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**NUCLEAR ENERGY AGENCY  
COMMITTEE ON NUCLEAR REGULATORY ACTIVITIES**

**Cancels & replaces the same document of 02 July 2014**

**CNRA Working Group on the Regulation of New Reactors**

**Supplementary Report on the Regulation of Site Selection and Preparation**

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The mission of the NEA is:

- to assist its member countries in maintaining and further developing, through international co-operation, the scientific, technological and legal bases required for a safe, environmentally friendly and economical use of nuclear energy for peaceful purposes, as well as
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The NEA Data Bank provides nuclear data and computer program services for participating countries. In these and related tasks, the NEA works in close collaboration with the International Atomic Energy Agency in Vienna, with which it has a Co-operation Agreement, as well as with other international organisations in the nuclear field.

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## COMMITTEE ON NUCLEAR REGULATORY ACTIVITIES

The Committee on Nuclear Regulatory Activities (CNRA) shall be responsible for the programme of the Agency concerning the regulation, licensing and inspection of nuclear installations with regard to safety. The Committee shall constitute a forum for the effective exchange of safety-relevant information and experience among regulatory organisations. To the extent appropriate, the Committee shall review developments which could affect regulatory requirements with the objective of providing members with an understanding of the motivation for new regulatory requirements under consideration and an opportunity to offer suggestions that might improve them and assist in the development of a common understanding among member countries. In particular it shall review current management strategies and safety management practices and operating experiences at nuclear facilities with a view to disseminating lessons learnt. In accordance with the NEA Strategic Plan for 2011-2016 and the Joint CSNI/CNRA Strategic Plan and Mandates for 2011-2016, the Committee shall promote co-operation among member countries to use the feedback from experience to develop measures to ensure high standards of safety, to further enhance efficiency and effectiveness in the regulatory process and to maintain adequate infrastructure and competence in the nuclear safety field.

The Committee shall promote transparency of nuclear safety work and open public communication. The Committee shall maintain an oversight of all NEA work that may impinge on the development of effective and efficient regulation.

The Committee shall focus primarily on the regulatory aspects of existing power reactors, other nuclear installations and the construction of new power reactors; it may also consider the regulatory implications of new designs of power reactors and other types of nuclear installations. Furthermore it shall examine any other matters referred to it by the Steering Committee. The Committee shall collaborate with, and assist, as appropriate, other international organisations for co-operation among regulators and consider, upon request, issues raised by these organisations. The Committee shall organise its own activities. It may sponsor specialist meetings and working groups to further its objectives.

In implementing its programme the Committee shall establish co-operative mechanisms with the Committee on the Safety of Nuclear Installations in order to work with that Committee on matters of common interest, avoiding unnecessary duplications. The Committee shall also co-operate with the Committee on Radiation Protection and Public Health and the Radioactive Waste Management Committee on matters of common interest.

## FOREWORD

The Committee on Nuclear Regulatory Activities (CNRA), based on the regulatory actions underway or being considered in different member countries concerning the design and construction of advanced nuclear power plants, established a working group responsible of the regulatory issues of siting, licensing and regulatory oversight of generation III+ and generation IV nuclear reactors. The Working Group on the Regulation of New Reactors (WGRNR) main purposes are to improve regulatory reviews by comparing practices in member countries; improve the licensing process of new reactors by learning from best practices in member countries; ensure that construction inspection issues and construction experience is shared; promote cooperation among member countries to improve safety; and enhance the effectiveness and efficiency of the regulatory process.

The WGRNR has established a programme of work which includes: the collection of construction experience and the assessing of the information collected in order to share lessons learned and good practices; the review of regulatory practices concerning the regulation of nuclear sites selection and preparation; and the review of recent regulatory experience concerning the licensing structure of regulatory staff and regulatory licensing process.

The WGRNR began in May 2008 a task of examining and documenting the various practices used by regulatory authorities in the regulation of nuclear power plant siting. The purpose of the task was to provide the member countries with practical information that would be helpful in assessing and potentially improving their regulatory practices and requirements on the regulation of sites. The task considered also regulatory practices on sites where a mixture of activities are taking place (e.g. operating units, new construction, and decommissioning, etc.). This work led to the publication in 2010 of the *Report on the Survey on Regulation of Site Selection and Preparation* NEA/CNRA/R(2010)3<sup>1</sup>. This report describes the outcomes from the task, including the survey with a discussion of the survey responses provided by regulatory organisations. The report includes High Level Summaries describing how sites are evaluated, how the sites are selected and how the preferred site is licensed or permitted.

The WGRNR also convened a workshop<sup>2</sup> in 2010 in Prague, Czech Republic, which provided an excellent opportunity to discuss the lessons learned in the regulation of site selection, evaluation and site preparation.

In December 2011, the CNRA approved the WGRNR proposal to prepare a supplemental report augmenting *Report on the Survey on Regulation of Site Selection and Preparation* NEA/CNRA/R(2010)3 to address additional siting issues, such as assessing impacts of multi-unit sites, seismicity, security, specific design features of the nuclear power plant (NPP) against the fixed site parameters, public consultation during siting, and to obtain more details on regulatory approaches for new reactor siting including changes or enhancements as a result of the Fukushima Daiichi nuclear power plant accident.

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<sup>1</sup> Follow this link to download the report <http://www.oecd-nea.org/nsd/docs/2010/cnra-r2010-3.pdf>

<sup>2</sup> Workshop proceedings NEA/CNRA/R(2011)7 (Follow this link to download the workshop proceedings <http://www.oecd-nea.org/nsd/docs/2011/cnra-r2011-7.pdf>)

This report describes the outcomes from the task, including the survey with a discussion of the survey responses provided by regulatory organisations. The report includes high level summaries describing how external hazards, human-induced hazards, combinations of internal and external hazards, survivability of local infrastructure and emergency preparedness arrangements/feasibility at siting stage are assessed through the siting process.

## **ACKNOWLEDGMENTS**

Gratitude is expressed to Mr Philip Webster (CNSC, Canada), for compiling the survey responses and preparing this report. Answers to the questionnaire and high level summaries were provided by Canada (CNSC), Finland (STUK), France (ASN), Hungary (HAEA), India (AERB), Japan (NISA/JNES), Republic of Korea (KINS), Slovenia (SNSA), Slovak Republic (UJD SR), Sweden (SSM), United Kingdom (ONR) and United States of America (NRC). Alejandro Huerta and Aurélie Lorin have been the NEA Secretariat officers.

## TABLE OF CONTENTS

1. Background .....	9
1.1. Original siting survey .....	9
1.2. Background to supplemental siting survey .....	10
1.3. Preparation of supplemental siting survey .....	10
2. High-level summaries of responses to supplemental siting survey .....	13
2.1. Canada.....	13
2.2. Sweden.....	13
2.3. United States of America .....	14
2.4. Slovak Republic .....	15
2.5. United Kingdom.....	16
2.6. Slovenia.....	16
2.7. Republic of Korea .....	17
2.8. India .....	18
2.9. Japan.....	20
2.10. Finland .....	21
2.11. France.....	22
2.12. Hungary.....	23
3. Analysis of detailed responses to supplemental siting survey .....	25
4. Conclusions .....	29
Appendix A WGRNR Supplemental siting survey .....	31
Appendix B Detailed responses to the Supplementary siting survey.....	33
Response on behalf of Japan (NISA/JNES) .....	35
Response on behalf of Republic of Korea (KINS) .....	39
Response on behalf of United Kingdom (ONR) .....	43
Response on behalf of India (AERB).....	47
Response on behalf of United States of America (NRC) .....	51
Response on behalf of Slovenia (SNSA).....	59
Response on behalf of Canada (CNSC) .....	65
Response on behalf of France (ASN).....	77
Response on behalf of Slovak Republic (UJD SR) .....	83
Response on behalf of Hungary (HAEA).....	89





## 1. BACKGROUND

### 1.1. Original siting survey

The Committee on Nuclear Regulatory Activities (CNRA) created the Working Group on the Regulation of New Reactors (WGRNR) in May 2008. It was tasked with examining and documenting practices used by regulatory authorities in the regulation of nuclear power plant siting and was assigned an action to “develop [...] a survey on the regulation of nuclear sites including seismicity issues, security issues, multi-unit aspects [...]”. The initial survey was issued in July 2008. All twelve states who were then members of the WGRNR responded. The responses were reviewed at the second meeting of the Working Group in October 2008 and the first draft of the report issued in January 2009. This was then reviewed at the third meeting in March 2009, where it was realized that further topics needed to be explored so supplementary questions were submitted to CNRA who approved them in June 2009. The next draft of the report (containing responses from the fifteen states that were by then members) was discussed at the fourth meeting in September 2009 and the report updated and submitted to CNRA in December 2009 for approval. In May 2010, the *Report on the Survey on Regulation of Site Selection and Preparation* was published under the reference NEA/CNRA/R(2010)3.

The report contained a high-level summary for each member state, summarizing the responses to the four key questions:

- How are sites evaluated?
- How is the preferred site selected?
- How is the preferred site licensed or permitted?
- How does the safety regulator oversee site preparation activities?

The report contained a discussion of the detailed responses from each member state (that were included in an Appendix to the report) and drew tentative conclusions. These were, in brief, that:

- International Atomic Energy Agency (IAEA) Safety Standard NS-R-3 forms basis of site selection;
- Environmental Assessment/Environmental Impact Statement is always required;
- Site is accepted by safety regulator.

The report noted that “external factors always play a major role when justifying the suitability of a selected site, be they natural factors [...] or human-induced factors. Natural factors include seismology, geotechnics, meteorology and hydrology. Specific natural effects are considered in certain member states depending on local conditions, such as tsunamis, tornadoes, fires, drought or ice formation”.

At the fifth meeting in September 2010 (having been delayed from March 2010 by the eruption of the Icelandic volcano), that was held coincident with the first International Workshop, an update to the survey was proposed to look at factors such as:

- Approaches to public consultation,
- Impact of the site on the design,
- Environmental assessment aspects.

These were to have been considered at the sixth meeting in March 2011 but just before that meeting, the accident at the Fukushima Daiichi nuclear power plant happened.

### **1.2. Background to supplemental siting survey**

The need to follow-up on siting issues was discussed further at the seventh meeting on September 2011 and a proposal developed for the WGRNR Chair to discuss with the Chair of the CNRA Senior Task Group (STG) that had been formed to prepare lessons-learned from the Fukushima Daiichi nuclear power plant accident.

Although the impact of the site on the design had previously been surveyed, no conclusions had been generated. Also, the layout of plant on the site to minimize impact from terrestrial and aquatic environment and reduce vulnerability to severe external events had not been considered. Although the earlier survey had investigated environmental assessments, it was felt beneficial to pursue further the extent to which the member states covered seismology/meteorology/hydrology and whether severe events/combinations of external events were considered.

Possible additional topics were considered, such as:

- Population Density/Land Use Planning Control,
- Emergency Preparedness Integration/Exercise,
- Social Acceptability/Public Consultation,
- Multi-Unit Aspects/Other Facilities onsite.

Land use planning control could include factors such as site evaluation and selection to consider population density within emergency planning zone and agreements with local municipalities/regions on growth within emergency planning zone. Emergency preparedness could include factors like early involvement by the proponent with local municipalities/regions and coordination between onsite and offsite response, both in planning and exercising. Social acceptability could include factors such as consultation with public, special interest groups and requiring support from the local municipality/region. Multi-unit aspects could include factors such as single-unit core damage frequency versus site, the source term considered for releases and other facilities onsite such as operating reactors, decommissioning units and waste facilities.

### **1.3. Preparation of supplemental siting survey**

Following discussion at the seventh meeting, a proposal was developed and submitted to the CNRA STG in December 2011, where it was approved. The eighth meeting of the working group in March 2012 then developed a supplementary survey for response by member state, following which the report would be revisited. The members agreed that the emphasis should be on re-assessing defence-in-depth and dealing with uncertainties in decision-making, principally in the area of cliff-edge effects for natural hazards. The supplementary survey was issued in May 2012 (see Appendix A) and had seven questions on various topics, some of which were new and some were re-visiting earlier topics in more detail. Members were asked to respond to the survey within a few months, so that an initial report could be made at the tenth meeting, that was to be held coincident with the second International Workshop.

In June 2012, the CNRA Chair encouraged member states to provide answers to the survey and charged WGRNR to “conduct interactive workshop to discuss initial responses, obtain feedback on survey questions and [...] enhancements of the level of detail on the initial survey responses”, then to prepare a supplemental report on “Regulatory approaches used [...] for NPP siting and enhancements or changes [...] as a result of the Fukushima accident”.

By the time of the ninth meeting in October 2012, eight responses had been received. An initial analysis was presented at the meeting and at the second International Workshop on New Reactor Siting, Licensing and Construction Experience, held in Atlanta, Georgia, U.S.A.

At the tenth meeting in March 2013, an updated analysis of the responses was presented for discussion. Participants were then asked to prepare a brief summary of their national responses for some key areas, as had been done for the original report. An example summary for Canada was provided. These are listed below in the order in which they were received. A total of ten detailed responses were eventually received; these are contained in Appendix B, again in the order in which they were received.



## 2. HIGH-LEVEL SUMMARIES OF RESPONSES TO SUPPLEMENTAL SITING SURVEY

### 2.1. Canada

*External Hazards:* Proponents are required to characterise at the siting stage all natural and human-induced hazards that could impact the site. Site-specific data is used to determine hazards, unless such data is unobtainable. The Canadian Nuclear Safety Commission (CNSC) is currently engaged in clarifying existing requirements to stress that analysis of external hazards is required to consider those both within design basis and beyond the design basis. In particular, the concept of potential cliff-edge effects must be considered when analysing external hazards, where a small increase in intensity of the hazard may result in significantly higher effects. For new reactor facilities, the analysis of external hazards needs to be done at the site evaluation stage, in order to confirm that the reactor facility will be able to respond effectively to such events. CNSC has determined that no changes are required to the current requirements. The applicant is required to determine and justify both the spatial and temporal boundaries for each type of external hazard and is expected to show how they arrived at those conclusions. CNSC staff will be looking for how operating experience, such as the one gained from the Fukushima Daiichi nuclear power plant accident, has shaped the proponent's investigations.

*Human-induced Hazards:* The proponent is expected to develop, document, and implement a systematic approach to identifying all external, non- malevolent, human-induced events. Such events include, without being limited to: aircraft crashes, other transportation hazards, fires and explosions, chemical and radiological hazards; and electromagnetic interference hazards. Human induced events of a malevolent nature are handled separately.

*Combinations of Internal and External Hazards:* CNSC is strengthening existing language requiring a proponent to consider synergies of multiple simultaneous events and their after-effects.

*Survivability of Local Infrastructure:* As part of the post-Fukushima investigations by CNSC and licensees, improvements were identified to enhance emergency plans and capabilities to respond effectively in a severe event or multi-unit accident. This will include survivability of the local infrastructure.

*Emergency preparedness arrangements/feasibility at siting stage:* At present, the proponent is required to confirm at the construction licence stage with the surrounding municipalities and the affected provinces, territories, foreign states, and neighbouring countries, that implementation of their respective emergency plans and related protective actions will not be compromised for the life cycle of the proposed site. CNSC is currently engaged in clarifying that this confirmation is performed by the proponent prior to the site licence being granted.

### 2.2. Sweden

*External Hazards:* Licensees and applicants are required to characterise at the siting stage all natural and human-induced hazards that could impact the site. Site-specific data is used to determine hazards, unless such data is unobtainable. The Swedish Radiation Safety Authority (SSM) is currently revising existing

regulation for Nuclear Power Plants (NPPs) and developing new requirements for new reactors (including specific requirements related to siting). In this review updates to international practice (including lessons learned from the Fukushima Daiichi nuclear power plant accident, outcome of the 2<sup>nd</sup> extraordinary meeting of the Contracting Parties to the Convention on Nuclear Safety, updates to IAEA Safety Standards and updates to the Western European Nuclear Regulators' Association (WENRA) reference levels) regarding external hazards will be considered in regards of analysis and assessments of design basis events and combinations of events and design extension conditions as well as margin assessments and identification of potential cliff-edge effects related to external hazards.

*Human-induced Hazards:* Licensees and applicants are expected to develop, document, and implement a systematic approach to identifying all external, non-malevolent, human-induced events. Such events include, without being limited to: aircraft crashes, other transportation hazards, fires and explosions, and chemical and radiological hazards. Human induced events of a malevolent nature are handled separately.

*Combinations of Internal and External Hazards:* SSM will in the regulation review consider potential synergies of multiple simultaneous events and their after-effects.

*Survivability of Local Infrastructure:* As part of the post-Fukushima investigations (including the European Union (EU) stress tests), SSM and licensees identifies improvements to enhance emergency plans and capabilities to respond effectively in a severe event or multi-unit accident. This will include survivability of the local infrastructure.

*Emergency preparedness arrangements/feasibility at siting stage:* SSM is currently reviewing regulations regarding emergency preparedness and response (EPR). It is also expected that EPR will be considered in the requirements for siting. Such requirements are expected to take into account the surrounding municipalities and potentially affected provinces, territories, foreign states, and neighbouring countries and the implementation of their respective emergency plans and related protective actions.

### **2.3. United States of America**

*External Hazards:* Physical characteristics including geology, seismology, meteorology, and hydrology are considered when evaluating a site. These factors are used to ensure that structures, systems, and components (SSCs) important to safety are designed to withstand effects of natural phenomena without loss of capability to perform safety functions. Human-induced hazards are also considered. As a result of the Fukushima Daiichi nuclear power plant accident, the U.S. Nuclear Regulatory Commission (NRC) issued a request for information (RFI) to power reactor licensees and holders of construction permits to obtain information to support evaluation of regulatory actions to be taken. The RFI addressed methods and procedures for seismic and flooding hazard walkdowns to identify and address degraded, nonconforming, or unanalysed conditions and for verifying the adequacy of monitoring and maintenance procedures. The RFI also requires re-evaluations of seismic and flooding hazards at operating reactor sites to determine if design bases for SSCs important to safety should be updated. The NRC staff expects to also prepare an RFI related to regulatory action for natural external hazards other than seismic and flooding.

*Human-induced Hazards:* Human-induced hazards are considered and include onsite storage of chemicals, compressed or liquefied gases such as hydrogen, propane, and natural gas; and industrial, transportation, and military facilities that involve the use of potential hazardous materials such as toxic chemicals and petroleum products or pose other risks such as a barge collision with an intake structure or airplane crash at the site. Design basis events on or in the vicinity of the nuclear power plant are established and are defined as accidents with a probability of occurrence in excess of an order of magnitude of  $10^{-7}$  per year with potential consequences exceeding the [10 CFR Part 100](#) guidelines.

*Combination of Internal and External Hazards:* NRC regulations require that SSCs important to safety be appropriately protected against dynamic effects, including the effects of missiles, pipe whipping, and discharging fluids, that may result from equipment failures and events and conditions outside the nuclear plant. To satisfy regulations, plant designs consider appropriate combinations of design loads resulting from a natural design basis event with the abnormal loads. For example, seismic design loads are combined with pressure and temperature loads associated with design basis accidents. Assessments of man-made hazards are also included in evaluating a site. For man-made hazards, the impact is evaluated based on the resulting hazard (e.g. toxic chemical release) not on the cause of accident that created the hazard. Therefore, for man-made hazards, the maximum potential or bounding impact from each source facility/product is exclusively determined and addressed.

*Survivability of Local Infrastructure:* The NRC does not assess the survivability of the local infrastructure for its ability to support site recovery during the siting review. Although not for the siting stage, as a result of the Fukushima Daiichi nuclear power plant accident the NRC is working to establish expectations for additional onsite and offsite capabilities for accident mitigation and recovery.

*Emergency preparedness arrangements/feasibility at siting stage:* NRC review at the siting stage focuses on (1) the identification of the physical characteristics that could pose a significant impediment to the development of an emergency plan and (2) ensuring that an applicant has identified measures to eliminate or mitigate any significant impediments. Arrangements with local/state/federal agencies are included with the submittal of an application. As a result of the Fukushima Daiichi nuclear power plant accident, the NRC staff issued an RFI to power reactor licensees and holders of construction permits to obtain information to support evaluation of regulatory actions regarding power supplies for communication systems, and the sufficiency of staffing for necessary emergency preparedness (EP) positions during a multi-unit event. The NRC staff also developed a plan to evaluate other EP recommendations for possible rulemaking.

## **2.4. Slovak Republic**

*External Hazards:* During the siting phase applicant has to prepare a geological and seismic loading assessment for the selected site. Nuclear safety requirements for a nuclear facility in the siting phase also involve area characteristics that exclude the siting of a nuclear facility in this area. These characteristics cover external hazards as well as human-induced hazards. Other requirements concerning external hazards the nuclear facility project has to fulfil and they are also set in the above mentioned regulation. Based on these requirements the nuclear facility has to be designed so that during natural disasters that can be realistically expected, such as earthquakes, windstorms, flooding, deluge, extreme outdoor temperatures, extreme cooling water temperatures, rain of all forms, moisture, frost, the effects of flora, fauna and so on, it is possible to:

- safely shut down the nuclear facility and maintain it in a subcritical state;
- remove residual heat from spent nuclear fuel or radioactive waste;
- maintain leaks of radioactive substances below specified levels.

