NATIONAL NUCLEAR REGULATOR

For the protection of persons, property and the environment against nuclear damage

REGULATORY GUIDE

INTERIM GUIDANCE FOR THE SITING OF NUCLEAR FACILITIES

RG-0011

Rev 0

professionalism integrity value our people excellence teamwork openness & transparency

UNRESTRICTED

APPROVAL RECORD				
	Name	Designation	Signature	Date
Prepared	P Bester	Special Nuclear Projects Coordinator		
	A Muller	Special Nuclear Projects Coordinator		
	S Nhleko	Specialist		
Edited	L Kleu	Language and Technical Editor		
Reviewed	U Coetzee	Principal Specialist: Operational Safety		
	A Duffy	Specialist		
	S Masike	Senior Specialist		
	B Ntuane	Chief Advisor: Nuclear Security		
	EXCO			
Recommended	O Phillips	Senior Manager: SARA		
Approved	Dr MB Tyobeka	Chief Executive Officer		

Note: The original, signed document is retained by the Record Management.

The following person/s contributed to the preparation of the document:
Adriaan Joubert
Boikanyo Ntuane
Solofelang Masike
Annie Duffy

TABLE OF CONTENTS

1 INTRODUCTION

Regulations are mandatory and set down specific requirements to be upheld by the authorisation holder or an applicant for a nuclear authorisation. Guidance documents are developed by the National Nuclear Regulator (NNR) to assist authorisation holders and/or applicants for authorisations in meeting regulatory requirements. In general, guidance documents have to be adhered to by the holder/applicant. Any deviation from NNR guidance has to be justified.

The mandate of the NNR is to, amongst others, exercise regulatory control over the siting of nuclear facilities to protect the public, property and environment against nuclear damage. As part of this mandate, the NNR has prepared this guideline to ensure that the country's nuclear facilities are sited in compliance with safety requirements, approved plans and procedures. However, the holder of the nuclear facility nuclear licence (the licensee) bears the primary responsibility for ensuring that the facility is sited in compliance with applicable safety and security requirements, approved plans and procedures. The licensee is also obliged to ensure that the facility's supplier and sub-suppliers, delivering services and products important to nuclear safety, comply with safety and security requirements.

2 PURPOSE

This document provides guidance on the implementation of the regulatory requirements as contained in the draft General Nuclear Safety Regulations, the draft Specific Nuclear Safety Regulations: Nuclear Facilities and the draft Nuclear Security Regulations as it pertains to the siting of nuclear facilities.

The NNR strives to ensure that this Regulatory Guidance document is complete and accurate. However, in recognition of the fact that this document is being presented to authorisation holders prior to the promulgation of its associated Regulations, the NNR makes no warranty, express or implied, to the accuracy, completeness, or usefulness of any information, including warranties to the adequacy of its contents. This Regulatory Guidance document is provided as INTERIM guidance in good faith and its aim is to assist authorisation holders to achieve high levels of safety for facilities and activities that are part of the nuclear fuel cycle. The NNR assumes no legal liability or responsibility for any action taken by you due to information in this document and such actions are expressly carried out at your own risk. The information in this document is subject to change due to promulgation of its associated Regulations. Complying with applicable laws remains the responsibility of authorisation holder.

The guidance is applicable to all nuclear facilities regulated by the NNR in terms of the provisions of the NNR Act and associated regulations.

3 SCOPE

The scope of the document is limited to the licensing of sites for land-based nuclear facilities. The guidance provided here can be applied to the licensing of new nuclear facilities within existing sites (brownfield sites) and/or new sites (greenfield sites).

4 TERMS, DEFINITIONS AND ABBREVIATIONS

4.1 Terms and Definitions

In this Regulatory Guidance document (RG) any word or expression to which a meaning has been assigned in the NNR Act, the Regulations promulgated in terms of the NNR Act, the draft General Nuclear Safety Regulations, the draft Specific Nuclear Safety Regulations: Nuclear Facilities or the draft Nuclear Security Regulations, shall have the meaning so assigned. Only additional terms, definitions and abbreviations are provided.

"**Atmospheric dispersion**" means the transport and dilution of radionuclides in the atmosphere. The radionuclides released may be blown downwind, mix with the surrounding air and become diluted. Depending on physical form and chemical characteristics of the release, it may be deposited onto surfaces, thereby contaminating them.

"**Derived Consideration Reference Levels (DCRLs)**" mean a band of dose rate within which there is likely to be some chance of deleterious effects of ionising radiation occurring to individuals of that type of reference animal or plant (derived from a knowledge of defined expected biological effects for that type of organism). When this is considered, together with other relevant information, it can be used as a point of reference to optimise the level of effort expended on environmental protection, dependent upon the overall management objectives and the relevant exposure situation.

"**Early site activities**" mean the preparation of the site for construction of the nuclear facility including: initial earthworks and site levelling (terrace); construction of offices and access control; preparation of construction roads, borrow pit areas, parking areas and railroad spurs; utilities such as potable water, electricity, sanitary sewage systems, data cables and transmission lines; erection of support buildings; dewatering; building of diaphragm wall; and excavation and clearance to bedrock.

"**Nuclear site licence (NSL)**" means a nuclear authorisation for a nuclear site that is earmarked for the siting, constructing and operation of one or multiple nuclear facilities. Individual nuclear licences are required for each nuclear facility being constructed on the nuclear site.

"**Place-bound**" means any development directly supporting the functions associated with the siting, design, construction, operation and decommissioning of a nuclear facility on a site for which an authorisation has been granted in terms of the Act.

"**Reference accident**" means a selected accident that envelopes the set of accidents that can reasonably be foreseen in the safety analysis.

"**Reference animal or plant (RAP)**" means a hypothetical entity with the assumed basic biological characteristics of a particular type of animal or plant (as described to the generality of the taxonomic level of family) with defined anatomical, physiological and life history properties. A RAP can be used for the purposes of relating exposure to dose and dose to effects, for that type of living organism.

"**Site establishment**" means the establishment on the site of security infrastructure, construction of temporary support buildings and site clearance.

4.2 Abbreviations

EPZ	Overall Emergency Planning Zone
EZ	Exclusion Zone
IAEA	International Atomic Energy Agency
NNR	National Nuclear Regulator
NNRA	National Nuclear Regulator Act, Act No. 47 of 1999
QA	Quality Assurance
RG	Regulatory Guidance document
SSC	Structure, System and Component
SSR	Site Safety Report

5 REGULATORY FRAMEWORK

5.1 Legal Basis

1) The legal basis for the NNR relating to the siting of nuclear facilities is derived from the NNR Act (henceforth referred to as "the Act"), specifically sections 5(b), 20(1), 21(1) and 23.
2) Section 5(b) of the Act grants the NNR the power to, amongst others, exercise regulatory control related to safety over the siting, design, construction, operation, manufacture of component parts, decontamination, decommissioning and closure of nuclear installations, through the issuing of nuclear authorisations.
3) Section 20(1) of the Act states that: "No person may site, construct, operate, decontaminate or decommission a nuclear installation, except under the authority of a nuclear installation licence." In terms of the provisions of this section, the siting, construction, operation, decontamination or decommissioning of any nuclear installation as defined in section 1(xviii) of the Act must be authorised by way of a nuclear licence granted by the NNR.
4) Furthermore, section 21(1) requires that any person wishing to site, construct, operate, decontaminate or decommission a nuclear installation may apply in the prescribed format to the Chief Executive Officer of the NNR for a nuclear installation licence and must furnish such information as required by the NNR board of directors.
5) In terms of Section 23 of the Act, the Chief Executive Officer may impose (and amend) conditions of authorisation which are necessary to ensure the protection of persons, property and the environment against nuclear damage, or to provide for rehabilitation of the site.

5.2 Regulatory Standards

1) The NNR has promulgated, in terms of section 36 of the Act, regulations on nuclear safety criteria pertaining to dose and risk relating to the safety of the public. These are given in Regulation R388 on Safety Standards and Regulatory Practices and must be complied with given the characteristics of the site and its environs, and preliminary information on the design and operation of the facility [*these regulations are currently being revised and will be replaced by the draft General Nuclear Safety regulations*].
2) Regulation R927 on Licensing of Sites stipulates the regulations relating to the licensing of sites for new nuclear installations [*these regulations have been incorporated in the draft General Nuclear Safety regulations*].
3) The following requirements, documents and position papers should be used as additional guidance and be complied with:
   a) RD-0014: Emergency Preparedness and Response Requirements for Nuclear Installations;

b) RD-0016: Requirements for Authorisation Submission Involving Computer Software and Evaluation Models for Safety Calculations;
c) RD-0022: Radiation Dose Limitation at Koeberg Nuclear Power Station;
d) RD-0024: Requirements on Risk Assessment and Compliance with Principal Safety Criteria for Nuclear Installations;
e) RD-0034: Quality and Safety Management Requirements for Nuclear Installations;
f) PP-0014: Consideration of External Events for Nuclear Installations; and
g) PP-0015: Emergency Plan Technical Basis for new nuclear installations.

