ASSESSMENT OF SITE CHARACTERISTICS

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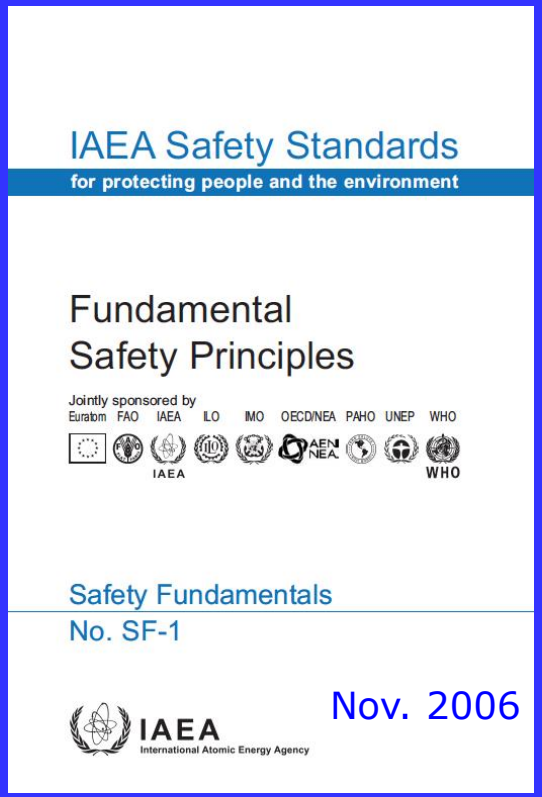
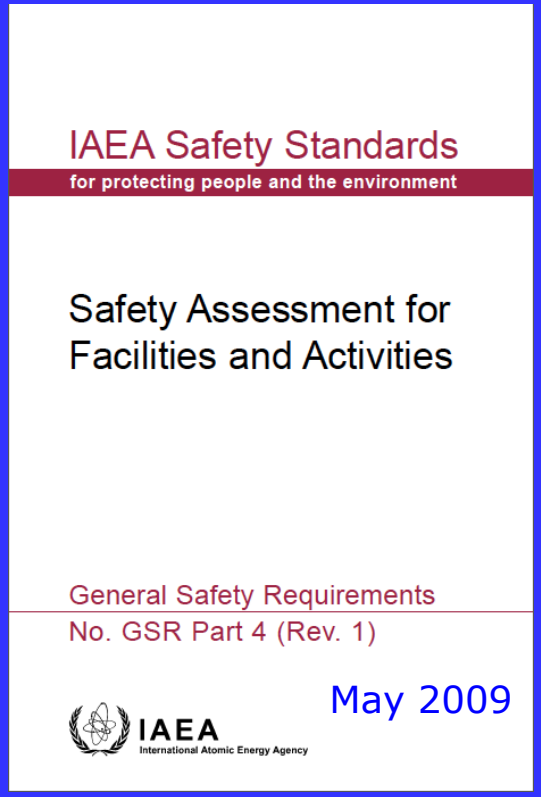
Trieste, October 9 of 2017

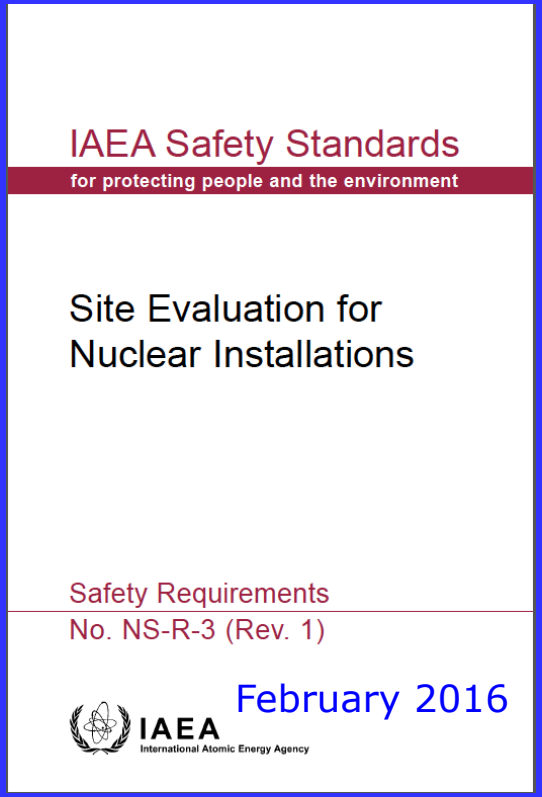
CONTENT

1 REGULATION AND SITE ASSESSMENT SCOPE

REGULATION OF FIRST ORDER



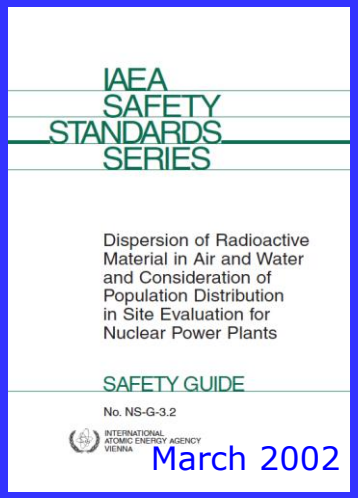




1 REGULATION AND SITE ASSESSMENT SCOPE

SAFETY GUIDES

http://www-ns.iaea.org/committees/files/CSS/205/status.pdf



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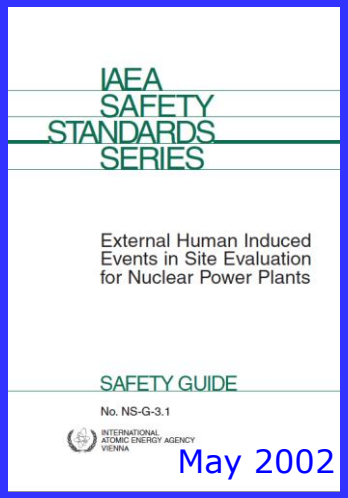

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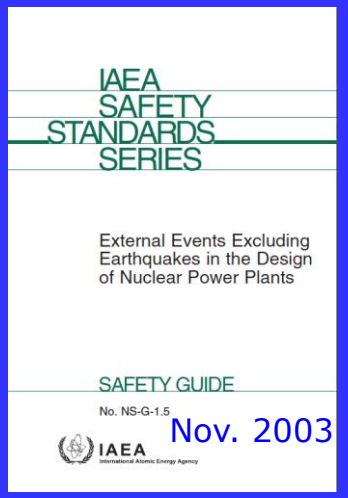

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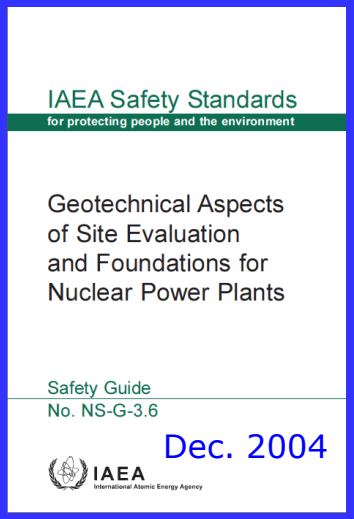

