION

~~This section contains general requirements that are applicable to the site evaluation process for all external hazards and types of nuclear installations.~~

##### Requirement 2: ~~Site safety~~Safety objectives in site evaluation for nuclear installations

The ~~main~~ safety ~~objective~~objectives in site evaluation for nuclear installations shall be (a) to characterize the natural and human induced~~man-made~~ hazards that ~~may~~ might challenge the safety of the nuclear installation and (b) to provide adequate input for demonstration of the protection of ~~the~~ people~~public~~ and the environment from ~~the~~ radiological consequences of radioactive releases due to accidents.

~~4.1. The site safety objectives in site evaluation are derived based on the fundamental safety objective (see para. 2.2 and [1]) relating to both short term and long term radiological impact to on people and the environment.~~

~~4.1.4.2. The site evaluation process shall contain detailed acceptance criteria which are derived from safety objectives (see para. 2.2 and [1]). These criteria shall together contribute to demonstration~~Demonstration of compliance with the safety requirements presented established in this document publication provides the basis for demonstration of achieving the ~~site safety objectives in site evaluation~~ which address all stages of the project lifetime (siting, design, construction, commissioning, operation and decommissioning) as well as emergency preparedness and additional matters as appropriate.

~~Site safety objectives shall be defined with reference to both short and long term radiological impact to people and the environment. The objectives shall be expressed in terms associated with radiological consequences for individuals, public and the environment.~~

##### Requirement 3: Scope of the site evaluation for nuclear installations

The scope of the site evaluation shall ~~consider~~ encompass both site related factors relating to the site and site installation interaction factors relating to the interaction between the site and the installation, for relating to all operational states and ~~accidents~~accident conditions, including ~~those accidents~~ that could warrant emergency response actions. ~~The scope shall cover and external natural and human induced events hazards external to the nuclear installation that could affect the safety of the nuclear installation.~~

4.2.4.3. The scope of the site evaluation shall covers all external hazards and site specific parameters relevant for the safety of the nuclear installations safety, with the use of In determining the scope of the site evaluation, a graded approach shall be applied on the basis of the radiation risk that they posed to people and the environment. The main principle of the graded approach is stated in SF-1[1] and defined in [2].

#### USE OF THE GRADED APPROACH

4.3.4.4. For nuclear installations other than nuclear power plants, The graded approach is aimed to scale down the application of the safety requirements for analysis, evaluation, and documentation considering shall be commensurate with the potential hazards associated with operating the nuclear installation facilities other than nuclear power plants.

4.4.4.5. The level of details needed in an evaluation to meet the requirements established in this publication shall be commensurate with the risk associated with the facilities nuclear installation and its site and vary will differ depending on according to the type of nuclear installation located at the site. Nuclear power plants will generally require the highest level of details.

4.5.4.6. The scope and depth of the site evaluation process necessary to support the installation's safety demonstration cases shall be determined. A site can be screened out from following a formal site evaluation process if no unacceptable radiological consequences would be likely for workers or for the public or for the environment for the nuclear installation shall be determined.-

4.6.4.7. For nuclear installations other than nuclear power plants where a graded approach is applied to site safety evaluation, the following shall be taken into consideration in application of a graded approach:

- a) The amount, type and status of the radioactive inventory at the site (e.g. whether the radioactive material on the site is in solid or fluid, form, and whether the radioactive material is being processed in the nuclear installation or is being stored on the site);
- b) The intrinsic hazard hazards associated with the physical and chemical processes that take place at the nuclear installation;
- c) For research reactors, (The thermal power of in case of research reactors;
- d) The distribution and/or location of radioactive sources in the nuclear installation;
- e) The changing nature of the configuration and layout for of installations designed for experiments; and how whether these are likely to change;

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- f) The need for active systems and/or operator actions for the prevention of accidents and for mitigation of the consequences of accidents;
- g) The potential for on-site and off-site consequences in the event of an accident.

#### Requirement 4: Site suitability

The site suitability of the site shall be assessed in the at an early stage of the site evaluation and shall be confirmed for the lifetime of the planned nuclear installation.

4.7.4.8. In the assessment of the suitability of a site for a nuclear installation, the following aspects shall be addressed in the at an early stage of the site evaluation:

- a) ~~(a)~~—The effects of external events affecting occurring in the region ~~of a~~ surrounding a the particular site (~~the~~ external events can be of ~~a~~ natural origin or human induced);
- b) ~~(b)~~—The characteristics of the site and its environment that ~~can~~ could influence the transfer to people persons and to the environment of radioactive material ~~that has been~~ ingen released from the nuclear installation;
- c) ~~(c)~~—The population density, population distribution and other characteristics of the external ~~region~~ zone in so far as they ~~can~~ could affect the feasibility ~~of of~~ planning planning to to implement ~~planned the~~ emergency response actions effectively, as required in GSR Part 7 [~~3~~103], and the need to evaluate the risk to individuals and to the population.

4.8.4.9. The site shall be deemed unsuitable for the location of the nuclear installations if the site evaluation for one or more of the three aspects cited ~~above indicate in para 4.8~~ indicates that site is unacceptable and ~~that the safety~~ deficiencies cannot be compensated for by means of a proper balance of measures for site protection ~~measures~~, design features of the nuclear installation, and administrative procedures, ~~either upon initial analysis or after subsequent reviews~~.

4.9.4.10. Site suitability shall be assessed on the basis of current and relevant ~~updated~~ data and methodologies and shall be consistent with planned operations at the site. Conservative criteria ~~shall be~~ developed in relation to site specific accident [?] scenarios; ~~in such a case~~ and their consistency of such criteria with the generic overall criteria for site suitability criteria shall be demonstrated.

4.10.4.11. A decision regarding ~~site the~~ site's suitability shall be based on the installation's characteristics of the nuclear installation, the amount and nature of potential radiological releases and their impact on ~~the people and the~~ environment.

4.11.4.12. For nuclear power plants, the total nuclear capacity to be installed at the site shall be determined at the first stages of the siting process. If it is later determined or anticipated that the installed nuclear capacity and the inventory of nuclear material or its impact have been increased to a level significantly greater than that previously determined to be acceptable, the site shall be re-evaluated considering the higher capacity or impact.

4.12.4.13. ~~In The~~ overall evaluation of site suitability, ~~shall assess conditions for safe operation of the installation. Site~~ site related-specific- attributes/parameters such as cooling water availability or extreme environmental conditions shall also be addressed regarding in their potential role in affecting the safe, continuous operation of the nuclear installation.