Project also has to consider the most serious natural phenomena historically recorded in the area around the site of the nuclear facility, requirements for earthquake-resistant nuclear facility systems, components and structures or parts and aircraft crash.

*Human-induced Hazards:* If the area interferes with protection zone of industrial or other economic structures with which unfavourable operating collisions could occur, it cannot be used for siting of the nuclear facility. There are also the same requirements regarding human-induced non-malevolent hazards as in case of the external hazards. The proponent has to elaborate and submit the document (in this case it is

reference safety report) by which he demonstrates that he considered all possible human-induced non-malevolent hazards.

*Combination of Internal and External Hazards:* Requirements for considering of combination of internal and external hazards are also covered in above mentioned regulation and proponent has to demonstrate that the nuclear facility design takes into account combination of internal and external hazards.

*Survivability of Local Infrastructure:* As a consequence of the Fukushima Daiichi nuclear power plant accident the stress-tests were performed in the European Union. Licensees in Slovakia together with regulatory body also performed these stress-tests. The role of these stress-tests was to demonstrate that NPPs are able to manage severe event or multi-unit accident. Based on results of the stress-tests the action plan of the corrective measurements has been set. The measurements also include survivability of the local infrastructure.

*Emergency preparedness arrangements/feasibility at siting stage:* The proponent is required to submit together with application form for the agreement for siting of the nuclear installation proposal of boundaries of a nuclear installation and proposal for the size of the emergency planning zone for a nuclear installation. Preliminary onsite emergency plan the proponent has to submit before issuing of the building permission by regulatory body.

## **2.5. United Kingdom**

*External Hazards:* Acceptable sites in the United Kingdom (UK) are first nominated by central government. However, if an application wants to proceed with new build at one of these sites they have meet the requirements of a number of regulators including the Office for Nuclear Inspectorate (ONR). ONR will grant a site licence only when certain criteria are met. Some of these have to be met up front but some may be deferred to certain decision points throughout the life of the plant. External Hazards are considered prior to site licencing but these are continually assessed throughout the build. For example a seismic envelope is assumed under the Generic Design Assessment (GDA) process. For build at a particular site, the local seismic envelope would be compared against the GDA assumptions. Combinations of internal and external hazards would be considered at an appropriate stage.

*Human Induced Hazards:* Malevolent acts are considered separately. Human induced but non malevolent acts are generally considered by the GDA process. As detailed design progresses this would be considered for the site specific design. This does not necessarily form part of the siting assessment, but start of construction and any associated permissions would be considered by this point.

*Local Infrastructure:* Consequent on the work being done in the aftermath of the Fukushima Daiichi nuclear power plant accident, the level of robustness of local infrastructure is being continually assessed.

*Emergency preparedness arrangements/feasibility at siting stage:* In the UK, new build is likely to take place at sites with existing facilities and with emergency preparedness already well established. For siting and even for granting of a nuclear site licence it is not expected that arrangements for new build would need to be well established. However, by the time fuel arrives on site ONR will expect fully developed arrangements for the new build.

## **2.6. Slovenia**

*External Hazards:* The choice of an area for the location of a new nuclear facility is based on a Special Safety Analysis, which is used to assess all the factors in the area for the new location of a nuclear facility which may affect nuclear safety during its operating lifetime. The detailed contents and the scope of the Special Safety Analysis shall be defined during the procedure of drawing up a specific national site



development plan by the Slovenian Nuclear Safety Administration (SNSA). The extent of external hazard defined in the Special Safety Analysis report mainly follows the requirements of the IAEA standards. Rules on radiation and nuclear safety factors require that at least the following external hazards and their combinations are considered: extreme winds, extreme outside temperatures, extreme rainfall, extreme snowfall, flooding, extreme cooling-water temperatures and freezing, earthquakes, aircraft crashes and other events on nearby transport routes, in industrial facilities or within the site region that might lead to fire, explosion or other hazards to the safety of a nuclear power plant.

*Human-induced Hazards:* The extent of human induced hazards assessment is also defined in a Special Safety Analysis report. The extent of human induced hazards mainly follows the requirements of the IAEA document NS-G-3.1 *External Human Induced Events in Site Evaluation for Nuclear Power Plants*. Regarding the design basis the Rules on radiation and nuclear safety factors, for site conditions require that the SSC design shall take due account of special environmental loads and conditions to which SSCs may be exposed due to external and internal events, including natural events characteristic for the site region, as well as events associated with human activities.

*Combinations of Internal and External Hazards:* The integral effects of internal and external including human induced hazards are determined during the preparation of Special Safety Analysis. The so-called envelope of site parameters shall be established representing the design conditions for the new nuclear facility.

*Survivability of Local Infrastructure:* The survivability of the local infrastructure and its ability to support site recovery are not assessed in details during the siting review process.

*Emergency preparedness arrangements/feasibility at a siting stage:* A description of feasibility of the emergency preparedness plan is also part of the Special Safety Analysis. Using estimates of emissions during severe accidents and taking into account meteorology, hydrology and other features of location, it is necessary to determine the potentially affected area. For this area (taking into account the assessment of population distribution) an emergency plan must be prepared, which will provide an acceptably low radiological risk to population. Additionally, the provisioned arrangements, such as organisations, information tools, connections and arrangements with local and state authorities, measures in and outside the plant for protecting the health and safety, needed procedures, the necessary preparations to ensure adequate care for the injured, etc. shall be described in the Special Safety Analysis.

## **2.7. Republic of Korea**

*External Hazards:* The applicant for construction permit of new nuclear reactor facilities shall submit the result of the site survey and evaluation as the chapter 2 “siting” of the safety analysis report (SAR). It contains external hazards including natural and man-induced hazards. Natural hazards for the consideration are extreme meteorological conditions, inundations, collapse of ground materials or adjacent slopes, tectonic ground surface deformations, strong earthquakes, and so on. Man-induced hazards are explosion, diffusion of toxic materials, fire, unintended aircraft crashes (intended aircraft crash matter is being taken care of for future facilities) and so forth. The Korea Institute of Nuclear Safety (KINS) reviews the SAR in a view of credibility of the data, evaluation methods and the results described in the SAR and reports the safety review results to the Nuclear Safety and Security Commission (NSSC). The Korea Hydro and Nuclear Power (KHNP), the sole construction permit applicant and operator of commercial nuclear reactor facilities in Korea, has conducted a research project for reassessing the design basis and precautionary facilities against earthquakes and tsunamis, which was completed at the end of 2013. The KHNP plans to establish appropriate measures, if necessary, after the review from the regulatory body.

*Human-induced Hazards:* The applicant for construction permit of new nuclear reactor facilities shall develop, document, and implement a systematic approach to identifying all external, unintended, human-induced events. Such events include, without being limited to: unintended aircraft crashes, other transportation hazards, fires and explosions, chemical and radiological hazards, and military activities.

*Combinations of Internal and External Hazards:* The KHNP has conducted extensive safety inspections for domestic NPPs after the Fukushima Daiichi nuclear power plant accident. As part of its follow-up actions, the KHNP has upgraded the new plant design and/or re-enforced already built facilities to prevent possible impact from combinations of internal and external hazards. The regulatory body, combined by NSSC and KINS, is reviewing the KHNP's follow-up actions and plans to revise existing regulations in this regard, if necessary.

*Survivability of Local Infrastructure:* As part of the follow-up actions after the Fukushima Daiichi nuclear power plant accident, the KHNP has upgraded the new plant design and/or re-enforced already built facilities to secure survivability of local infrastructure, especially for the multi-unit plants. This includes upgrading seawalls, mobile emergency diesel generators, water-proof doors, and so forth. The regulatory body is reviewing the KHNP's follow-up actions and plans, if necessary, to revise existing regulations in this regard.

*Emergency preparedness arrangements/feasibility at siting stage:* The applicant for operating licence of new nuclear reactor facilities shall formulate a radiological emergency plan as prescribed by the Presidential Decree, and obtain approval thereof from the NSSC prior to operating licence for the given nuclear facilities. The radiological emergency plan shall include details on general guidelines for emergency planning, emergency organisation and duties, radiological emergency declaration requirements, radiological disaster response facilities, emergency response activities, and sustenance and management of emergency response capacity. KINS reviews the appropriateness of the radiological emergency preparedness plan and the review result is incorporated in KINS safety review results report for operating licence by NSSC.

## **2.8. India**

*External Hazards:* Safety of the plant against external events is ensured either by observing screening distance value (SDV) or by engineering the site and plant to mitigate the hazard caused by such events. If no practical solution is available to mitigate the hazards, the site is rejected.

Some of the external events where concept of SDV is applied include distance to a seismic fault that is capable of movement during an earthquake, proximity to airports and defence installations, distance from industries storing toxic or explosive substances, etc. Depending on the severity of the hazard and engineer ability against the hazard, SDVs are used as a rejection criterion or as a criterion for ready acceptance. The Atomic Energy Regulatory Board (AERB) safety code, AERB/SC/S delineates in detail the SDVs related to different types of external events.

The criteria to derive design basis parameters of external natural hazards like earthquakes, floods, cyclone and wind are based on the concept of mean recurrence interval (MRI). Due to the statistical nature of the variability of the parameters, the design value of a parameter considered in engineering of the plant should have MRI much larger than the life time of the facility.

Detailed guidelines for derivation of design basis ground motion are given in AERB guide AERB/SG/S-11, whereas guidelines for evaluation of probable maximum precipitation and flooding due to probable maximum flood or failure of water control structures are covered in AERB/SG/S-6A and guidelines for evaluation of flooding due to cyclonic storms in coastal sites are covered in AERB/SG/S-6B.

Interim guidelines regarding meteorological hazards have been proposed as part of AERB recommendations post-Fukushima.

*Human-induced Hazards:* Human activities relating to industry, military, mining, transportation, etc. in the region of the proposed site may have the potential to challenge the safety of NPP. It is therefore necessary to collect information regarding all human activities in the region of interest at siting stage of the nuclear power plant and evaluate their impact on the proposed plant under various postulated worst-case scenarios and design the NPP to withstand the effect, if necessary. AERB guide, AERB/SG/S-7 covers in detail various human induced events and procedures for estimation of corresponding design bases.

Other potential natural and human-induced events such as the blockage/diversion of a river, depletion of a reservoir, excessive marine organism, ship collisions, oil spills and fires, which could cause a loss of heat sink function for a nuclear power plant, are assessed and related hazards are established.

*Combinations of Internal and External Hazards:* Hazards associated with external events are characterised in terms of parameters that can be used as the basis for design for the plant. Effects of the combination of these hazards with ambient hydrological, hydrogeological and meteorological conditions as well as the plant internal events are given due consideration while deriving their design basis values.

AERB is in the process of review and revising the existing requirements in various AERB safety documents with respect to the recommendations raised subsequent to review of Indian NPPs post-Fukushima. This also includes recommendation to strengthen the requirement with respect to consideration towards multiple hazards due to common cause or consequential events.

*Survivability of Local Infrastructure:* As part of the post-Fukushima review and assessment of Indian NPPs, the AERB apex committee constituted for the purpose, had given special attention towards survivability of available infrastructure for accident management. AERB had recently approved the criteria for creation of an onsite emergency response facility capable of withstanding severe flood, cyclone, earthquake etc.

*Emergency preparedness arrangements/feasibility at siting stage:* Every NPP is required to formulate a comprehensive emergency preparedness plan. Influence of site parameters on emergency preparedness is deliberated in AERB guide, AERB/SG/S-8.

During siting stage, the relevant site features that have a bearing on the various protective measures that may need to be initiated following an offsite emergency condition are assessed. Although, the area within 16 km radius of plant is designated as emergency planning zone (EPZ) the relevant information required for estimation of dose to public such as population data, land and water use, dietary habits, etc. are collected, up to a radial distance of 30km. Full details of population distribution sector wise (16 sectors of 22.5 degrees in EPZ) is also obtained. It is ensured that population data takes into account all people employed at site including construction workers, if any.

The existence of environmentally sensitive locations like national parks, sensitive marine environment/biota may also impose rejection of candidate site by Ministry of Environment and Forest. Site characteristics and characteristics of natural environment in the site region, which may affect safety of the nuclear power plant are investigated and assessed for a projected time period encompassing the lifetime of the plant.

## 2.9. Japan

*External Hazards:* The previous assumptions on the impact of earthquakes, tsunamis and other external hazards such as volcanic eruptions, typhoons, tornadoes and forest fires were re-evaluated. And countermeasures for nuclear safety against these external hazards as well as rainfall, fallen snow, thunderbolt, landfall, biological hazards were required by the new regulatory requirements. Furthermore, it is required to take countermeasures against internal fires and internal flooding, and to enhance the reliability of onsite and offsite power sources to deal with the possibility of station blackout (SBO). In addition to the above-described enhancement of countermeasures established at design basis, countermeasures for severe accident response against core damage, containment vessel damage and a diffusion of radioactive materials, enhanced measures for water injection into spent fuel pools, countermeasures against malicious airplane crash, and an installation of emergency response building are also required.

*Human-induced Hazards:* The new regulatory standards require "specialized safety facilities" with function to suppress a large amount of radioactive material release caused by containment vessel failure in the event of severe core damage or almost damaged core as a result of acts of terrorism, etc., such as intentional airplane crash. Specialized safety facilities must keep distance from reactor buildings. And procedures must be prepared under the situation that the plant has suffered large-scale damage due to acts of terrorism such as intentional airplane crash. Furthermore, organisational systems and necessary equipment enabling these activities in accordance with the procedures must be prepared.

*Combinations of Internal and External Hazards:* Licensees and applicants are required to postulate events caused by combinations of internal and external hazards, that is, combinations of natural hazards and situations as a consequence of the hazards depending on site specific conditions. For example, combinations of forest fire and petrochemical complex fire, combinations of SBO and loss-of-coolant accident (LOCA), and combinations of airplane crash fire and light oil tank fire have been discussed in licensing reviews.

*Survivability of Local Infrastructure:* The Nuclear Regulation Authority (NRA) does not assess the survivability of local infrastructure during the siting stage. After the Fukushima Daiichi nuclear power plant accident, licensees and applicants are required to strengthen countermeasures against power failure which may trigger simultaneous loss of all safety functions due to common causes. For example, offsite power systems must be connected to two or more substations located in different places through two or more transmission lines.

*Emergency preparedness arrangements/feasibility at siting stage:* The NRA is reviewing regulations concerning emergency preparedness and response. The new "Nuclear Emergency Response Guideline" was enforced on June 2013. The guidelines encompass the following points:

- Introduction of precautionary action zone (PAZ, about 5 km in radius from a nuclear power station) and urgent protective action planning zone (UPZ, approximately between 5 and 30 km in radius from a nuclear power station, where residents take actions (e.g. sheltering, intake of iodine tablets) based on the emergency action level (EAL) and the operational intervention level (OIL) with environmental monitoring data);
- Requirements of offsite centres (e.g. location in UPZ, installation of telecommunications equipment, radiation protection measures and alternative centres);
- Nuclear emergency drills (e.g. scenario of severe accidents/coincident disasters, drills);
- Enhancement of measures after nuclear emergency.

## 2.10. Finland

*External Hazards:* When the operating NPPs were built, there were no requirements for seismic design in the Finnish regulations, as seismic activity in Finland is very low. Extreme weather etc. was considered in design mainly according to the general building code. The capacities of the operating units to resist earthquakes and other exceptional external events have been later analysed in the probabilistic risk assessment (PRA) framework and PRAs were important sources of information in the stress tests.

For new NPP under construction, Olkiluoto 3 EPR, has been originally designed to be quite resistant against earthquakes, large airplane collision, harsh weather conditions and the loss of ultimate heat sink (seawater) and the containment has been designed to withstand a core melt accident. However, the safety systems are driven by electric power and a long term total station black-out would result in a core melt. The need to implement diverse cooling systems is still under considerations.

New regulatory guides on nuclear safety (YVL Guides) were introduced in December 2013 and YVL Guide B.7 *Provisions for internal and external hazards at a nuclear facility*, along with YVL Guide B.1 *Safety design of a nuclear power plant*, is presenting extensive requirements for new NPPs on internal and external hazards. In revised *Government Decree on the Safety of Nuclear Power Plants (717/2013)*, a new requirement concerning residual heat removal based on lessons from the Fukushima Daiichi nuclear power plant accident was introduced: a nuclear power plant shall be provided with means to accomplish the removal of the decay heat in reactor and spent fuel pools for the duration of three days independently of external power and water supply in a situation caused by a rare external event or a disturbance in the internal electrical supply system.

*Human-induced Hazards:* The regulatory requirements concerning human induced Hazards are included in the *Government Decree on the Security in the Use of Nuclear Energy (734/2008)* and *Government Decree on the Safety of Nuclear Power Plants (717/2013)* as well as in new regulatory guide YVL A.11 *Security of a nuclear facility*.

*Combinations of Internal and External Hazards:* The Finnish stress tests drew attention to some limitations of the external events PRAs. For example, the time span analysed was typically 24 hours and the special issues of simultaneous accidents at several units have not been analysed. Although the stress tests did not reveal problems requiring immediate actions, several studies for safety improvements were initiated.

*Survivability of Local Infrastructure:* The new regulatory guide YVL A.2 *Site for a nuclear facility* has a new requirement on two operable road connections to the NPP site for plant safe operation and EP.

*Emergency preparedness arrangements/feasibility at siting stage:* Following new requirements were introduced in Government Degree onsite Emergency Preparedness: a simultaneous accident of all nuclear facilities on the same site and its possible consequences has to be considered; a long duration of an emergency situation shall be considered in planning of emergency preparedness as well as emergency centre shall be provided where adequate working conditions can be maintained in all emergency situations and which is available also in the case of long term loss of electricity supply. Also other requirement changes were introduced concerning protection arrangements of workers, radiation measuring devices and communication systems.

## 2.11. France

*External Hazards:* As there are no new sites expected to be proposed in France for new nuclear facilities in a foreseeable future, there are no siting stage to be considered. Nevertheless, the different external hazards, including natural hazards and human-induced hazards, to be considered for sites and nuclear facilities are defined and listed in regulatory documents. This list includes all plausible combination of hazards. The applicant has to perform a specific analysis of the hazards taking into account site specific data. For new reactors facilities, the specific analysis of external hazards has to be done at the stage of authorisation for creation of the installation, as a part of the preliminary safety analysis report. For external hazards, as for other hazards, the safety should be demonstrated based on a prudent deterministic approach completed by probabilistic analyses of accidents and their consequences. Following the Fukushima Daiichi nuclear power plant accident, safety requirements have been reinforced regarding natural hazards and combination of natural hazards, in particular combination of earthquake and flooding, has to be assessed.

*Human-induced Hazards:* The licensee shall perform a safety analysis for all external hazards covering human induced hazards. These human induced hazards include hazards induced by industrial facilities, explosions, fires, airplane crashes, other transportation hazards, electromagnetic hazards, chemical and radiological hazards, any hazardous substance emissions, malevolent acts and any plausible combination of these hazards. This list, set by regulations, specifies also that any other external hazard identified by the applicant or that the Nuclear Safety Authority (ASN) considers has to be taken into account.

*Combinations of Internal and External Hazards:* As part of the safety analysis regarding external hazards, the licensee has to consider the induce effects especially the internal hazards induced. This requirement has further been enhanced after the Fukushima Daiichi nuclear power plant accident, especially through complementary safety assessments that have been performed. Different combinations of external hazards with consequential internal events and hazards have been reassessed, with more stringent hypothesis (beyond design basis).

*Survivability of Local Infrastructure:* Survivability of the local infrastructure is assessed as part of the commissioning licence application review. As a consequence of the Fukushima Daiichi nuclear power plant accident, onsite emergency organisations and infrastructures have been reassessed. As part of the hardened safety core, the licensee has to implement a emergency centre designed for extreme external hazards. (The concept of the “hardened safety core” aims to create structures and equipment able to withstand extreme events and perform functions that are vital to the safety of the reactor. The aim is to provide the equipment necessary for controlling the safety functions with protection from hazards, more specifically those greater than the hazards adopted for the general design of the facility, in order to ensure ultimate protection of the facilities against them.)

*Emergency preparedness arrangements/feasibility at siting stage:* As there are no new sites expected in France, and given the safety objectives set by ASN for any new nuclear power plant, it is not conceivable for a new plant created on an existing site to lead to radiological consequences exceeding those of the operating facilities on the dedicated site. At present time, the arrangements consist, at the stage of the preliminary safety analysis report, in a sizing of the onsite emergency plan focused on the identification of the accidents that would require protective measures on or offsite.