4) The following draft regulations, specifically addressing siting of nuclear facilities, will supersede the above regulatory standards once promulgated:
   a) Regulation 3 of Part FOUR: Authorisation of Activities of the draft General Nuclear Safety Regulations addressing authorisation requirements for sites;
   b) Regulation 4(4) of Part FOUR: Authorisation of Activities of the draft General Nuclear Safety Regulations addressing activities on an authorised site; and
   c) Regulations 4(4) and 4(5) of Part FIVE: Safety Assessment of the draft General Nuclear Safety Regulations addressing safety assessments.
5) In addition, the following regulations are generally applicable during the siting stage of a nuclear facility:
   a) Part THREE: Management of Safety of the draft General Nuclear Safety Regulations addressing management systems;
   b) Part SIX: Radiation Protection of the draft General Nuclear Safety Regulations;
   c) Part EIGHT: Emergency Planning of the draft General Nuclear Safety Regulations; and
   d) Regulation 5 of the Specific Nuclear Safety Regulations: Nuclear Facilities addressing external events.

5.3 Other Legal Considerations

1) Applications for nuclear licences relating to the siting of nuclear facilities should comply with the publication and public hearing processes as contemplated in Section 21 of the Act as well as the draft regulations on Public Participation.
2) Nuclear authorisations of any form obtained from the NNR do not relieve the applicant from provisions of other applicable legislations such as those of the Department of Environmental Affairs, Department of Energy and Department of Water and Sanitation, etc.
3) The authorisation processes of the NNR and the Department of Environmental Affairs are independent processes.
4) The cooperative agreement between the NNR and the Department of Environmental Affairs should be used as a vehicle to exchange information common to the authorisation processes.

5) All radiological related issues, identified during the Department of Environmental Affairs' Environmental Impact Assessment (EIA) processes, should be addressed through the EIA process.
6) Project specific radiological safety issues should be addressed in terms of safety assessments within the framework of the NNR licensing process.

6 SITE LICENSING PROCESS

6.1 General

1) In the evaluation of the suitability of a site for a nuclear facility, the following aspects should be considered:
   a) Effects of external events occurring in the region of the particular site (natural or human induced);
   b) Characteristics of the site and its environment which could influence the transfer of released radioactive material to persons; and
   c) Population density and distribution, as well as other characteristics in relation to the possibility of implementing emergency measures and the need to evaluate the risk to individuals and the population.
2) If the site evaluation for these three aspects indicates that the site has serious deficiencies that cannot be compensated for by means of:
   a) design features,
   b) site protection measures, or
   c) administrative procedures,

   the site should be deemed unsuitable.
3) Design features (a), and site protection measures (b), are the preferred methods for compensating for the deficiencies.
4) Site characteristics that may affect the safety of the nuclear facility should be investigated and assessed. Characteristics of the natural environment in the region that may be affected by potential radiological impacts in operational states and accident conditions should be investigated.
5) A quality management programme should be established to control the effectiveness of the execution of the site investigations and assessments and engineering activities performed in the different stages of the site evaluation process, covering all activities that may influence safety or the derivation of parameters for the design basis.

6.2 Concept of Site Licensing

1) An applicant has the option to apply for a nuclear site licence (NSL) or a nuclear licence (NL) to site, construct and operate a nuclear facility.
2) Applications for an NSL and an NL initiate separate but similar licensing processes. An NSL considering multiple nuclear facilities once granted, cannot be varied into an NL. If an NSL considering multiple nuclear facilities has been granted, a separate application for an NL must still be granted for a specific facility to be sited on the site.
3) The safety case for an NSL typically considers enveloping characteristics of all the nuclear facilities contemplated to be constructed on the site, while an NL to site, construct and/or operate would be for a specific nuclear facility or reactor design at the specific site.

6.2.1 Licensing of sites for new nuclear facilities (NSL)

1) Nuclear site licences may be issued as part of the process of regulatory control over siting of nuclear facilities pursuant to section 5 of the Act and in accordance to regulation R927 on Licensing of Sites for new nuclear installations [to be superseded by regulation 3 of Part FOUR: Authorisation of Activities of the draft General Nuclear Safety Regulations].
2) A nuclear site licence is effectively a statement that the relevant siting factors (including external hazards) have been appropriately characterised and the site parameter envelope quantified considering the impact and risk to the public from all nuclear facilities planned for the site and in the vicinity of the site.
3) The site would therefore be acceptable for future siting, construction and operation of nuclear facilities conforming to the range of technologies specified in the application and other conditions specified in the licence.
4) On this basis, an application for a nuclear licence to site, construct and operate a facility on the site would not be refused on the grounds of external hazard characterisation, unless:
   a) Site or environmental conditions changed for the worse in the interim; or
   b) New generic or technological issues come to light which invalidate the safety case.
5) For this purpose, conditions will be imposed on the nuclear site licence to ensure the ongoing validity of the safety case. The nuclear site licence should therefore serve to:
   a) Confirm the NNR's acceptance of the safety case including the Site Safety Report (SSR);
   b) Impose conditions on the holder to ensure its validity; and
   c) Give permission for specific, limited site work to proceed.

6.2.2 Nuclear licence to site a nuclear facility (NL)

1) A prospective applicant for a nuclear licence may apply for a nuclear site licence for the purpose of licensing a nuclear site prior to the siting, constructing and operation of a nuclear facility. Such

a site may be licensed to subsequently accommodate the construction and operation of more than one nuclear facility (as would be indicated in the application for a NSL).

2) Individual nuclear licenses are required in accordance with section 20(1) of the Act to site, construct, operate, etc. each nuclear facility, which should include the demarcation of each nuclear facility (within the overall licensed site) on which each facility is being constructed or situated.

6.3 Siting on Existing Site

1) In the case of a site on which nuclear facilities are already in operation, an application should be made for a licence to site, construct, operate and decommission a particular facility design on that site.
2) Each nuclear facility, including the existing facilities, within the overall licensed site should be demarcated.

6.4 Licensing Process and Schedule

1) The licensing process for nuclear sites can be broken down into three partially overlapping phases:
   a) The preparatory phase following notification of intent to apply for a site licence for a new nuclear installation or a nuclear licence to site, construct, operate and decommission a nuclear facility;
   b) The regulatory activities following an application for a site licence or nuclear licence including the public participation process; and
   c) The NNR board review and decision process.

6.4.1 Preparatory phase

1) The preparatory phase can be initiated by either a notification of intent or a licence application.
2) In case of a licence application appropriate allowance should nevertheless be made for the preparatory phase.
3) The notification letter of intent from the potential applicant should cover the following:
   a) Intention to apply for a site licence or nuclear licence that should be based on a firm investment decision;
   b) Technologies under consideration for design, construction and operation on the site;
   c) Proposed licensing schedule taking cognisance of the time constraints for the site licensing process (a typical schedule for a nuclear power plant is presented in Attachment A); and
   d) Commitment to licensing fees covering the preparatory phase.

4) National priorities and policies as well as the NNR's resource constraints will determine the prioritisation of the application and impact the proposed licensing schedule, notwithstanding the typical schedule provided in Attachment A.
5) The preparatory phase should focus on the following main activities:
   a) Identification of potential licensing issues, i.e. technical issues which could require considerable time and effort to resolve;
   b) Investigating and securing arrangements for technical support;
   c) Staff recruitment and training on proposed technologies and licensing; and
   d) Development of a Review Plan, including acceptance criteria as appropriate, and the NNR Inspection Plan.

6.4.2 Review of the application

1) The application should be made in accordance with the current regulations on the siting of new nuclear installations [*to be superseded by Part FOUR: Authorisation of Activities of the draft General Nuclear Safety Regulations*] and should include the following:
   a) Licensing schedule respecting the regulatory timescales and constraints;
   b) Scope of technologies proposed for the site; and
   c) Safety case, including a Site Safety Report.
2) Applications for which public participation is invoked by the NNR, pursuant to Section 21(4)(b) of the Act, should include a Public Information Document in accordance with regulation 5 of the draft Regulations on Public Participation.
3) The NNR's review should include, amongst others, the following:
   a) Assessment of the safety case;
   b) Closure of technical issues identified during the preparatory phase;
   c) Audit and inspection of the site as well as the applicant's organisation, management system and processes;
   d) Liaison with local, provincial and national authorities;
   e) Consideration of comments arising from the public participation process; and
   f) Compilation of a preliminary safety evaluation report (SER).
4) For a nuclear power plant it is typically estimated that the review of the application and safety case, including the public participation process and compilation of the final SER will take approximately 18 months. These timescales may be adjusted accordingly for other types of nuclear facilities and will need to be discussed and agreed to with the NNR.

6.5 Activities on an Authorised Site

1) Site establishment and early site activities which are not place-bound are forbidden within the Precautionary Action Zone (PAZ) of any old nuclear facility (i.e. one authorised prior to the siting regulations coming into effect) or within the exclusion zone of any new site (i.e. a site licensed after the siting regulation came into effect).
2) Site establishment, early site activities, early construction or construction activities (place-bound or otherwise) that have potential nuclear safety implications for an existing nuclear facility or proposed facility should be supported by a safety case submitted by the respective holder/applicant for the potentially affected installation or proposed facility.
3) The requirements as detailed in regulation 4(4)(b) of Part FOUR: Authorisation of Activities of the draft General Nuclear Safety Regulations should be complied with before site establishment and early site activities can be performed.
4) Applications for site establishment activities are subject to either an application for a nuclear site licence or a nuclear licence and any other form of authorisation issued by the NNR.
5) Early site activities should only be undertaken under the authority of a nuclear site licence or a nuclear licence.