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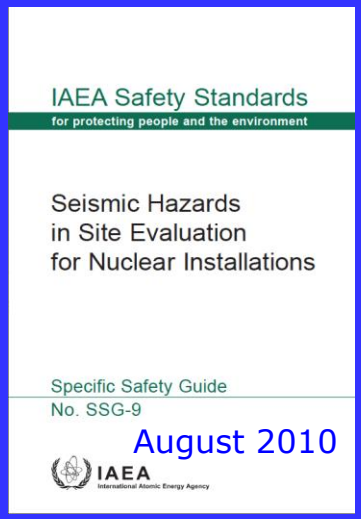

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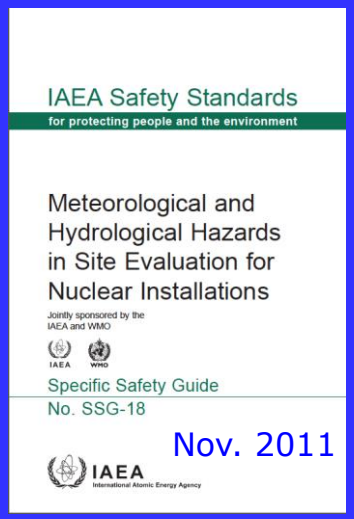

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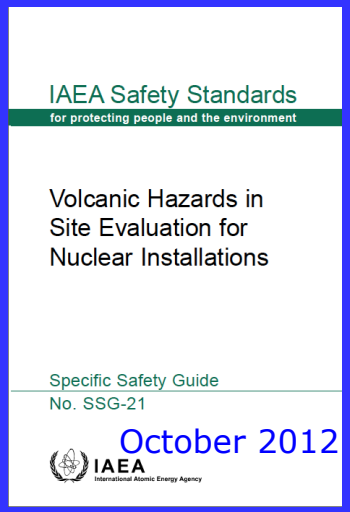

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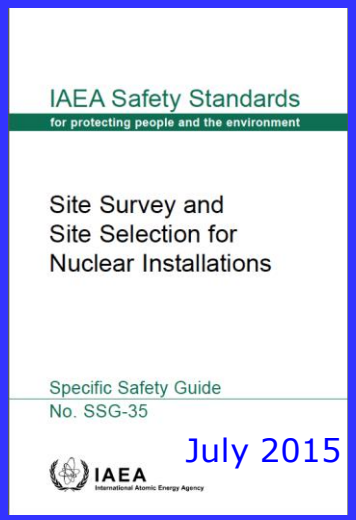

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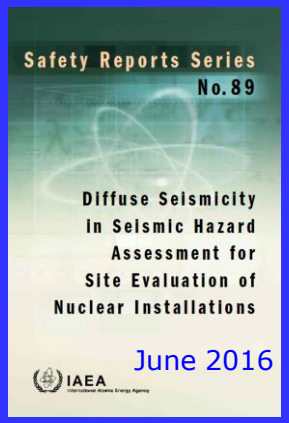
1 REGULATION AND SITE ASSESSMENT SCOPE



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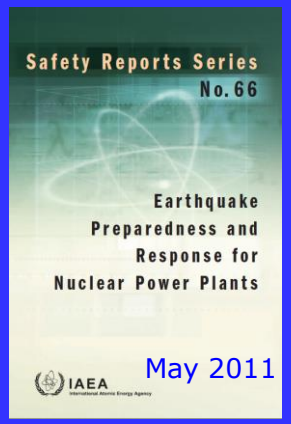

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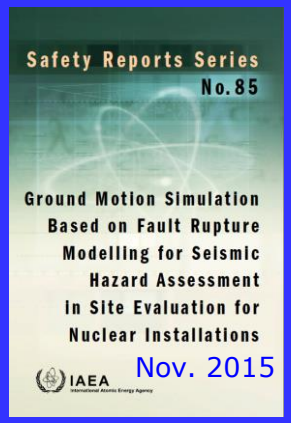
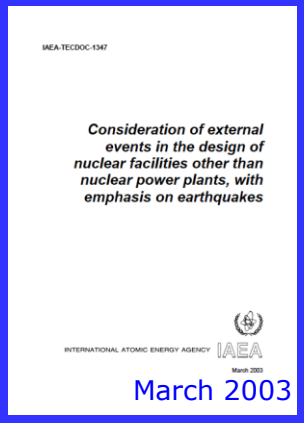


Nov. 2015

SAFETY REPORTS

AND

TECDOCS



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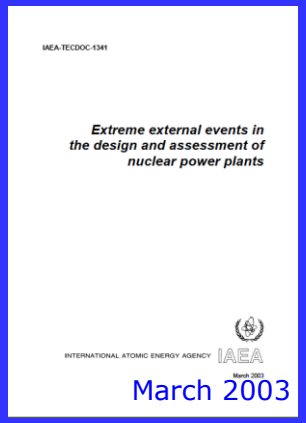

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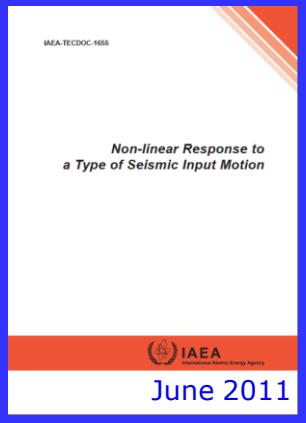

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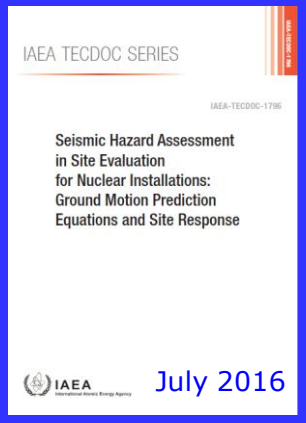

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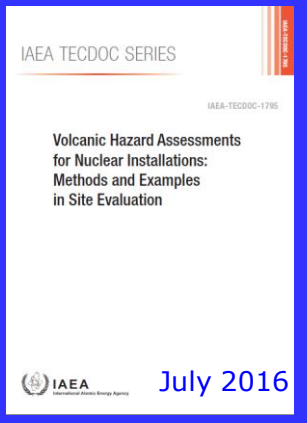

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1 REGULATION AND SITE ASSESSMENT SCOPE

SITE ASSESSMENT:

✓ **Concept** (IAEA Safety Glossary, 2007): Analysis of those factors at a site that could affect the safety of a facility or activity on that site.

This includes (a) site characterization, (b) consideration of factors that could affect safety features of the facility/activity resulting in a release of radioactive material and/or could affect the dispersion of such material in the environment, (c) population and (d) access issues relevant to safety (e.g. feasibility of evacuation, location of people and resources).

For a NPP site, this term normally refer the analysis of the origins (sources) of external events that could give rise to hazards with potential consequences for the safety of the NPP sited on that place.

1 REGULATION AND SITE ASSESSMENT SCOPE

SF-1:

✓ § **2.1**. The fundamental safety objective is to protect people and the environment from harmful effects of ionizing radiation. To ensure this statement, measures have to be taken:

(a) To control the radiation exposure of people and the release of radioactive material to the environment;

(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) To mitigate the consequences of such potential events.