## 2.12. Hungary

*External Hazards:* In Hungary site evaluation is required in two cases: full scope evaluation for new builds, and targeted re-evaluation every ten years for existing facilities as part of their Periodic Safety Review (PSR). Evaluation of external hazards is an integral part of these processes. Goal of the full scope evaluation is to provide site specific information and data for the designing of the new build (determination of the design basis), for the Preliminary Safety Analysis Report (PSAR) including the evaluation of cliff-edge margins, for the planning of emergency preparedness arrangements and for radioactive material spread calculations. Goal of the targeted re-evaluation is to check the validity of the assumptions made earlier and to make corrective actions if necessary (e.g. factoring in the effects of the climate change). During the evaluation of external hazards currently available national and international requirements and recommendations (IAEA requirements, WENRA Reference Levels, etc.) are considered.

*Human-induced Hazards:* According to the Hungarian Nuclear Safety Code, safety, security and safeguard requirements have to be enforced in an integrated manner, taking into account interfaces. To fulfill these requirements human-induced hazards are analysed as part of the external hazard evaluation.

*Combination of Internal and External Hazards:* According to the Hungarian requirements all credible combination of hazards has to be considered during the design and evaluation of facilities, including the possible combination of internal and external hazards. The requirements for the combination of hazards is expected to be modified when the review of international recommendations (IAEA requirements, WENRA Reference Levels, etc.) based on the lessons learned from the Fukushima Daiichi nuclear power plant accident are completed.

*Survivability of Local Infrastructure:* Currently survivability of the local infrastructure is not evaluated in detail, but availability of equipment and transportation solutions in the vicinity of the site, that could be used in case of a severe accident (e.g. mobile generators and pumps, heavy lift helicopters) have been analysed as part of the mandatory EU “Stress-test”, and corrective actions are under development.

*Emergency preparedness arrangements/feasibility at siting stage:* Currently in Hungary, new builds are considered at sites with existing facilities and with Emergency Preparedness already well established. Although as a result of the EU “Stress-test” further improvements have been implemented. In case of new builds – based on site specific information acquired from the full scope site evaluation – a preliminary emergency preparedness plan has to be presented with the PSAR during the construction licensing, and those arrangements have to be set in action by the time fuel arrives on site.





### 3. ANALYSIS OF DETAILED RESPONSES TO SUPPLEMENTAL SITING SURVEY

Question 1 on multi-unit sites asked about limits on the source term/number of units, contribution of all facilities to the source term, the arrangement of units, arrangements to deal with impact on different facilities in the same area and impacts on the nuclear facility from co-located (or nearby) industrial facilities.

The answers revealed that:

- There are no explicit limits on the number of units per site, though India apportions dose from normal operation.
- Source term/safety goal/dose limits are per unit, though all in-plant events to be considered. UK considers contribution of all facilities to source term but no specific limit is applied.
- Impacts from other units/facilities are considered, and interactions are to be evaluated and prevented. Distance limits may apply and sharing of safety equipment is an issue.

Question 2 on site layout asked about considerations, such as utilizing natural and/or man-made features to minimize common cause initiators and considerations for establishing safety/support equipment/facilities locations based on site specific geographical features and potential vulnerabilities.

The answers revealed that:

- Generally there are no specific requirements to utilize natural or man-made features protect safety equipment.
- Stations are protected against flooding, other external events.
- Viability of access roads after severe flooding is sometimes considered, as is placing important equipment on the highest ground.
- The question had not been sufficiently clear that it addressed safety equipment, rather than the stations themselves.

Question 3 on external hazards and combinations asked about how they are considered at the siting stage. Respondents were asked to describe the extent of external hazards considered for the site and the source of the information used to establish the external hazard design basis. Respondents were also asked whether any changes were being considered to update the return frequency for external events as a result of the Fukushima Daiichi nuclear power plant accident. Respondents were further asked to describe the human induced hazards considered for the site and the source of the information used to establish the design basis, the assessments made to consider combinations of external or human induced hazards with consequential internal events to establish a bounding case for overall site hazards and whether the survivability of the local infrastructure and its ability to support site recovery is assessed during the siting review.

The answers revealed that:

- Natural hazards such as geology, seismicity, meteorology (ice/snow, precipitation, drought, lightning, wind, storm surge and tsunami), hydrology, fires and even climate change are considered.
- Man-made hazards such as transport routes (explosion, release of corrosive or toxic liquid or gas), industrial activities, blasting, airplane crash and malevolent events are considered.
- Frequently many combinations of these events are also considered, if they can be consequential, not simultaneous; for example, an internal flood/fire due to an earthquake.
- Analysis considers both Design Basis Accident (DBA) and Beyond Design Basis Accident (BDBA) and periodic re-evaluations are performed.
- There is a movement towards considering what are often called “Cliff-edge effects”, where a small increase in hazard causes a much larger consequence.
- There is no overall move to re-evaluate return frequencies for DBAs, though Japan is improving the seismic guide and UK is to re-consider seismic guide adequacy.

Question 4 on land use and population density asked whether the existing population density is considered during the siting review and to describe any arrangements or agreements on future development of population centres or municipal development over the life of the facility.

The answers revealed that:

- Land use and population density are considered for emergency measures planning and may influence site suitability. The US addressed these in 10CFR100.20 and 21.
- Historically sites have been located in remote areas in most member states so this has not been a major issue.
- In most member states, exclusion zones apply within which no permanent residences are permitted. Some states place further limits on development and in Finland STUK must approve structures in that zone.
- Typically there has been no involvement of the safety regulator in land use planning or limits on population growth.

Question 5 on emergency preparedness asked about the arrangements or feasibility at the siting stage and whether an acceptable level of established local/state/federal arrangements was sought during the siting review.

The answers revealed that:

- There may be limited consideration at the siting stage in that a physical impediment to a plan may be identified and measures to eliminate or mitigate it taken.
- This topic is generally considered prior to construction/operation, when the applicant must confirm with relevant jurisdictions that their emergency plans are adequate.
- This topic is one that a nuclear safety regulator is unwilling to discuss since it is usually considered someone else’s problem or jurisdiction.

Question 6 on social acceptability asked about the extent of public consultation and whether the regulator and applicant engage the local population and what level of local agreement is needed to proceed.

The answers revealed that:

- The proponent is expected to take the lead role.
- No formal local agreement is needed, though lack of agreement would need to be addressed.
- The safety regulator sometimes also consults, such as by holding public hearings during licensing.

Question 7 on design parameters asked about practices or assessments to determine if NPP design parameters are enveloped or suitable for a given site. Respondents were asked to describe the specific design parameters that are evaluated against the site characteristics and any site specific design changes or additional design analyses that may be needed when approving a site (e.g. seismic, meteorology, hydrology). Also to describe the extent of regulatory review and/or requirements as to how specific site features or nearby facilities support extended station blackout.

The answers revealed that:

- Grid availability and stability are important.
- Station blackout is generally considered in the design.
- Some states specify duration for onsite backup power fuel supply/battery duration.



#### 4. CONCLUSIONS

The majority of the responses to the supplementary siting survey, while providing further information on many topics, did not reveal fundamental changes in approach on such topics as external hazards, multi-unit sites, land-use planning and emergency preparedness arrangements. The overall conclusion of the supplementary survey is therefore that the overarching requirements for site evaluation, selection and preparation phases were already generally adequate. If any changes were found to be required as a result of the Fukushima Daiichi nuclear power plant accident, they were to clarify requirements or to provide guidance as to how requirements should be met.

Some member countries are developing or revising siting requirements for new reactors. Design basis natural hazards and human-induced hazards, combinations of hazards and design extension conditions are typically being addressed as well as margin assessments and potential cliff-edge effects. Some member countries are re-evaluating seismic and flooding hazards at operating reactor sites to determine if regulatory requirements for structures, systems, and components important to safety should be updated. Some member countries are reviewing the adequacy of countermeasures against hazards internal to the station, such as fire or flood, and are enhancing the ability of onsite and offsite power sources to deal with station blackout.

In the fullness of time, when the accident progression is better understood and as other developments occur on the international scene (such as revision of the IAEA Safety Standards series); it is possible that national approaches may undergo some refinement. It may therefore be worth re-visiting this survey in a few years' time.



**APPENDIX A**  
**WGRNR SUPPLEMENTAL SITING SURVEY**

**1. Multi-unit sites**

- a. Limits on source term/number of units? (Contribution of all facilities to the source term including spent fuel storage, waste management and reactors.)
- b. Arrangement of units (distance, common equipment)
- c. Arrangements to deal with impact on different facilities sited on one location (e.g. other industrial facilities)
  - i. During the siting review (or environmental assessment), do you consider potential impacts on the nuclear facility from co-located (or nearby) industrial facilities?

**2. Site layout considerations (utilizing natural and/or man-made features to minimize common cause initiators)**

- a. Describe considerations for establishing safety/support equipment/facilities locations based on site specific geographical features and potential vulnerabilities.

**3. Consideration of external hazards or combination of hazards at the siting stage**

- a. Described extent of external hazards considered for the site and the source of the information used to establish the external hazard design basis.
  - i. Specifically, are there any changes being considered to update the return frequency for external events as a result of the Fukushima Daiichi nuclear power plant accident?
- b. Describe the human induced hazards considered for the site and the source of the information used to establish the design basis.
- c. Describe the assessments made to consider combinations of external or human induced hazards with consequential internal events to establish a bounding case for overall site hazards.
- d. Is the survivability of the local infrastructure and its ability to support site recovery assessed during the siting review?

**4. Land use/Population density**

- a. Describe considerations for existing population density during the siting review.
- b. Describe any arrangements/agreements on future development of population centres or municipal development over the life of the facility.

**5. Emergency preparedness arrangements/feasibility at siting stage**

- a. Describe acceptable level of established local/state/federal arrangements during siting review.

**6. Social acceptability (extent of public consultation)**

- a. Describe how the regulator and the applicants engage local population and what level of local agreement is needed to proceed.

**7. Practices/assessments to determine if NPP design parameters are enveloped or suitable for a given site**

- a. Describe the specific design parameters that are evaluated against the site characteristics and any site specific design changes or additional design analyses needed when approving a site (e.g. seismic, meteorology, hydrology).
- b. Describe the extent of regulatory review and/or requirements as to how specific site features or nearby facilities support extended station blackout.



**APPENDIX B**  
**DETAILED REPOSSES TO THE SUPPLEMENTARY SITING SURVEY**

The detailed responses by the member countries are listed in the approximate order in which they were received, as was done also for the original survey.



## RESPONSE ON BEHALF OF JAPAN (NISA/JNES)

### 1. Multi-unit sites

- a. Limits on source term/number of units? (Contribution of all facilities to the source term including spent fuel storage, waste management and reactors.)

When the establishment permit is reviewed, no occurrence of radiation hazard on the surrounding public outside a non-inhabitable area is evaluated and confirmed for a serious accident such as loss of coolant from view of a technical standpoint. (A standard of radiation dose is 1.5 Sv for the thyroid (child) and 0.25 Sv for the whole body.) In addition, a single unit accident of reactor is assumed for the accident to evaluate.

- b. Arrangement of units (distance, common equipment)

When structures, systems and components (SSCs) having safety functions are shared in two or more units of nuclear reactors, it is verified that their designs do not impair the reactor safety.

- c. Arrangements to deal with impact on different facilities sited on one location (e.g. other industrial facilities)

The periphery located within a certain distance from the reactor is defined as non-inhabitable area. (The area exceeding 1.5 Sv for the thyroid (child) and 0.25 Sv for the whole body, when the serious accident such as loss of coolant is assumed.)

- i. During the siting review (or environmental assessment), do you consider potential impacts on the nuclear facility from co-located (or nearby) industrial facilities?

Any industrial/economic activity outside the site for the nuclear reactor facility has not regulated. In addition, when the establishment permit is reviewed, it is verified that the designed safety functions of SSCs are not impaired by external human events assumed, such as collapsed dam and explosion.

### 2. Site layout considerations (utilizing natural and/or man-made features to minimize common cause initiators)

- a. Describe considerations for establishing safety/support equipment/facilities locations based on site specific geographical features and potential vulnerabilities.

Application for the establishment permit requires attachments of description on situation such as weather, ground, hydrology, earthquake, and social environment at a location of nuclear reactor facility to be installed as well as maps of the siting area. Considerations on the design of natural phenomena are also reviewed.

### **3. Consideration of external hazards or combination of hazards at the siting stage**

- a.** Described extent of external hazards considered for the site and the source of the information used to establish the external hazard design basis.

Public information such as scientific/technical treatises and investigated information by public organisations, investigated data by the applicant for siting, and investigation conducted by the regulatory agency (if necessary).

- i.** Specifically, are there any changes being considered to update the return frequency for external events as a result of the Fukushima Daiichi nuclear power plant accident?

Based on the Fukushima Daiichi nuclear power plant accident, the seismic guide is now being improved.

- b.** Describe the human induced hazards considered for the site and the source of the information used to establish the design basis.

The applicant's description relevant to aircraft route, maps of the area where the reactor or its other main accessory facilities are installed, anticipated population, data on climate, and class, grade and consequence of assumed reactor accidents occurring due to operational error of the reactor.

- c.** Describe the assessments made to consider combinations of external or human induced hazards with consequential internal events to establish a bounding case for overall site hazards.

Based on the Fukushima Daiichi nuclear power plant accident, the review guide is now being improved.

- d.** Is the survivability of the local infrastructure and its ability to support site recovery assessed during the siting review?

Infrastructural conditions outside the site at the time of regional (wide-area) disaster have not been a subject to be reviewed.

### **4. Land use/Population density**

- a.** Describe considerations for existing population density during the siting review.

When the review is conducted, the following 3 items of the reactor periphery are confirmed: a periphery within a certain limit of distance from the reactor is non-inhabitable area; a fixed limit of area outside the non-inhabitable area is a low-level population zone; and the reactor periphery is far away from the densely populated section.

- b.** Describe any arrangements/agreements on future development of population centres or municipal development over the life of the facility.

In the document referenced for application for reactor establishment, the outline of development plan at the siting area is described.

## **5. Emergency preparedness arrangements/feasibility at siting stage**

- a. Describe acceptable level of established local/state/federal arrangements during siting review.

A disaster prevention plan is prescribed by a scheme different from the review relevant to the establishment.

## **6. Social acceptability (extent of public consultation)**

- a. Describe how the regulator and the applicants engage local population and what level of local agreement is needed to proceed.

When the Nuclear and Industrial Safety Agency (NISA) activities are double-checked by the Nuclear Safety Commission, a public hearing is performed and the opinions of residents at the siting area are heard. Moreover, while hearing their opinions for a review of environmental assessment in the planning phase before application for the establishment, it is defined that the governmental promotion section holds the public hearing. On the occasion of the startup of operation, the applicant has concluded the safety agreement with cities, towns and villages around the site. Consequently, based on this agreement, a consensus of the local governments (autonomous bodies) is usually needed.

## **7. Practices/assessments to determine if NPP design parameters are enveloped or suitable for a given site**

- a. Describe the specific design parameters that are evaluated against the site characteristics and any site specific design changes or additional design analyses needed when approving a site (e.g. seismic, meteorology, hydrology).

Application for the establishment permit requires attachments of site information such as weather, ground, hydrology, earthquake, and social environment. Considerations on the design relevant to natural phenomena are also reviewed. Especially, with regard to earthquake, from seismological and seismic engineering standpoints, such as geology and geologic structure around the site as well as seismic activity, an assumption of possibility having significant effects on the facilities develops suitable earthquake motions, and a review of the seismic safety is carried out.

- b. Describe the extent of regulatory review and/or requirements as to how specific site features or nearby facilities support extended station blackout.

Countermeasures against the severe accident that have not been conventionally taken into consideration in reviewing are now being studied based on the Fukushima Daiichi nuclear power plant accident.



## **RESPONSE ON BEHALF OF REPUBLIC OF KOREA (KINS)**

### **1. Multi-unit sites**

- a.** Limits on source term/number of units? (Contribution of all facilities to the source term including spent fuel storage, waste management and reactors.
- b.** Arrangement of units (distance, common equipment)
- c.** Arrangements to deal with impact on different facilities sited on one location (e.g. other industrial facilities)
  - i.** During the siting review (or environmental assessment), do you consider potential impacts on the nuclear facility from co-located (or nearby) industrial facilities?

Yes. The regulatory body reviews possible safety impacts from industrial facilities and man-made incidents to the projected nuclear facilities according to the guidelines for “investigating and evaluating man-made incidents for site selection” required in the MEST Notice No.2009-37 (MEST.react.004) “Technical Standards for Locations of Nuclear Reactor Facilities” and Article 8 (Human Induced Incidents) of Ordinance of the MEST “Enforcement Regulations concerning the Technical Standards of Reactor Facilities, etc.” The heads of the administrative agencies having authorities of the licence to the industrial facilities with a potential impact, by means of explosion, vibration and the release of toxic chemicals, on existing nuclear facilities within 8 km shall submit to the Minister of Education, Science and Technology (MEST) the relevant data in order to conduct consultations for permission, authorisation or approval of the facilities subject to consultations according to the MEST Notice No.2009-37 (MEST.react.036) “Objects of Consultations due to Installation of Industrial Facilities around the Nuclear Reactor Facilities, etc.”, as well.

### **2. Site layout considerations (utilizing natural and/or man-made features to minimize common cause initiators)**

- a.** Describe considerations for establishing safety/support equipment/facilities locations based on site specific geographical features and potential vulnerabilities.

### **3. Consideration of external hazards or combination of hazards at the siting stage**

- a.** Described extent of external hazards considered for the site and the source of the information used to establish the external hazard design basis.

Extent of external hazards considered for the site evaluation:

- Sources of seismicity, surface faulting, tsunami or other types of geological hazards within 320 km of the site, based on records, publications, survey results, etc.;
- Industrial facilities within 8 km of the site (greater distance for military and aviation facilities);

- Local meteorological hazards (e.g. typhoon, heavy snow/rain, etc.) recorded at the weather stations of local governments near nuclear power stations for the last 100 years.
- i. Specifically, are there any changes being considered to update the return frequency for external events as a result of the Fukushima Daiichi nuclear power plant accident?

No.

- b. Describe the human induced hazards considered for the site and the source of the information used to establish the design basis.

External hazards to be considered for the site and design basis are as follows:

- Explosion: the events should be reflected in the plant design if the evaluated results do not satisfy the safety conditions as follows:
  - Separation distance from explosive storage ( $\geq 18 \times (\text{TNT equivalent weight in kg}) / 3$ );
  - Exposure probability of explosion on transport route ( $\leq 10^{-7}/\text{year}$ );
  - Airplane crash: No airway, approach route or staying route within 3.2 km; no airport or military training airway within 8 km; no airport with annual flight frequency exceeding  $193 \times D^2/\text{year}$  within 16 km and no airport with annual flight frequency exceeding  $386 \times D^2/\text{year}$  beyond 16 km, where D is the distance (km) between the plant centre and the airport;
  - Other types of external hazards: Events with the occurrence probability under  $10^{-7}/\text{year}$  are not to be considered for the plant design in general.
- c. Describe the assessments made to consider combinations of external or human induced hazards with consequential internal events to establish a bounding case for overall site hazards.
- d. Is the survivability of the local infrastructure and its ability to support site recovery assessed during the siting review?

Regulatory body does not review such item in Korea.

#### **4. Land use/Population density**

- a. Describe considerations for existing population density during the siting review.

The utility shall describe the population density within 48 km of the site for the duration of the operation of the planned nuclear facility using most recent population data (residents and temporary visitors) provided by local government and governmental offices in the SAR. The regulatory body reviews acceptability of the data and evaluation methods used. Site with low population density is preferable unless other site factors.

- b. Describe any arrangements/agreements on future development of population centres or municipal development over the life of the facility.

Arrangements or agreements on future development of population centres at or adjacent to the planned nuclear facility site shall be described in the PSAR and in the final safety analysis report (FSAR), and hence considered for the site suitability review in terms of Exclusion Area Boundary (EAB), Low Population Zone (LPZ), population centre distance, and population density. However, there are no regulations to prohibit new development of population centres near operating nuclear facilities.



## 5. Emergency preparedness arrangements/feasibility at siting stage

- a. Describe acceptable level of established local/state/federal arrangements during siting review.

The site of reactor facilities shall be determined at such a place where an emergency plan can be implemented in order to protect the people against radiological emergency within 8 to 10 km of the reactor facility site, in accordance to Article 9 (Feasibility of Emergency Plans) of Ordinance of the MEST “Enforcement Regulations concerning the Technical Standards of Reactor Facilities, etc.” as well as “Act on Physical Protection and Radiological Emergency”. Detailed requirements are described in the MEST Notice No.2009-37 (MEST.radiation.003) “Technical Standards for Locations of Nuclear Reactor Facilities”. The applicant shall prepare and submit a “Radiation Emergency Plan Report” as an attachment to the Operating Licence (OL) application, and the regulator review the acceptability of the plan.

## 6. Social acceptability (extent of public consultation)

- a. Describe how the regulator and the applicants engage local population and what level of local agreement is needed to proceed.