6.6 Format and Content of the Safety Case (NSL and NL)

6.6.1 Safety case for a nuclear site licence

1) The safety case for the NSL should amongst others:
   a) Provide assurance that the nuclear safety criteria (pertaining to dose and risk) given in Regulation R388 and relevant Regulatory Requirements Documents (RDs) [draft General Nuclear Safety Regulations], relating to the safety of the public, can be complied with given the characteristics of the site and its environs, and preliminary information on the design and operation of the facilities.
   b) Assess whether the site characteristics do not preclude the designs of the technologies proposed for construction on the site.
   c) Assess the feasibility of developing and implementing emergency and security plans, given the characteristics of the site and its environs.
   d) Assess the feasibility of arrangements for controlling developments in the vicinity.
   e) Address the factors as specified in Regulation R927 on the Licensing of Sites for new nuclear installations [regulation 3(1) of Part FOUR: Authorisation of Activities of the draft General Nuclear Safety Regulations].
2) The safety case for the NSL must therefore include the following:

a) Assessment of the suitability of the site considering amongst others external events and civil engineering issues;

b) Assurance of safety in including concept designs and engineered safety features that will ensure an acceptable low risk of public exposure, Probabilistic Safety Assessment and source term analyses;

c) Public and Environmental Impact Analyses;

d) Emergency Planning including the identification of Emergency Planning Zones, preliminary work on establishment of emergency plans and proposed arrangements for control of developments;

e) Security measures including security policy, security clearance and vetting of personnel, information security, cyber security, physical protection systems, nuclear security culture programme and off-site security response;

f) Organisation for site licensing including an overview of the management system, processes and associated procedures; and

g) Site Safety Report.

3) Although the detailed design and operating rules may not be available when the site licence is applied for, there should be sufficient preliminary information available for the range of technologies considered for the site to be able to assess the scale of the nuclear and radiation hazard posed by the facilities and to motivate that compliance to the nuclear safety criteria would be achievable.

4) The Probabilistic Safety Assessment (PSA) should be representative of the characteristics of the site and should consider the impact of all nuclear facilities, existing and proposed, on the site.

5) The PSA for a new nuclear facility should be based on site-specific data and suitably envelop plant-specific design and safety information for the range of technologies and plant designs being considered for the site.

6) Where plant-specific data are not available, conservative generic data (e.g. generic failure data, release source terms, etc.) may be used with appropriate justification.

6.6.2 Safety case for a nuclear licence to site a nuclear facility

1) The safety case for an NL to site must:

a) Provide assurance that the nuclear safety criteria (pertaining to dose and risk) given in Regulation R388 and relevant Regulatory Requirements Documents [draft General Nuclear Safety Regulations], relating to the safety of the public, are complied with given the characteristics of the site and its environs, and the design and operation of the facility.

b) Demonstrate that site characteristics do not preclude the siting and construction of the facility on the site.

c) Provide the technical basis or bounding envelope of the facility design and site parameter values for the safety assessment that must be performed for the construction safety case.

d) Determine the emergency planning zones and demonstrate the feasibility of implementing emergency and security plans, given the characteristics of the site and its environs.
e) Provide for the protection of non-human species.
f) Provide for arrangements for controlling developments in the vicinity.

2) The safety case for a nuclear licence to site a nuclear facility must address the factors as specified in Regulation R927 on the Licensing of Sites for new nuclear installations and should specifically address other requirements relating and relevant to siting of nuclear facilities [*as stipulated in Part FOUR: Authorisation of Activities, Part FIVE: Safety Assessment of the draft General Nuclear Safety Regulations as well as requirements contained in the draft Specific Nuclear Safety Regulations: Nuclear Facilities*].
3) The NNR must be provided with sufficient information, including siting and design information covering the full technical safety basis, to enable it to perform a detailed assessment to the practicable extent. The NNR can therefore determine whether the proposed facility design will meet the requirements and that all safety issues identified during the safety case review will be mitigated at the appropriate stage of the licensing process.
4) The PSA must be based on the site characteristics and plant-specific design information. The design information should be at a level of detail that will allow for the assessment of compliance with the risk limits as well as for the determination of the emergency planning zones around the facility.
5) Where detailed design information is not available, conservative assumptions should be made. It should be demonstrated that the analyses performed are enveloping with respect to the target parameter.
6) Compliance with the full scope of the nuclear safety requirements *[as contained in the draft General Nuclear Safety Regulations and draft Specific Nuclear Safety Regulations: Nuclear Facilities*] would only need to be demonstrated with the application for construction and operation of the nuclear facility.

6.6.3 Site Safety Report

1) The Site Safety Report should contain all the information as required by the Regulations on the Licensing of Sites for new nuclear installations [*regulation 4(5) of Part FIVE: Safety Assessments of the draft General Nuclear Safety Regulations*]. The typical structure and content of a Site Safety Report is given in Attachment B as an example.
2) The Site Safety Report should characterise all the factors relevant to the site, including natural and human-induced external events.
3) The Site Safety Report should include the necessary external events data in support of the safety assessment for a given facility.

7 ASSESSMENT OF HAZARDS ASSOCIATED WITH EXTERNAL NATURAL AND HUMAN-INDUCED EVENTS

7.1 General approach for External Events

1) All the requirements specified in the NNR Regulations pertaining to siting, as listed in paragraph 5.2, must be taken into account during siting. Regulation 5(2) of the draft Specific Nuclear Safety Regulations: Nuclear Facilities, as specifically relating to external and internal events, must be complied with.
2) Proposed sites should be adequately investigated with respect to all the characteristics that could affect safety in relation to natural and human-induced events.
3) The hazards associated with external events, which are to be considered in the design of the nuclear facility, must be determined. For an external event (or a combination of events), the parameters and the values of those parameters used to characterise the hazards must be chosen so that they can be used readily in the design of the nuclear facility.
4) The foreseeable significant changes in land use, such as expansion of existing facilities and human activities or the construction of high-risk installations, should be considered and already approved regional plans must be taken into consideration.
5) Prehistorical, historical and instrumental information and records, as applicable, of the occurrences and severity of those important natural phenomena or human-induced situations/activities should be collected for the region and carefully analysed for reliability, accuracy and completeness.
6) Appropriate methodologies should be adopted for establishing the hazards from important external phenomena.
7) The methodologies used should be the current and state of the art, and should be justified as being compatible with the characteristics of the region.
8) Preferential consideration should be given to applicable probabilistic methodologies.
9) It should be noted that probabilistic hazard curves are generally required to conduct external event PSAs.
10) The size of the region, to which a method for establishing the hazards associated with major external phenomena is to be applied, should be large enough to include all the features and areas that could be of significance in the determination of the natural and human-induced phenomena under consideration and for the characteristics of the event.
11) All natural events that have a probability of occurrence of more than the minimum safety goal defined in PP-0014 [10] (i.e. about 10^{-7} per year) should be considered. Natural phenomena, which may exist or can occur in the region of a proposed site, should be identified and classified

as per their impact on plant safety. Design bases should be derived for each credible event and credible combination of events by adopting appropriate methodologies.

12) If data for a particular type of natural phenomenon are incomplete for the region, then data from other regions having sufficiently similar characteristics should be used, with proper justification, in evaluation of the design basis event.
13) The site and surrounding region should be examined for facilities and human activities that may affect the safety of the proposed nuclear facility. These facilities and activities should be identified and the conditions under which the safety of the plant is likely to be affected should be postulated in deriving the design basis for external human-induced events.
14) Information concerning the frequency and severity of important human-induced events should be collected and analysed for reliability, accuracy and completeness.
15) The evaluation of site characteristics to determine design basis parameters should include considerations for exceedance of design basis and/or design extension conditions.
16) The evaluation of site characteristics to determine design basis parameters should take into account changes of hazards (both natural and human induced) with regards to the design life of the facility.

7.2 Natural Events

7.2.1 Seismic and geological considerations

1) Hazards associated with earthquakes should be assessed by means of seismotectonic evaluation of the region taking into consideration site-specific conditions. All features that can substantially affect the severity of ground motion due to earthquakes in the region should be studied. The geological and seismotectonic conditions in the region and geotechnical aspects of the site area should be evaluated. Information on all earthquakes including prehistorical, historical and instrumentally recorded earthquakes in the region should be collected, documented and considered.
2) All seismically active structures and active faults in the region should be identified. On the basis of geological, geophysical, geodetic or seismological data, a fault should be considered active if one of the following conditions, as defined in [3], applies:
   a) It shows evidence of past movement or movements (significant deformations and/or dislocations) of a recurring nature within such a period that it is reasonable to infer that further movements at or near the surface could occur. In highly active areas, where both earthquake data and geological data consistently reveal short earthquake recurrence intervals, periods in the order of tens of thousands of years may be appropriate for the assessment of capable faults. In less active areas, it is likely that much longer periods may be required.