§ **2.2**. This objective applies for all N.I. and activities and for all stages over the lifetime of a N.I. or radiation source, including planning, siting, design, manufacturing, construction, commissioning, and operation, as well as decommissioning and closure.

1 REGULATION AND SITE ASSESSMENT SCOPE

SF-1:

✓ **Addressing Principles 8 and 9**:

Principle 8. The primary mean of preventing and mitigating the accident consequences is '*defence in depth*'. One element of the *defence in depth* is an adequate site selection, a good design and engineering features providing safety margins, and to provide diversity, independency and redundancy in the design of safety systems.

Principle 9. The site evaluation process shall identify the reasonably foreseeable external hazards, including those of very low probability, the site characteristics that can affect the interactions between the N.I. the environment and the population, and also assessing the implementation of emergency response actions.

1 REGULATION AND SITE ASSESSMENT SCOPE

GSR, Part 4, Rev. 1:

Requirement 8. Assessment of site characteristics:

✓ § **4.22**. An assessment of the site characteristics relating to the safety of the facility/activity shall be carried out that shall cover:

(a) The physical, chemical and radiological characteristics of the site that will affect the dispersion or migration of radioactive material released in normal operation or as a result of anticipated operational occurrences or accident conditions;

(b) Identification of external events in the region that have the potential to affect the safety of facilities and activities;

(c) The distribution of the population around the site with regard to any siting policy, the potential for neighbouring States to be affected and the requirement to develop an emergency plan.

1 REGULATION AND SITE ASSESSMENT SCOPE

GSR, Part 4, Rev. 1. Graded Approach

✓ § **4.23**. The scope and level of detail of the site assessment shall be consistent with the possible radiation risks for the people and the environment, associated with the facility/activity, the type of facility to be operated or activity to be conducted, and the purpose of the assessment. The site assessment shall be reviewed periodically over the lifetime of the N.I. or activity:

NS-R-3, Rev. 1. Graded Approach

✓ § **1.9 / 1.10**. The level of the detail needed in an evaluation will vary according to the type of installation being sited. NPPs will generally require larger coverage and the highest level of detail, but depending on the level of risks posed by the installation, less detail and smaller areas of coverage may be sufficient to comply with this requirements.

1 REGULATION AND SITE ASSESSMENT SCOPE

SSG- 35:

✓ § **2.4**. The site evaluation continues throughout the operating lifetime of the N. I. and taking into account changes in site characteristics, the availability of data and information, operational records, regulatory approaches, evaluation methodologies and new safety standards. He is a very large process that extends from the last stage of the siting process to:

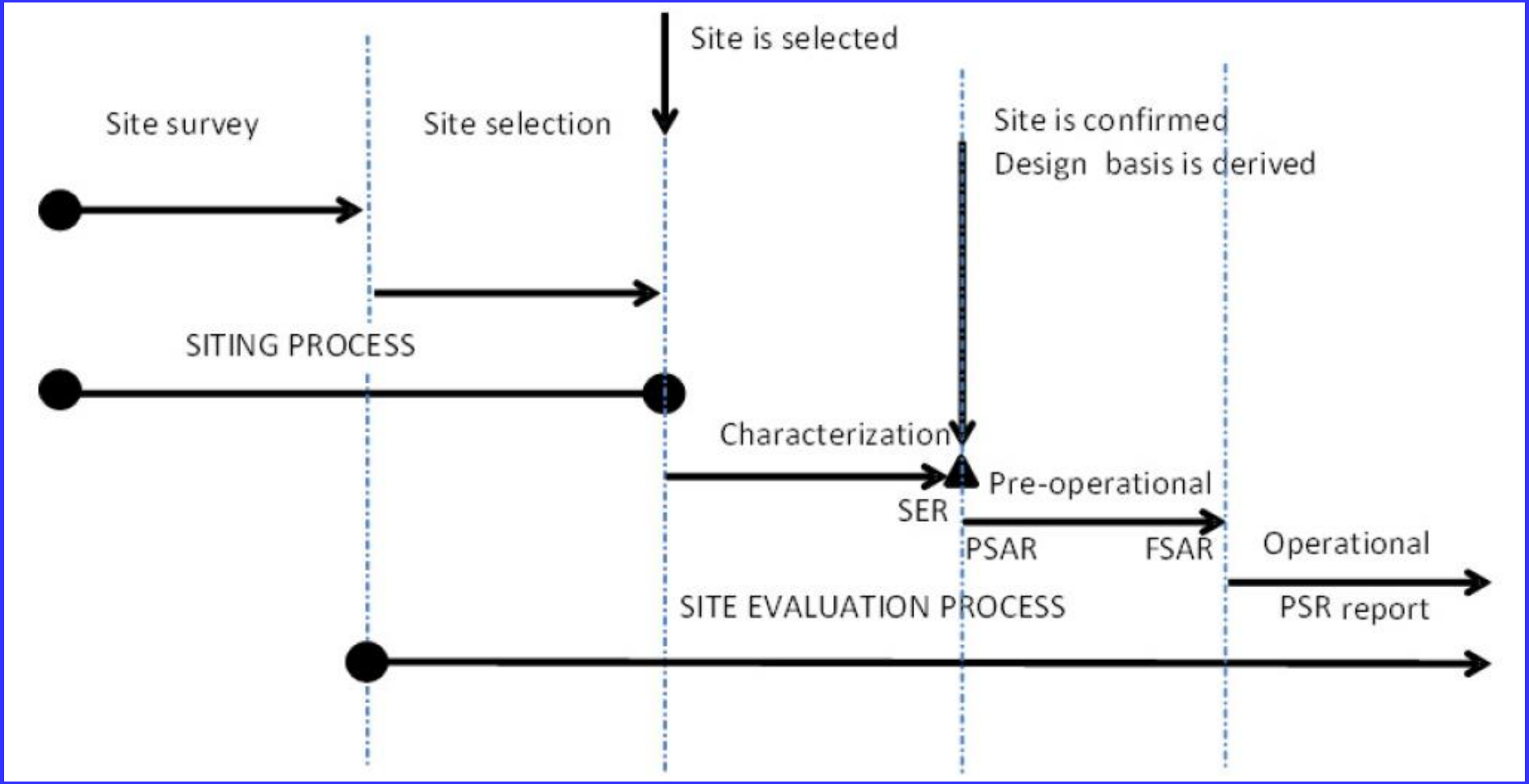
(a) The detailed site characterization stage for the selected site to confirm its suitability, its characterization and derivation of the site related design basis for the N.I.;

(b) The confirmation and completion of the assessment at the pre-operational stage for the N.I. (design, construction, assembly and commissioning stages);

(c) The operational stage of the N.I. included within the framework of periodic safety review.