The applicant shall prepare a Preliminary Environmental Report (PER) and a Preliminary Radiation Environmental Report (PRER) and collect opinions of the local government and the residents of the proposed site area on the PER and the PRER through public hearings. The results from the public hearing, i.e. summary of the opinions and the measures, shall be described in the ER – a supplementary document of the application for the licence for Action Plan and Site Preparation as required by the Electric Source Development Promotion Act, and in the RER – a supplementary document of the application for the Construction Permit (CP) as required by the MEST Notice 2009-37 (MEST. Reactor.03) “Standard Format and Contents of Radiation Environmental Report for Nuclear Power Facilities”. The regulator reviews the RER at the stage of the safety reviews for CP and OL.

## 7. Practices/assessments to determine if NPP design parameters are enveloped or suitable for a given site

- a. Describe the specific design parameters that are evaluated against the site characteristics and any site specific design changes or additional design analyses needed when approving a site (e.g. seismic, meteorology, hydrology).

The design parameters required for approving a site are as follows:

- Exclusion Area Boundary (EAB): Whole body radiation exposure ( $\leq 25$  rem (0.25 Sv) (individual)) or thyroid radiation exposure ( $\leq 300$  rem (3 Sv) (individual)) in 2 hours after a postulated radiation accident;
- Low Population Zone (LPZ): Whole body radiation exposure (25 rem (individual)) or thyroid radiation exposure  $\leq 300$  rem (individual) during the entire period after a postulated radiation accident;
- Population Centre Distance (PCD): Population centres ( $> 25\ 000$ ) shall not be located within one and one-third times the radius of the LPZ from the reactor centre;
- Ground Water Level: 0 m (maximum) and 2.0 m (normal) below the plant ground level;
- Flood (or Tsunami) Level: 0.35 m below the plant ground level;
- Maximum Rainfall: 242.7 mm/h or 87.5 mm/5 min;
- Maximum Snow Design Load: 205.1 kg/m<sup>2</sup>;

- Design Temp. (Ambient): 39.4°C (Max. at 0% Exceedance), 33.3°C (Max. at 1% Exceedance), -20.2°C (Min. at 0% Exceedance) and -10.6°C (Min. at 1% Exceedance);
  - Design Temp. (Intake water): Max. 35.5°C (ESW) and 31.2°C (CCW);
  - Extreme Wind Velocity: 57 m/s;
  - Tornado: 49 m/sec (Max. wind speed), 39.5 m/s (Rotational speed), 9.5 m/s (Translation velocity), 50 m (Radius), 0.02 kg/cm<sup>2</sup> (Max. pressure differential), and per SRP 3.5.1.4 Spectrum II (Missile spectra);
  - Safe Shutdown Earthquake (SSE): 0.3 g for APR1400 and 0.2 g for the rest;
  - Operating Based Earthquake (OBE): 0.1 g;
  - Capacity of the reactor foundation: Foundation strength (> 3 times the structure/facility loading) and Foundation settlement (< 2.54 cm).
- b.** Describe the extent of regulatory review and/or requirements as to how specific site features or nearby facilities support extended station blackout.

The regulator does not review site features or nearby facilities in terms of a possible station blackout.

## **RESPONSE ON BEHALF OF UNITED KINGDOM (ONR)**

### **1. Multi-unit sites**

- a.** Limits on source term/number of units? (Contribution of all facilities to the source term including spent fuel storage, waste management and reactors.)

No specific limits are applied. We would however expect each plant to meet the risk targets in our Safety Assessment Principles (SAPs). Risks meeting these low levels are judged not to need further supplementary limits. The risk estimates should take account of all the contributions listed in the question.

- b.** Arrangement of units (distance, common equipment)

Our SAPs principle ST.6 and its supporting text set out our expectations for siting aspects on multi-unit sites. This seeks assessments that take into account risks from the site as a whole and interactions between units (e.g. the sharing of common equipment or services). We do not prescribe any specific rules on the arrangement of units, but would expect to see arguments put forward in the safety case(s) as to why the arrangement of the units reduces risks to as low as is reasonably practicable.

- c.** Arrangements to deal with impact on different facilities sited on one location (e.g. other industrial facilities)
- i.** During the siting review (or environmental assessment), do you consider potential impacts on the nuclear facility from co-located (or nearby) industrial facilities?

Yes at least to the extent of how credible is the hazard and can it be mitigated by design. The hazardous effects typically include potential for missiles and explosions, and are classed as industrial hazards.

### **2. Site layout considerations (utilizing natural and/or man-made features to minimize common cause initiators)**

- a.** Describe considerations for establishing safety/support equipment/facilities locations based on site specific geographical features and potential vulnerabilities.

Not aware of a specific example of this, but e.g. cooling water intakes/outfalls are normally sited so as to minimize re-circulation. Post-Fukushima work is being undertaken in the UK to ensure emergency access to site of resources needed after an event. This will consider viability of roads and other infrastructure after severe flooding etc. The National Policy Statement (NPS) for Nuclear Power Generation EN(6) requires that equipment layout design should consider the vulnerability to flooding and important equipment should be situated on the highest ground practicable.

### **3. Consideration of external hazards or combination of hazards at the siting stage**

- a. Described extent of external hazards considered for the site and the source of the information used to establish the external hazard design basis.

External hazards consideration is extensive at siting stage and includes all significant natural and man-made external hazards. The extent of consideration is generally to show whether or not the hazard is credible or can be effectively mitigated by design. In the UK this was done as part of the NPS EN(6) development process. Information sources will have been numerous, including existing nuclear industry, regulators, academics, and competent government organisations.

- i. Specifically, are there any changes being considered to update the return frequency for external events as a result of the Fukushima Daiichi nuclear power plant accident?

In the UK, the adequacy of site-specific methods to predict external flood and seismic return frequencies are being considered in the light of the Fukushima Daiichi nuclear power plant accident. But new build sites will undertake comprehensive re-analysis of return frequencies anyway, even if co-located near existing sites, and this would include any Fukushima Daiichi nuclear power plant accident lessons learnt.

- b. Describe the human induced hazards considered for the site and the source of the information used to establish the design basis.

Nearby industrial hazards and potentially hazardous transport activities would be considered. This would include for example, accidental aircraft crash from local airfields and military bases. Information sources would be hazard specific but would normally draw on existing nuclear industry practice. Not all hazards would require a design basis to be developed. For many industrial hazards it will be possible to show that the effects on the NPP are negligible with no need for design features to mitigate.

- c. Describe the assessments made to consider combinations of external or human induced hazards with consequential internal events to establish a bounding case for overall site hazards.

This is a complex area and is very site dependent. Typical combination hazards would be seismically induced fire and flood, missile damage caused by extreme weather, etc. At a siting stage the extent of consideration would be limited to an “in principle” assessment, e.g. the effects of siting a NPP close to a wind turbine farm, or extracting cooling water from an area of intense shipping activity. Typically, for credible combinations of hazards, bounding cases are developed to simplify the hazards analysis.

- d. Is the survivability of the local infrastructure and its ability to support site recovery assessed during the siting review?

Certainly these issues are considered in constructing the onsite and offsite emergency plans. There is a lot of post-Fukushima work in this area in the UK at present.

### **4. Land use/Population density**

- a. Describe considerations for existing population density during the siting review.
- b. Describe any arrangements/agreements on future development of population centres or municipal development over the life of the facility.

**5. Emergency preparedness arrangements/feasibility at siting stage**

- a. Describe acceptable level of established local/state/federal arrangements during siting review.

**6. Social acceptability (extent of public consultation)**

- a. Describe how the regulator and the applicants engage local population and what level of local agreement is needed to proceed.

**7. Practices/assessments to determine if NPP design parameters are enveloped or suitable for a given site**

- a. Describe the specific design parameters that are evaluated against the site characteristics and any site specific design changes or additional design analyses needed when approving a site (e.g. seismic, meteorology, hydrology).

This is too complex to answer in a few sentences. Typically the external hazards associated with a potential site are called the site challenge, and include: seismic ( $10^{-4}$ /year peak ground acceleration, free field response spectra, soil stiffness, potential for capable faulting), meteorology ( $10^{-4}$ /year wind speed,  $10^{-4}$ /year intense and daily precipitation,  $10^{-4}$ /year high/low air and sea temperatures), hydrology ( $10^{-4}$ /year high/low sea or river levels,  $10^{-4}$ /year high/low groundwater levels), geotechnical suitability of the site, and many others.

- b. Describe the extent of regulatory review and/or requirements as to how specific site features or nearby facilities support extended station blackout.

Nuclear sites must be licensed in the UK, and licensees must prepare safety cases justifying the safety of operations undertaken by demonstrating that the nuclear risks they pose to the public and workers on site are as low as reasonably practicable (ALARP) and satisfy various safety related criteria. This demonstration is primarily to assure the licensee that his operations are safe. The nuclear regulatory organisation assesses the adequacy of the licensee's management arrangements, processes, safety cases and onsite implementation by sampling a selection of these features. This applies to all aspects of site operations including extended station blackout, but this particular aspect is also being reviewed as part of post-Fukushima work. But none of this will be done as part of site selection, except at the "in principle" level.



## RESPONSE ON BEHALF OF INDIA (AERB)

### 1. Multi-unit sites

- a.** Limits on source term/number of units? (Contribution of all facilities to the source term including spent fuel storage, waste management and reactors.)

Dose apportionment is carried out for normal operating conditions considering release from all nuclear facilities in a particular site. Sufficient dose reserve is kept for future expansions.

Radiological Impact Assessment (RIA) during accident conditions generally consider postulated accident in single unit as a practice. Adequacy of Severe Accident (SA) mitigation measures following an extreme external event where possibility of destruction of assisting facilities both inside plant and surroundings and affecting multiple units is being contemplated.

Guidance for source term calculation is provided in AERB document on Radiation Protection Aspects In Design For Pressurised Heavy Water Reactor Based Nuclear Power Plants AERB/NPP-PHWR/SG/D-12.

- b.** Arrangement of units (distance, common equipment)

Distance between adjacent units is governed by path of low trajectory turbine missiles, security requirements, and construction/erection/maintenance requirements including movement of ODCs and cranes.

Twin units concept has been followed with a few common facilities like spent fuel storage, waste management plant and D<sub>2</sub>O upgrading plant. No sharing of safety related equipment/systems between units is allowed.

- c.** Arrangements to deal with impact on different facilities sited on one location (e.g. other industrial facilities)

At siting stage of NPP, a screening distance value (SDV) criterion is followed to locate NPPs away from other industrial facilities. No NPP in India is co-located with any other industrial facilities except at Rajasthan Atomic Power Station (RAPS) site. At this site, an H<sub>2</sub>S based Heavy Water Plant (HWP) is also located. This HWP undergoes regulatory safety review and inspections by AERB with respect to industrial safety. A common offsite emergency plan for all NPPs and HWP at RAPS site exists to handle any H<sub>2</sub>S leakage related accident or a nuclear accident.

- i.** During the siting review (or environmental assessment), do you consider potential impacts on the nuclear facility from co-located (or nearby) industrial facilities?

Postulated scenarios due to accident in the surrounding industrial facilities are required to be assessed including any transport corridors in the site vicinity and possible explosions in the chemicals carrying vehicles.

## **2. Site layout considerations (utilizing natural and/or man-made features to minimize common cause initiators)**

At site selection stage, among the candidate sites, the sites with low population, less prone to flooding due to higher natural grades, away from industrial/military installations, and in the region not susceptible to ground failures (viz. lands, subsidence, liquefaction, etc.) are preferred.

- a. Describe considerations for establishing safety/support equipment/facilities locations based on site specific geographical features and potential vulnerabilities.
  - The scenarios/phenomena considered during evaluation depends on the location of site (e.g. for flooding; inland vs. coastal);
  - The safe grade level of the facility is decided based on the estimated design basis flood level. In general, finished floor level of facilities is kept 300 mm above safe grade level;
  - The capability of plant drainage to cater to the local intense precipitation is assessed and amount of ponding of water/sheet flow under extreme conditions is also assessed with the requirement that the access roads to safety related areas shall not be flooded;
  - Possibility of subsidence, surface collapse, liquefaction, slope failure etc. as well as adequacy of foundation parameters is also assessed.

## **3. Consideration of external hazards or combination of hazards at the siting stage**

- a. Described extent of external hazards considered for the site and the source of the information used to establish the external hazard design basis.

The external events considered during site evaluation include:

- Earthquakes,
- Floods (storm/cyclone/tsunami/dam break/local rainfall),
- Meteorological conditions (wind, temperature),
- Landslides, liquefaction,
- Ground subsidence,
- Volcanism,
- Shoreline erosion,
- Loss of ultimate heat sink.

The return periods to be considered for important events are prescribed in AERB documents. The detailed guidelines to be followed for estimation of these parameters are also described in relevant AERB guides/national standards (Code of Practice on Safety in Nuclear Power Plant Siting AERB/SC/S and guides made their under). Source of information include recorded data as well as historical data from old texts/scriptures, catalogues, and site specific investigations.

- i. Specifically, are there any changes being considered to update the return frequency for external events as a result of the Fukushima Daiichi nuclear power plant accident?

The return periods of the events were re-visited subsequent to the Fukushima Daiichi nuclear power plant accident. It was concluded that for design basis no significant change in the annual frequency of the events



is called for in light of Fukushima Daiichi nuclear power plant accident. Assessment of margins to cater to the extreme events beyond design basis is contemplated including assessment of such extreme events.

- b.** Describe the human induced hazards considered for the site and the source of the information used to establish the design basis.

The human induced hazards to be considered for the assessment include:

- Aircraft crash,
- Chemical explosions and toxic gas releases,
- Oil slick,
- Blasting operations,
- Mining, drilling and water extraction.

The preliminary screening for certain type of events is carried out based on screening distance values. Detailed evaluation generally follows deterministic approach based on postulated worst case conditions.

- c.** Describe the assessments made to consider combinations of external or human induced hazards with consequential internal events to establish a bounding case for overall site hazards.

Events/effects arising out of mutually inclusive phenomena are considered. For example, the flood in the river or cyclone may coincide with high local precipitation, the dam break may be coincident with a small flood in the river. The earthquake causing dam break may affect the plant also besides the flood due to dam break. Emergency operating procedure (EOPs) exists to address internal events and external events. Severe accident analyses address internal events and severe accident management guidelines (SAMGs) are prepared from such analyses. The external events and consequential internal events are contemplated to be addressed in an integrated manner as EOPs and SAMGs.

- d.** Is the survivability of the local infrastructure and its ability to support site recovery assessed during the siting review?

Availability of local infrastructure (i.e. two independent escape routes) from emergency response angle is ensured before the plant is commissioned. Survivability of the local infrastructure and its ability to support site recovery is contemplated as a part of SAMG and offsite emergency measures. Further creation of an emergency facility at each NPP site is being envisaged which should remain functional under extreme events including radiological, have adequate provisions of communication and capable of housing essential personnel for a minimum period of one week.

#### **4. Land use/Population density**

- a.** Describe considerations for existing population density during the siting review.

The plant is required to establish an exclusion zone of more than 1 km and a sterilized zone of 5 km radius. Only natural growth of population and other facilities are allowed in sterilized zone. There are no mandatory requirements with regard to population except that no habitable population is permitted in exclusion zone. Collection of population data around the site is mandatory including periodic updating of the data. These data are used in preparing and updating offsite emergency plans. The feasibility of implementation of emergency plans is also assessed during siting review.



**RESPONSE ON BEHALF OF UNITED STATES OF AMERICA (NRC)****1. Multi-unit sites**

- a.** Limits on source term/number of units? (Contribution of all facilities to the source term including spent fuel storage, waste management and reactors.)

The NRC regulations have no explicit limit on the number of units on a site. For licensing of commercial power reactor facilities, in order to show compliance with the siting criteria dose reference values in 10 CFR 50.34 and equivalent sections of 10 CFR Part 52, the design basis accident dose evaluation considers a large release from a hypothetical accident with substantial meltdown of the reactor core. The design basis accidents are postulated to occur regardless of cause; therefore the analyses are performed without explicit consideration of the initiating event and associated likelihood. These analyses result in a source term for one reactor unit.

The General Design Criteria (GDCs) in 10 CFR 50, Appendix A, provide criteria to prevent interaction of multiple facilities on a site, including design bases for protection of the facility against natural phenomena (GDC-2), provisions to prevent interaction of systems leading to impairment of safety functions (GDC-5), independence of the reactor protection system (GDC-22), control of releases of radioactive materials to the environment (GDC-60), and fuel storage and handling and radioactivity control, including provisions for appropriate containment, confinement and filtering systems (GDC-61). Releases from radwaste systems are evaluated separately during licensing of the facility to show compliance with GDC-60 and Part 20, but not explicitly to show compliance with the siting regulations in the context of accidents. Releases from the spent fuel pools at the reactor units are considered for siting purposes as fuel handling accidents, with releases from a few spent fuel assemblies (usually 1-2). Because of the provisions of GDC-2 and GDC-61, other accident releases from the spent fuel pools from natural phenomena leading to mechanical damage, loss of cooling or water level are considered to be beyond the design basis for the facility and are not considered for reactor siting.

Given the postulated nature of the DBA events evaluated to show compliance with the siting regulation and the reactor design criteria as discussed above, which are intended to prevent common-cause failures of multiple units on a site, the evaluation of coincident accident source terms from more than one unit or facility has not been required to meet the NRC's siting criteria dose reference values, regardless of the total number of reactor units and other facilities on the site.

- b.** Arrangement of units (distance, common equipment)

- c. Arrangements to deal with impact on different facilities sited on one location (e.g. other industrial facilities)
  - i. During the siting review (or environmental assessment), do you consider potential impacts on the nuclear facility from co-located (or nearby) industrial facilities?

Yes. During the siting review, the NRC staff considers and reviews the site and its vicinity for the presence of transportation facilities and routes including airports and airways, roadways, railways, navigable waterways, and pipelines. Also included in the review are industrial activities such as fixed manufacturing, processing, and storage facilities. The staff evaluates the data provided by the applicant in the Safety Analysis Report (SAR) to confirm that the applicant has adequately addressed by describing each facility to include the location, distance, potential hazardous materials and products used, stored or transported. The review also includes materials data as applicable pertaining to type, size, quantity, and shipping frequency (if applicable) for all facilities and activities within 8 km (5 miles) of the plant. Facilities and activities at distances greater than 8 km (5 miles) are considered if they have the potential for affecting the safe operation of the plant. For multi-unit sites, the existing unit(s) is considered as a nearby facility. The evaluations are required to conform to the regulatory requirements specified in 10 CFR 100.20(b). The guidance is provided in regulatory guides such as RG 1.91, RG 1.206, RG 4.7, RG 1.78; and review plan NUREG-0800.

The environmental assessment for a facility mainly considers the impact of the operation of the facility on the surrounding natural environment. Although impacts from co-located or industrial facilities on the nuclear power plant are not explicitly described for the purposes of the environmental assessment, design basis and severe accident impacts are described. In the Environmental Impact Statement for a nuclear power plant operating licence renewal or combined operating license, the probability-weighted consequences (i.e. risks) of severe accidents from the facility are evaluated, and cumulative severe accident impacts from co-located or nearby nuclear power plants within 80 km (50 miles) are also discussed.

## **2. Site layout considerations (utilizing natural and/or man-made features to minimize common cause initiators)**

- a. Describe considerations for establishing safety/support equipment/facilities locations based on site specific geographical features and potential vulnerabilities.

The site location and the engineered features included as safeguards against the hazardous radiological consequences of an accident should ensure a low risk of public exposure. Both 10 CFR 100.20(b) and 10 CFR 100.21 require the staff to review population density and use characteristics of the site environs, including the exclusion area, low-population zone, and population centre distance to be considered in determining the acceptability of a site for a power reactor. Specifically, 10 CFR 100.20 (b) requires that siting and plant design should reflect the population density and use characteristics of the plant environs. 10 CFR 100.21 requires that the applicant determine an exclusion area of such size that an individual located at any point on its boundary for 2 hours immediately following onset of a postulated fission product release would not receive a radiation dose exceeding prescribed limits. The Standard Review Plan Section 2.1.1 guides to the staff that the transportation corridors within the exclusion area do not interfere with normal plant operation. Meeting these regulations and guides ensure that an accidental release of fission products will be maintained within acceptable levels and that there is reasonable assurance that appropriate protective measures can be taken in the event of an accident.

### 3. Consideration of external hazards or combination of hazards at the siting stage

- a. Described extent of external hazards considered for the site and the source of the information used to establish the external hazard design basis.

Appendix A, “General Design Criteria for Nuclear Power Plants”, to 10 CFR Part 50, GDC 2, “Design Bases for Protection against Natural Phenomena” states that structures, systems, and components (SSCs) important to safety at nuclear power plants must be designed to withstand the effects of natural phenomena such as earthquakes, tornados, hurricanes, floods, tsunami and seiches without loss of capability to perform their intended safety functions. The design bases for these SSCs are to reflect appropriate consideration of the most severe of the natural phenomena that have been historically reported for the site and surrounding area. The design bases are also to reflect sufficient margin to account for the limited accuracy, quantity, and period of time in which the historical data have been accumulated.