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

c) The maximum potential earthquake associated with a seismogenic structure is sufficiently large and at such a depth that it is reasonable to infer that, in the geodynamic setting of the site, movement at or near the surface could occur.

3) Potential for permanent ground displacement such as surface faulting or folding, fault creep, subsidence or collapse should be evaluated. The proposed methods and investigations for assessing surface faulting should be sufficiently detailed.

4) The site should be deemed to be unacceptable if the existence of an active/capable fault can cause potential surface faulting affecting the safety.

5) The design basis ground motion (DBGM) should be expressed by response spectra for various damping factors and time histories of appropriate durations of shaking. Site-specific DBGM parameters should be established for engineering designs of the facility.

6) The site-specific DBGM parameters should be derived from considering the maximum earthquake potential that could be attributed to the seismotectonic provinces of the region within which the site is located. Due consideration should be given to reservoir-triggered seismicity on account of existing dams or dams sanctioned to be built in the region, as well as current and planned mining activities.

7) The selection of design basis vibratory ground motion(s) should be based on the satisfaction of the safety goals defined in [10].

8) A lower level of earthquake ground motion during which the plant is capable of continued operation should also be defined. When this level of ground motion is exceeded during plant operation, the nuclear facility should be shut down and inspected. The approval of the NNR should be obtained to restart operations.

9) DBGM parameters should not be less conservative than the corresponding ground motion level specified in national standards for industrial facilities of the highest safety or hazard category. The peak ground acceleration (PGA) of design basis ground motion should not be less than 0.10g.

10) Design basis ground motion parameters should be derived following a risk-informed graded approach.

11) The selection of annual frequencies of exceedance of design basis ground motion(s) should be based on the satisfaction of the safety goals defined in [10] for each operational state.

12) Water control structures such as dams located upstream or downstream, whose failure could potentially compromise the safety of a nuclear facility, should be checked for structural integrity.

13) Suitable instrumentation should be provided so that the response of the site, structures, systems and components of the facility that are important to safety can be determined promptly to permit comparison to the response used as the design basis.

7.2.2 Meteorological events

1) The meteorological and climatological characteristics for the region around the site should be investigated and evaluated to ensure the safety of nuclear facility. Meteorological events/parameters to be considered for evaluation of design bases include: wind, precipitation, storm surge, tropical cyclone, air temperature (dry bulb and wet bulb), cooling water temperature and humidity.
2) In addition to the above meteorological phenomena, the following rare meteorological events should also be considered in the evaluation of site characteristics: lightning; tornado; snow; waterspouts; dust and sand storms; hail storm; freezing precipitation and frost related phenomena; cloud burst and any other phenomena specific to the site.
3) Hazards associated with all relevant meteorological phenomena should be identified and evaluated to arrive at the corresponding design basis parameter to ensure the safety of the facilities to be located at the site.
4) Historical data of the event at and around the site should be utilised for evaluation of the potential of occurrence, frequency and severity of the meteorological event. Uncertainties involved in the data, its adequacy and evaluation procedure should be taken into account in the evaluation of hazards while arriving at the design basis parameter for any event. Output of the hazard evaluation should be described in terms of suitable design parameters that can be used in ensuring the safety of the facilities.
5) Historical data on persistent high winds during cyclones, tornadoes and storms occurring at and around the region should be used for static loading and wind induced missile generation, while data on short duration bursts of wind should be utilised for studies of dynamic loading. Historical data on circulating wind during tornadoes, if any, occurring at or around the region should also be collected.
6) The collected data should be used to generate design basis wind speeds taking into account the safety goal defined in [10].
7) Site-specific design basis wind speeds should be based on sufficient and reliable data. In the absence of sufficient and reliable site-specific data, design basis wind speeds derived from South African National Standards and international codes should be used provided these have been justified and accepted by the NNR.

7.2.3 Flooding

1) Inland sites should be assessed for: flooding hazards due to precipitation, storms, wind-induced waves, seiches, failure of water storage/carrying structures, melting of snow, etc.
2) Coastal sites should be assessed for: high tides, cyclones/storm surge, wind-induced waves, precipitation, tsunami-generated waves, etc. Appropriate combinations of these phenomena should also be considered.
3) The design basis should take into account the highest water level reached at the site during the above events. Other associated parameters like the duration of flood, flow conditions, warning time for flood and the height and period of waves, if relevant, should also be estimated.
4) Suitable meteorological, hydrological and topographical data, including data on relevant bodies of water, should be collected. Uncertainty and data inadequacy, if any, should be taken into consideration when deriving the design basis value of the flood water level. The design basis' highest water level at the site should be arrived at by using appropriate flood routing models.
5) A probable maximum storm (PMS) and resulting probable maximum flood (PMF) should be identified. Appropriate models for routing this water along a channel/river should be used. If the origin of a flood is upstream of a reservoir, water should be routed downstream and the water level at the site should be generated using appropriate hydrological models. The assumed water level in the reservoir during a flood should be taken as the full reservoir level (FRL).
6) Outflow from a dam in the region of a site should be used as the input for the downstream channel and routed along the channel to arrive at the highest water level reached at the site.
7) Structural stability of the upstream/downstream dam against a water level rise or earthquakes should be evaluated. If stability is not established then failure of the dam should be assumed and the consequent hazard should be evaluated adopting appropriate methods.
8) The possibility of change in a river's course and consequent flood hazard should be assessed where applicable.
9) The potential for seiches in enclosed bodies of water should be examined for inland sites located close to such bodies of water.
10) Coastal sites should be examined for potential flooding caused by a surge due to cyclones, wind-induced waves as well as tsunami waves.
11) Wave run-up should also be considered taking into account any amplification due to the coastal configuration adjacent to the site.
12) Bathymetry and topography data of the coastal region should be collected and utilised.
13) The region should be evaluated to determine the potential for tsunamis that could affect the safety of nuclear facilities on the site. The hazards associated with tsunamis should include potential drawdown and run-up as well as hydrodynamic forces, if applicable.

14) Design basis earthquake should be arrived at with data of earthquakes resulting from a tsunami wave landing at the site using appropriate hydrological and numerical models.
15) The frequency of occurrence, magnitude and height of regional tsunamis should be estimated. On the basis of the available data for the region, prehistorical and historical, and comparison with similar regions that have been well studied, all potential tsunamigenic sources and their maximum potential should be identified and used in determining the possible hazards associated with tsunamis. Appropriate models should be used in the evaluation and should take into account any amplification due to the coastal configuration adjacent to the site.
16) Flooding from local intense precipitation should be mitigated by the site drainage system.
17) The safety-related systems and components, waste storage/management areas and escape routes or entrance/exit roads to safety-related areas should not be rendered dysfunctional by the occurrence of a design basis or design basis extension precipitation event.

7.2.4 Geotechnical hazards

1) The site and its vicinity should be evaluated for slope instability (such as land and rock slides and land erosion) which could affect the safety of the facility.
2) If such a potential exists, the hazard should be evaluated using site-specific parameters such as design basis ground motion of earthquakes and/or slope instability due to heavy rain, etc. The site should be rejected if a suitable engineering solution is not feasible.
3) Geological and other appropriate information of the region should be examined for the existence of natural features like caverns, sink holes, karst formations, subsidence; and human-induced features/activities like mines, water extraction and gas/oil wells. If the potential for surface collapse, subsidence or uplift exists in the site vicinity, the corresponding hazard should be evaluated. The site should be deemed unsuitable if no engineering solution is possible for ensuring the safety of the nuclear facility.
4) The potential for soil liquefaction at the site should be evaluated using design basis ground motion parameters. If the potential for soil liquefaction exists, the site should be deemed unsuitable unless engineering solutions are demonstrated to be available.
5) The geotechnical characteristics of the subsurface materials should be investigated and a stratigraphic profile for the site, in a form suitable for design purposes, should be determined.
6) It should be ensured that the site has competent strata for bearing the design loads transferred through the foundation. The details of local geology, e.g. karstic phenomena, should also be examined.
7) Adequate geotechnical investigations should be carried out to examine the competence of the founding media. The stability of the founding strata under static and seismic loading should be assessed.

8) The groundwater regime and the chemical properties of the groundwater should be studied.
9) Unless engineering solutions exist, regions that have or are prone to migratory sand dunes should be avoided.
10) The site should be investigated for evidence of volcanic activity in the region. If such evidence exists, the impact of associated phenomena should be studied. Unless the impact of these phenomena could be mitigated by engineering measures, the site should be deemed unsuitable.
11) The possibility of occurrence of certain phenomena, viz. pyroclastic density currents; lava flows; debris avalanches; landslides and slope failures; opening of new vents; and ground deformation would deem the site unsuitable.
12) For coastal sites, the potential for shore instability due to erosion or sedimentation should be investigated. In case of inland sites or sites located on riverbanks, the potential of riverbank erosion or change in river course should be investigated.
13) If the potential for such instability exists and is unacceptable from the safety consideration of the nuclear facility, the site should be considered unsuitable unless a reliable and practical engineering solution is available.
14) The potential for the loss of ultimate heat sink of a nuclear facility should be analysed. If the potential exists, the site should be considered unsuitable unless a reliable and practical engineering solution is available.