1 REGULATION AND SITE ASSESSMENT SCOPE

SSG- 35:



2 GENERAL REQUIREMENTS FOR SITE EVALUATION.

NS-R-3, Rev. 1. Management System for Site Evaluation:

- ✓ § **6.1**. 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 for the N.I.
- ✓ § **6.2**. The QAP shall cover the organization, planning, work control, personnel qualification and training, verification and documentation for the activities to ensure that the required quality of the work is achieved.
- ✓ § **6.3**. The QAP is a part of the overall QAP for the N.I. However, since activities for site investigation are normally initiated long before the establishment of a nuclear project, the QAP shall be established at the earliest possible time consistent with its application in the conduct of site evaluation activities for the N.I.

2 GENERAL REQUIREMENTS FOR SITE EVALUATION.

NS-R-3, Rev. 1. Management System for Site Evaluation:

- ✓ **§ 6.4 / § 6.5 / § 6.9**. The results of site investigations shall be compiled in a report that documents all in situ works, laboratory tests and geotechnical analyses and evaluations.

  The documented detail shall be enough to permit a peer review, and records of the works carried out for site evaluation shall be kept.

- ✓ **§ 6.6**. A QAP shall be implemented for all activities that could influence safety or the derivation of parameters for the design basis for the site.

  The QAP may be graded in accordance with the importance to safety of the individual siting activity under consideration.

2 | GENERAL REQUIREMENTS FOR SITE EVALUATION.

NS-R-3, Rev. 1. Management System for Site Evaluation:

- ✓ § **6.7**. If any site parameters and analysis not lend themselves to direct verification by inspections, tests or other techniques that can be precisely defined and controlled, their evaluation shall be reviewed and verified by entities separates from those who did the work.
- ✓ § **6.8**. The assessment of site hazards important to the N.I. safety and safety related structures, such as liquefaction, swelling, subsidence, slope stability or earth and buried structures, include analyses of feedback experience of failures in comparable situations.

2 GENERAL REQUIREMENTS FOR SITE EVALUATION.

NS-R-3, Rev. 1. Safety Objectives in Site Evaluation for NN.II.:

✓ § **1.4**. This safety requirements are established to be applied as appropriate to site and site–installation interactions in operational states and accident conditions, including those interactions that could lead to conditions that warrant emergency response actions, for:

(a) Defining the extent of information on a proposed site to be presented by the applicant;

(b) Evaluating a proposed site to ensure that the site related phenomena and characteristics are adequately taken into account;

(c) Analysing the characteristics of the population of the region and the capability of implementing emergency plans over the projected lifetime of the N.I.;

(d) Defining site related hazards.

2 GENERAL REQUIREMENTS FOR SITE EVALUATION.

NS-R-3, Rev. 1. Safety Objectives in Site Evaluation for NN.II.:

✓ § **2.1**. The main objective in site evaluation for N.I. in terms of nuclear safety is to protect the public and the environment from radiological consequences of radioactive releases due to accidents. Radioactive releases due to operation shall also be considered. Following aspects shall be considered:

(a) Effects of external events;

(b) Site characteristics and its environment that could influence the transfer to persons and to the environment of radioactive releases;

(c) Population density and distribution and other characteristics in so far as they could affect the implementing of emergency actions and the need to evaluate the risks to individuals and to the population

2 GENERAL REQUIREMENTS FOR SITE EVALUATION.

NS-R-3, Rev. 1. Safety Objectives in Site Evaluation for NN.II.:

- ✓ § **2.13**. The total nuclear capacity to be installed on the site shall be determined as far as possible at the first stages of the siting process. If the installed capacity will be increased to a level greater than that previously determined to be acceptable, the suitability of the site shall be re-evaluated.
- ✓ § **4.15**. Before commissioning of the N.I. the ambient radioactivity of the atmosphere, hydrosphere, lithosphere and biota in the region shall be assessed so as to be able to determine the effects of the N.I.

  The data thus obtained are intended for use as baseline of the background data in future investigations.

2 | GENERAL REQUIREMENTS FOR SITE EVALUATION.

NS-R-3, Rev. 1. Scope of the Site Evaluation for NN.II.:

- ✓ **§ 1.6**. The scope encompasses site and site–installation interaction factors relating to all operational states and accident conditions (including those that could warrant emergency actions), and also the external events that are important to safety.

  The term "external events" cover the natural and human induced events external to the N.I. that are important to safety. The human induced events considered are all of accidental origin.

- ✓ **§ 1.3**. A fully characterization of site-specific external events conditions pertinent to the safety of the N.I. shall be done.

2 | GENERAL REQUIREMENTS FOR SITE EVALUATION.

NS-R-3, Rev. 1. Scope of the Site Evaluation for NN.II.:

✓ § **1.7**. The phrase 'external to the N.I.' is intended to include more than the external zone. In addition the site area itself could contain objects that pose a hazard to the installation, such as an oil storage tank for diesel generators or another reactor on a multiunit site.

External Zone Concept (IAEA Safety Glossary, 2007): 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.

2 GENERAL REQUIREMENTS FOR SITE EVALUATION.

NS-R-3, Rev. 1. Scope of the Site Evaluation for NN.II.:

- ✓ **§ 1.11**. The site evaluation shall ensure that combination of site/installation factors does not constitute an unacceptable risk to individuals, population or environment over the lifetime of the N.I.
- ✓ **§ 1.12**. A comprehensive risk analysis includes all sequential steps of analysing all the initiating events, following for each initiating event all the possible sequences of subsequent events, associating a probability value with each of these sequences and finally assessing the consequences for individuals, population and the environment.

2 GENERAL REQUIREMENTS FOR SITE EVALUATION.

NS-R-3, Rev. 1. Scope of the Site Evaluation for NN.II.:

✓ § **2.27**. The combined site/installation effects shall be such that:

(a) During all operational states the population exposure remains as low as reasonably achievable and is in compliance with national requirements, with account taken of international recommendations;

(b) The population radiation risks associated with accident conditions are acceptably low.

✓ § **2.24**. The site and the design for the N.I. shall be examined in conjunction to ensure that the radiation risks to the public and to the environment associated with radioactive releases are acceptably low.

✓ § **2.6**. If necessary, appropriate measures shall be taken to ensure that the overall risk from the N.I. remains acceptably low.

2.1 REQUIREMENTS USING THE GRADED APPROACH.

NS-R-3, Rev. 1. Site Suitability:

- ✓ **§ 1.8 / 1.15 / 2.1 / 2.2 / 2.4 / 2.6 / 2.9 / 2.13 / 2.25 / 2.27 / 2.28 / 3.7 / 3.10 / 3.25 / 3.35 / 3.36 / 3.40 / 3.47 / 3.48 / 3.50 / 3.51 / 3.55**

2.1 REQUIREMENTS USING THE GRADED APPROACH.

NS-R-3, Rev. 1. Site Suitability:

- ✓ For site suitability evaluation purposes, the following issues related to the safety of the N.I. from other installations located in the site region or within the site fence, included collocated units and other installations are considered:
  - Possibility to give rise missiles of any type;
  - Storage and transport of input and output materials (uranium ore, UF6, UO2, etc.), fresh fuel and spent fuel and radioactive waste;
  - Activities 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;
  - Potential effects of electromagnetic interference, eddy currents in the ground and the clogging of air or water inlets by debris.