#### **Requirement 5: Site and regional characteristics**

The site and the regional area surrounding the site ~~[regional area not used elsewhere]~~ shall be investigated with regard to the characteristics that can impact nuclear safety and the potential radiological impact of the nuclear installation on population/people and environment. ~~in the region surrounding the site or in the whole world?].~~

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4.13.4.14. Natural phenomena as well as human activities in the ~~site~~-region surrounding the site-with potential to induce hazards at the site that may affect the safety of the nuclear installation shall be identified and evaluated, ~~according to their safety significance. The extent of this evaluation shall be graded in accordance with their safety significance of the potential hazards at the site.~~

4.14.4.15. Characteristics of the natural environment in the region surrounding the site that can be affected by the potential radiological impact of the nuclear installation ~~in all operational states and accident conditions throughout its lifetime~~ shall be investigated and assessed, ~~for all operational states and accident conditions and for all stages of the lifetime of the nuclear installation (See Section 6).~~

4.15.4.16. The size of the region surrounding the site to be investigated, ~~—also called as the geographic area of interest, [delete this if you include new para 1.9]~~ shall be defined for each of the external natural ~~and human induced hazards and associated phenomena and human induced hazards and situations and associated~~ activities. ~~Adequate regions shall be identified and considered for the potential hazards that can affect the safety of the nuclear installation for all external natural phenomena.~~ under evaluation and it shall be large enough to include those features, sources and areas that can be of significance in the determination Both ~~(The correlation between event~~ magnitude of the hazard and the distance from the source of the

hazard to the site shall be ~~given priority~~considered in ~~the definition of~~determining the size of the region to be investigated. For ~~some specific~~certain external natural phenomena, such as tsunamis and volcanic ~~manifestations, phenomena,~~ it adequate regions shall be ensured that the size of the region surrounding the site identified and considered for the potential hazards that can could affect the safety of the nuclear installation is sufficiently large to address the potential effects of these hazards at the site.

4.16.4.17. The site and the region shall be studied to evaluate the present and foreseeable future characteristics that ~~can could~~ have an impact on nuclear safety. This includes potential changes in the magnitude and/or frequency of the natural hazards, the distribution of the population in the region, the present and future use of land and water, the further development of existing nuclear<sup>[2]</sup> installations ~~and human activities~~ or the construction of facilities that can impact ~~on on~~ the safety of the nuclear installation ~~or, and~~ the feasibility of planning the implementation of the planning to implement~~planned~~ emergency response actions effectively.

#### **Requirement 6: Identification of the site specific hazards**

**Potential hazards resulting from external natural phenomena and human induced events and activities ~~which can that could occur affect~~ in the region ~~of the site~~ shall be identified through a screening process. ~~External hazards that are not screened~~excluded on the basis of this inged process out shall be evaluated and selected for ingment the design basis or re-evaluation purposes accordingn on the site, to with their significance of these hazards to the safety of the nuclear installation.**

4.17.4.18. The screening process and associated criteria used in screening of the site specific hazards shall comply with the ~~site~~ safety objectives for site evaluation and shall be properly justified and documented.

4.19. Events of high severity but low probability<sup>6</sup> that could contribute to the overall risk shall be included in the site evaluation process. Events of low severity but high probability that could contribute to the overall risk shall also be included in the site evaluation process. The scope of evaluation of external events shall cover the full range of severity and frequency of occurrence relevant for the design and safety assessment, including ~~those events~~ of high severity but low probability that could contribute to the overall risk.

<sup>6</sup>For example the low probability could be defined as the annual probability smaller than the threshold used for defining the hazard severity for design (e.g.  $10^{-4}$ ) but higher than that threshold for CDF/LERF (e.g.  $10^{-5}/10^{-6}$ ).

~~4.18-4.20.~~ External hazards that are not excluded on the basis of the screening process shall be evaluated and selected for the purpose of establishing the site specific design parameters or for re-evaluating the site, in accordance with the significance of these hazards to the safety of the nuclear installation.

~~4.21. For the~~ With respect to hazards and their associated events that are ~~excluded on the basis of the~~ screening ~~out events~~ process, it shall be ensured that all effects relevant for design and/or safety assessment ~~(e.g., loaded cases)~~ resulting from these events are bounded by the effects associated with other events or ~~Events may be screened out through enveloping within~~ a set of events.

~~4.19.~~

#### **Requirement 7: Evaluation of external natural and human induced hazards**

**The impact of external natural and human induced hazards on the safety of the nuclear installation shall be evaluated ~~taking into~~ with account ~~taken of the potential evolution of site specific conditions~~ over the lifetime of the nuclear installation.**

~~4.20-4.22.~~ Proposed sites for a nuclear installation shall be evaluated with regard to the frequency and severity of external natural and human induced events, and the potential combinations of such events, that could affect the safety of the nuclear installation.

~~4.21-4.23.~~ Information on frequency and severity of external events derived from the characterization of the hazards ~~resulting from external events~~ shall be used in establishing the site specific design parameters for the nuclear installation. Adequate account shall be taken of both aleatory and epistemic uncertainties in the ~~design basis hazard level~~ site specific design parameters.

~~4.22-4.24.~~ Appropriate methods, supported by numerical models when ~~needed,~~ necessary, shall be used to derive ~~hazard~~ hazard characteristics relevant for site evaluation and design of the facility. A thorough uncertainty analysis of the method and input data shall be performed as part of the hazard ~~?~~ evaluation.<sup>22</sup>

4.25. The decision ~~for using probabilistic or~~ to use ~~to use~~ deterministic ~~and/or probabilistic~~ methodologies in hazard evaluation shall be based on the nature of the hazard, the availability of data and the applicable requirements for safety assessment. ~~Special consideration shall be given to applicable probabilistic methodologies since external events~~

~~4.23. Probabilistic~~ Special consideration shall be given to the use of applicable probabilistic methodologies since ~~and the use of external events~~ probabilistic hazard ~~curves~~ curves;

representing external events are needed as input for probabilistic safety assessment against for external hazards.

4.24-4.26. Such pProbabilistic hazard curves shall be developed with reference to the specific site conditions, application (e.g. design, margin evaluation, probabilistic safety assessment, hazard monitoring, and emergency planning).

4.25-4.27. Hazard assessments-evaluations shall address the possibility that external events can occur in combination, simultaneously or within short time frames. Interrelationships and causality between external events, as well as modifications changes of site conditions in characteristics within time, shall be evaluated.