7.3 External Human-induced Events

7.3.1 Aircraft crash (accidental origin)

1) Screening values compatible with the safety goals in [10] should be established to inform the need for detailed evaluations.
2) If screening values are not satisfied the site should be further evaluated.
3) For this purpose, data such as the distance of the nearest airport along with the present flight frequency, expected growth, air traffic corridors in the region and the type of aircraft used should be collected. This data should be used to arrive at the projected annual frequency of aircraft crashes on the site. If this frequency is found to be greater than screening values, a detailed evaluation should be carried out to assess the impact hazard including secondary consequences such as fire and explosions due to burning fuel. If engineering solutions acceptable to the NNR do not exist, the site should be deemed unsuitable.

7.3.2 External fire

1) External fire hazards should be evaluated with appropriate considerations for the safety of the facility (e.g. access to the site, availability of power, ventilation, impairment of safety function, operator action, etc.) with special emphasis on the unavailability of power or any threat to operator action owing to the release of smoke and toxic gases.

7.3.3 Explosions and asphyxiant/corrosive/toxic gas releases

1) Activities in the region around the site involving the handling, processing, transporting and storing of chemicals and explosives that have the potential for safety concerns, such as explosions and asphyxiant/corrosive/toxic gas releases, should be identified. All these activities should be taken into account during the site evaluation of the facility.
2) The areas, in the vicinity of the site, where explosive chemicals are manufactured, stored or transported should be identified along with their type and quantity. Computations should be carried out to arrive at effect of the generated pressure wave and thermal load on the facility from postulated accident scenarios.
3) The potential for the release of asphyxiant and toxic gases should be evaluated. These events affect the nuclear facility both externally and internally by damaging or impairing safety-related systems and operator action.
4) The concentration levels of toxic chemicals (manufactured, handled, stored or transported in the surrounding environment of the site), released due to an accident at the manufacturing/handling plants or during transportation of these chemicals, should be evaluated. If levels are above the toxic levels stipulated for the respective chemicals, appropriate engineering measures should be introduced to ensure the safety of the nuclear facility and site personnel.
5) The design basis for chemical explosion events should consider overpressure including a variation of the pressure wave with respect to time and its duration as well as the impact on structural elements and humans. For chemical releases, the tolerance level of toxic material should be considered.
6) The release of corrosive gases or liquids from industrial plants in the vicinity of the site or from transit accidents and spills from ships or trains constitute a potential hazard. Leakage of corrosive gases and liquids may also occur from the storage of chemicals on the site. The impact of such an event on the plant should be evaluated.

7.3.4 Release of radioactive materials

1) The impact of the release of radioactive materials from adjacent operating nuclear facilities and from vehicles transporting radioactive material on the proposed facilities should be evaluated considering possible scenarios.

7.3.5 Oil slick/chemical spill

1) Information regarding the proximity of offshore oil wells, near-shore oil wells, movement of oil tankers in the nearby shipping channels/waterways and any other potential source of an oil slick should be obtained. The impact on nuclear facilities due to the potential oil slick should be investigated.

7.3.6 Blasting operation

1) Information regarding blasting operations, including those during site excavation in the site vicinity (up to 5km), should be obtained and the impact of such operations on the safety of existing nuclear facilities at the site should be assessed.

7.3.7 Mining, drilling and water extraction

1) All activities related to mining, drilling, subsurface extraction and injection of water and other fluids should be carefully studied in order to assess their impact on the safety of the facility.

7.4 Other Events

1) Natural and human-induced events, other than those addressed in the preceding sections, that could cause loss of function to structures, systems and components (SSC) important to nuclear safety should be identified. Examples of such events include: blockage/diversion of a river, depletion of a reservoir, blockage of a reservoir/cooling tower by freezing or the formation of ice, electromagnetic interference, eddy current in the ground, extraterrestrial hazard, biological infestation, corrosion, etc.
2) The investigation should also include objects that may give rise to missiles of any type that could affect the safety of nuclear facilities. Potential hazards associated with these events should be established. If the hazard is unacceptable for the nuclear facility and no practicable solution is available, the site shall be deemed unsuitable.

8 ASSESSMENT OF THE POTENTIAL RADIOLOGICAL IMPACTS OF THE NUCLEAR FACILITY

8.1 Potential Effects on the Region

1) In the evaluation of a site or siting of a nuclear facility to determine its potential radiological impact on the region (for normal operational conditions and accident conditions which could lead to emergency measures), appropriate estimates should be made of expected or potential releases of radioactive material, taking into account the design of the facility and its safety features.
2) The relationship between the site and the design/s for the nuclear facility/facilities should be examined to ensure that the radiological risk to the public and the environment arising from releases defined by the source terms is acceptably low. This must be demonstrated by analysis with reference to relevant PSA studies for the potential designs.
3) The effects and consequences for the public and the environment of short-term or long-term radioactive discharges should be assessed on the basis of meteorological information and site-specific conditions relating to land and water uses, population distribution, infrastructure in the vicinity of the site and relevant radiological parameters.
4) The design of the facility should compensate for any otherwise unacceptable effects of the nuclear facility on the region, or else the site should be deemed unsuitable.

8.2 Land and Water Use in the Region

1) The uses of land and water should be characterised in order to assess the potential effects of the nuclear facility on the region and particularly for the purpose of preparing emergency plans.
2) The investigation should cover land and bodies of water that may be used by the population or may serve as a habitat for organisms in the food chain.
3) Investigations of the land and water utilised in the region should cover:
   a) Land devoted to agricultural uses, its extent, and the main crops and their yields;
   b) Land devoted to dairy farming, its extent and yields;
   c) Land devoted to industrial, institutional and recreational purposes, its extent and the characteristics of its use;
   d) Bodies of water used for commercial, individual and recreational fishing, including details of the aquatic species fished, their abundance and yield;
   e) Bodies of water used for commercial purposes, including navigation, community water supply, irrigation and recreational purposes such as bathing and sailing;
   f) Land and bodies of water supporting wildlife and livestock;
   g) Direct and indirect pathways for potential radioactive contamination of the food chain;
   h) Products imported to or exported from the region which may form part of the food chain; and

i) Free foods such as mushrooms, berries and seaweed.

4) The present use of water which could be affected by changes in the water temperature and by radioactive material discharged from a nuclear power plant, together with the location, nature and extent of usage, should be identified. Changes in the use of water in the region should also be considered.

5) The information presented should include:
   a) Maps showing the locations of the nearest residences, groundwater supply boreholes, and abandoned boreholes;
   b) Types of water use both present and projected (life of facility), e.g. municipal, domestic, agricultural, livestock, and descriptions of the methodology and sources used to develop projections;
   c) Present and projected (life of facility) water use estimates by type for both groundwater and surface water, including present and projected withdrawal, and descriptions of the methodology and sources used to develop projections;
   d) Description of existing boreholes, borehole depth, groundwater elevations, borehole yields, drawdowns, and a description of the producing aquifer(s);
   e) Descriptions of the nature and extent of projected land use (e.g. agriculture, recreation, industry, grazing and infrastructure) and descriptions of the methodology and sources used to develop projections; and
   f) The location of any other nuclear and/or radiological facilities located or proposed within the vicinity of the site.

6) Recent agricultural production data should be tabulated for vegetables, meat, milk and other foodstuffs in addition to predictions for future production by government, industry or institutions within the region surrounding the planned facility. For nuclear facilities, site-specific data should be used based on land and water use and habitation study.

8.3 Transport and Diffusion of Effluents Discharged into the Atmosphere

8.3.1 General considerations

1) A meteorological investigation should be carried out to evaluate regional and site-specific meteorological parameters. Data should be collected from appropriate elevations above ground in order to obtain realistic dispersion parameters.

2) The calculations of the dispersion and concentrations of radioactive materials should show whether the radiological consequences of routine discharges and potential accidental releases of radioactive materials into the atmosphere are acceptable. The results of these calculations

may be used to establish authorised limits for radioactive discharges from the plant into the atmosphere.

3) The type and extent of acquired and stored meteorological data should allow for reliable statistical analyses to determine the distribution of radiation exposures.
4) Contamination in the air, on the ground and in water over short and long periods of time should be described in the atmospheric dispersion models, with account taken of diffusion conditions in the region.
5) Use of parameters in calculational models should be substantiated as to their appropriateness for use in estimating releases.
6) The atmospheric dispersion and deposition models used must be documented, described in detail and substantiated to allow a review of their accuracy and validity, source configuration, suitability of input parameters, topography, and appropriateness for the site, plant and release characteristics.

8.3.2 Meteorological considerations

1) A programme for meteorological investigation should be designed to collect and evaluate data continuously and should provide data for an adequate time period (for at least two full years) that are representative of the site and should continue for the lifetime of the facility. In addition, the data should be compared with data collected after the plant is constructed, but before operation, to determine whether changes are necessary to the design bases or to assumptions made in the calculational model.
2) In collecting meteorological data, care should be taken to prevent local effects from unduly altering the values of the parameters to be measured. It should be ensured that the data collected adequately represent local meteorological conditions.
3) In order to provide a description of the meteorological conditions, data on the following should be obtained concurrently:
   a) Wind vectors (i.e. wind directions and speeds);
   b) Specific indicators of atmospheric turbulence;
   c) Precipitation;
   d) Air temperatures;
   e) Humidity; and
   f) Air pressure.