2.1 REQUIREMENTS USING THE GRADED APPROACH.

NS-R-3, Rev. 1. Site Suitability:

- ✓ Assessing the site suitability is primarily concerned with the later stage of the sitting process for a N.I.; and the site suitability shall be confirmed during the lifetime of the N.I.
- ✓ The site shall be deemed unsuitable if the site evaluation or follow up reviews, shows that site deficiencies highlighted from the site evaluation results could not be compensate by practicable measures (design features, site protection or administrative procedures), to meet the protection requirements of the individuals and the environment from radiological consequences of radioactive releases under all operational stages or accident conditions (including those that could warrant emergency actions).

2.1 REQUIREMENTS USING THE GRADED APPROACH.

NS-R-3, Rev. 1. Site Suitability:

- ✓ If there is reliable evidence of any of the the following hazards from external events, that hazard is an exclusionary criteria and the site shall be deemed unsuitable for locate a N.I.:
  - Collapse, subsidence/uplift of the surface (swelling, karstification);
  - Soil liquefaction;
  - A capable fault;
  - Potential aircraft crashes;
  - Potential chemical explosions from activities at the site-region.
- ✓ The suitability of the site will be re-evaluated if the total nuclear inventory defined at the beginning increases significantly with respect to what was initially established as acceptable.

2.1 REQUIREMENTS USING THE GRADED APPROACH.

NS-R-3, Rev. 1. Site and Regional Characteristics:

- ✓ § **2.4**. Both, site characteristics that could affect the safety of the N.I., and characteristics of the environment that might be affected by potential radiological impacts in operational states and in accident conditions shall be investigated. All these characteristics shall be observed and monitored throughout the lifetime of the N.I.
- ✓ § **2.19**. The size of the region to identify the hazards associated with major external phenomena shall be large enough to include all the features that could be significant for the determination of the external events under consideration and for the characteristics of the event.
- ✓ § **2.20**. Major external events shall be expressed in terms that can be used as input for deriving the hazards associated with the N.I.; that is, appropriate parameters for describing the hazard shall be selected or developed.

2.1 REQUIREMENTS USING THE GRADED APPROACH.

NS-R-3, Rev. 1. Site and Regional Characteristics:

✓ § **2.29**. The external zone for a proposed site shall be established with account taken of the potential for radiological consequences for people and the feasibility of implementing emergency plans, and of any external events or phenomena that might hinder their implementation.

The region shall be analysed to evaluate the current and foreseeable future characteristics that can have an impact safety of the N.I. This includes distribution of the population in the region, the present and future use of land and water, the development of existing installations and human activities or the construction of facilities that can impact on the safety of the N.I., and the feasibility of planning to implement emergency response actions effectively.

2.1 REQUIREMENTS USING THE GRADED APPROACH.

NS-R-3, Rev. 1. Screening of the Site Specific Hazards:

- ✓ § **2.14 / 2.15**. All possible external events in the site region shall be identified and evaluated according to their significance for the safe operation of the N.I. This evaluation shall be used to identify the important external events in association with which potential hazards are to be investigated.
- ✓ § **2.5 /2.7**. Sites for locate a N.I. shall be evaluated with regard to the frequency and severity of external events, and potential combinations of such events that could affect the safety of the N.I.
- ✓ § **2.5A**. Information on frequency and severity derived from the characterization of the hazards resulting from external events shall be used in establishing the design basis hazard level for the N.I. Account shall be taken of uncertainties in the design basis hazard level.

2.1 REQUIREMENTS USING THE GRADED APPROACH.

NS-R-3, Rev. 1. Screening of the Site Specific Hazards:

- ✓ § **2.18**. Appropriate methods of screening shall be adopted for establishing the hazards associated with major external phenomena. The methods shall be justified in terms of being up to date and compatible with the characteristics of the region.

  Special consideration shall be given to applicable probabilistic methodologies (probabilistic hazard curves are generally needed to conduct probabilistic safety assessments for external events).

- ✓ § **2.18**. Events of high severity but low probability (e.g. smaller than 10^{-4} the threshold used for defining the hazard severity for design, and higher than 10^{-5} / 10^{-6}, for CDF/LERF) that could contribute to the overall risk shall be included in the site evaluation process; and events of low severity but high probability that could contribute to the overall risk shall also be included in the site evaluation process.

2.1 REQUIREMENTS USING THE GRADED APPROACH.

NS-R-3, Rev. 1. Evaluation of External Events:

- ✓ § **1.11 / 2.4 / 2.8**. Hazard assessments 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 of site conditions in time shall be evaluated.
- ✓ § **2.21**. In the determination of hazards, site specific data shall be used, unless such data are unobtainable. In this case, data from other regions that are sufficiently relevant may be used in the determination of hazards. Appropriate and acceptable simulation techniques may also be used. In general, data obtained for analogue events and simulation techniques could be used to augment the site specific data.

2.1 REQUIREMENTS USING THE GRADED APPROACH.

NS-R-3, Rev. 1. Site Protection Measures:

✓ § **2.6**. The foreseeable evolution of external factors (natural and human-made) that could have a bearing on safety shall be evaluated for a time period that encompasses the projected lifetime of the N.I. These factors, and in particular population growth and population distribution, shall be monitored over the lifetime of the N.I.

If necessary, appropriate measures shall be taken to ensure that the overall risk remains acceptably low. There are three means available to ensure that risks are acceptably low: design features, measures for site protection and administrative procedures. Design features and protective measures are the preferred means of ensuring that risks are kept acceptably low.

2.1 REQUIREMENTS USING THE GRADED APPROACH.

NS-R-3, Rev. 1. Site Evaluation for Multiple N.I. at the same site and co-located sites:

- ✓ **§ 2.11**. 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.
- ✓ **§ 2.13A**. An assessment shall be made of the feasibility of implementation of emergency plans. All on-site and collocated installations shall be considered in the assessment, with special emphasis on N.I. that could concurrently experience accidents.

2.1 REQUIREMENTS USING THE GRADED APPROACH.

NS-R-3, Rev. 1. Site Evaluation for Multiple N.I. at the same site and co-located sites:

✓ **§ 3.51**. The region shall be investigated for installations (including collocated units of NPPs and installations within the site boundary) where flammable, explosive, asphyxiant, toxic, corrosive or radioactive materials are stored, processed, and transported, that if released under normal or accident conditions, could jeopardize the safety of the N.I.

This investigation shall also include installations that could give rise to missiles that could affect the safety of the N.I.

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.

2.1 REQUIREMENTS USING THE GRADED APPROACH.

NS-R-3, Rev. 1. Change of Hazards and Site Characteristics with Time:

- ✓ § **2.6**. The foreseeable evolution of external events factors in the region that could have a bearing on safety shall be evaluated for a time period that encompasses the projected lifetime of the N.I. These factors, and in particular population growth and distribution, shall be monitored over the lifetime of the N.I.
- ✓ § **2.16 / 2.26**. The region shall be studied to evaluate the present and foreseeable distribution of the population and future characteristics, including uses of water and land use such as the expansion of existing installations and human activities or the construction of high risk installation; account shall be taken of any special characteristics that could affect the potential consequences of radioactive releases for individuals and the population as a whole.