4.28. Natural and human induced phenomena shall be analysed and resultsThe results of hazard evaluations shall be expressed in terms that can be used as input for deriving the hazards associated with site specific design parameters design basis for the nuclear installation; that is, appropriate parameters for describing the severity of the hazard effects shall be selected or developed.

4.29. The possible non-radiological impact of the nuclear installation, due to chemical or thermal releases, and the potential for explosion and the dispersion of chemical products shall be taken into account in the site evaluation process.

4.26-4.30. The potential for interactions between radioactive and non-radioactive effluents, such as interactions due to the combination of heat or chemicals with radioactive material in liquid effluents, shall be considered.

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**Requirement 8: Site Measures for Site protection measures**

~~The need for site protection measures shall be evaluated~~ **If** the projected design of the nuclear installation is not able to ~~safely~~ withstand safely ~~either~~ the impact of external natural and human induced hazards, ~~either as defined as for the design basis during the early site evaluation stage or resulting from the re-evaluation of the external natural and human induced hazards during the operating lifetime of the nuclear installation,~~ the need for measures for site protection measures shall be evaluated.

~~4.27-4.31.~~ The need for protection of the site against the effects of specific phenomena of external natural and human induced hazards ~~(e.g. flooding, explosions, etc.),~~ shall be evaluated considering ~~adequate~~ safety margins.

~~4.28-4.32.~~ The availability of adequate engineering solutions for implementing measures for site protection measures shall be evaluated. ~~and~~ if such engineering solutions are not available, the site shall be deemed unsuitable.

~~4.29-4.33.~~ If ~~either as a result of the evaluation performed according to Requirement 7 during the early site evaluation stage or later, during the operating lifetime as a result of periodic safety site re-evaluation,~~ measures for site protection measures are required to be implemented. ~~are required to be implemented, conservative assumptions shall be taken in order to account for the~~ uncertainties shall be properly taken into account in the evaluation of ~~the~~ extreme values of external natural and human induced hazards associated to with the measures for site protection measures. ~~Also the~~ Measures for site protection measures shall be classified, designed, built, maintained and operated as structures, systems and components important to safety.

**Requirement 9: Site evaluation for multiple nuclear installations at-on the same site and at co-located sites.**

The site evaluation shall consider the potential ~~of for~~ external natural and human induced hazards ~~that can~~ affect multiple nuclear installations at-on the same site as well as at co-located sites.

4.34. Occurrences of external natural and human induced ~~hazards events~~ and their credible combinations, ~~which that~~ are able to challenge the safety of ~~multi~~ multiple installations on the same site unit or installations on co-located sites, ~~and to generate disruptions of infrastructure affecting communications, transportation and utilities,~~ shall be considered. The potential for hazards ~~originated~~ originated from one nuclear installation ~~of multi~~

~~installation site on to affect~~ other nuclear installations located ~~at on~~ the same site ~~or at co-~~  
located sites shall be assessed.

~~4.30-4.35.~~ The combined effects of nuclear installations located on the same site or at nearby sites on the public and the environment shall be evaluated for region affected by the identified accident scenarios (see Requirement 12).

**Requirement 10: ~~Change~~Changes of hazards and site characteristics with time**

The external hazards and the site characteristics shall be assessed regarding their potential for changing with time and the ~~impact of these changes to the design basis and the feasibility of planning to implement emergency response actions effectively. If necessary, the estimate of changes during the installation operating lifetime shall be incorporated, taking due consideration of the uncertainties involved in these assessments.~~potential- impact of these changes shall be evaluated.

~~4.31-4.36.~~ The natural and human induced hazards affecting the safety of ~~a-~~ nuclear installations as well as the site characteristics that can change over time shall be identified. ~~The~~The potential consequences of such changes shall be duly assessed for the planned operating lifetime of the nuclear installation.

~~4.32-4.37.~~ ~~Taking Due~~ account shall be taken of ~~the~~ uncertainties in the projections of ~~climatic variability and change,~~ any potential changes in time of the external hazards and site characteristics by means of appropriate safety margins ~~shall be included~~ in the related site specific design ~~parameters envelope of the nuclear installation.~~

**Requirement 11: Special considerations for the ultimate heat sink for nuclear installations requiring an ultimate heat sink**

The evaluation of site specific external and human induced hazards shall consider hazards that can impact the availability and reliability of the ultimate heat sink for nuclear installations requiring an ultimate heat sink.

~~4.33-4.38.~~ As appropriate for the ultimate heat sink under consideration, ~~the following~~ data for the following shall be evaluated:

a) Ice, including frazil ice;

~~a) fire~~

~~b) oilFire~~

~~e)b) Oil~~ and chemical spills;

~~d)c) Air temperature~~ and; humidity;

e)d) Water ~~depth and temperature~~temperature;

f)e) Water quality characteristics, including turbidity, suspended solids, floating debris, and chemical and biochemical changes (both natural or and human induced changes);

g)f) ~~Available and sustainable~~Availability and sustainability of the water flow (for a river), minimum and maximum water level and the period of time for which safety related sources of cooling water are at a minimum level, with account taken of the potential for failure of water control structures.

4.34.4.39. ~~Potential of a~~All external natural and human induced events that can cause a loss of the ultimate heat sink function of systems required for the long term heat removal shall be identified and evaluated.

**Requirement 12: Potential effects of the nuclear installation on people the public and the environment of the region surrounding the site.**

In ~~site evaluation, to determine~~determining the potential radiological impact of the nuclear installation on the region surrounding the site for operational states and accidents that can warrant emergency response actions, appropriate estimates shall be made of expected or potential releases of radioactive material, with account taken of the design of the nuclear installation and its safety features.

4.35.4.40. The potential effects of the nuclear installation on ~~the public~~people and the environment shall be evaluated considering ~~co-located installations (e.g. 'a multiple installation site')~~, ~~their~~covered in Req 9 and para 4.39 sufficiently I think ~~their~~its postulated accident scenarios (including resulting source terms), and the feasibility of planning and infrastructures, to implement emergency response actions effectively at the site and in the external zone~~region~~. These estimates shall be confirmed when the design of the nuclear installation and its safety features have been established.

~~4.36. The potential effects of nuclear installations located on the same site or at nearby sites (e.g., 'multiple sites') shall be evaluated based on their correlation in relation to the size of to for the area region [?] affected by the identified hazard accident scenarios.~~

4.37.4.41. The direct and indirect pathways by which radioactive material released from the nuclear installation could potentially affect the public and the environment shall be identified and evaluated. In ~~such an~~this evaluation, specific regional and site characteristics and the population distribution in the region shall be taken into account, with special attention paid to the function of the biosphere in the accumulation and transport of radionuclides.