Subpart B to 10 CFR Part 100 discusses the factors to be considered when evaluating sites for stationary power reactor site applications on or after January 10, 1997. Subpart B states, in part, that the factors to be considered when evaluating sites include:

- The nature and proximity of man-related hazards such as airports, dams, transportation routes, and military and chemical facilities;
- The physical characteristics of the site, including geology and seismology (e.g. safe shutdown earthquake ground motion, potential for surface tectonic and non-tectonic deformations, seismically induced floods and water waves, soil and rock stability, liquefaction potential, natural and artificial slope stability), meteorology (e.g. maximum probable wind speed and precipitation), and hydrology (e.g. probable maximum flood).

Guidance on the sources of information used in establishing the external hazard design bases can be found in the following sections of NUREG-0800, “Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition”:

- Identification of Potential Hazards in Site Vicinity
- Evaluation of Potential Accidents
- Regional Climatology
- Floods
- Probable Maximum Flood (PMF) on Streams and Rivers
- Potential Dam Failures
- Probable Maximum Surge and Seiche Flooding
- Probable Maximum Tsunami Hazards
- Flooding Protection Requirements
- Low Water Considerations
- Basic Geologic and Seismic Information
- Vibratory Ground Motion
- Surface Faulting
- Stability of Subsurface Materials and Foundations
- Stability of Slopes

- i. Specifically, are there any changes being considered to update the return frequency for external events as a result of the Fukushima Daiichi nuclear power plant accident?

No. Note that the approaches used to evaluate flooding hazards apply deterministic approaches (instead of probabilistic approaches or flood frequencies) to develop the design basis flood.

- b. Describe the human induced hazards considered for the site and the source of the information used to establish the design basis.

Onsite or nearby facilities that may have potential for human induced hazards include onsite storage of chemicals, compressed or liquefied gases such as hydrogen, propane, and natural gas; and industrial, transportation, and military facilities that involve the use of potential hazardous materials (e.g. oil or toxic chemicals) or pose other risks (e.g. a barge collision with an intake structure or airplane crash at the site).

Design basis events are established based on appropriate facility data including location, distance, type, size, quantity, and shipping frequency. Design basis events on the site or in the vicinity of the nuclear power plant are defined as accidents with a probability of occurrence of an order of magnitude of  $10^{-7}$  per year with potential consequences exceeding the 10 CFR Part 100 guidelines.

- c. Describe the assessments made to consider combinations of external or human induced hazards with consequential internal events to establish a bounding case for overall site hazards.

The assessments made in evaluating site hazards include the potential hazard from the onsite or nearby site facilities due to overpressure (explosion or vapour cloud explosion), thermal (fires), missiles from explosion, toxic chemicals for control room habitability, missiles from co-located facility and aircraft crash. The hazard impact is evaluated based on the release or result of potential accident, but not on the nature or cause of accident. Therefore, the maximum potential or bounding case impact is determined and addressed. Combinations of hazards occurring simultaneously are not explicitly addressed.

- d. Is the survivability of the local infrastructure and its ability to support site recovery assessed during the siting review?

The NRC does not assess the survivability of the local infrastructure during the siting review. The focus of the siting review regarding emergency preparedness is primarily on the ability to implement measures to ensure protective actions can and will be taken to ensure public health and safety. Siting factors and criteria are important in assuring that radiological doses from normal operation and postulated accidents will be acceptably low, that natural phenomena and potential man-made hazards will be appropriately accounted for in the design of the plant, that site characteristics are such that adequate security measures to protect the plant can be developed, and that physical characteristics unique to the proposed site are identified.

#### **4. Land use/Population density**

- a. Describe considerations for existing population density during the siting review.

As required by 10 CFR 100.20 and 10 CFR 100.21, site suitability is determined on the basis of consideration to population density and other site characteristics including exclusionary area boundary (EAB), Low Population Zone (LPZ), and population centre.

The staff evaluates the population density in the vicinity of site to determine whether it exceeds the guidelines specified in Regulatory Position C.4 of RG 4.7. These guidelines state that the population density, including the weighted transient population projected at the time of initial site approval and 5 years thereafter, should not exceed 500 persons per 2.59 km<sup>2</sup> (1 square mile) averaged over any radial

distance out to 32.2 km (20 miles) (i.e. cumulative population at a distance divided by the area at that distance).

- b. Describe any arrangements/agreements on future development of population centres or municipal development over the life of the facility.

The NRC staff reviews to verify that the distance to the nearest population centre is at least one and one third times the distance to the outer boundary of low population zone (LPZ), as required by 10 CFR Part 100. Communities that are closer than the existing population centre should be evaluated to determine its projected population based on available data on land use, zoning requirements, potential population growth rate(s), and determine the likelihood of their population growing greater than 25 000 people within the operational life time of the existing or proposed plant.

In cases where population centre requirement is anticipated not meeting the one and one third distance requirement within the operational life of the plant, compensating engineering safeguards in the plant design may be necessary, and are to be considered on case-by-case basis. Guidance is provided in RG 1.206 and review plan NUREG-0800.

## **5. Emergency preparedness arrangements/feasibility at siting stage**

- a. Describe acceptable level of established local/state/federal arrangements during siting review.

The NRC does not require emergency arrangements/feasibility at the siting stage. However, our review focuses on the identification of the physical characteristics that could pose a significant impediment to the development of an emergency plan. Any significant impediments identified, would have to have measures identified to eliminate or mitigate the impediment.

The arrangements with local/state/federal agencies would be included with the submittal of an application. The applicant would have to provide copies of letters of agreement (LOA) or other certificates reflecting contacts and arrangements made with these agencies that support emergency preparedness. These LOAs or certificates should reflect the use of the proposed site for possible construction of the new reactor(s). It should be noted that the Commission's final rules are based on the significance of adequate emergency planning and preparedness. The protection of the health and safety of the public provided by proper siting and engineered design features is bolstered by the ability to take adequate protective measures during an event.

## **6. Social acceptability (extent of public consultation)**

- a. Describe how the regulator and the applicants engage local population and what level of local agreement is needed to proceed.

The NRC licensing process includes opportunities for the public to provide input to the NRC on their concerns or comments on the siting of a nuclear power facility. Included in the process are opportunities to provide comments directly to the staff, either verbally or in writing through public meetings or request by the staff. The public can also file contentions within the hearing process, as provided in regulation (10 CFR Part 2). The NRC conducts meetings for the public near the proposed site as part of NRC development of the Environmental Impact Statement (EIS) and elucidation of NRC's licence review process. The public is invited to these public meetings, where they can elect to present their concerns or preferences to the proposed action. These public meetings facilitate direct interaction between the public and the regulator and/or applicant, and the public has an opportunity to express concerns or opinions for or against for the proposed action. Public comments/concerns are considered and clarified as appropriate, and are also documented as part of comment/response process for preparation of the EIS. In addition, the public is also

invited to participate in the presentation of staff's review of the licence application to ACRS (Advisory Committee on Reactor Safeguards) and potential contested hearings. However, no agreements with the public are negotiated.

**7. Practices/assessments to determine if NPP design parameters are enveloped or suitable for a given site**

- a. Describe the specific design parameters that are evaluated against the site characteristics and any site specific design changes or additional design analyses needed when approving a site (e.g. seismic, meteorology, hydrology).

The plant design parameters that are evaluated against site characteristics have typically included the following:

- Meteorology
  - Air Temperature (for example, dry-bulb and coincident wet bulb temperature values and non-coincident wet bulb temperature values that represent historical extreme values and values that are expected to be exceeded one percent of the time during the year);  
Wind speed (for examples, a 3-second gust value that represented a 100-year return value at 10 m above plant grade);
  - Design basis tornado (for example, wind speed, pressure drop, and rate of pressure drop of a tornado that has an exceedance frequency of  $10^{-7}$  per year);
  - Tornado missiles (associated with the design basis tornado);
  - Maximum snow/ice roof loads;
  - Maximum cumulative degree days below freezing (for use in determining the potential for ice formation affecting the ultimate heat sink design);
  - Atmospheric dispersion factors (for accessing design basis accident releases to the control room and offsite receptors).
- Hydrology
  - Maximum rainfall rate (for example, cm/h; used for roof drainage design);
  - Maximum short term rainfall (for example, cm in 5 minutes);
  - Maximum flood level (with respect to plant elevation, usually caused by either river flooding, onsite flooding, tsunami, storm surge, or dam break events);
  - Maximum ground water level (with respect to plant elevation).
- Soil
  - Minimum (or average) static and dynamic bearing capacity;
  - Minimum soil angle of internal friction;
  - Dynamic bearing capacity for normal plus safe shutdown earthquake;
  - Limits of acceptable settlement without additional evaluation;
  - Lateral variability (variations in subgrade stiffness);
  - Minimum shear wave velocity;
  - Liquefaction potential;
  - Required stability of slopes (static/non-seismic and dynamic/seismic loading).
- Seismic
  - Seismic design response spectra;
  - Fault displacement potential.

An applicant for a combined licence that references a certified design must demonstrate that the site characteristics fall within the site parameters specified in the design certification. If the design of the



facility does not fall within the site characteristics and site-related design parameters, the applicant needs to provide supporting justification that the proposed facility is acceptable at the proposed site.

- b.** Describe the extent of regulatory review and/or requirements as to how specific site features or nearby facilities support extended station blackout.

NRC regulations address station blackout (SBO) conditions, which are defined as the complete loss of alternating current (AC) electric power to the essential and nonessential switchgear buses in a nuclear power plant (i.e. loss of offsite electric power system concurrent with turbine trip and unavailability of the onsite emergency AC power system). SBO does not include the loss of available AC power to buses fed by station batteries through inverters or by alternate ac sources meeting specific criteria, nor does it assume a concurrent single failure or design basis accident (DBA). At single unit sites, any emergency AC power source(s) in excess of the number required to meet minimum redundancy requirements (i.e. single failure) for safe shutdown (non-DBA) is assumed to be available and may be designated as an alternate ac source(s) provided the applicable requirements are met. At multi-unit sites, where the combination of emergency AC power sources exceeds the minimum redundancy requirements for safe shutdown (non-DBA) of all units, the remaining emergency ac sources may be used as alternate ac sources provided they meet the applicable requirements. If these criteria are not met, SBO would be assumed to include loss of all AC power on all the units.

The NRC reviews applicant submittals on SBO to determine that the specified SBO duration for an applicant to withstand and recover from an SBO (coping time) conforms to the guidance provided in Section C.3.1 of Regulatory Guide (RG) 1.155, "Station Blackout". A series of tables in RG 1.155 based on the factors laid out in the SBO rule, 10 CFR 50.63, provide a method for determining an acceptable minimum SBO coping time for the plant. Site features and/or nearby facilities are included as follows:

- Characteristics of the offsite power system that have been found to contribute to the expected frequency of a loss of offsite power;
- Potential environmental effects on the operability and reliability of equipment necessary to cope with the SBO, including possible effects of fire protection systems;
- Potential effects of other hazards, such as weather, on SBO response equipment (e.g. auxiliary equipment to operate onsite buses or to recover EDGs and other equipment as needed).

With respect to extended station blackout, on 12 March 2012, the NRC issued Order EA-12-049 Order Modifying Licenses with Regard to Mitigation Strategies for Beyond Design-Basis External Events, which addresses extended station blackout. The order does have some requirements that cover nearby facilities, specifically, the portion of the requirements for the final phase of mitigation and its reliance on acquisition of offsite resources. It is performance based; licensees need to be able to acquire resources prior to running out of onsite resources. Licensees or construction permit holders must provide reasonable protection for the associated equipment from external events. Such protection must demonstrate that there is adequate capacity to address challenges to core cooling, containment, and spent fuel pool (SFP) cooling capabilities at all units on a site subject to the order.



## RESPONSE ON BEHALF OF SLOVENIA (SNSA)

### 1. Multi-unit sites

- a.** Limits on source term/number of units? (Contribution of all facilities to the source term including spent fuel storage, waste management and reactors.)

There are no explicit limitations regarding source term or number of units on site. Anyway, the limiting dose values to most exposed individual from population shall be respected on site.

- b.** Arrangement of units (distance, common equipment)

In Ionising Radiation Protection and Nuclear Safety Act (in the following text Atomic Act), Article 64 a (location of a nuclear facility) requires that the municipal and detailed municipal spatial plan and regional land use plan shall consider a limited area of land use due to nuclear facility when planning.

- c.** Arrangements to deal with impact on different facilities sited on one location (e.g. other industrial facilities)

Decree on the areas of limited use of space due to a nuclear facility and the conditions of facility construction in these areas sets the limitations and spatial limits for the spatial planning and construction in the vicinity of a NPP.

Additionally, the Special safety analysis (SSA) is provisioned in Article 65 of Atomic Act, it stipulates that the selection of an area for location of a nuclear facility shall be performed through the SSA, which will be used to assess all the factors in the area for the location of the nuclear facility which may affect the nuclear safety and also the effects of the operation of the facility on the population and the environment. The Slovenian Nuclear Safety Administration (SNSA) shall determine detailed content and scope of the SSA during the process of preparation of national spatial plan.

For example, the content of Special safety analysis for the new Krško NPP (JEK2) (draft version) includes chapter "Site characteristic and influence on nuclear and radiological safety" for which the investor must assess the potential impacts of industry objects, military centres and transport routes on the site.

- i.** During the siting review (or environmental assessment), do you consider potential impacts on the nuclear facility from co-located (or nearby) industrial facilities?

Yes. In the phase of spatial planning in the SSA potential impacts of industry objects, military centres and transport routes on the site and/or the plant must be assessed, and based on that the design bases are set.

The environmental impact assessment report prepared by investor shall again contain information about impacts on the nuclear facility from nearby located industrial, transportation and military facilities.

## **2. Site layout considerations (utilizing natural and/or man-made features to minimize common cause initiators)**

In Atomic Act, Article 65 (analysis of the safety of an area for the location of a nuclear facility) requires that:

The choice of an area for the location of a nuclear facility shall be based on a Special safety analysis, which will be used to assess:

- all the factors in the area for the location of the nuclear facility which may affect the nuclear safety of the facility during its operating lifetime and;
- the effects of the operation of the facility on the population and the environment.

The detailed contents and the scope of the Special safety analysis shall be defined during the procedure for the drawing up of the national site development plan by the ministry competent for the environment.

- a. Describe considerations for establishing safety/support equipment/facilities locations based on site specific geographical features and potential vulnerabilities.

No special considerations are proposed regarding the location of equipment or separate facilities. General requirement is that safety related SSCs must be designed to withstand the environmental effects on the location (including internal and external hazards) in all modes of operation including accidents. Concepts such as single failure criteria, defence in depth, independency, redundancy and diversity must be taken into account.

## **3. Consideration of external hazards or combination of hazards at the siting stage**

The Rules on radiation and nuclear safety factors (JV5) require that at least the following external hazards and their combinations shall be considered: extreme winds, extreme outside temperatures, extreme rainfall, extreme snowfall, flooding, extreme cooling-water temperatures and freezing, earthquakes, aircraft crashes, and other events on nearby transport routes, in industrial facilities or within the site region that might lead to fire, explosion or other hazards to the safety of the nuclear power plant.

See also the answer No. 2.

- a. Described extent of external hazards considered for the site and the source of the information used to establish the external hazard design basis.

of external hazard is defined in Special safety analysis report. It mainly follows the requirements from IAEA standards. For example, the content of Special safety analysis for new NPP JEK2 (draft version) includes in chapter “Site characteristic and influence on nuclear and radiological safety” the following subchapters: Geography, Industry objects, Military centres and transport routes, External human induced events, Geology, geo-chemistry and geotectonic, Tectonic and seismology, Meteorology and climate conditions, Hydrogeology and hydrology, Insurance for long term heat removal from reactor core and from spent fuel pool, Transport of materials, nuclear fuel and radioactive waste and Influence of existing objects.

- i. Specifically, are there any changes being considered to update the return frequency for external events as a result of the Fukushima Accident?

Currently there are no detailed requirements on the return frequency for external events and also no changes are considered at this time.

- b.** Describe the human induced hazards considered for the site and the source of the information used to establish the design basis.

The extent of human induced hazards assessment is defined in Special safety analysis report, following IAEA document NS-G-3.1: External Human Induced Events in Site Evaluation for Nuclear Power Plants. For example, the content of Special safety analysis for new NPP JEK2 (draft version) includes in chapter “Site characteristic and influence on nuclear and radiological safety” also human induced hazards such as aircraft crash, chemical explosions, missiles, etc..

Regarding the design basis the regulation JV5, Article 8 (site conditions) require that the design shall take due account of special environmental loads and conditions to which SSCs may be exposed due to external and internal events, including natural events characteristic for the site region, as well as events associated with human activities.

- c.** Describe the assessments made to consider combinations of external or human induced hazards with consequential internal events to establish a bounding case for overall site hazards.

The integral effects of internal and external including human induced hazards are determined during the preparation of Special safety analysis. The so called envelope of site parameters shall be established which represents the design conditions for the new build.

- d.** Is the survivability of the local infrastructure and its ability to support site recovery assessed during the siting review?

Not in details.

#### **4. Land use/Population density**

- a.** Describe considerations for existing population density during the siting review.

The demography and estimation of influent radiological effects on the population shall be described in detail in the Special safety analysis. A special analysis shall be performed to evaluate the population distribution and characteristics in the region with intent to evaluate the effects of radioactive exposure during normal operation and accidents, as well as to support the feasibility of the emergency preparedness plan. IAEA standards, such as IAEA NS-G-3.2 Dispersion of Radioactive Material in Air and Water and Consideration of Population Distribution in Site Evaluation for Nuclear Power Plants shall be used.

- b.** Describe any arrangements/agreements on future development of population centres or municipal development over the life of the facility.

The distribution of population information inside the location region shall be known to evaluate the radiological effects on the population during normal and accidental conditions. For this reason the detail information of currently population distribution and predicted one are needed and shall be described in the Special safety analysis. Also this information should be updated throughout the lifetime of the plant.

## **5. Emergency preparedness arrangements/feasibility at siting stage**

- a.** Describe acceptable level of established local/state/federal arrangements during siting review.

The description of feasibility of emergency preparedness plan in emergency situations is also part of the Special safety analysis.

Depending on the characteristics and distribution of the population, the combined effects of location and facility must be such, that the radiological risk to population associated with accident conditions, including those which may lead to protective measures, remains acceptably low.

Using estimates of emissions during severe accidents and taking into account meteorology, hydrology and other features of location, it is necessary to determine the potentially affected area. For this area (taking into account the assessment of population distribution) an emergency plan must be prepared, which will provide an acceptably low radiological risk to population. It is necessary to analyse the feasibility of protective measures taking into account the constraints arising from the physical properties of the environment (roads, railways, flood potential, distribution of population, land use, ...), estimated time of evacuation, etc.. The feasibility of emergency plan must be assessed for the potentially affected area, both inside and outside the plant.

Also the provisioned arrangements, such as organisations (internal and external) responsible for implementation of emergency plan, information tools, connections and arrangements with local and state authorities, measures in and outside the plant for protecting the health and safety, needed procedures (e.g. evacuation), system for informing and guiding the population, the necessary preparations to ensure adequate care for the injured, etc. shall be described in the Special safety analysis.

For the assessment of the emergency preparedness the Slovenian Nuclear Safety Administration will encourage the use of methodology described in U.S.NRC Regulatory Guide 1.101 Emergency Planning and Preparedness for Nuclear Power Reactors and IAEA Safety Guide No. GS-G-2.1 Arrangements for Preparedness for a Nuclear or Radiological Emergency, or comparable.

## **6. Social acceptability (extent of public consultation)**

- a.** Describe how the regulator and the applicants engage local population and what level of local agreement is needed to proceed.

The public is involved in the process of siting couple of times. According to the Spatial Planning Act and the Environmental Act, the public has a possibility to review the States Spatial Plan, Environmental Report, Environmental Impact Assessment report and to pose questions and remarks. During the siting process there are two one month public proceedings, when public is acquainted with the plan and environmental impacts. The public gives remarks and poses questions, of which all have to be answered, before the process can continue. The role of the public is complete when the site is accepted.

The current government has also agreed that it would carry through a referendum, before the siting process can start.

**7. Practices/assessments to determine if NPP design parameters are enveloped or suitable for a given site**

- a.** Describe the specific design parameters that are evaluated against the site characteristics and any site specific design changes or additional design analyses needed when approving a site (e.g. seismic, meteorology, hydrology).