2.1 REQUIREMENTS USING THE GRADED APPROACH.

NS-R-3, Rev. 1. Considerations for the Ultimate Heat Sink:

✓ § **3.53**. In the design of systems for long term heat removal from the core, site related parameters such as the following shall be considered:

(a) Air temperatures and humidity;

(b) Water temperatures;

(c) Available flow of water, minimum 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.

2.1 | REQUIREMENTS USING THE GRADED APPROACH.

NS-R-3, Rev. 1. Considerations for the Ultimate Heat Sink:

✓ § **3.54**. Potential external 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 as the blockage or diversion of a river, the depletion of a reservoir, an excessive amount of marine organisms, the blockage of a reservoir or cooling tower by freezing or the formation of ice, ship collisions, oil spills and fires.

If the probabilities and consequences of such events cannot be reduced to acceptable levels, then the hazards for the N.I. that are associated with such events shall be established.

2.1 REQUIREMENTS USING THE GRADED APPROACH.

NS-R-3, Rev. 1. Potential Effects of the N.I. on the Population and the environment:

- ✓ § **2.22**. To determine the potential radiological impacts on the region for operational states and accident conditions that could warrant emergency response actions, the site evaluation shall be made appropriate estimates of expected or potential releases of radioactive material, with account taken of the design of the N.I. and its safety features. These estimates shall be confirmed when the design and its safety features have been confirmed.
- ✓ § **2.12**. The site evaluation shall be consider relevant factors as population distribution, dietary habits, uses of land and water, and any other releases of radioactive material.

2.1 REQUIREMENTS USING THE GRADED APPROACH.

NS-R-3, Rev. 1. Potential Effects of the N.I. on the Population and the environment:

- ✓ § **2.23**. The direct and indirect pathways by which radioactive material released from the N.I. could potentially reach and affect people and the environment shall be identified and evaluated.

  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.

- ✓ § **4.14**. The uses of land and water shall be characterized in order to assess the potential effects of the N.I. in the region and in particular for the purposes of preparing emergency plans. The investigation shall cover land and water bodies that may be used by the population or that could serve as a habitat for organisms in the food chain.

2.1 REQUIREMENTS USING THE GRADED APPROACH.

NS-R-3, Rev. 1. Feasibility of Planning to Implement Emergency Response Actions Effectively:

✓ § **2.29**. Before the N.I. construction, it shall be confirmed that there will be no insurmountable difficulties in establishing an emergency plan for the external zone before the starting the N.I. operation.

The site evaluation cover also the infrastructures in and other characteristics of the external region where emergency response actions may be warranted.

A causal relationship between external events and installation conditions shall be considered in evaluating the feasibility of planning to implement emergency response actions effectively.

2.1 REQUIREMENTS USING THE GRADED APPROACH.

NS-R-3, Rev. 1. Data Collection in Site Evaluation for N.I:

✓ § **2.17**. Prehistoric, historical and instrumental information of the occurrences and severity of external events with the potential to give rise to adverse effects on the safety of the N.I. over his lifetime shall be collected for the region and shall be carefully analysed for reliability, accuracy and completeness.

Associated uncertainties shall be documented.

Collected data shall be reviewed periodically, within the framework of periodic safety review, (to address evolutions in data gathering, analysis, storage and use) and to confirm that the data remain pertinent to the site in the face of evolving hazards.

3 SPECIFIC REQUIREMENTS FOR EE.EE. EVALUATION.

NS-R-3, Rev. 1. Seismic Hazards Evaluation. Fault Displacement:

- ✓ § **3.1**. The seismological and geological conditions in the region and the engineering geological aspects and geotechnical aspects of the site area shall be evaluated.
- ✓ § **3.2**. Information on prehistoric, historical and instrumentally recorded earthquakes in the region shall be collected and documented.
- ✓ § **3.5**. The potential for surface faulting shall be assessed for the site. The methods to be used and the investigations to be undertaken shall be sufficiently detailed that a reasonable decision can be reached using the definition of fault capability.

  A thorough uncertainty analysis shall be performed when evaluating this hazard.

3 SPECIFIC REQUIREMENTS FOR EE.EE. EVALUATION.

NS-R-3, Rev. 1. Seismic Hazards Evaluation. Fault Displacemen:

✓ § **3.6. Concept** (SSG-9): A fault is considered capable if on the basis of all geological, geophysical, geodetic or seismological data together (including palaeoseismological and geomorphological data) one or more of the following conditions applies:

(a) It shows evidence of past movement or movements 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 data reveal short earthquake recurrence intervals, periods of the order of tens of thousands of years (e.g. Upper Pleistocene to the present) may be appropriate for the assessment of capable faults. In less active areas, it is likely that much longer periods will be required (e.g. Pliocene to the present).

3 SPECIFIC REQUIREMENTS FOR EE.EE. EVALUATION.

NS-R-3, Rev. 1. Seismic Hazards Evaluation. Fault Displacemen:

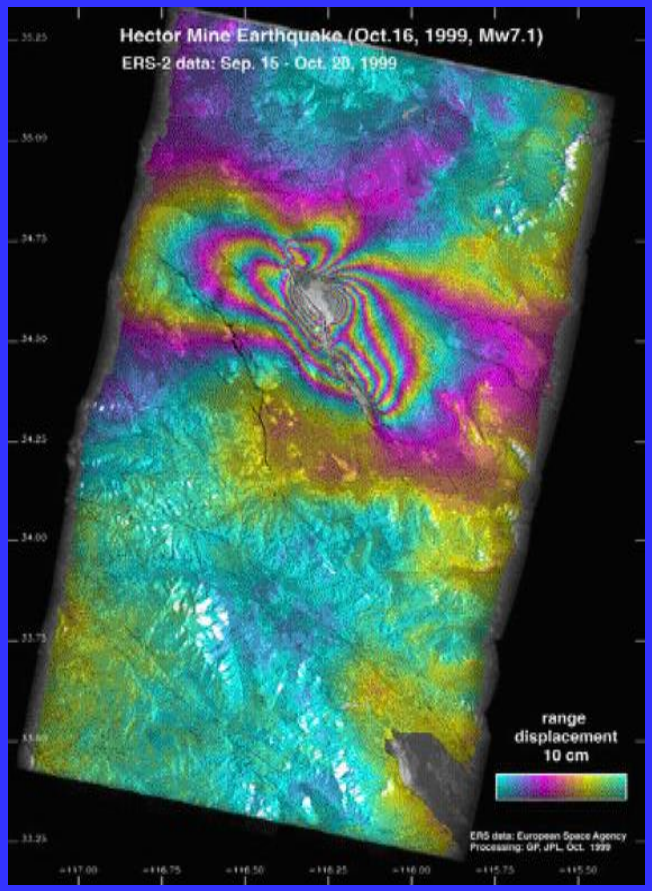
(b) A structural relationship with a known capable fault has been demonstrated such that movement of one could cause movement of the other at or near the surface.

(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.

Fault displacement hazard shall be evaluated to provide needed input for the design or upgrading of the SSCs of the N.I., as well as the safety analyses performed during the lifetime of N.I.