**Requirement 13: Feasibility ~~of to of planning to implement~~implementing planned emergency response actions effectively**

The feasibility ~~to of planning to implement~~implementing planned emergency response actions effectively on the site and in the external ~~region~~zone shall be evaluated, ~~with taking~~ account ~~taken~~ of ~~the~~ site characteristics ~~and~~, characteristics of the ~~external zone region surrounding area the site~~ and any external events that could ~~significantly~~ hinder the establishment of ~~a set of complete~~ complete emergency arrangements prior to operation.

~~4.38-4.42.~~ The requirements for site evaluation apply also to the infrastructure ~~in~~ and other characteristics of the external ~~region~~zone where emergency response actions may be warranted.

~~4.39-4.43.~~ An assessment shall be made of the feasibility ~~of of planning to implement~~ development and implementation of an emergency response actions effectively ~~plan for taking emergency response actions effectively~~ as required in GSR Part 7 [103]. ~~The on-site and co-located Nuclear installations on the same site and co-located at nearby sites~~ shall be considered in the assessment, with special emphasis on nuclear installations that can experience concurrent accidents.

~~4.40-4.44.~~ A causal relationship between external events, ~~and~~ site and external zone infrastructure conditions shall be considered in evaluating the feasibility ~~of to planning of planning to~~ implement planned emergency response actions effectively.

~~4.41-4.45.~~ ~~In the site evaluation, it~~ shall be demonstrated that the information provided to assess radiological radiation risk to the population associated with accident conditions, including those that could warrant emergency response actions being taken in the external ~~zone~~region, is compliant with the site safety objectives. ~~++~~

**Requirement 14: Data collection in site evaluation for nuclear installations**

The ~~necessary data necessary needed~~ to perform an assessment of external natural and human induced hazards and to assess both the impact of the environment on the nuclear installation safety and the impact of the nuclear installation on ~~the~~ public and the environment shall be collected.

~~4.42-4.46.~~ Data regarding external natural and human induced hazards with the potential to give rise to adverse effects on the safety of the nuclear installation ~~over the lifetime of the installation~~ shall be collected ~~throughout the lifetime of the nuclear installation~~. Data shall

be confirmed to be spatially and temporally pertinent to the site, with preference given to the use of site-specific data in site evaluation.

~~4.43-4.47.~~ The extent, objectives and scope of the data collection process shall be defined based on the based on site-safety objectives for site evaluation, graded to in accordance with the hazard posed by the nuclear installation to the public to people and the environment.

~~4.44-4.48.~~ The data collection process shall address the following as a minimum:

- a) ~~External~~ Information on External natural and human induced hazards ~~information:~~ sources of hazards, propagation of hazards, potential effects on the nuclear installation and on workers, ~~the~~ public and the environment;
- b) Information describing site conditions and regional environmental conditions;
- c) Information on Characteristics of the proposed engineering and administrative protective site features and mitigation measures;
- d) Information on Characteristics of the -potential impact of the nuclear installations on the public and the environment as a result of both normal operations as well as radiological accidents-;
- e) Information required ~~for the establishment of emergency planning to implement~~ planned for planning emergency actions on the -site and off the -site in any all environmental conditions and ~~installations~~ conditions of the nuclear installation;
- f) Conditions ~~Information on~~ Conditions for access to the site and site infrastructure ~~circulation at the~~;
- f) Site Characteristics resulting of from monitoring of site  
~~Characteristics of site hazard hazards monitoring, hazard alerts [hazard alerts not mentioned elsewhere] and periodic review of the site re-evaluation conditions..[??]~~

~~4.45-4.49.~~ Prehistoric, historical and instrumentally recorded information and records of the occurrences and severity of important natural phenomena shall be obtained, if available, as appropriate for the hazard to be evaluated and shall be analysed for reliability, accuracy, temporal pertinence and completeness.

~~4.46-4.50.~~ The data shall be reviewed periodically, and/or as needed, as part of a review of the site evaluation ~~review~~ within the framework of periodic safety review, for example, to address evolutions-developments in data gathering, techniques ~~[?]~~ and, in the analysis;

storage, and use of data and to confirm that the data remain pertinent to the site in the face of evolving hazards.

~~4.47-4.51.~~ The data ~~collection~~collected~~ion~~; ~~analysis and processing methods~~ for the site investigations shall be sufficiently detailed to support the selected methodology for hazard evaluation~~safety decisions~~. ~~The data shall be maintained and the documentation shall be sufficiently detailed to permit an independent review.~~

~~4.48.~~ The details of ~~the information collected~~information collected for each hazard shall be appropriate to the distance from ~~(the source of the hazard to the site~~ ~~[what distance?]~~ and the potential impact on) the site.

~~4.49. Prehistoric, historical and instrumentally recorded information and records of the occurrences and severity of important natural phenomena shall be obtained, if available, as appropriate for the hazard to be evaluated and analysed for reliability, accuracy, temporal pertinence and completeness.~~

~~4.50-4.52.~~ The sources of uncertainties ~~related~~relating~~ed~~ to data collection shall be documented.

## 5. ~~SPECIFIC REQUIREMENTS FOR EVALUATION OF EXTERNAL~~ ~~EVENTS~~HAZARDS

5.1. This section ~~addresses~~ establishes requirements for the evaluation of external ~~events.~~  
~~They~~ hazards. ~~These~~ requirements are to be applied as appropriate for the type of nuclear  
installation as well as the ~~specific~~ site under consideration. ~~A justification shall be provided~~  
~~[to whom?]~~ for why a specific requirement external hazard is not included in the site  
evaluation shall be provided.

### SEISMIC HAZARDS

#### Requirement 15: ~~Fault~~Evaluation of F~~fault capability displacement hazard evaluation~~

Faults ~~beyond~~ within a certain size ~~range~~ and within a certain distance of the nuclear  
installation ~~critical~~ that are significant ~~[? what is critical to site safety? the fault? the~~  
~~size? the distance? the installation?]~~ to site safety shall be evaluated to identify whether  
these faults are to be considered as capable faults ~~the capability of the fault.~~ and For  
capable faults, potential challenge ~~challenges~~ to the safety of the nuclear installation site  
safety in terms of ground motion and/or fault displacement hazard shall be evaluated.