Regulation JV5, in Article 8 (Site conditions) requires that the design shall take due account of special environmental loads and conditions to which SSCs may be exposed due to external and internal events, including natural events characteristic for the site region, as well as events associated with human activities. In the preparation of Special safety analysis the site characteristics shall be assessed and based on them the design conditions envelop shall be set. These characteristics are: industry objects, military centres and transport routes, man induced events (chemical explosions, aircraft accidents, other man induced hazards), geology of the location, geotechnical hazards, seismic hazards and faults, meteorology and climatology, hydrogeology and hydrology (water bodies and floods), interactions between units, dispersion of radioactive material through air and waters, demography and assessment of potential radiological impacts on the population, feasibility of emergency plan.

- b.** Describe the extent of regulatory review and/or requirements as to how specific site features or nearby facilities support extended station blackout.

Currently there are no specific regulatory requirements regarding site features or nearby facilities supporting the extended station blackout.





## RESPONSE ON BEHALF OF CANADA (CNSC)

### 1. Multi-unit sites

- a. Limits on source term/number of units? (Contribution of all facilities to the source term including spent fuel storage, waste management and reactors.)

For NPPs (reactor facilities approx > 200 MWth), the limits below are per unit and are specific to water-cooled reactors. Per RD-337 Design for New Nuclear Power Plants, 2008, CNSC sets criteria for safety goals as follows:

- For Accident Prevention, CNSC uses Core Damage Frequency and the sum of frequencies of all event sequences that can lead to core degradation is expected to be less than  $10^{-5}$ /reactor-year;
- For Short Term Evacuation, CNSC uses Small Release Frequency Safety Goal, the sum of frequencies of all sequences that can lead to a release of more than 1 015 Bq of Iodine-131 is expected to be less than  $10^{-5}$ /reactor-year;
- For Long Term Relocation, CNSC uses Large Release Frequency Safety Goal, the sum of frequencies of all event sequences that can lead to a release to the environment of more than 1 014 Bq of Caesium-137 is expected to be less than  $10^{-6}$ /reactor-year.

For accidents more frequent than one in 100 000 years, the dose limits must be met. These ensure that consequences are small, relative to the risks to which people are normally exposed.

For Small Reactors (reactor facilities approx < 200 MWth), the limits below are per plant and are written more generically because technologies for small reactors vary more than for NPPs. Per RD-367 Design for New Small Reactor Facilities, 2011, CNSC sets criteria for safety goals as follows:

- For Accident Prevention, CNSC uses Core Damage Frequency and the sum of frequencies of all event sequences that can lead to core degradation is expected to be less than  $10^{-5}$ /reactor-year;
- For Short Term Evacuation, CNSC uses Small Release Frequency Safety Goal. The sum of frequencies of all event sequences, whose release to the environment requires temporary evacuation of the local population, shall be less than  $10^{-5}$  per reactor year;
- For Long Term Relocation, CNSC uses Large Release Frequency Safety Goal, The sum of frequencies of all event sequences, whose release to the environment requires long-term relocation of the local population, shall be less than  $10^{-6}$  per reactor year.

For accidents more frequent than one in 100 000 years, the dose limits must be met. These ensure that consequences are small, relative to the risks to which people are normally exposed.

For NPPs and small reactors, the above considers all in-plant events including those that affect in-plant fuel storage, waste management areas etc.

For other facilities (e.g. waste facilities) co-located on the same site as the NPP/Small Reactor facility there are no fixed limits on the “source term”. Those facilities’ accidents and malfunctions are assessed separately and addressed based on risk contribution. CNSC experience has found that these “extra” facilities do not contribute in any significant way to the overall site source term.

**b. Arrangement of units (distance, common equipment)**

The Class 1 Facilities Regulations Section 3(a) sets high level requirements for this area requiring an applicant for a licence to submit “a description of the site of the activity to be licensed, including the location of any exclusion zone and any structures within that zone”.

The applicant/licensee is required to propose, among other things, in their safety case how the facility’s arrangement ensures that Canadian requirements are met. CNSC does have high level requirements around arrangement of SSCs important to safety in RD-337 Design for New Nuclear Power Plants, 2008. (for example section 7.6.1 discusses requirements for avoidance of common-cause failures such as separation, diversity.)

CNSC does not have explicit requirements regarding use of common SSCs. The safety case proposed by the applicant/licensee is required to demonstrate, among other things:

- Safety objectives will be met;
- There is adequate defence-in-depth in the design;
- Design for reliability – i.e. the plant is designed, constructed, and operated in a manner that is consistent with the assumptions and risk importance of SSCs important to safety (includes examination for common cause events).

In a proposed amendment to RD-337 Design for New NPPs currently in progress as part of CNSC’s response to the Fukushima Daiichi nuclear power plant accident, staff has proposed an additional requirement to ensure that the design will take due account of challenges to a multi-unit site. Specifically, the risk associated with common-cause events affecting more than one unit at a time is expected to be considered.

**c. Arrangements to deal with impact on different facilities sited on one location (e.g. other industrial facilities)**

- i.** During the siting review (or environmental assessment), do you consider potential impacts on the nuclear facility from co-located (or nearby) industrial facilities?

Yes. Under the existing published version of RD-346 Site Evaluation for New Nuclear Power Plants, the proponent of the new facility is required to evaluate hazards (as external events) from outside the new site. These would include events from other nearby nuclear facilities as well as any facility in the vicinity of the site that could affect the safety of the new facility.

If a new nuclear facility is proposed to be built next to an existing nuclear facility, the licensee of the existing facility is required to evaluate any hazards originating from the new build site during site preparation, construction and operation. Results of the evaluation are expected to be incorporated into the existing plant’s safety case.

## **2. Site layout considerations (utilizing natural and/or man-made features to minimize common cause initiators)**

- a. Describe considerations for establishing safety/support equipment/facilities locations based on site specific geographical features and potential vulnerabilities.

There are no specific site layout requirements established for utilizing natural and/or man-made features to minimize common cause initiators.

Security requirements do provide guidance in this area and require a proponent to outline how they are using these features to their advantage.

The CNSC sees no need at this time to set prescriptive design requirements around use of site specific features/locations as current licensees have been historically employing this thinking voluntarily in their design strategies.

Per RD-346 Site Evaluation for New Nuclear Power Plants, proponents are required to characterise the site and the surrounding region and the characterisation is expected to include information about extreme events (including combinations of events) that could affect the facility.

RD-337 Design for New Nuclear Power Plants, 2008 and RD-367 Design for New Small Reactor Facilities require a proponent to address external events in the design. This is further reinforced in the following regulatory documents:

- RD-310 Safety Analysis for Nuclear Power Plants, 2008,
- GD-310 Guidance on Safety Analysis for Nuclear Power Plants, March 2012,
- RD-308 Deterministic Safety Analysis for Small Reactor Facilities, June 2011.

An application for a Licence to Construct would be required to show how the site specific design addresses external events (including extreme events relevant to the site).

Amendments to RD-337, RD-310 and RD-308 are being proposed as part of CNSC's Fukushima Action Plan to strengthen requirements in this area. (RD-367 will be amended at a later time.) For example, CNSC has clarified requirements in the area of survivability of plant SSCs to mitigate certain BDBAs. CNSC recognizes that Design Extension Conditions (DEC) also factor into overall plant design by confirming that specific SSCs important to safety (called Complementary Design Features) can mitigate DEC events.

## **3. Consideration of external hazards or combination of hazards at the siting stage**

- a. Described extent of external hazards considered for the site and the source of the information used to establish the external hazard design basis.
  - i. Specifically, are there any changes being considered to update the return frequency for external events as a result of the Fukushima Daiichi nuclear power plant accident?

Section 4(b) of the Class 1 Facilities Regulations requires an applicant for a licence to submit "a description of the site's susceptibility to human activity and natural phenomena, including seismic events, tornadoes and floods".

RD-346 Site Evaluation for New Nuclear Power Plants (2008) requires proponents to characterise all natural and human-induced hazards that could impact the site. Requirements for proponents and licensees regarding extent of external hazards considered for the site is discussed in Section 5.3 of RD-346 as follows:

"The proposed site is examined with regard to the frequency and severity of external natural and human-induced events that could affect the safety and security of the proposed NPP.

A systematic approach for identifying and assessing the hazards associated with external events, including underlying rationale, is developed, documented, and implemented in an auditable fashion.

Each external natural and human-induced event is identified and assessed with the following considerations:

1. The potential direct and indirect effects of the event on the proposed NPP structures, systems, and components (SSCs), including those that could affect the safe operation of the NPP in both normal and abnormal operating states. Examples include:

- a) direct effect—an earthquake resulting in a main steam line break, and
- b) indirect effect—a corrosive gas release from a nearby chemical plant degrading NPP safety system trip circuits via ventilation intakes;

2. The potential combined effects of external and human-induced events with normal and accidental releases from the proposed NPP that would exceed environmental limits or cause a significant adverse effect to occur; and

3. Effects that would influence the ability to successfully implement emergency plans.

Derivation of the hazards associated with external events includes consideration of the combined effects of these hazards with the ambient conditions (e.g., simultaneous aircraft crash and heavy snowstorm). Combined effects of external hazards can have significant impact on such facets of the proposed NPP as the implementation of emergency plans, accident mitigation, and contaminant pathway models.

The region assessed for each identified external event encompasses the environment that could be affected. The evaluation considers foreseeable changes in land use for the projected lifetime of the NPP to assess and plan for mitigation of new external hazards introduced by change in land use.

Site-specific data is used to determine hazards, unless such data is unobtainable. In this case, data from similar regions that is sufficiently relevant to the region of interest, or data derived from appropriate and acceptable simulation techniques, may be used. Data from similar regions and from simulated findings may also be used to augment site-specific data.

Prehistoric, historic, and instrumentally recorded information, and records of the identified external events and their severity, is collected for the region and analysed for reliability, accuracy, and completeness.”

CNSC is currently engaged in clarifying existing requirements to stress that analysis of external hazards is required to consider both design basis and beyond design basis events. In particular, the concept of potential cliff-edge effects must be considered when analysing external hazards, where a small increase in intensity of the hazard may result in significantly higher effects. CNSC is also strengthening existing requirements language requiring a proponent to consider synergies of multiple simultaneous events and their after-effects. For new reactor facilities, the analysis of external hazards needs to be done at the site evaluation stage, in order to confirm that the reactor facility will be able to respond effectively to such events.

In response to the specific question, CNSC has determined that no changes are required to the current requirements. The applicant is required to determine and justify both the spatial and temporal boundaries for each type of external hazard and is expected to show how they arrived at those conclusions. CNSC staff will be looking for how operating experience, such as the one gained from the Fukushima Daiichi nuclear power plant accident, has shaped the proponent’s investigations.

- b.** Describe the human induced hazards considered for the site and the source of the information used to establish the design basis.

RD-346 Site Evaluation for New Nuclear Power Plants (2008) requires proponents to characterise all natural and human-induced hazards that could impact the site. The evolution of natural and human-induced factors in the environment that may have a bearing on safety and security are expected to be evaluated across a time period that encompasses the projected lifetime of the NPP, with the understanding that different levels of evaluation and monitoring apply to the various phases of the plant lifetime.

The scope of investigations is discussed in Section 5.3 of RD-346 (see response to 3.a. above). “As discussed in Section 8.0 of RD-346:

The proponent is expected to develop, document, and implement a systematic approach to identifying all external, non-malevolent, human-induced events. Such events include, without being limited to:

1. Aircraft crashes;
2. Other transportation hazards;
3. Fires and explosions;
4. Chemical and radiological hazards; and
5. Electromagnetic interference hazards.”

Human induced events of a malevolent nature are handled separately.

- c.** Describe the assessments made to consider combinations of external or human induced hazards with consequential internal events to establish a bounding case for overall site hazards.

Please refer to the response provided for 3.a. In addition, RD-346 requires of the proponent:

- (section 5.1) proposed NPP designs to be evaluated against applicable safety goals, taking into account the characteristics of the site, the risks associated with external hazards, and the potential impact of the NPP on the environment.
  - (section 5.4) bounding scenarios involving modeling of potential effects from maximum possible releases to be completed to establish the outer boundaries or worst case scenarios for the NPP. These bounding scenarios also contribute to the scenarios used for emergency planning.
- d.** Is the survivability of the local infrastructure and its ability to support site recovery assessed during the siting review?

Yes. Per RD-346 Site Evaluation for New Nuclear Power Plants (2008), Section 5.5.4:

Prior to construction, the proponent confirms with the surrounding municipalities and the affected provinces, territories, foreign states, and neighbouring countries, that implementation of their respective emergency plans and related protective actions will not be compromised for the life cycle of the proposed site.

CNSC is currently engaged in clarifying this requirement to ensure this confirmation is performed by the proponent prior to the first licence (Licence to Prepare Site) being granted by the Commission of the CNSC.

In addition, the applicant seeking a licence is required to submit their emergency planning and response program (encompassing their licensed activities) for review by CNSC. Submissions are expected show how they have considered guidance contained in G-225 Emergency Planning at Class I Nuclear Facilities and Mills which includes how internal and external resources are used in mitigation of plant events.

As part of the post-Fukushima investigations by CNSC and licensees, improvements were identified to enhance emergency plans and capabilities to respond effectively in a severe event or multi-unit accident. As a result, per the CNSC Fukushima Action Plan, CNSC has taken an action to prepare a draft regulatory document on emergency management, reviewing and incorporating existing information in G-225, Emergency Planning at Class I Nuclear Facilities and Uranium Mines and Mills, and RD-353, Testing the Implementation of Emergency Measures and, following a period of public consultation, submit to the Commission for approval to publish.

#### **4. Land use/Population density**

- a.** Describe considerations for existing population density during the siting review.

The following sections of the Class 1 Facilities Regulations set high level requirements for this area:

- Section 3(a) requires an applicant for a licence to submit “a description of the site of the activity to be licensed, including the location of any exclusion zone and any structures within that zone”;
- Section 4(b) requires an applicant for a licence to submit “a description of the site's susceptibility to human activity and natural phenomena, including seismic events, tornadoes and floods”.

Per RD-346 Site Evaluation for New Nuclear Power Plants (2008), Section 4.0, a proponent is, as part of siting investigations, required to address:

- population density, population distribution, and other characteristics of the protective zone, in so far as they may affect the implementation of emergency measures and the need to evaluate the risks to individuals and to the general population;
- predictions about the evolution of the natural and human environment in the region, particularly population growth and distribution, that may have a bearing on safety and security throughout the projected lifetime of the NPP;
- predictions about the impact of the NPP on the population, including those that could lead to emergency conditions, with due consideration of relevant factors (e.g. population distribution, use of land and water, radiological impact of any other releases of radioactive material in the region, etc.).

The proponent is required to take population and emergency planning considerations into account to support achievement of the safety goals over the lifetime of the facility.

- b.** Describe any arrangements/agreements on future development of population centres or municipal development over the life of the facility.

Please refer to response for 4.a. In addition: Land controlled directly by the proponent/licensee:

A licensee is required to propose an Exclusion Zone around the proposed facility. An Exclusion Zone in Canada is a parcel of land within or surrounding a nuclear facility on which there is no permanent dwelling and over which a licensee has the legal authority to exercise control. The case for the extent of a proposed exclusion zone boundary is expected to clearly consider the following criteria:

- The committed whole-body dose for average members of the critical groups who are most at risk, at or beyond the site boundary is calculated in the deterministic safety analysis for a period of 30 days after the analysed event;
- The proposed boundary is 914 m from the outer wall of the reactor building;

- Under normal operating conditions, the effective dose at the exclusion zone boundary to a person who is not a nuclear energy worker does not exceed 1 mSv over the period of one calendar year;
- Under Anticipated Operational Occurrence (AOO) conditions, the effective dose at the exclusion zone boundary to a person who is not a nuclear energy worker does not exceed 0.5 mSv over the release time due to the AOO;
- Under Design Basis Accident (DBA) conditions, the effective dose at the exclusion zone boundary to a person who is not a nuclear energy worker does not exceed 20 mSv over the release time due to the DBA.

The extent of the exclusion zone is also expected to factor in security and emergency response considerations (e.g. response times).

Land outside the control of the proponent/licensee:

As discussed in the response to 4.a., population growth pressures and changes in land use play a role in the facility safety case. Where the safety case may be adversely affected, the licensee is expected to propose additional measures to reduce the risks (design or programmatic changes). In addition, the licensee is required to maintain ongoing engagement with municipal, provincial and federal emergency preparedness and response agencies to ensure that long term land-use plans consider the emergency planning needs of the nuclear facility for the life of the facility.

## **5. Emergency preparedness arrangements/feasibility at siting stage**

- a.** Describe acceptable level of established local/state/federal arrangements during siting review.

As discussed in the response to 3.d., per RD-346 Site Evaluation for New Nuclear Power Plants (2008), Section 5.5.4:

Prior to construction, the proponent confirms with the surrounding municipalities and the affected provinces, territories, foreign states, and neighbouring countries, that implementation of their respective emergency plans and related protective actions will not be compromised for the life cycle of the proposed site.

CNSC is currently engaged in clarifying this requirement in RD-346 to ensure this confirmation is performed by the proponent prior to the first licence (i.e. Licence to Prepare Site) being granted by the Commission of the CNSC. Although under the Licence to Prepare Site, any emergency program submitted by the applicant is only required to address emergencies that arise as a result of site preparation activities, the Commission raised a number of questions during the Environmental Assessment and Licence to Prepare Site public hearings around this subject. It was clear from the line of questions that discussions and plans around long-term local/state/federal arrangements should be well advanced such that roles, responsibilities and accountabilities of each participating level of government in future emergency planning are clear. Also, in this particular case, because the new build site is next to an existing four-unit nuclear generating station, questions from the Commission also focused on plans to evacuate a very large population of construction workers from the new build site should a major event occur at the adjacent operating facility.

## **6. Social acceptability (extent of public consultation)**

- a. Describe how the regulator and the applicants engage local population and what level of local agreement is needed to proceed.

### Proponent's Role:

In Canada, the proponent is expected take the lead role and consult with stakeholders and the general public early in the site evaluation process, and before any substantive decisions are made. This ongoing two-way communication is expected to continue over the life of the facility and is subject to compliance inspection (desk top reviews or by in-field by CNSC staff). CNSC requirements and guidance is contained in RD/GD-99.3 Public Information and Disclosure, March 2012, which provides general information on the regulatory requirements for public information programs for licensed facilities (including NPPs and small reactors). It explains how the review of a public information program fits into the overall licensing process, and defines CNSC expectations for the public information program documentation that is submitted with licence applications and licence renewals.

The consultation process associated with site evaluation is expected to demonstrate involvement of stakeholders in good faith, openness, respect, and fairness, with a genuine desire to utilize the input received.

There are no formal requirements to obtain local agreement; however, indications of lack of local agreement need to be addressed by the proponent in their licensing submissions. The Commission will take local concerns into account in its decision making.

As discussed in RD-346 Site Evaluation for New Nuclear Power Plants (2008), Section 12.0:

Early consultation is an important part of good governance, sound policy development, and decision-making. The proponent is therefore expected to demonstrate that consultation with the appropriate parties has been integrated into site evaluation activities. Because of the constitutional obligations discussed in subsection 3.3 (of RD-346), early consultation with Aboriginal groups is conducted separately from consultation with the general public. However, in both cases, the proponent is expected to work with all stakeholders to establish:

1. The most appropriate methods by which to consult;
2. The objectives and expectations of the consultation process;
3. The means by which interested parties will be able to participate in the formulation and implementation of decisions; and
4. A dispute resolution mechanism that documents disputes and records efforts taken in their resolution.

Proponents are encouraged to thoroughly document the consultation process, and to include a summary of that process when submitting a project description to the CNSC. The summary is expected to include such information as:

1. A list of the stakeholders that were engaged and how they were identified;
2. The project information provided to the stakeholders;
3. A summary of issues raised; and
4. A description of how the proponent has already responded, or plans to respond, to any concerns raised.

### CNSC's (Regulator) Role:



In essence, CNSC has two major roles in this area of concern:

1. To establish and maintain regulatory processes that ensure adequate opportunities for stakeholder participation in the regulatory process. The CNSC welcomes public participation whenever possible and offers many ways to get involved:

- Participate in consultations requested by the CNSC (for example CNSC has historically posted guidelines for Environmental Impact Statements for public input);
- Participate in a public hearing or an environmental assessment (access to a Participant Funding Program is possible) – CNSC has a history of holding hearings in communities near projects;
- Observe a public meeting;
- Attend a CNSC information session, open house or workshop;
- Comment on a draft regulatory document or proposed regulatory amendments;
- Watch a CNSC webcast of a public hearing;
- CNSC participation in events.

2. Under the Nuclear Safety and Control Act, to disseminate technical and scientific information to the public. This is done in many interactive ways such as:

- Performing outreach activities in communities (workshops, information sessions);
- Performing outreach activities on-line or in CNSC office locations (interactive web workshops, information sessions);
- Participating at technical forums;
- Discussion papers (generally posted online for public comment);
- CNSC meetings and hearings;
- Web content.

**7. Practices/assessments to determine if NPP design parameters are enveloped or suitable for a given site**

- a.** Describe the specific design parameters that are evaluated against the site characteristics and any site specific design changes or additional design analyses needed when approving a site (e.g. seismic, meteorology, hydrology).