8.3.3 Instrumentation and measurements

1) Meteorological equipment should be installed in such a way as to obtain data representing the dispersion conditions at release points. Examination of the terrain around a nuclear facility site is necessary. Topographical features of interest should be considered in the installation of equipment. Instruments should be capable of obtaining data representing the entire profile of the wind, at least up to the height of potential releases.
2) At sites where there is a potential for fogging or icing, due to an increase in atmospheric moisture content caused by plant operation, instrumentation should be provided for measuring the dew point (or humidity) on the tower or mast.
3) Equipment should be properly exposed and should be positioned far enough from any obstacles to minimise their effects on measurements. The tower or mast should be sited at approximately the same elevation as finished plant grade and in an area where plant structures will have little or no influence on the meteorological measurements.
4) Meteorological instrumentation and systems should be shielded, maintained, serviced and calibrated on a regular basis in order to mitigate harmful environmental effects such as sun, lightning, ice, sandstorms and corrosive agents and to ensure availability and reliability of data.
5) In assessing the accuracy of instrumentation, allowance should be made for errors due to cabling, signal conditioning, recording, solar radiation and the effects of fluctuations in environmental temperature.
6) Measurements should be made at more than one location where the wind speed or direction varies significantly across the region.
7) Measurements should be made at the following elevations in order to obtain wind data continuously:
   a) At an elevation of 10m in accordance with standards that have been established by the World Meteorological Organization (WMO), for purposes of comparing and correlating wind data from the site with wind data from the synoptic network of meteorological stations; and
   b) At the point representing the effective height of discharge.
8) Measurement techniques for recording meteorological data should be in line with the standards published by the national meteorological services. The general tendency is to record average values for a given constant duration, such as 3s gusts, 60s averages or 10min averages (the averaging time is a characteristic of the database).
9) The wind vector at different elevations and temperatures should be averaged at least once per hour, while the period of integration for other variables such as solar radiation levels and precipitation levels should be one hour. Wind direction should be averaged as a vector and wind speed as a scalar over the prescribed time period.

10) The basic reduced data should be compiled into monthly or seasonal and annual joint frequency distributions of wind speed and wind direction by atmospheric stability class. Similar tables of joint frequency distribution should be prepared for each of the other atmospheric stability classes.
11) In developing site-specific diffusion models, sufficient information should be acquired on the space and time distributions of wind and temperature to be able to understand and determine the trajectory of effluents.
12) Turbulence should be indicated by the use of data relating to one or more of the following:
    a) Fluctuations in wind direction (sigma theta method);
    b) Air temperature and temperature lapse rate (delta-T method);
    c) Wind speed and solar radiation levels or sky cover during the daytime, and sky cover or net radiation levels at night-time (insulation method); and
    d) Wind speed at different heights.
13) Determination of the temperature variation for an atmospheric layer with height between at least two measurement levels should be provided. These levels should include the level at which the wind is measured.
14) The frequency, duration and time of the measurements of temperature variation with height should be concomitant with the wind data.
15) Precipitation and humidity should be recorded at least hourly.
16) A joint frequency distribution of wind direction and wind speed for each stability class (three-dimensional weather statistics) should be provided.
17) The probability of occurrence of different sets of meteorological conditions should be determined during different periods of time over the duration of, for example: an accident, in the first hours of the postulated accident, on the first day, over the first week and over the balance of the duration of the accident.

8.4 Transport and Diffusion of Effluents Discharged into the Hydrosphere

8.4.1 General considerations

1) A detailed investigation of the hydrosphere in the region should be carried out. Calculations of dispersion and concentrations of radionuclides should be performed to assess the radiological consequences to the hydrosphere in order to establish limits for radioactive discharges into water, and to developing monitoring and sampling strategies for exposure situations.
2) Characterisation of the hydrology at the site should be sufficient to establish potential effects of operational activities on the adjacent surface water and groundwater resources and the potential effects of surface water flooding on the facility and surroundings.

8.4.2 Hydrological considerations

1) The areas of study should include:
   a) Descriptions of surface water features on the site area including type, size, pertinent hydrological or morphological characteristics, and proximity to on-site facilities that might be negatively affected by surface erosion or flooding.
   b) Assessment of the potential for erosion or flooding that may require special design features or mitigation measures to be implemented.
   c) A description of site hydrogeology, including:
      i) Identification of aquifer and aquitard formations that may affect or be affected by the operational processes;
      ii) A description of aquifer properties, such as material type, formation thickness, effective porosity, hydraulic conductivity, and hydraulic gradient;
      iii) Estimated thickness and lateral extent of aquitards, and other information relative to the control and prevention of excursions; and
      iv) Data to support conclusions concerning the local groundwater flow system based on borehole logs, core samples, water level measurements, pumping tests, laboratory tests, soil surveys, and other methods.
   d) Assessment of available groundwater resources and quality within the boundaries of the authorised area and adjacent properties, including quantitative descriptions of the chemical and radiological characteristics of the groundwater and potential changes in water quality caused by operations.
   e) An assessment of typical seasonal ranges and averages and the historical extremes for levels of surface water bodies and aquifers.
2) An acceptable conceptual model of the site hydrology, adequately supported by the data presented in the site characterisation, should be developed. Therefore the study should include:
   a) All surface water data such as: maps that identify nearby lakes, rivers, surface drainage areas or other surface water bodies; water applications; stream flow; and the assessment of the likely consequences of surface water contamination from operational activities.
   b) An evaluation of the potential for erosion or flooding.
   c) An evaluation of the site hydrogeological conceptual model for groundwater flow in potentially affected aquifers. Data collected from borehole logs and hydrological tests and measurements should build confidence in the hydrological conceptual model for groundwater flow within and around the authorised area.
   d) An assessment of seasonal and historical variability for levels of surface water bodies and water levels or potentiometric heads in aquifers, ensuring that sufficient time intervals have elapsed between measurements to allow assessment of seasonal variability.

e) Information on past, current and anticipated future water uses, including descriptions of local groundwater, borehole locations, types of use, amounts used and screened intervals. This information must be sufficient to evaluate potential risks to groundwater or surface water users in the vicinity of the planned facility.

An assessment of water quality of potentially affected groundwater resources. A sufficient number of baseline groundwater samples should be collected to provide meaningful statistics. The samples should be spaced in time sufficiently to capture temporal variations, and the chemical constituents and water quality parameters evaluated should be sufficient to establish preoperational water quality, including classes of use.

8.4.3 Surface water

1) For sites located on the shores of large lakes, estuaries, seas and oceans, the hydrological information should include the following:

a) The general shore and bottom configuration in the region, and unique features of the shoreline in the vicinity of the discharge. Data on bathymetry out to a distance of several kilometres, and data on the amount and character (transport, deposition and resuspension) of sediments in the shallow shelf waters.

b) Speeds, temperatures and directions of any near shore currents that could affect the dispersion of discharged radioactive material. Measurements should be made at appropriate depths and distances, depending on the bottom profile and the location of the point of discharge.

c) The duration of stagnation and characteristics of current reversals. After a stagnation, a reversal in current usually leads to a large-scale mass exchange between inshore and offshore waters that effectively removes pollutants from the shore zone.

d) The thermal stratification of water layers and its variation with time, including the position of the thermocline and its seasonal changes.

e) The load of suspended matter, sedimentation rates and sediment distribution coefficients, including data on sediment movements characterised by defining at least the areas of high rates of sediment accumulation.

f) The background levels of activity in water, sediment and aquatic food due to natural and artificial sources.

g) Seasonal cycles of phytoplankton and zooplankton, with at least the periods of their presence and cyclical evolutions of their biomass.

h) Spawning periods and feeding cycles of major fish species.

2) The models used for radionuclide dispersion in surface water should be based on the type of discharge, the type of water body and the use of the water. The results from a calculational model should be compared with laboratory data or field data for a specific site.
3) For situations where the contaminants have a high affinity to sediments, and a surface water body has a high concentration of sediments, models used must include sediment-contaminant interactions.

8.4.4 Groundwater

1) The evaluation of hydrogeological characteristics should determine the following:
   a) Estimated concentration of radioactive material in groundwater at the nearest point in the region where groundwater is drawn for human consumption;
   b) Transport paths and travel times for radioactive material to reach the source of consumption from the point of release;
   c) Transport capacity of the surface flow, interflow and groundwater recharge;
   d) Susceptibility to contamination of the aquifers at different levels; and
   e) Time and space distributions of the concentrations in the groundwater of radioactive material resulting from accidental releases from the plant.
2) Both local and regional information should be collected to identify the hydrogeological system and the preferential flow paths. The information to be collected should include:
   a) Climatological data;
   b) Background concentrations of radionuclides;
   c) Major hydrogeological units, their hydrodynamic parameters and the ages or mean turnover times of groundwater;
   d) Recharge and discharge relationships; and
   e) Data on surface water and groundwater interaction, if any.
3) The extent and degree of hydraulic connections between bodies of surface water and groundwater should be identified. The amount of the exchanges should be estimated and their corresponding exchange regimes should be determined.
4) Modelling of dispersion and retention of radionuclides in groundwater should be performed using simplified evaluations with conservative assumptions and data to evaluate the effects of postulated accidental releases of radioactive material to the groundwater. Furthermore, refined analysis with more realistic assumptions and models should be performed if necessary.
5) The complexity of the model chosen should reflect the complexity of the hydrogeological system at a particular site.