5.2. ~~Fault capability~~ Capable faults<sup>7</sup> ~~faults~~ shall be identified and evaluated. The evaluation  
shall consider the fault characteristics in the vicinity of the site. The methods ~~to be~~ [why 'to  
be?'] used and the investigations ~~to be~~ made shall be sufficiently detailed to support safety  
related decisions.

5.3. The ~~effect of~~ fault displacement on safety related structures, systems and components  
shall be evaluated ~~hazard shall be evaluated to provide the input needed for the design or~~  
~~upgrading of the structures, systems and components of the nuclear installation, as well as the~~  
~~safety analyses performed during the lifetime of the installation.~~ Evaluation of fault  
displacement hazard shall include detailed geological mapping of excavations for safety  
related engineered structures to enable evaluation of fault capability at the site.

5.4. If a capable fault is identified in the vicinity of the site of a new or an existing nuclear  
installation and the safety of the nuclear installation cannot be demonstrated, the site shall be

<sup>7</sup> A fault is considered capable if, on the basis of geological, geophysical, geodetic or seismological data (including palaeoseismological and geomorphological data), one or more of the following conditions applies:

- (a) ~~The~~ fault shows evidence of past movement or movements (significant surface 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 and/or exclusively 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 will be required.
- (b) A structural relationship with a known capable fault has been demonstrated such that movement of one could cause movement of the other at or near the surface.
- (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.

~~deemed unsuitable, if the safety of the site cannot be demonstrated. For a new nuclear power plant installation, an evaluation of fault displacement hazard shall include detailed geological mapping of excavations for safety related engineered structures to enable evaluation of fault capability at the site.~~

**Requirement 16: ~~Ground~~ Evaluation of Ground motion ~~hazard~~ hazards evaluation**

~~An evaluation of~~ ground motion ~~hazard~~ hazards ~~evaluation~~ shall be conducted to provide the input needed for the seismic design or ~~seismic~~ safety upgrading of the structures, systems and components of the nuclear installation, as well as for performing the deterministic and/or probabilistic safety analyses necessary during the lifetime of the nuclear installation.

5.5. Hazards due to earthquake induced ground motion shall be assessed ~~for the site with account taken, by means of appropriate methods, of the seismic source~~ source characteristics of the seismic source, and areas of diffuse seismicity, areas of the regional seismotectonics ~~seismotectonic characteristics of the region, seismic waves~~ wave propagation characteristics of the seismic wave and site specific conditions using proper methods. ~~appropriate methods. [this paragraph is incomprehensible - pls let's discuss]~~

5.6. The potential for seismicity due to human activities<sup>8</sup> shall be considered.

5.7. The effect of the vibratory ground motion ~~shall be considered~~ in combination with other seismically induced hazards, if any, shall be considered.

**VOLCANIC HAZARDS**

**Requirement 17: ~~Volcanic hazard~~ Evaluation of vVolcanic ~~hazard~~ hazards evaluation**

~~The hazard~~ Hazards due to volcanic activity that have the potential to affect the safety of the nuclear installation shall be evaluated.

5.8. Capable volcanos<sup>9</sup> shall be identified and evaluated. The evaluation shall consider the volcanic characteristics of the region ~~surrounding the site,~~ for sufficient distances to ~~assure~~ ensure that ~~the sources of~~ potentially hazardous volcanic phenomena ~~have been~~ are considered appropriately.

<sup>8</sup> Such as ~~construction of dams, mining, and operation of oil wells and gas wells operation, etc.~~

<sup>9</sup> A capable volcano ~~or volcanic field [volcanic field not in this text]~~ is ~~one a volcano~~ that: (i) has a credible likelihood of ~~experiencing~~ undergoing future activity and producing hazardous phenomena, including non-eruptive phenomena, during the lifetime of ~~the a nuclear installation concerned~~ and (ii) has the potential to produce phenomena that ~~which~~ may potentially affect the site ~~of the installation.~~



5.9. The hazards of capable volcanoes shall be evaluated to provide the input needed for ~~determining the site specific design parameters design basis or for upgrading-re-evaluating~~ of the ~~nuclear installation~~ site, as well as ~~the-for~~ deterministic and/or probabilistic safety analyses performed during the lifetime of the ~~nuclear~~ installation.

5.10. ~~For A proposed~~ new sites, ~~it~~ shall be screened out from the list of candidate sites, ~~when~~ ~~if~~ reliable evidence shows the existence of a capable volcano that has the potential to affect the safety of the nuclear installation ~~that-and which~~ cannot be compensated for through design ~~features and/or measures for~~ site protection ~~measures~~.

5.11. The volcanic hazards ~~assessment~~ shall be ~~assessed conducted~~ using ~~appropriately supporting numerical appropriate -information and models models, and shall consider, with and taking into account~~ adequately ~~account taken of~~ the uncertainties ~~in the information and models~~.

5.12. The effect of volcanic phenomena ~~shall be considered~~ in combination with other volcanically induced hazards, ~~shall be considered~~. This ~~should shall~~ include ~~a~~ consideration of volcanic ash fall.

#### METEOROLOGICAL AND HYDROLOGICAL HAZARDS

##### **Requirement 18: ~~Extreme~~Evaluation of Extreme meteorological hazards ~~evaluation~~**

~~The extreme~~Extreme meteorological and hydrological hazards and their possible combinations that have the potential to affect the safety of the nuclear installation shall be evaluated.

5.13. Meteorological ~~hazards-phenomena~~ such as wind, precipitation, snow and ice, air and water temperature, ~~lean temperature be a hazard?~~ humidity, storm surges and sand ~~-or~~ dust storms, as well as ~~the~~their plausible-credible [as para 4.33?] combinations, shall be evaluated for their extreme values<sup>10</sup> based on available ~~records documentation for an appropriate period of time~~. If necessary, efforts shall be made to extend the database on meteorological hazards (e.g. by incorporating paleo-meteorological paleo-historical -climate data, numerical models ~~or-and~~ simulations).

5.14. Appropriate methods shall be applied for deterministic and/or probabilistic evaluation of the hazards considering the ~~available~~ amount of data (available (both measured data and and historical data); and known past changes in relevant characteristics of the region.

<sup>10</sup> Extreme values of meteorological parameters are identified by means of statistical analysis of recorded parameters that are measured periodically on an ongoing basis.

**Requirement 19: ~~Rare~~Evaluation of Rare meteorological hazards ~~evaluation~~**

The potential for the occurrence of rare<sup>11</sup> meteorological ~~hazards~~events such as lightning, tornados and cyclones, including information on their severity and frequency, shall be evaluated for the site.