RD-346 Site Evaluation for New Nuclear Power Plants (2008) provides requirements and guidance around the use of bounding approaches and the parameters that are expected to be characterised for the site (and taken into account in the bounding envelope). Please refer to RD-346 for a list of site characterisation parameters. The parameters are, for the most part, identical to those discussed in the IAEA Safety Requirements No. NS-R-3 Site Evaluation for Nuclear Installations. Requirements around the use of bounding approaches are further reinforced in the following regulatory documents:

- RD-310 Safety Analysis for Nuclear Power Plants, 2008;
- GD-310 Guidance on Safety Analysis for Nuclear Power Plants, March 2012;
- RD-308 Deterministic Safety Analysis for Small Reactor Facilities, June 2011.

CNSC defines “Bounding Envelope” in RD-346 as follows:

A combination of facility design parameters and site characteristics that establishes a set of limiting values for any facility design that could be proposed for the site and which allows for the assessment of environmental impacts and site suitability. The design eventually selected must fit within the bounding envelope.

The proponent is responsible for proposing the methodology for defining the bounding envelope, including the rationale and bases behind the methodology. Bounding approaches for site evaluation will be considered but CNSC staff expects bounding limits for a proposed facility to be based on credible information from designs being considered for that site. The proponent is responsible for supporting the credibility of the information submitted (i.e. bounding limits), including accounting for uncertainties that may exist in site data as well as predicted performance of the design. As stated above, the design eventually selected must fit within the bounding envelope even if it requires design changes.

RD-337 Design for New Nuclear Power Plants (2008) and RD-367 Design for New Small Reactor Facilities provide requirements around how the design is expected to take site characteristics (including natural and human induced external events) into account in the development of the plant design envelope and overall safety case for the facility. The application for a Licence to Construct is expected to demonstrate how the design “fits” within the proponent’s bounding envelope and will meet regulatory requirements.

CNSC is continuing to develop additional regulatory documents and guides in support of RD-337 and RD-367 in order to further clarify design requirements for specific areas of design (for example Electrical Systems, Instrumentation and Control).

- b.** Describe the extent of regulatory review and/or requirements as to how specific site features or nearby facilities support extended station blackout.

The currently published versions of RD-337 Design for New Nuclear Power Plants 2008 and RD-367 Design for New Small Reactor Facilities provide requirements to be met by an applicant in the design of all plant Structures, Systems and Components (this includes facility power systems as well as other systems that would support an extended station blackout). Under the Canadian regulatory approach, a proponent may propose how specific site features or nearby facilities might be used to support extended station blackout. This is, however, not an explicit requirement.

As part of the post-Fukushima action-plan being executed by CNSC, a number of enhancements to requirements were identified, including some enhancements to RD-337 (RD-367 will be addressed later). The amended RD-337 has just completed wider public consultation and will be presented to the Commission once the final draft is ready for publication. Enhancements were made in the area of electrical power systems and standby & emergency power systems to, among other things:

- Clarify what a Station Blackout is;
- Specify how the design is robust against internal and external electrical disturbances, taking into account common-cause failures involving loss of normal power supply and standby power supply (if applicable);
- Further clarify requirements on use of defence-in-depth provisions – For example “emergency power system shall be electrically independent, physically separate and diverse from normal and standby power systems”;
- Set requirements for use of Alternate AC power supplies – For example, new requirement 8.9.2 Alternate AC power supply states as follows (draft text):

“The electrical power system design shall include provisions for mitigating the complete loss of onsite and offsite AC power. This is accomplished by the use of an onsite or offsite portable or transportable power sources, or a combination of these.

The alternate AC power source shall be available and located at or nearby the NPP, and shall:

1. be connectable to but not normally connected to the offsite or onsite standby and emergency AC power systems
2. have minimum potential for common mode failure with offsite power or the onsite standby and emergency AC power sources
3. be available in a timely manner after the onset of a station blackout
4. have sufficient capacity and reliability for operation of all systems required for coping with station blackout and for the time required to bring and maintain the plant in a safe shutdown state..

The design shall include provision for periodic capacity testing of the alternate power supply to confirm its capability to cope with a station blackout event.”

Accompanying draft regulatory guide GD-337 Guidance for Design of New Nuclear Power Plants, has been developed and is currently undergoing public consultation. GD-337 contains guidance to further clarify the requirements contained in the amended RD-337. Again, this area is further reinforced in the following regulatory documents:

- RD-310 Safety Analysis for Nuclear Power Plants, 2008;
- GD-310 Guidance on Safety Analysis for Nuclear Power Plants, March 2012;
- RD-308 Deterministic Safety Analysis for Small Reactor Facilities, June 2011.

#### Emergency Planning and Response:

As discussed in the response to question 3.d., as part of the post-Fukushima investigations by CNSC and licensees, improvements were identified to enhance emergency plans and capabilities to respond effectively in a severe event or multi-unit accident. As a result, per the CNSC Fukushima Action Plan, CNSC has taken an action to prepare a draft regulatory document on emergency management, reviewing and incorporating existing information in G-225, Emergency Planning at Class I Nuclear Facilities and Uranium Mines and Mills, and RD-353, Testing the Implementation of Emergency Measures and, following a period of public consultation, submit to the Commission for approval to publish.



## RESPONSE ON BEHALF OF FRANCE (ASN)

### 1. Multi-unit sites

- a.** Limits on source term/number of units? (Contribution of all facilities to the source term including spent fuel storage, waste management and reactors.)

French regulation does not set any predefined limits either on the source term, or on the number of units of one given site.

An authorisation for all discharges in the environment out of the site (liquid and gaseous) is required for each nuclear site. This authorisation is given on the basis of file provided by the licensee, which studies the impact on the environment and neighbouring population of all units under normal operating conditions. The file is reviewed by ASN and the Institute for Radiological Protection and Nuclear Safety (IRSN), its technical support organisation.

This is also true for a new reactor on an existing site (no new sites are expected in France in a foreseeable future); the different files to be provided for the authorisation creation request should include a file studying the impact under normal operating conditions. The source term for this study has to be envelope under these conditions and is defined for one reactor with its dedicated facilities (spent fuel storage, waste management and reactor).

Furthermore, the creation authorisation decree sets the maximum thermal power of the facility.

- b.** Arrangement of units (distance, common equipment)

There is no minimum distance between two reactors on the same site required by the regulation. Nevertheless, the impact of the units nearby has to be assessed in the safety report.

In case the licensee uses equipment common to several units, it should be justified that this equipment has appropriate capacity and availability for the different units concerned.

- c.** Arrangements to deal with impact on different facilities sited on one location (e.g., other industrial facilities)

- i.** During the siting review (or environmental assessment), do you consider potential impacts on the nuclear facility from co-located (or nearby) industrial facilities?

This is typically assessed as part of the application for authorisation of the NPPs. Besides, these subjects have been reassessed after Fukushima Daiichi nuclear power plant accident for all NPPs (under operation or construction).

The impact of industrial facilities located nearby the nuclear facility has to be taken into account in the PSAR. These hazards have to be listed in the PSAR/SAR with their potential impact on the nuclear

facilities. The basic safety rule No. I.2.d is a regulatory guide that sets the way ASN recommends to deal with these hazards in the safety analysis report.

Onsite, the impact of one unit to the others should also be taken into account in the PSAR/SAR.

## **2. Site layout considerations (utilizing natural and/or man-made features to minimize common cause initiators)**

- a. Describe considerations for establishing safety/support equipment/facilities locations based on site specific geographical features and potential vulnerabilities.

Yes, the site specific geographical features are considered in some cases for location of facilities and/or support equipment, in particular for the positioning of the platform (rig) and/or the dike against the risk of external flooding (location of EPR on the site of Flamanville, for example).

## **3. Consideration of external hazards or combination of hazards at the siting stage**

- a. Described extent of external hazards considered for the site and the source of the information used to establish the external hazard design basis.
  - i. Specifically, are there any changes being considered to update the return frequency for external events as a result of the Fukushima Daiichi nuclear power plant accident?

As stated before, no new nuclear sites are expected in France in a foreseeable future.

The ministerial order of 7 February 2012 setting the general rules relative to basic nuclear installations lists the different external hazards that have to be taken into account in the safety analysis. These hazards are:

- Risks induced by the industrial activities and communication routes, including explosions, hazardous substance emissions and airplane crashes;
- Earthquakes;
- Lightning and electromagnetic interferences;
- Extreme meteorological or climatic conditions;
- Fires;
- Floods originating outside the perimeter of the basic nuclear installation, including their dynamic effect;
- Malevolent acts;
- Any other external hazard identified by the licensee or, if appropriate, that ASN considers have to be taken into account;
- And all plausible combinations of the above listed hazards.

For such external events (flooding, seismic events, ...), the approach is mainly deterministic. Generally speaking, the licence applicant is to perform a specific analysis of the hazards liable to occur on the site taking into account the regional/local situation of the site (geology, meteorology, hydrology, etc.).

After the Fukushima Daiichi nuclear power plant accident, ASN:

- issued in 2013 the ASN regulatory Guide No. 13 Protection of Basic Nuclear Installations against external flooding taking into account experience feedback of the partial flooding of the Blayais NPP (1999, rated level 2 on the INES scale) and the most recent knowledge available;

- will reinforce the safety requirements for nuclear facilities with regard to the earthquake;
- has reassessed the risks induced by other industrial activities present in the vicinity of nuclear facilities;
- is reinforcing the safety requirements for operating NPPs with regard to extreme weather conditions as part of the coming PSRs.

WENRA has also created a working group on external hazards in which ASN contributes. ASN will consider the results of this working group to enhance, if necessary, its regulatory requirements.

- b.** Describe the human induced hazards considered for the site and the source of the information used to establish the design basis.

All human induced hazards liable to occur nearby the site have to be studied by the licensee in its PSAR. The assumptions taken into account are then reviewed by ASN and IRSN, as part of the licensing process.

Examples of human induced hazards considered are: hazardous industrial facilities, gas or oil pipes nearby the nuclear facility (possibility of explosion, toxic gases releases, temperature rise due to a fire...), failure of dams upstream from the facility (possibility of flooding), dangerous road/rail/maritime traffic (explosion or clogging of the heat sink due to oil slick drift), and malicious acts.

- c.** Describe the assessments made to consider combinations of external or human induced hazards with consequential internal events to establish a bounding case for overall site hazards.

At present time, the assessment is mainly achieved on the basis of a deterministic analysis.

Safety key equipment is designed to withstand to the design basis earthquake and the corresponding safety analysis is carried out with a cumulative lack of electrical power. The load drops induced by an earthquake (by non-seismically classified SSCs) has also to be considered.

Probabilistic safety studies are being developed to supplement the deterministic analysis, for example for seism, flooding and fire hazards.

Following the Fukushima Daiichi nuclear power plant accident, complementary safety assessments have been performed on all NPPs taking into account:

- Different initiating events separately (earthquake, flooding, combination of earthquake and flooding, extreme weather conditions);
- Three consequences of loss of safety functions from any initiating event (loss of electrical power including SBO, loss of ultimate heat sink with combinations of both losses).
- As part of these complementary safety assessments, different combinations of external hazards with consequential internal events have been assessed, for example in the event of an earthquake:
  - Fire and explosion induced by an earthquake;
  - Internal flooding induced by an earthquake (fracture of water tanks).

- d.** Is the survivability of the local infrastructure and its ability to support site recovery assessed during the siting review?

At the level of the creation authorisation request, there are no requirements or assessment of emergency plans, in particular for the survivability of the local infrastructure and its ability to support site recovery.

These subjects are assessed as part of the commissioning licence application review (occurring before the first fuel load).

As a consequence of the Fukushima Daiichi nuclear power plant accident, the onsite emergency organisations and infrastructures have been reassessed. New premises will be built on site or in the very close vicinity of the NPPs sites and should withstand a higher level of external hazards than those taken into account in the dimensioning of the plant, be able to accommodate emergency crews during long lasting accidental situation.

#### **4. Land use/Population density**

- a.** Describe considerations for existing population density during the siting review.

As stated before, no new nuclear sites are expected in France in a foreseeable future. Historically, even though there was no legally binding requirements, the nuclear sites has been chosen in locations where the population density was low (at that time).

The population density is considered in the impact study and also in the case of accidents.

If an emergency plan is required, the prefecture (local authority) should ensure that the measures to protect the population can be effectively implemented (sheltering in place, evacuation and iodine distribution for existing population around the site), given the density in the emergency planning zone and the kinetics of the accidents. To do so, ASN provides the prefecture with the accidental scenarios liable to occur on the installation.

- b.** Describe any arrangements/agreements on future development of population centres or municipal development over the life of the facility.

The process of urbanization control is a shared responsibility between the operator, the mayors and the state:

- The operator is responsible for its activities and associated risks;
- The mayor is responsible for the land planning documents and the issuance of building permits;
- The prefect (local Authority) informs the mayors of existing risks and exercises a control over the legality of the building permits;
- ASN provides technical elements at its disposal to characterise the risk and assists the prefect to support the control process of urbanization.

A circular from the Ministry of environment dated 17 February 2010 asked the prefects to exercise an increased vigilance on the development of urbanization in the vicinity of nuclear facilities.

Currently, ASN issues an advisory opinion on any building permit request around every NPP (2 km).

A non-mandatory doctrine has been developed. Its 3 main principles are to:

- ensure that the emergency plans can be implemented;
- promote new settlements beyond the emergency planning zone if possible;
- do not stop the development within the hazard area but restrict it to the direct needs of the population living in this “2 km” area.

The settlement may be authorised in this closest area under the 3 following conditions:

- provide the proof that there is no alternative;



- inform the population on the risks associated to the settlement in the hazard area;
- update the emergency plans if necessary.

## **5. Emergency preparedness arrangements/feasibility at siting stage**

- a. Describe acceptable level of established local/state/federal arrangements during siting review.

This question is not really relevant to the French context because, as already mentioned above, there are no new sites expected in France in a foreseeable future. Furthermore, ASN would not give a positive consent to the creation of a new NPP for which the radiological consequences exceeds the one of the operating NPPs. Then, it is not anticipated that there is any need to revise the offsite emergency plans currently in place in case of the creation of a new NPP.

Even though, a section of the preliminary safety analysis report, to be provided for the authorisation creation request, is dedicated to a sizing of the onsite emergency plan.

This sizing shall include a study focusing on the identified accidents that require protective measures on or offsite, with a description of different scenarios and their consequences on the safety of the installation as well as on protection of population.

The sizing shall also present the organisation proposed by the licensee of its own emergency means to combat the effects of a potential accident.

If the scenarios and their consequences remain tolerable considering the scientific knowledge at the time of the application but not included in boundaries the offsite emergency plan, the prefect (local state representative) who is in charge of the implementation of the plan will be informed by ASN. The Prefect will then have to revise the offsite emergency plan, or give a negative advice on the project.

The final onsite emergency plan has to be submitted to ASN with the request for the plant commissioning. This request has to be completed one year before the first introduction of nuclear materials in the facility.

In the case of Flamanville 3, ASN requested EDF to update its onsite emergency plan to take into account the augmented number of workers present in Flamanville 3 site due to construction activities.

## **6. Social acceptability (extent of public consultation)**

- a. Describe how the regulator and the applicants engage local population and what level of local agreement is needed to proceed.

There are two different kinds of public consultation for a new nuclear reactor creation in France.

First, there is, according to the law (environment code), a national public debate focusing on the appropriateness of the project, its objectives and its main features. This national debate is organized by a national commission set up by the national government. As part of the authorisation of creation request, the licensee is to document how it has taken into account the conclusions of the national public debate.

As part of the assessment of the authorisation of creation, there is a public inquiry involving people living close to the site (typically around 5 km). The result of this inquiry is taken into account before issuing the Authorisation creation decree.

According to the Law, a local information committee is created for each nuclear site and set up by the general council of the department where is located the site. This commission provides, all along the life of

the site, a general mission of monitoring, information and consultation. Before ASN is issuing its opinion on the decree authorising (or not) the creation of the NPP, ASN commission will propose a hearing for the local information committee.

**7. Practices/assessments to determine if NPP design parameters are enveloped or suitable for a given site**

- a.** Describe the specific design parameters that are evaluated against the site characteristics and any site specific design changes or additional design analyses needed when approving a site (e.g. seismic, meteorology, hydrology).

The site characteristics are described and included in the safety analysis performed in the safety documents (safety report, impact assessment, ...). All these documents are part of the request for authorisation and these documents are assessed by the regulator (ASN with the technical support of IRSN) before getting the approval for construction (DAC: construction authorisation decree).

As mentioned in 3.a., all sites characteristics are taken into account in the assessments (seismic, meteorology, hydrology, etc.).

All important safety functions must be preserved and all important equipment related to safety has to be designed to withstand to the site characteristics.

Changes in site parameters are taken into account in a periodic safety reviews every ten years.

- b.** Describe the extent of regulatory review and/or requirements as to how specific site features or nearby facilities support extended station blackout.

The EPR reactor, being built in Flamanville, is designed with 6 diesel generator sets, 4 main ones (one per safeguard system train) and two ultimate backup generator sets in case of station blackout (SBO).

Electric batteries with power autonomy of two hours on the EPR reactor will ensure and guarantee continuity of the electrical supply to certain key equipment items when the generator sets are not operating.

If the offsite electrical sources and the abovementioned onsite backup sources should fail, two dedicated batteries (called “12-hour” batteries) provide electrical supply to certain items that are critical for managing this situation (mainly SA equipment).

## **RESPONSE ON BEHALF OF SLOVAK REPUBLIC (UJD SR)**

### **1. Multi-unit sites**

- a.** Limits on source term/number of units? (Contribution of all facilities to the source term including spent fuel storage, waste management and reactors.)

There are no limits on source terms/number of units established in the Slovak legislation, but it is possible, that during EIA process status, which limits those sources, can be identified.

- b.** Arrangement of units (distance, common equipment)

In case of common equipment, applicant for licence has to prove (requirements of the regulation No 430/2011 Coll.) that objects and facilities important for nuclear safety that will be jointly used by multiple parts of the nuclear facility do not affect its safe operation; in the case of an incident on one part of the nuclear facility, the functionality of other parts must not be affected.

- c.** Arrangements to deal with impact on different facilities sited on one location (e.g. other industrial facilities)
- i.** During the siting review (or environmental assessment), do you consider potential impacts on the nuclear facility from co-located (or nearby) industrial facilities?

Assessment of the potential impact on the nuclear facilities from co-located industrial facilities applicant has to submit together with an application for permission for sitting of nuclear facility.

### **2. Site layout considerations (utilizing natural and/or man-made features to minimize common cause initiators)**

- a.** Describe considerations for establishing safety/support equipment/facilities locations based on site specific geographical features and potential vulnerabilities.

Based on Atomic Act Annex 1 applicant has to submit together with the application assessment of the potential impact of surrounding environment on the nuclear facilities. Environment covered also site layout. Other layout consideration is the part of the preliminary safety report.

### **3. Consideration of external hazards or combination of hazards at the siting stage**

- a. Described extent of external hazards considered for the site and the source of the information used to establish the external hazard design basis.
  - i. Specifically, are there any changes being considered to update the return frequency for external events as a result of the Fukushima Daiichi nuclear power plant accident?
- b. Describe the human induced hazards considered for the site and the source of the information used to establish the design basis.
- c. Describe the assessments made to consider combinations of external or human induced hazards with consequential internal events to establish a bounding case for overall site hazards.
- d. Is the survivability of the local infrastructure and its ability to support site recovery assessed during the siting review?

In the chapter 4 of the regulation No. 430/2011 Coll., the nuclear safety requirements for nuclear facility siting are defined:

1. During the siting of a nuclear facility, a geological and seismic loading assessment for the selected site must be produced, containing
  - a. a probabilistic seismic hazard analysis for the site;
  - b. an assessment of seismic and geological conditions in the area, and the geo-engineering and geotechnical aspects of the proposed site;
  - c. designation of earthquake-related hazard through a seismotectonic assessment of the area using the greatest possible scope of collected information;
  - d. an assessment of the risk due to movement caused by earthquakes, taking into account the seismotectonic nature of the area and site-specific conditions;
  - e. an uncertainty analysis as part of the seismic hazard analysis;
  - f. an assessment of the impact of potential surface shift at a fault on the site;
  - g. a review of the geological, geophysical and seismic characteristics of the region, regardless of state borders and the site's geotechnical characteristics, in accordance with international practice, performed in such a manner that the resultant set of data is homogenous for the entire area or at least permits sufficient determination of the nature of seismotectonic structures relevant for the site and the size of the region that was reviewed, the type of information analysed and the scope and details of the analysis that were specified according to the nature and complexity of seismotectonic conditions;
  - h. proof of the adequacy of the scope and detail of information analysed and research performed to determine danger resulting from seismic movement and shift at a fault.
2. Regardless of results of analyses performed pursuant to (1), the minimum level of seismic loading determined at the nuclear facility site must be represented by a standard free-field horizontal response spectrum corresponding to peak acceleration equal to 0.1 g.
3. Nuclear safety requirements for a nuclear facility in the siting phase also involve area characteristics that bar the siting of a nuclear facility in this area, and are listed in Annex No. 2.