8.4.5 Ecology

1) Descriptions of the flora and fauna in the vicinity of the site, their habitats and their distribution should be provided. The review should include identification of important species that are:
   a) Threatened or endangered;
   b) Commercially or recreationally valuable; and
   c) Affect the well-being of another species critical to the structure and function of the ecological system or a biological indicator of radionuclides or chemical pollutants in the environment.
2) An inventory should be provided of the majority of terrestrial and aquatic organisms on or near the site and their relative (qualitative) abundance, the quantitative abundance of the important species, and species that migrate through the area or use it for breeding grounds. The relative importance of the proposed site environs to the total regional area used as living resources (potential or exploited) should be described.
3) A count and description should be provided of agricultural and domestic fauna, in particular cattle, sheep and other meat animals that may be involved in the exposure of man to radionuclides. Important game animals should receive similar treatment. A map showing the distribution of the principal plant communities should be provided.
4) Species-environment relationships should be evaluated. This includes: descriptions of area usage (e.g. habitat and breeding) for important species; life histories of important regional animals and aquatic organisms; normal seasonal population fluctuations and habitat requirements; and identification of food chains and other interspecies relationships, particularly when these contribute to the prediction or evaluation of the impact of the facility on the regional biota. Pre-existing environmental stresses from sources such as pollutants, as well as pertinent ecological conditions suggestive of such stresses and the status of ecological succession should be defined.
5) The protection of non-human species against radiation damage requires that the exposure to non-human biota be determined. For this purpose a set of reference plants and animals should be established. Derived consideration reference levels as well as radiation dose assessments for the reference plants and animals need to be determined for a nuclear licence to site.

8.5 Population Distribution

1) The region of interest (henceforth referred to as the region) should include an area immediately surrounding the site of a nuclear facility. It should also include the overall Emergency Planning Zone (EPZ), where applicable, in which population distribution, population density, population growth rate, industrial activity and land and water uses are considered in relation to the feasibility of implementing emergency measures.

2) The distribution of the population within the region should be determined within 16 sectors of 22.5° each.
3) The most recent census data for the region, or the extrapolation of the data, should be used in obtaining the population distribution.
4) In the absence of reliable data, a special study should be carried out to determine the population in the region.
5) An exclusion zone (EZ) and a low population zone should be determined to facilitate offsite emergency planning and to develop a significant response base.
6) The specified low population zone should be determined so that appropriate urgent protective measures, such as iodine prophylaxis, precautionary sheltering and evacuation are effective in the event of a serious accident.
7) The size of population centres within the low population zone should be limited, in total number and density, so that there is a reasonable probability that appropriate protective measures could be taken in the event of a serious accident. This must be the reference accident for the emergency plan.
8) Projected changes in the population should cover the life of the plant and take into account already approved developments and regional plans. Otherwise liaison must take place to have the regional plans changed accordingly.
9) Data on the present population in the region should be obtained from local authorities or by means of special field surveys and these data should be as accurate and as up to date as possible. The term 'present population' includes the two categories of permanent population and temporary population.
10) Information on the permanent population of the region and its distribution should include: the occupations, places of work, means of communication and typical diet of the inhabitants. If a city or town in the region is associated with a major industrial facility, this should also be considered.
11) The information on the temporary population should cover:
    a) The short-term transient population, such as tourists and nomads; and
    b) The long-term transient population, such as seasonal inhabitants and students.
12) The maximum size of the temporary population and its periods of occupancy in the low population zone should be estimated. Particular types of institutions such as schools, hospitals, prisons and military bases within the zone should be identified for the purposes of emergency planning. In the area outside the zone, estimates of the approximate size of the temporary population together with its periods of occupancy should be made.
13) A projection of the present population in the region should be made for:
    a) The expected year of commissioning of the plant; and
    b) Selected years (e.g. every tenth year) over the lifetime of the plant.

14) Projections should be made on the basis of population growth rate, migration trends and plans for possible development in the region. The projected figures for permanent population and temporary population should be extrapolated separately if data are available.
15) Data should be analysed to give both the current and the projected population distribution in terms of direction and distance from the plant.
16) The representative person of the population associated with each nuclear facility should be identified considering particular dietary habits and specific locations for particular types of activity in the region.
17) The population data collected should be presented in a suitable format and scale to permit correlation with other relevant data, such as data on atmospheric dispersion and on uses of land and water. Additional details should be given for areas closer to the site, especially within the the low population zone.

8.6 Radiological Effects

8.6.1 General considerations

1) Internal and external exposures should be considered in the assessment of the radiological effects.
2) An assessment of the potential impact of the contamination of surface water and groundwater on the population should be performed by using the collected data and information in a suitable model.
3) Dose estimates should include all exposure pathways, namely inhalation, ingestion and external exposure.
4) Total human exposure should be calculated for the representative person from all intake and radiation exposure pathways. This value should not exceed the dose constraint of 250 µSv/a.
5) A nuclear site licence (NSL) requires that an analysis of the impact on the public due to planned operations, including anticipated operational occurrences, should be performed to demonstrate compliance with the dose limits considering all exposure pathways. The analysis should consider all facilities and activities planned for the site as well as nuclear facilities or activities in the vicinity. Where plant specific information is not available, enveloping results for typical plants covering the scope of proposed technologies must be used:
6) A nuclear licence to site (NL) requires that an assessment of the radiological effects of the planned operations, including anticipated operational occurrences, on the public and biota should be performed, which should include estimates of the radiological impacts from all exposure pathways for the proposed facility.

8.6.2 Dose assessment due to effluents discharged into the atmosphere

1) The following properties and parameters should be estimated for discharges into the atmosphere:
   a) The rate and variation of discharge of each important radionuclide and the total activity of each important radionuclide released in a specified period;
   b) Chemical characteristics of the material released;
   c) Physical properties of the material released; and
   d) Geometry and mechanics of the discharge.
2) A description of the code/model should be provided, including: the type of release (either a puff or continuous release), the duration of the release, topography, precipitation, atmospheric stability and mixing height. Building wake effects should be considered where appropriate.
3) The information necessary to perform dose assessments for exposure to radioactive materials includes:
   a) The source term for the discharge of radioactive material to the environment and its variation in time;
   b) Atmospheric, physical and physicochemical characteristics governing the transport, diffusion and suspension of radioactive materials;
   c) Relevant food chains leading to humans; and
   d) Characteristics of permanent and temporary populations, including their agricultural, industrial, recreational and institutional activities.
4) Atmospheric dispersion models to calculate concentrations and deposition values for the short, medium and long term should be applied for normal or accidental discharges.
5) The dispersion models should account for plume rise, transport and diffusion, and should consider:
6) Radioactive decay and build-up of daughter products;
7) Wet deposition;
8) Dry deposition;
9) Formation and coalescence of aerosols; and
10) Resuspension of materials deposited on surfaces.

8.6.3 Dose assessment due to effluents discharged into the hydrosphere

1) The information necessary to perform dose assessments relating to exposure pathways in the hydrosphere should include:
   a) The source term for the discharge of radioactive material to the environment.

b) Hydrological, physical, physicochemical and biological characteristics governing the transport, diffusion and retention of radioactive materials.
c) Relevant food chains leading to humans.
d) Locations and amount of water used for consumption, industrial, agricultural and recreational purposes.
e) Dietary and other relevant habits of the population, including special occupational activities such as the handling of fishing gear and recreational pursuits such as water sports and fishing.

2) The following properties and parameters should be estimated for the source term for normal and accidental discharges in the hydrosphere:
   a) The rate and variation of discharge of each important radionuclide and the total activity of each important radionuclide released in a specified period.
   b) Chemical properties of the liquid discharged.
   c) Physical properties of the liquid discharged.
   d) Flow rates for continuous discharges, or volume and frequency for batch discharges.
   e) The variation of the source term over the duration of the discharge, which is necessary to evaluate the concentrations due to long-term releases.
   f) The geometry and mechanics of the discharges.

8.7 Exposures to Flora and Fauna (Non-human Species)

1) For a nuclear site licence, estimates of maximum radionuclide concentrations that may be present in important local flora and local and migratory fauna should be calculated so that environmental impacts from facility operations can be assessed.
2) Particular attention should be paid to the impact on threatened and endangered species. Justification should be provided for the interpretation of data, bioaccumulation factors, approved calculations, and assumptions used in models to calculate consequences.
3) Detailed biosphere modelling is not necessary for these calculations.