3 SPECIFIC REQUIREMENTS FOR EE.EE. EVALUATION.

NS-R-3, Rev. 1. Seismic Hazards Evaluation. Fault Displacement:



3 SPECIFIC REQUIREMENTS FOR EE.EE. EVALUATION.

NS-R-3, Rev. 1. Seismic Hazards Evaluation. Ground Motion:

- ✓ § **3.3**. The hazards associated with earthquakes shall be determined by means of a seismotectonic evaluation of the region with the greatest possible use of the information collected.
- ✓ § **3.4**. Hazards due to earthquake induced ground motion, including any combination with other seismically induced hazards, shall be assessed for the site with account taken of the seismotectonic characteristics of the region and specific conditions of the site.

  The ground motion hazard evaluation shall be conducted to provide the input needed for the design or seismic safety upgrading of the SSCs of the N.I., as well as for performing the deterministic and/or probabilistic safety analyses necessary during the lifetime of the N.I.

  A thorough uncertainty analysis shall be performed when evaluating this hazard.

3 SPECIFIC REQUIREMENTS FOR EE.EE. EVALUATION.

NS-R-3, Rev. 1. Volcanic Hazards Evaluation:

✓ **Concept** (SSG-21). A capable volcano or volcanic field is one that: (1) has a credible likelihood of experiencing future activity during the lifetime of the N.I. and (2) has the potential to produce phenomena that may affect the site of the installation.

Hazards due to capable volcanoes, including any combination with other volcanically induced hazards, shall be assessed for the site with account taken of volcanic characteristics of the region and considering adequately the uncertainties.

Hazards from capable volcanoes shall be evaluated to provide the input needed for the design or upgrading of the SSCs of the N.I., as well as for performing the deterministic and/or probabilistic safety analyses necessary during the lifetime of the N.I.

3 SPECIFIC REQUIREMENTS FOR EE.EE. EVALUATION.

NS-R-3, Rev. 1. Meteorological Hazards Evaluation. Extreme Events:

- ✓ § **3.8**. The meteorological characteristics for the region around the site shall be investigated and associated extreme values of variables shall be evaluated for the site of any N.I. Efforts shall be made to extend the meteorological database.
- ✓ § **3.9**. In order to evaluate possible extreme values, the following meteorological phenomena shall be documented for an appropriate period of time: wind, precipitation, snow and ice, air and water temperature, humidity, storm surges sand / dust storms, as well as the plausible combinations among they.
- ✓ § **3.10**. The output of the site evaluation shall be described in a way that is suitable for design purposes for the N.I., such as the probability of exceedance of relevant values to design parameters.

3 SPECIFIC REQUIREMENTS FOR EE.EE. EVALUATION.

NS-R-3, Rev. 1. Meteorological Hazards Evaluation. Rare Events:

Lightning:

✓ **§ 3.11**. The potential for the occurrence and the frequency and severity of lightning shall be evaluated for the site.

Tornadoes and Cyclones:

✓ **§ 3.12 to 3.17**. The potential for the occurrence, frequency and severity of tornadoes, cyclones and associated missiles shall be evaluated in the region of interest, 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.

3 SPECIFIC REQUIREMENTS FOR EE.EE. EVALUATION.

NS-R-3, Rev. 1. Flooding Hazards Evaluation:

Induced by Precipitation and Other Causes:

- ✓ § **3.18 / 3.20**. The potential for flooding in the region due to one or more natural causes such as storm surge, wind generating waves, extreme precipitation (including in combination due to a common cause or due to relatively high frequency of occurrence), that could affect the safety of the N.I. shall be evaluated.
- ✓ § **3.22**. The parameters used to characterize the hazards due to flooding shall include the height of the flood, the height and period of the waves (if relevant), the warning time for the flood, and the duration and flow conditions.

3 SPECIFIC REQUIREMENTS FOR EE.EE. EVALUATION.

NS-R-3, Rev. 1. Flooding Hazards Evaluation:

Induced by Precipitation and Other Causes:

- ✓ **§ 3.19 / 3.21**. Suitable meteorological, hydrological and hydraulic models shall be developed to derive the flooding hazard for the site, including secondary effects such as debris, ice and sediments.

  The flood hazard assessment shall be based on instrumental and historical data, and considering the uncertainties.

- ✓ **§ 3.23**. The potential for instability of the coastal area or river channel due to erosion or sedimentation shall be investigated.

3 SPECIFIC REQUIREMENTS FOR EE.EE. EVALUATION.

NS-R-3, Rev. 1. Flooding Hazards Evaluation:

Induced by Earthquakes or other Geological Phenomena:

- ✓ § **3.24**: The potential for tsunamis or seiches in the region from seismic sources or other phenomena (underwater slides) that can affect the safety of a N. I. shall be evaluated.
- ✓ § **3.25 / 3.27 / 3.28**: The hazards associated with tsunamis or seiches shall be derived from known historical and prehistorical records as well as from physical and/or analytical modelling. These include potential draw-down, and run-up that can result in physical effects (scouring) on the site.
- ✓ § **3.26**: The hazards associated with tsunamis or seiches, with account taken of any amplification due to the coastal configuration at the site, such as near shore bathymetry and coastal topography.

3 SPECIFIC REQUIREMENTS FOR EE.EE. EVALUATION.

NS-R-3, Rev. 1. Flooding Hazards Evaluation:

Induced by Failure of Water Control Structures:

- ✓ § **3.29 / 3.30 / 3.32**: The upstream water control structures shall be analyzed to determine potential hazard to the N.I. resulting from the failure of one or more of them, including in combination with flooding from other causes as blockage of rivers up or downstream (by landslides or ice) or a change in land use.
- ✓ § **3.31**: If that analysis shows that the N.I. is not able to withstand safely the resulting effects, then the hazards associated with the N.I. shall be assessed.

3 SPECIFIC REQUIREMENTS FOR EE.EE. EVALUATION.

NS-R-3, Rev. 1. Geotechnical Characteristics of the Site:

- ✓ § **3.37 / 3.41**. The geotechnical characteristics of the subsurface materials shall be investigated and a soil/rock profile for the site in a form suitable for design shall be determined.
- ✓ § **3.42**. The stability of the foundation material and potential excessive settlement under static and seismic loading shall be assessed.
- ✓ § **3.43**. The groundwater regime and the chemical properties of the soil and groundwater shall be studied by appropriate methods and accounted for.

3 SPECIFIC REQUIREMENTS FOR EE.EE. EVALUATION.

NS-R-3, Rev. 1. Geotechnical Hazards Evaluation:

Slope Instability:

- ✓ § **3.33**. The site and its vicinity shall be evaluated to determine the potential for slope instability from external events, including snow avalanches, that could affect the safety of the N.I. Meteorological conditions and events, such as flooding, shall be taken into account.

  The site layout of the N.I. during and after site preparation activities shall be address.

- ✓ § **3.34**. The potential for slope instability from seismic loading that can affect the safety of the N.I. shall be evaluated by using the site specific ground motion, including ground water characteristics.