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*Lightning*

5.15. If the impact ~~to on~~ the safety of the nuclear installation cannot be screened out, the potential for the occurrence and the frequency and severity of lightning shall be evaluated for ~~the region of interestsurrounding the site vicinity. , together with the hazard posed by this phenomenon~~

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*Tornadoes and ~~c~~Cyclones*

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5.16. The potential for the occurrence ~~and the~~, frequency and severity of tornadoes, cyclones and associated missiles shall be evaluated in the region ~~of interestsurrounding the site, together with the hazard posed by these phenomena~~. The hazards associated with tornadoes and ~~or~~ cyclones 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.

**FLOODING ~~EVENTS~~HAZARDS**

**Requirement 20: ~~Flooding~~Evaluation of Fflooding hazards ~~evaluation~~**

~~The hazard~~Hazards due to flooding ~~for the nuclear installation~~ shall be evaluated for the site, considering natural causes and/or human induced events including their possible combinations.

*Floods due to precipitation and other causes*

5.17. The potential for flooding in the region surrounding the site due to one or more natural causes, such as storm surge, wind ~~generating~~generated waves, extreme precipitation (~~including such events~~ in combination due to a common cause or due to a relatively high frequency of occurrence), ~~which can affect the safety of the nuclear installation~~ shall be evaluated.

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<sup>11</sup> The terms 'rare' and 'extreme' are defined in IAEA document SSG-18, ~~better to provide the explanation here, not refer to a Safety Guide~~ Extreme values of meteorological parameters are identified by means of statistical analysis of recorded parameters ~~that are measured periodically on an ongoing basis.~~

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~~Rare meteorological parameters~~events are unlikely to be measured at any specific location because of their very low frequency of occurrence at any single place and the destructive effects of the phenomena, which may result in damage to standard measuring instruments.

5.18. Appropriate meteorological, hydrological and hydraulic models shall be developed to derive the flooding ~~hazard~~ hazards for the site, including secondary effects such as debris, ice and sediments. ~~Where it is feasible, information from studies paleo-of historic and prehistoric floods -studies should shall be used to inform estimates of the frequency and magnitude of riverine floods. frequency and magnitude estimates~~

5.19. The potential for instability of ~~the a~~ coastal area or river channel due to erosion or sedimentation shall be investigated.

*Water waves induced by earthquakes or other geological phenomena*

5.20. The potential for tsunamis or seiches in the region ~~surrounding the site~~ that can affect the safety of a nuclear installation on the site ~~shall~~ be evaluated. The potential for tsunamis or seiches from phenomena other than seismic sources shall be evaluated as appropriate for the region ~~surrounding the site~~.

5.21. The hazards associated with tsunamis or seiches shall be derived from ~~known~~ historical records, ~~available -on- prehistoric floods information~~ as well as from physical and/or analytical modelling. ~~These~~ Such hazards shall include potential draw-down and run-up<sup>12</sup> that can result in physical effects on the site.

5.22. The hazards associated with tsunamis or seiches, ~~with account taken of any amplification due to the coastal configuration at the site, such as nearshore bathymetry and coastal topography~~ shall be evaluated as appropriate for the region, ~~including artificial structures, with account taken of any amplification due to the coastal configuration including artificial structures at the site, such as using nearshore underwater bathymetry (bathymetry is the measurement of the underwater structure, not the underwater structure) and coastal topography.~~

*Floods and waves caused by failure of water control structures*

5.23. ~~The upstream~~ Upstream water control structures ~~such as dams~~ shall be analysed to determine ~~the potential hazard to the nuclear installation resulting from~~ associated with the failure of one or more of the upstream structures ~~such as dams~~, including ~~in in~~ combination with flooding from other causes.

5.24. If a preliminary examination of the nuclear installation indicates that it ~~is would not be~~ able to withstand safely the effects of the failure of one or more of the upstream structures,

<sup>12</sup> Draw-down is a lowering of the water level at a coastal site. Run-up is a sudden surge of water up a beach or a structure.

then the hazards associated with the nuclear installation shall be assessed ~~including with the inclusion of~~ such effects; ~~otherwise in the absence of such an assessment,~~ the site shall be deemed unsuitable.

5.25. Flooding and associated phenomena caused by storage of water as a result of a blockage of rivers ~~upstream~~ or downstream (e.g., caused by landslides or ice) or a change in land use shall be considered.

#### GEOTECHNICAL ~~AND GEOLOGICAL~~ HAZARDS

##### Requirement 21: Geotechnical characteristics and ~~geologiegeological~~ features of subsurface materials

The geotechnical characteristics and ~~geologiegeological~~ features of subsurface materials shall be investigated, and a soil and /rock profile for the site that considers the variability and uncertainty in subsurface materials shall be ~~determined~~ derived.

5.26. ~~Geologic features and~~ Static and dynamic geotechnical characteristics and ~~geologiegeological features (both static and dynamic)~~ of subsurface materials at the site, including any backfill, ~~at the site~~ shall be established. Laboratory and field-based methods shall be used, in conjunction with appropriate sampling techniques and sufficient repetition of each test, ~~shall be used to~~ characterize each parameter of the subsurface materials at the site.

5.27. The stability and bearing capacity of foundation materials shall be assessed, ~~to~~ including consideration of the potential for excessive settlement under static and seismic loading.

5.28. The physical and the geo-chemical properties of the soil and groundwater shall be studied by appropriate methods and ~~taken into account~~ for.

##### Requirement ~~221:~~ ~~Geotechnical~~2: Evaluation of ~~G~~geotechnical and hazard ~~geological~~ hazards evaluation

Geotechnical and geological hazards, including slope instability, collapse, subsidence or uplift, ~~soil and soil~~ liquefaction, zones of high geological stress and their effect on safety of the nuclear installation ~~structural deformation, -[is this the deformation of the structures of the installation?], and soft and organic weak soils and their effect on foundation stability~~ ~~[where does 'on foundation stability' fit into the sentence? could it actually be dropped?],~~ shall be evaluated.

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*Slope instability*

~~5.26-5.29.~~ The site and its vicinity shall be evaluated to determine the potential for slope instability (such as landslides, rock fall and snow avalanches) caused by natural or human induced phenomena that can affect the safety of the nuclear installation. In the evaluation of slope instability, the configuration of the site during and after site preparation activities shall be addressed. ~~Also #~~The evaluation of slope stability shall also take into account extreme meteorological conditions and rare events, ~~such as flooding~~.