Also in the Annex 3, Part B, letter J “Protection from external phenomena” of same regulation, the requirements for applicants in connection with external hazard are established. The requirements are as follows:

1. Selected facilities must be designed so that during natural disasters that can be realistically expected, such as earthquakes, windstorms, flooding, deluge, extreme outdoor temperatures, extreme cooling water temperatures, rain of all forms, moisture, frost, the effects of flora, fauna and so on, or during events caused by human activity outside the nuclear facility or during combinations thereof, it is possible to:
  - a. safely shut down the nuclear facility and maintain it in a subcritical state
  - b. remove residual heat from spent nuclear fuel or radioactive waste;
  - c. maintain leaks of radioactive substances below specified levels.
2. Aside from requirements for the physical protection of nuclear facilities and nuclear materials enacted by special legislation, the design must also take into account:
  - a. the most serious natural phenomena historically recorded in the area around the site of the nuclear facility and extrapolated taking into account limited accuracy as far as size and time of occurrence are concerned;
  - b. a combination of effects of phenomena caused by natural conditions and human activity;
  - c. maximum expected acceleration given for the site’s location, based on an assessment of the location’s seismic loading performed during the siting of the nuclear facility, specified as seismic level 1 and seismic level 2;
  - d. requirements for earthquake-resistant nuclear facility systems, components and structures or parts thereof that must correspond to their safety function and presumed effects of an earthquake according to specified seismic level 1 and seismic level 2;
  - e. airplane impacts.
3. The project design must include a nuclear facility buffer zone for protecting the nuclear facility from external phenomena that can be caused by natural conditions or human activity.

#### **4. Land use/Population density**

- a. Describe considerations for existing population density during the siting review.
- b. Describe any arrangements/agreements on future development of population centres or municipal development over the life of the facility.

Based on the Regulation 430/2011 Coll. Annex 2 an area cannot be used as a nuclear facility site if the area’s population density and distribution makes it impossible to effectively implement accident preparedness measures.

#### **5. Emergency preparedness arrangements/feasibility at siting stage**

- a. Describe acceptable level of established local/state/federal arrangements during siting review.

Based on Annex 1 of the Atomic Act an applicant, together with application for permission for siting, has to submit to regulatory body a proposal size of the emergency planning zone.

## **6. Social acceptability (extent of public consultation)**

- a. Describe how the regulator and the applicants engage local population and what level of local agreement is needed to proceed.

Public is a part of approval process during issuing of the licence for building placement (issued by local civil construction authority as result of spatial procedure with consents of the others authority), also during issuing of the permission for siting and building permission (issued by nuclear authority). In case that the public is persuaded that its right was violated, they can appeal against authority decision.

## **7. Practices/assessments to determine if NPP design parameters are enveloped or suitable for a given site**

- a. Describe the specific design parameters that are evaluated against the site characteristics and any site specific design changes or additional design analyses needed when approving a site (e.g. seismic, meteorology, hydrology)
- b. Describe the extent of regulatory review and/or requirements as to how specific site features or nearby facilities support extended station blackout.

In Slovak legislation, specifically in the Regulation No. 430/2011 Coll., there are established properties of site that bar its use as a nuclear facility site. The properties are as follows:

- a. During normal or abnormal operation or in the event of an operating incident, except for an accident, it cannot be ensured that in this area:
  1. set radiation dosage limits for the population shall not be exceeded;
  2. set limits for human noise and vibration exposure shall not be exceeded, including on neighbouring properties and buildings;
  3. a buffer zone can be provided for the protection of the population according to the type of production, materials stored and types of hazardous materials released;
  4. protection can be provided from the harmful effects of floods and extreme meteorological effects on nuclear facilities;
- b. the area is threatened by the consequences of undermining, barrages of mine water or strong tremors due to mining activity, gas or oil extraction or contains groundwater supplies;
- c. the area experiences geodynamic and karstic phenomena endangering the stability of rock masses in the area such as landslides, kinetically and seismically active faults, liquefaction of soils, tectonic activity or other phenomena that can change the area's surface grade past specified technical requirements;
- d. the area is impinged upon by buffer zones for natural therapeutic resources, and underground and surfaces sources of potable water;
- e. the area contains declared mining areas with extraction of raw materials;
- f. the area impinges upon the buffer zone of industrial or other economic structures with which unfavourable operating collisions could occur;
- g. the area's population density and distribution makes it impossible to effectively implement accident preparedness measures;
- h. planned installed electrical power output cannot be transmitted out of the area in a sufficiently safe and reliable fashion;

- i. in the case of a storage facility, if there is a high or hard to predict risk stemming from external events and events caused by human activity, or if the evolution of these activities cannot be reliably predicted for the duration of its designed useful life.

The applicant has to demonstrate via analysis in the PSAR the ability of the design to manage all potential events including those resulting from given site.





## RESPONSE ON BEHALF OF HUNGARY (HAEA)

### 1. Multi-unit sites

- a.** Limits on source term/number of units? (Contribution of all facilities to the source term including spent fuel storage, waste management and reactors.)

There is no limit on the number of units in a site. There is need for authorisation to all discharges in the environment out of the site (liquid and gases) for each nuclear site. This authorisation is issued on the documentation, in which the licensee investigates the impact on the environment and neighbouring population of all units under normal operating conditions. All events at the site have to be considered in the safety analysis.

- b.** Arrangement of units (distance, common equipment)

Some related requirements from the Annex 3 (Design requirements for nuclear power plants) of the Government Degree no. 118/2011. (VII. 11.)

“The arrangement shall ensure that the events in the design base and the interactions of the individual buildings and systems cannot cause impairment to an unacceptable extent within the nuclear power plant.” [3.3.5.0200]

“At a power plant site with several nuclear units, for the design of the whole nuclear power plant as well as for the individual nuclear power plant units shall be considered that some external hazards may affect all nuclear power plant units simultaneously.” [3.2.2.3500.]

“In case of such a site, where several nuclear facilities operate simultaneously, the counter effect of each facility on all of the other facilities, for all operation conditions of the facilities as well as for probable circumstances resulting from all hazards. For the analyses of the counter effects, the commissioning, installation, and decommissioning lifecycle phases shall also be considered.” [3.2.2.3600.]

However there is no exact limit for the minimum distance between two reactors in the same site. Sharing of equipment is not prohibited, if it is justified.

- c.** Arrangements to deal with impact on different facilities sited on one location (e.g. other industrial facilities)

- i.** During the siting review (or environmental assessment), do you consider potential impacts on the nuclear facility from co-located (or nearby) industrial facilities?

Yes. The impact of industrial facilities located nearby the nuclear facility has to be taken into account in the siting review.

Some related requirements from the Annex 7 (Site suitability investigation and assessment for nuclear installations) of the Government Degree no. 118/2011. (VII. 11.):

“The activities including the handling, processing, transport, and storage of hazardous chemical materials, which may involve the potential of serious explosion, and formation of gas clouds, shall be identified.” [7.3.5.0500.]

“It shall be assessed, whether there is a potential for the occurrence of large fire, which may jeopardize the nuclear safety of the nuclear installation by generation of toxic gas, or heavy smoke or thermal impact.” [7.3.5.0600.]

“The site shall be declared unacceptable, if the impacts caused by the human activities pursued in the adjacent areas are to be considered in the design basis of the nuclear facility and there is no engineering solution to ward off the impacts and to reduce the risk to an acceptable level.” [7.3.5.0700.]

“The site and the immediate environment thereof shall be assessed for the potential effects of nuclear facilities or hazardous industrial facilities being present in the area independently of the planned nuclear facility. This shall include the facilities, which are in connection with the given nuclear installation, even though their site is separated in legal sense, but their potential effects may reach the planned nuclear facility.” [7.3.5.0800.]

## **2. Site layout considerations (utilizing natural and/or man-made features to minimize common cause initiators)**

- a. Describe considerations for establishing safety/support equipment/facilities locations based on site specific geographical features and potential vulnerabilities.

In the Annex 7 to the Government Degree no. 118/2011. (VII. 11.) on the site suitability investigation and assessment for nuclear installations:

“The following shall be considered in the identification of the natural or man-made events and conditions, which may potentially jeopardise the nuclear safety and are to be considered in the design and the safety assessment of the nuclear installations:

- a. natural or man-made external events and conditions occurring on the plant site and in the vicinity thereof, which may have potential effects on the nuclear installation;
- b. properties of the plant site and its environment, which may influence the dispersion and the effects of discharged radioactive materials; furthermore
- c. the density and distribution of the population, and the particularities of the surrounding environment, which may potentially influence the consequence of discharges and the feasibility of emergency response actions.” [7.2.1.0300.]

“Site specific data shall be used in the determination of the external events and conditions to be included in the design basis. If no such data is available and can neither be produced by purposive investigations, or the production of such data is not practical for the given nuclear installation, then data obtained from other areas with similar properties, and data, which are considered relevant on the basis of professional judgment or specified in standards, can also be adopted. Appropriate and approved simulation techniques can also be adopted. The site specific data may be completed by data obtained from similar areas or produced by simulation techniques. However, the adequacy of such data shall be verified.” [7.2.2.0300.]

“In the course of the investigation and assessment of the potential site, the possible hazard factors can be excluded from further investigation and from the inclusion into the design basis as well, which are at a distance from the plant site that, considering the mitigation effect of such distance between the location of the hazard factor and the plant site and based on engineering considerations, experience, normative limit value or vulnerability analysis of the nuclear installation, the effect of the hazard factor on the nuclear installation is neutral or tolerable for the nuclear safety functions and for any person staying on the site of the nuclear installation.” [7.2.1.0500.]

### 3. Consideration of external hazards or combination of hazards at the siting stage

- a. Described extent of external hazards considered for the site and the source of the information used to establish the external hazard design basis.

Annex 7 to the Government Degree no. 118/2011. (VII. 11.) on the nuclear safety requirements of nuclear facilities and related regulatory activities contains all significant natural and man-made external hazards. On the basis of the Annex 7, in the pursuance of the site suitability investigation and assessment “the natural or man-made events and conditions, which may potentially jeopardise the nuclear safety and are to be considered in the design and the safety assessment of the nuclear installations, shall be identified” and “the potentially hazardous natural and man-made external events and the effects thereof shall be studied and assessed”.

For the identification and assessment of external hazards to the nuclear installation:

1. Historical data and investigation results on the occurrence and severity of major natural phenomena and man-made events shall be collected and carefully analysed for their reliability, accuracy, and completeness.
2. If it is necessary for the determination of the site properties in compliance with the relevant regulations, purposive investigations shall be undertaken to identify the occurrence and characteristics of the natural phenomena and man-made events. Such investigations shall be carried out in accordance with the relevant standards and well-proven practices used by the relevant professional fields, unless specific nuclear safety requirements are specified by the relevant legal regulations for this work.
3. In the investigation of external events and conditions, simple procedures, such as literature data, may be used instead of purposive investigations, if the conservatism and the enveloping nature of the results can be demonstrated.

Due to the extremely low occurrence frequency of natural and man-made events and conditions relevant for the design and safety assessment of nuclear facilities, the extreme natural circumstances and events in the region of similar sites and nuclear installations shall also be assessed.

There are detailed requirements regarding the following hazards:

- Earthquakes,
- Permanent surface displacements,
- Geotechnical hazards,
  - Slope instability,
  - Collapse, slumping, sinking, or emergence of the surface of the site,
  - Soil liquefaction,
  - Behaviour of the foundation of the nuclear facility,
- Meteorological properties,
- Inundations,
  - Flooding of the site,
  - Hazards caused by water structures,
- Man-made external events,
  - Airplane crash,
  - Explosion of hazardous chemical agents, cloud of toxic gases, smoke and thermal impacts,
  - Other significant man-made events.

- i. Specifically, are there any changes being considered to update the return frequency for external events as a result of the Fukushima Daiichi nuclear power plant accident?

Not yet. Our intention is to modify the related national regulation after the finalization of the lessons learnt of Fukushima Daiichi nuclear power plant accident. Based on the result of OECD/NEA, IAEA and the modified WENRA safety reference levels, HAEA will update these requirements in Nuclear Safety Regulations.

But due to the Periodic Safety Review, the Stress Test and the following requirements from the Annex 3 (Design requirements for nuclear power plants) of the Government Degree no. 118/2011 (VII. 11.), the licensee shall update the design bases and its justification:

“The design basis and its validation shall be periodically reviewed at the completion of the design, as well as during the whole lifetime of the nuclear power plant, when significant new safety information is received and based on the results of deterministic and probabilistic calculations modifications shall be implemented if necessary. The identified defects shall be evaluated and the necessary corrective actions shall be performed.” [3.2.3.0700.]

- b. Describe the human induced hazards considered for the site and the source of the information used to establish the design basis.

“The effect of the Code covers only the events among those of human origin, which may occur as a consequence of deliberate human activities not purposely intended against nuclear installations or as a result of inadvertent onsite or offsite human activities.” [7.1.2.0100.]

Nearby industrial hazards and potential transport accidents (road, air) has been considered. These potential hazards may result in an explosion, getting out of toxic gas, smoke and heat effects and aircraft crash.

For other significant man-made events:

“The site and the immediate environment thereof shall be assessed for the potential effects of nuclear facilities or hazardous industrial facilities being present in the area independently of the planned nuclear facility. This shall include the facilities, which are in connection with the given nuclear installation, even though their site is separated in legal sense, but their potential effects may reach the planned nuclear facility.” [7.3.5.0800.] and

“This assessment shall cover the items of equipment, the malfunction of which may make objects to become missile. The possibility of generation of electromagnetic interference, Eddy current in the soil and other interactions shall also be identified and assessed.” [7.3.5.0900.]

- c. Describe the assessments made to consider combinations of external or human induced hazards with consequential internal events to establish a bounding case for overall site hazards.

Combination of external or human induced hazards is site dependent. At a siting stage, “the geological structure of the area shall be assessed to determine whether natural formations and man-made objects are present, which may cause the collapse, sinking, or emergence of the surface”.

“The natural phenomena and conditions, and the human activities in the vicinity of the site shall also be assessed by their impact on the nuclear safety, in consideration of the design of the potential types of the nuclear installation. The conclusions of the assessment shall be reviewed after the design and the nuclear safety characteristics of the nuclear facility have been finalised.” [7.2.1.1300.]

It is assessed during the evaluation of the application of construction licence.

- d. Is the survivability of the local infrastructure and its ability to support site recovery assessed during the siting review?

The survivability of local infrastructure was not considered in the regulatory assessment in the past. Changes have been decided after introduction of lessons learned from Fukushima Daiichi nuclear power plant accident into Nuclear Safety Regulations. But during the Stress Test it was evaluated in a comprehensive way.

#### 4. Land use/Population density

- a. Describe considerations for existing population density during the siting review.

In the siting review, the IAEA recommendations are taken into consideration on the population density. The population density nearby the site and its 30 km zones is below the national average value.

“Considering the distribution of population, the properties of the site and the nuclear installation shall together ensure that:

- a. the radiation exposure to the population is as low as reasonably achievable and always complies with the relevant regulations; and
- b. the radiological risk to the population arising from accident conditions, including those requiring the introduction of emergency measures, complies with the relevant regulations.” [7.2.4.0200.]

“The distribution of the population, and the demographical characteristics, including the existing and predicted data and the temporary and permanent inhabitants in the adjacent areas, shall be identified to support the assessment of the effects of radioactive discharges and the emergency impacts and to allow the development of the accident prevention procedures and the assessment of the feasibility thereof. In the framework of the assessment work, highlighted priority shall be given to the densely populated areas in the direct environment of the site, and social institutions, and public centres in the region. Purposive surveys shall be undertaken if the available data are insufficient.” [7.3.6.1100.]

- b. Describe any arrangements/agreements on future development of population centres or municipal development over the life of the facility.

Considering the location of Paks NPP there is no need for further restrictions of development of population.

“The variation of the natural and man-made events and conditions affecting the nuclear safety shall be predicted and assessed for the entire lifetime of the nuclear facilities.” [7.2.5.0100.]

“The foreseeable significant changes in the use of the site, such as extension of existing facilities and human activities, or construction of facilities of high risk, shall be considered.” [7.2.5.0300.]

#### 5. Emergency preparedness arrangements/feasibility at siting stage

- a. Describe acceptable level of established local/state/federal arrangements during siting review.

Annex 7 to the Government Degree no. 118/2011. (VII. 11.) on the nuclear safety requirements of nuclear facilities and related regulatory activities contains the requirements for emergency preparedness. But the compliance with the requirements specified in Annex 7 shall be demonstrated in the framework of the construction licensing procedure. (Rationale: for Paks NPP 1-4. units there is an approved emergency preparedness plan.)

“Considering the distribution of population, the properties of the site and the nuclear installation shall together ensure that:

- a. the radiation exposure to the population is as low as reasonably achievable and always complies with the relevant regulations; and
- b. the radiological risk to the population arising from accident conditions, including those requiring the introduction of emergency measures, complies with the relevant regulations.” [7.2.4.0200.]

“The assessment shall cover the following:

- a. the radioactive discharges under accident condition, including the severe accidents to a reasonable degree, shall be assessed with the use of the data of the nuclear installation and the site specific parameters; and
- b. for assessing the feasibility of the emergency plans, the following shall be identified:
  - ba. the density and distribution of the population, the distance from the centres of population, the characteristics and distribution of public facilities capable of accommodating crowds of people, and groups, which are difficult to protect or evacuate in case of nuclear emergency, and the variation of all these data and characteristics during the entire design service life of the nuclear installation;
  - bb. specific geographical circumstances, traffic, and communication conditions; and
  - bc. relevant properties of the areas surrounding the site to allow the quick assessment of problems associated with the release of radioactive materials and for the identification of the medium and long term accident prevention measures.” [7.2.4.0300.]

## **6. Social acceptability (extent of public consultation)**

- a. Describe how the regulator and the applicants engage local population and what level of local agreement is needed to proceed.

The public is involved in the licensing procedure of siting. According to the Government Degree no. 113/205. (XII. 25.) on the environmental effect study and the uniform environment usage licensing procedure, the public shall have a possibility to review the Preliminary Examination report and the Environmental Impact Assessment report and to pose questions and remarks.

In the Environmental Impact Assessment procedure, the Environmental Authority keeps a public consultation (public, environmental organisations, civil organisation). The Authority takes notice of all information (including public remarks, opinion) with the issuance of a licence.

## **7. Practices/assessments to determine if NPP design parameters are enveloped or suitable for a given site**

- a. Describe the specific design parameters that are evaluated against the site characteristics and any site specific design changes or additional design analyses needed when approving a site (e.g. seismic, meteorology, hydrology).

Based on Annex 7 to the Government Degree no. 118/2011. (VII. 11.) on the nuclear safety requirements of nuclear facilities and related regulatory activities, the next design parameters are evaluated against site characteristics:

- Earthquakes and permanent surface displacements,

- Seismic design response spectra,
- Fault displacement potential,
- Geotechnical hazards, hydrogeology,
  - Slope instability,
  - Collapse, slumping, sinking, or emergence of the surface of the site,
- Soil liquefaction,
- Meteorology,
  - Wind speed,
  - Fall,
  - Snow roof loads,
  - Air temperature,
  - Lightning threat,
  - Tornado,
- Hydrology,
  - River flooding
  - Flooding is caused by water works,
  - Low water.

The above mentioned parameters are evaluated in the siting stage. But there are requirements for the design stage based on the Annex 3 (Design requirements for nuclear power plants) of the Government Degree no. 118/2011. (VII. 11.):

“During the design of the nuclear power plant all possible internal and external hazards shall be determined.” [3.2.2.2900.]

“The following external hazards shall at least be considered:

- a. extreme wind load,
- b. extreme external temperatures,
- c. extreme rains, snow, floods and draught,
- d. lightning bolts,
- e. icy floods, summer floods, and low water level,
- f. the danger of damage to upstream and downstream facilities,
- g. flying apparatuses moved by wind,
- h. extreme cooling water temperatures and icing,
- i. earthquake,
- j. crash of a military or civil aircraft,
- k. transport or industrial activities near the plant site,
- l. disturbances in the connecting external electric lines, complete and lasting failure of the electric network included, also
- m. such buildings on site or in the vicinity of the nuclear power plant that may present fire, explosion or other dangers to the plant.” [3.2.2.3000.]

- b.** Describe the extent of regulatory review and/or requirements as to how specific site features or nearby facilities support extended station blackout.

The station blackout is considered in the design, but the “extended” station blackout was not considered in the regulatory assessment in the past. Changes have been decided after introduction of lessons learned from Fukushima Daiichi nuclear power plant accident into Nuclear Safety Regulations. But during the Stress Test it was evaluated in a comprehensive way.