3 SPECIFIC REQUIREMENTS FOR EE.EE. EVALUATION.

NS-R-3, Rev. 1. Geotechnical Hazards Evaluation:

Collapse, Subsidence or Uplift of the Site Surface:

✓ **§ 3.35 / 3.37**. The hazards associated with the collapse, subsidence or uplift of the surface that can affect the safety of the N.I. over its lifetime shall be evaluated using a detailed description of subsurface conditions obtained from reliable methods of investigation.

Geological information shall be examined for the existence of natural or human-made features as caverns, karstic formations (limestone and gypsum), soluble materials (gypsum), water wells, etc.

3 SPECIFIC REQUIREMENTS FOR EE.EE. EVALUATION.

NS-R-3, Rev. 1. Geotechnical Hazards Evaluation:

Soil Liquefaction:

- ✓ § **3.38**. The potential for liquefaction and non-linear behaviour of the subsurface materials at the site of the N.I. shall be evaluated by using the site specific ground motion, including ground water characteristics.
- ✓ § **3.39**. The evaluation of soil liquefaction shall include the use of accepted methods of soil investigation and analytical methods to determine the hazards.

3 SPECIFIC REQUIREMENTS FOR EE.EE. EVALUATION.

NS-R-3, Rev. 1. Other Natural Hazards Evaluation:

- ✓ **§ 3.52**. The design basis for other natural external hazards like wild-fires, drought, hail storm, sub-surface freezing of subcooled water (frazil), diversion of a river, biological hazards (algae, mussel, jelly fish, small animal, barnacle, etc.), electromagnetic storm from the Sun, shall be identified and assessed so that design basis for these events can be derived.

3 SPECIFIC REQUIREMENTS FOR EE.EE. EVALUATION.

NS-R-3, Rev. 1. Human Induced Hazards Evaluation:

✓ **§ 3.51**. The hazards due to human induced events within or outside the site boundary of the N.I. that could jeopardize the safety of the N.I. shall be evaluated.

Human induced events to be addressed include, the hazards due to:

- Sea or air transport (collision, explosion…);
- fire, explosions, missile generation, releases of hazardous gases from stationary sources such as nearby industries to the site;
- electromagnetic interference.

Human activities which may influence the type or severity of natural hazards, such as resource extraction or significant re-contouring of land or extracting water shall be considered.

3 SPECIFIC REQUIREMENTS FOR EE.EE. EVALUATION.

NS-R-3, Rev. 1. Human Induced Hazards Evaluation:

Aircraft Crashes:

- ✓ **§ 3.44 / 3.45 /3.46**. The potential for 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 hazards (impact, fire, and explosion).

Chemical Hazards:

- ✓ **§ 3.48**. Current or foreseeable 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 or detonation shall be addressed.
- ✓ **§ 3.49**. 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.

3 SPECIFIC REQUIREMENTS FOR EE.EE. EVALUATION.

NS-R-3, Rev. 1. Human Induced Hazards Evaluation:

Other Human Induced Events:

- ✓ § **3.44 / 3.45 /3.46**. Investigations shall be performed for installations in the region (including co-located N.I. in which radioactive materials are stored, processed, transported and otherwise dealt with that, if released under normal or accident conditions, can jeopardize the safety of the installation.

4 EVALUATION OF POTENTIAL EFFECTS OF THE N.I.

NS-R-3, Rev. 1. Dispersion of Radioactive Material Evaluation:

Atmospheric Dispersion:

- ✓ **§ 4.1 / 4.3**. The atmospheric dispersion of radioactive material released shall be assessed with the use of an appropriate model. This model shall include basic parameters and phenomena (precipitation, wind speed and direction, air temperature, humidity, atmospheric stability parameters, and prolonged inversions), all significant site specific and regional orography features and characteristics of the N.I. that could affect atmospheric dispersion.
- ✓ **§ 4.2**. A meteorological plan shall be carried out at or near the site, for measuring and recording needed parameters at appropriate elevations and locations. Data from at least one full year prior to submittal of the SER shall be collected, together with any other data available from other sources.

4 EVALUATION OF POTENTIAL EFFECTS OF THE N.I.

NS-R-3, Rev. 1. Dispersion of Radioactive Material Evaluation:

Surface and Groundwater Dispersion:

- ✓ **§ 4.4 / 4.6 / 4.7 / 4.9**. An assessment of the potential impact from surface and groundwater on the population and environment shall be performed by using the collected data in a suitable model. This model shall include basic data and phenomena (interaction between surface water and groundwater, characteristics of water bodies (natural and artificial), structures for water control, locations of discharge and intake structures and water use in the region), so that relevant data is available for the radiological impact assessment.
- ✓ **§ 4.5 / 4.8**. A plan for the surface and underground hydrology shall be carried out to gather data (transfer mechanisms of radionuclides, dilution and dispersion characteristics for waters, the retention ability of geologic units and biota), relevant for radionuclide movement in the affected hydrological units and exposure pathways.

4 EVALUATION OF POTENTIAL EFFECTS OF THE N.I.

NS-R-3, Rev. 1. Public Exposure Evaluation:

- ✓ **§ 4.13**. The distribution of the population within the region over the lifetime of the N.I. shall be determined in terms of direction and distance from the N.I., and the evaluation of the potential impact of radioactive releases, either due to normal operation or under accident conditions on the public shall be performed.
- ✓ **§ 4.10 / 4.11 / 4.12**. Information on existing and projected population distributions in the region, including resident and transient population shall be collected and kept up to date over the lifetime of the N.I. A special attention shall be paid to vulnerable populations and institutions such as schools, hospitals and prisons when considering the feasibility to implement protective measures.

4 EVALUATION OF POTENTIAL EFFECTS OF THE N.I.

NS-R-3, Rev. 1. Uses of Land and Water Evaluation:

- ✓ **§ 4.13**. The uses of land and water shall be characterized in order to assess the potential effects of the N.I. in the region and in particular for the purposes of preparing emergency plans. The investigation shall cover land and water bodies that may be used by the population or that serve as a habitat for organisms in the food chain.

5 MONITORING AND PERIODIC RE-EVALUATION.

NS-R-3, Rev. 1. Monitoring of External Hazards and Site Conditions:

✓ § **5.1**. The characteristics of all external hazards and site conditions that are pertinent to the licensing and safe operation of the N.I. shall be monitored over his entire lifetime.

This monitoring shall be commenced no later than the construction starting and shall be continued up until decommissioning.

The monitoring plan shall be developed as part of the objectives and scope of the site evaluation.

5 SPECIFIC REQUIREMENTS FOR EE.EE. EVALUATION.

NS-R-3, Rev. 1. Reassessment of External Hazards and Site Conditions:

✓ § **5.1A**. Site specific hazards and site conditions shall be periodically reviewed during the lifetime of the N.I., typically every ten years, using updated knowledge. Also shall be re-evaluated after a shorter interval when necessary:

- Updating of the regulatory requirements,
- Technical findings of inadequate design or vulnerability of SSCs against external hazards,
- Needed confidence of sufficient margin to prevent cliff edge effects,
- Evidence of significant changes in hazards (from operating experience, a major accident or extreme events occurrence),

The implications of such a review of site specific hazards and site conditions for the safe operation of the N.I. shall be evaluated.

THANK YOU FOR YOUR ATTENTION !