~~5.27-5.30.~~ The potential for slope instability resulting from seismic loading ~~that can affect the safety of the nuclear installation~~ shall be evaluated ~~by~~ using parameters consistent with appropriate for describing the seismic ~~hazard~~hazards at the site including and the soil and ground water/groundwater characteristics at the site.

#### *Collapse, subsidence or uplift of the site surface*

~~5.28-5.31.~~ The ~~hazards associated with potential for the~~ collapse, subsidence or uplift of the surface that can affect the safety of the nuclear installation over its lifetime shall be evaluated using a detailed description of subsurface conditions obtained from reliable methods of investigation. Non-tectonic surface deformation at the site shall be included in the geotechnical hazard evaluation.

#### *Soil liquefaction*

~~5.29-5.32.~~ The potential for liquefaction and non-linear effects of the subsurface materials at the proposed site shall be evaluated ~~by~~ using parameters consistent with appropriate for describing the seismic ~~hazard at~~hazards and the site geotechnical properties of the subsurface materials at the site.

~~5.30-5.33.~~ The evaluation of soil liquefaction and in situ reinforcements shall include the use of accepted methods ~~offor~~ field and laboratory testing in combination ~~to~~ with analytical methods to determine the potential for hazards.

#### **~~Requirement 22: Geotechnical characteristics of subsurface materials~~**

**~~The geotechnical characteristics of the subsurface materials shall be investigated and a soil/rock profile for the site shall be determined.~~**

~~5.31.~~ The stability of the foundation material and potential excessive settlement under static and seismic loading shall be assessed.

~~5.32.~~ The groundwater regime and the chemical properties of the soil and groundwater shall be studied by appropriate methods and accounted for.

## OTHER NATURAL HAZARDS

### Requirement 23: Evaluation of other natural hazards

~~In addition to the natural hazard hazards previously addressed listed above,~~  
~~Other~~ **Other** natural phenomena that are specific to the region and **which** have the potential to affect the safety of the nuclear installations shall be investigated.

~~5.33-5.34. Other natural external hazards, such as like wild-fires, drought, hail, frazil ice formation, diversion of a river, debris avalanche and biological hazards (e.g. jelly-fish, small animals, s-and, barnacles, etc.) shall be identified and assessed so that the site specific design parameters for these events hazards can be derived. The design basis for other natural external hazards like wild fires, drought, hail, sub-surface freezing of subcooled water (frazil), diversion of a river and biological hazards (e.g. jelly fish, small animal, barnacle, etc.) shall be identified and assessed so that design basis for these events can be derived.~~

## HUMAN INDUCED EVENTS

### Requirement 24: Evaluation of hazards due to human induced events

The hazards due to human induced events within or outside the site **boundary area** shall be evaluated.

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~~5.34-5.35. Human induced events to be addressed shall include, but shall not be limited to, the hazards due to:~~

- a) ~~Events associated with~~ nearby land, sea or air transport (~~collision, explosion~~ e.g. collisions and explosions);
- b) ~~F~~ire, explosions, missile generation and releases of hazardous gases from ~~stationary sources such as nearby industries to industrial facilities to near~~ the site and;
- c) ~~E~~lectromagnetic interference.

~~5.35-5.36. Human activities which may that might influence the type or severity of natural hazards, such as resource extraction (e.g., hydraulic fracturing) or other significant re-contouring of land, or water such as or reservoir-induced seismicity, shall be considered. shall be considered.~~

#### *Aircraft crashes*

~~5.36-5.37. The potential for accidental aircraft crashes on the site shall be assessed with account taken, to the extent practicable, of the potential changes in future air traffic and aircraft characteristics that can affect the aircraft crash hazard.~~

*Chemical hazards*

~~5.37~~5.38. Current or foreseeable activities in the region surrounding the site 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 or detonation shall be addressed.

~~5.38~~5.39. Hazards associated with chemical explosions or other releases shall be expressed in terms of heat, overpressure and toxicity (if applicable), with account taken of the effect of distance, and the worst combinations of atmospheric conditions at the site. In A~~additionally,~~ the potential effects of such events on site- workers shall be evaluated.

6. ~~SPECIFIC REQUIREMENTS THE FOR EVALUATION OF~~ POTENTIAL  
EFFECTS OF THE NUCLEAR INSTALLATION ~~IN ON~~ THE REGION

~~This section addresses the requirements for assessing the impact of the nuclear installation on the surrounding population and the environment.~~

**Requirement 25: Dispersion of radioactive material**

~~Dispersion~~ The Ddispersion in air and water of radioactive material ~~in air and water~~ released from the nuclear installation under in normal operating operational states and accident conditions shall be assessed.

*Atmospheric dispersion of radioactive material*

6.1. The analysis of the atmospheric dispersion of radioactive material shall account for a description of regional orography, be based on a meteorological description of the region surrounding the site, including descriptions of the regional orography land cover and meteorological features of the region, including parameters ~~of meteorological phenomena~~ such as wind speed and direction, air temperature, ~~and quality,~~ precipitation, humidity, atmospheric stability parameters, ~~and~~ prolonged atmospheric inversions and any other parameters required for diversion modelling purpose. If possible, long-term meteorological data from for nearby locations should shall be obtained, evaluated for quality, and used.

6.2. 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 and sampling intervals. Data from at least one representative full year shall be collected and used in the analyses, together with any other relevant data that ~~can be are~~ available from other sources. The meteorological data shall be expressed in appropriate reflect the 'up to date' climate and meteorological parameters in an appropriate manner.

*Dispersion of radioactive material through surface water and ground-water*

6.3. A survey programme shall be designed to gather relevant data to characterize the hydrogeological and hydrological parameters at the site location and in the region to permit the assessment of dynamics of radionuclides in the potentially affected hydrological units and the subsequent assessment of the radiological impact. This programme of measurement shall be carried out for at least one full year prior to hydrogeological investigations (see para. 6.7).



The data shall be expressed in appropriate parameters for surface hydrology and groundwater.

6.4. A program of surface water investigations in the region (including the interactions between surface water and groundwater) shall be developed. The descriptions of the surface waters shall include the main physical and chemical characteristics of the water bodies, both natural and artificial, the major structures for water control, the locations of water intake structures and information on water use in the region.

6.5. A programme of measurement and investigations relevant for determining the radiological impact on the environment shall be carried out and used in the analyses to permit the assessment of radionuclide movement in the affected hydrological units. This programme of measurement shall be carried out for at least one full year prior to hydrogeological investigations (see para. 6.5). The data shall be expressed in appropriate parameters for surface hydrology and groundwater.  
A program of the hydrogeological investigations of the region shall be developed, including descriptions of the main characteristics of the water bearing formations and their interaction with surface water and data on the uses of groundwater in the region.

6.3-6.6. The programme of hydrogeological investigations shall include investigations of the migration and retention characteristics of radionuclides in groundwater and associated exposure pathways.

6.4. A description of the groundwater and surface water hydrological characteristics of the region (including the interaction with between surface water and groundwater) shall be developed for the region surrounding the site, including descriptions of the main characteristics of water bodies, both natural and artificial, the major structures for water control, the locations of water intake structures and information on water use in the region, so that relevant information is available for the radiological environmental impact assessment.

6.5. A programme of measurement shall be carried out to gather data relevant for the assessment of radionuclide movement in the affected hydrological units. A programme of investigation and measurements of the surface hydrology and groundwater shall be carried out for at least one full year prior to submittal of the site evaluation report and used in analyses to determine to the extent necessary the dilution and dispersion characteristics of water bodies, the re-concentration ability of sediments and biota, migration and retention characteristics of radionuclides and the determination of transfer mechanisms of radionuclides in the hydrosphere and along exposure pathways.

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6.7. The hydrogeological and hydrological investigations shall determine to the extent necessary the dilution and dispersion characteristics of water bodies, the re-concentration ability of sediments and biota, migration and retention characteristics of radionuclides and the determination of transfer mechanisms of radionuclides in the hydrosphere and along exposure pathways.

~~6.6. these investigations of hydrogeological investigations associated A programme of hydrogeological investigations shall be carried out prior to submission of the site evaluation report and used in the analyses to assess radionuclide movement in hydrogeological units. This programme shall include investigations of the migration and retention characteristics of radionuclides in groundwater and their exposure pathways.~~

~~6.7. A description of the groundwater hydrology of the region shall be developed, including descriptions of the main characteristics of the water bearing formations and, their interaction with surface water and data on the uses of groundwater in the region.~~

**Requirement 26: Population distribution and public exposure of the public**

The distribution of the population within the region over the lifetime of the nuclear installation shall be determined projected and evaluation of the potential impact of radioactive releases, ~~either due to normal operation in both operational states and or under accident conditions~~, on the population shall be performed conducted and periodically updated.

6.8. Information on existing and projected population distributions in the region, including resident populations and to the extent possible transient ~~populations, populations~~ shall be collected and kept up to ~~date date~~ over the lifetime of the nuclear installation. Special attention shall be paid to vulnerable populations and residential institutions such as schools, hospitals and prisons when evaluating the potential impact of radioactive releases and considering the feasibility ~~to implement of implementing~~ protective ~~actions, measures, for site protection~~

6.9. The most recent census data for the region, or information obtained by extrapolation of the most recent data on resident and temporary ~~population populations, data~~ shall be used in obtaining the population distribution. In the absence of reliable data, a special study shall be carried out.

6.10. The data shall be analysed to obtain the population distribution in terms of the direction and distance from the nuclear installation. This information shall be used to ~~perform carry out~~ an evaluation of the potential radiological impact 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 and models as appropriate.

**Requirement 27: Uses of land and water in the region surrounding the site**

**The uses of land and water shall be characterized in order to assess the potential effects of the nuclear installation ~~in-on~~ the region surrounding the site.**

6.11. The investigation shall cover land and resources of surface water and ground-waters that ~~may-might~~ be used by the population or that serve as a habitat for organisms in the food chain.

## 7. MONITORING AND PERIODIC ~~RE-EVALUATION~~REVIEW OF THE SITE

~~This section provides requirements for the monitoring of hazards and the periodic reassessment of site-related hazards and conditions that can affect safety over the entire lifetime of the nuclear installation.~~

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### Requirement 28: Monitoring of external hazards and site conditions

All external natural and human induced hazards and site conditions that are pertinent to the licensing and safe operation of the nuclear installation shall be monitored over the entire lifetime of the nuclear installation.

7.1. This monitoring shall be commenced no later than the start of construction and shall be continued ~~up~~ until decommissioning. The monitoring plan shall be developed as part of the objectives and scope of the site evaluation.

7.2. The monitoring plan shall include the monitoring target and the type of data, the location, methodology, for data collection, including the location and frequency, of data collection, the necessary resolution and precision, data recovery requirements ~~and~~, operational procedures and management, as well as requirements ~~for~~ data processing and analysis.

7.3. Before commissioning of the nuclear installation begins, the ~~background~~ambient~~background~~ radioactivity of the atmosphere, hydrosphere, lithosphere and biota in the region shall be assessed so as to be able to determine the additional effects of the operation of the nuclear installation.

### Requirement 29: ~~Reassessment~~Review of external hazards and site conditions

All external natural and human induced hazards and site conditions ~~that are covered in this Safety Requirements publication~~ shall be periodically reviewed ~~reassessed~~ by the operating organization as part of periodic safety reviews and as appropriate throughout the operating lifetime of the nuclear installation, with due account taken of operating experience and ~~significant~~ new safety related information ~~from the relevant sources~~.

7.4. As part of ~~safety reviews such as~~ periodic safety reviews or safety assessments under alternative arrangements, external natural and human induced hazards and site conditions shall be ~~reviewed, and reassessed~~ re-evaluated ~~if necessary~~ based on using updated information throughout the lifetime of the nuclear installation, at regular intervals and as frequently as necessary (typically no less than once in ten years) and in the event of any of the following:

- a) An update of the regulatory requirements;
- b) ~~Inadequate~~ Indications of inadequate design against external hazards;
- c) New technical findings, such as the vulnerability of ~~selected-particular~~ structure systems and components ~~s and/or non-structural elements~~ to any external hazards;
- d) New information, experience and lessons from the occurrence of actual external events affecting the safety of another nuclear installations or hazardous ~~facilities~~ industrial facilityies;
- e) Changes of hazards over time, for which new information and assessments ~~are~~ have become available;
- f) ~~To~~ A need To provide confidence that there are sufficient margins to prevent cliff edge effects;
- g) As part of a programme of long term operation, or in support of an application for a life extension.
- g)h) The development of Nnew methods to analyse hazards are developed that substantially improve the earlier estimates.

7.5. ~~The implications of such a reassessment~~ If necessary, based on the outcome of the periodic review of site specific hazards or of data relevant for the radiological environmental impact assessment for the safe operation of the nuclear installation, ~~shall be evaluated. The outcome of such an evaluation may result into a reassessment of the site specific hazards and/or the~~ of the data site conditions shall be re-evaluated if necessary.



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