8.8 Non-radiological Effects

1) For a NSL, the estimated concentrations of nonradioactive constituents in effluents at the point of discharge and the projected effects for both acute and chronic exposure of the biota should be adequately quantified. Where applicable, these estimates should be supported by properly interpreted data, reasonable bioaccumulation factors, calculations, and model results using reasonable assumptions.

2) For siting of facilities on multi-unit sites, an evaluation of the potential hazards to the structures, systems and components important to the nuclear safety of operating facilities, resulting from siting activities, should be performed. A description of the managerial and administrative controls to be used should be provided for assurance that the limiting conditions for operation are not exceeded as a result of siting activities at the multi-unit sites.

9 ASSESSMENT OF REGIONAL CONDITIONS FOR ZONING AND EMERGENCY PLANNING

9.1 General

1) Before final approval of a site, the feasibility of an emergency plan should be demonstrated. There should be no adverse site conditions which could hinder the sheltering or evacuation of the population in the region, or the ingress or egress of external services needed to deal with an emergency.
2) For a nuclear licence to site, the emergency planning zones should be determined using site and facility design-specific information and the feasibility of an emergency plan should be demonstrated on the basis of site-specific natural and infrastructural conditions in the region. In this context, infrastructure means transport and communications networks, industrial activities and, in general, anything that may influence the rapid and free movement of people and vehicles in the region of the site. Other information on the region, such as information on the availability of sheltering, the systems for the collection and distribution of milk and other agricultural products, special population groups such as those resident in institutions (e.g. hospitals and prisons), industrial facilities, and environmental conditions such as the range of weather conditions, should be collected for demonstrating the feasibility of an emergency plan.
3) For a nuclear site licence, emergency planning zones must be identified and arrangements be in place for the controlling of developments in the vicinity, where appropriate, for the implementation of emergency measures. The emergency planning zones must be identified using enveloping source terms obtained from PSA studies for the scope of facility designs for which the application is made. See 9.5 (Reference Accident).
4) Many site-related factors should be taken into account in demonstrating the feasibility of an emergency plan. The most important factors are:
   a) Population density and distribution in the region;
   b) Distance of the site from population centres;
   c) Special groups of the population that are difficult to evacuate or shelter, such as people in hospitals or prisons, or nomadic groups;
   d) Particular geographical features such as islands, mountains and rivers;

e) Characteristics of local transport and communications networks;
f) Industrial facilities which may entail potentially hazardous activities;
g) Agricultural activities that are sensitive to possible discharges of radionuclides; and
h) Possible concurrent external events.

9.2 Roads and Infrastructure

1) A site should be chosen with adequate roads, bridges, traffic control equipment and other facilities to support an orderly evacuation of identified populations.
2) Transportation facilities should be readily available to support evacuation of identified persons.
3) A qualitative assessment of the availability and quality of transportation infrastructure should be submitted.

9.3 Evacuation Time Estimates

1) Evacuation time estimate (ETE) calculations using conservative assumptions, qualified modellers and a generally accepted computer model should be submitted, with consideration to adverse weather and unusual situations.

9.4 Coordination with Local Government

1) It should be demonstrated that regional and local authorities have been contacted and that arrangements have been agreed to for the implementation of an emergency plan, if required.
2) An assessment of the capability of local authorities to support emergency response functions should be provided.
3) The submittal should include plans to compensate for any gaps in the ability of local authorities to support an emergency response.

9.5 Reference Accident

1) For a nuclear licence to site, all potential accidents should be identified and considered such as:
   a) Events that could affect the facility or activity, including events of very low probability and events not considered in the design.
   b) Events involving a combination of a nuclear or radiological emergency with a conventional emergency, such as an earthquake, a volcanic eruption, a tropical cyclone, severe weather, a tsunami, an aircraft crash or civil disturbances that may affect wide areas and/or impair capabilities to provide support in the emergency response.

c) Events that could affect several facilities and activities concurrently and the interactions among the facilities and activities affected.

2) Similarly, for a NSL the reference accident must be identified using PSA studies for the scope of facility designs for which the application is made.

3) For the purposes of the siting assessment, the consequences of a reference accident should be determined using enveloping assumptions. The reference accident selected should cover the set of accidents that can reasonably be foreseen in the safety analysis.

4) In calculating the effective dose to a population arising from the reference accident, no allowance should be made for the aversion of individual doses by means of short-term countermeasures such as sheltering, administration of stable iodine and evacuation.

5) The population considered when determining the effective dose should be the projected population for the lifetime of the facility including the temporary population.

6) The assumptions regarding meteorological conditions used in the dispersion calculation model should be demonstrated to be conservative with respect to the target parameter.

9.6 Requirements and Criteria for Population and Emergency Planning Zones

1) The emergency planning zones should include the following:
   a) An exclusion zone (EZ);
   b) An overall emergency planning zone (EPZ); and
   c) A long-term protective action planning zone (LPZ).

2) In determining the emergency planning zones, the following criteria should be used in the definition of the required zones:
   i) EZ – an effective dose (projected) of 100 mSv in the first seven days.
   ii) LPZ – an effective dose (projected) of 100 mSv per annum.
   iii) Overall EPZ – an effective dose (projected) of 1 mSv per annum.

3) The overall EPZ should include a low population zone considering arrangements for urgent protective actions such as iodine prophylaxis, for which an equivalent dose to the thyroid of 50 mSv (projected) should be used in the first seven days.

4) In the case of multiple nuclear facilities on the same site, the accident scenarios of the facilities that pose the highest impact should be used to derive the emergency planning zones. However in the consideration of external events, the integrated impact from all affected installations for a specific accident scenario should be considered. The emergency planning zones for the site may have to be modified should the existing zoning scheme be compromised as a result of the new nuclear installation's source term.

5) In addition to the determination of the boundaries of the three emergency planning zones, radii should be specified for all protective actions and low population zone areas.

6) An exclusion area should be determined where the applicant has the authority to determine all activities within that area, including the removal of personnel and property.

9.7 Developments Around Nuclear Sites

1) In the case of a nuclear licence to site a nuclear facility, the NNR will direct the holder in terms of section 38(1) of the NNR Act to enter into an agreement with the relevant municipalities and provincial authorities to establish an emergency plan within a period determined by the Regulator. In terms of section 38(4) of the NNR Act the NNR will propose regulations for promulgation by the Minister on the development surrounding any nuclear facility to ensure the effective implementation of any applicable emergency plan.
2) In the case of a NSL the validity the proposed emergency planning zones and measures to control development should be reassessed periodically.
3) The applicant as well as municipal and provincial authorities should ensure adequate infrastructure as per their legislated mandates and/or cooperative governance agreements as may be necessary for the effective implementation of the emergency plan.
4) Within the low population zone, arrangements should be in place for other urgent protective actions such as iodine prophylaxis. Contingency arrangements should be in place for the sheltering and evacuation of the public in the low population zone.
5) Within the low population zone, compliance with the evacuation time criteria should be demonstrated by the municipal authority by means of a traffic evacuation model.
6) Any increase in the population in the low population zone should be controlled in terms of the regulations on the control of development for the site issued in accordance with Section 38(4) of the NNR Act.

10 NUCLEAR SECURITY ARRANGEMENTS DURING SITING

10.1 General

1) An authorisation holder must comply with the respective security requirements as specified in the draft Regulations on Nuclear Security in general. The application should demonstrate that the site selected for the construction of a nuclear facility provides the applicant with the ability to construct and install security-related equipment and components and to implement a physical security programme in accordance with the regulatory requirements.

2) The Site Safety Report must describe the security features and arrangements for the site and should include an assessment on the suitability of the site from a nuclear security perspective.

3) Limited security measures, including vetting and security clearance, need to be instituted in the siting and construction stages of the facility to secure storage facilities and to prevent theft and sabotage of critical facility components. However, comprehensive security measures should be in place prior to nuclear materials being moved to the site.

10.2 Site Location

1) The site location should be described with the aid of illustrations, including topographical maps. All threat environments, risks or vulnerabilities presented by the location of the proposed site should be described and applicant should also submit the diagrams to approximate scale, displaying, but not limited to the following for the review:

   a) Layout of all configurations of site structures being considered;

   b) Pedestrian land approaches;

   c) Vehicular land approaches;

   d) Railroad approaches;

   e) Water approaches;

   f) Potential “high-ground” adversary advantage areas;

   g) Nearby road transportation routes;

   h) Nearby pipelines;

   i) Existing and planned culverts;

   j) Location of vital equipment and vital areas;

   k) Nearby hazardous facilities surrounding the site and threats they may present to the site;

   l) Location of the nearest communities;

   m) Location of proposed intake structure;

   n) Location of proposed protected area boundary for power block and safety-related water structures; and

   o) Locations of the proposed owner-controlled area and protected area vehicle checkpoints.

2) The suitability of the selected site should be demonstrated based on the credible threats, adversary pathways and tactics. The following should be assessed as a minimum:

a) The topography of the site with regards to the visibility from outside, hidden access, potential issues with external physical barriers (fence, ingress/egress points) and area protection which can impact the overall security barrier.

b) The potential of extreme meteorological conditions over the site and whether they could have an influence on the continuous provision of effective physical protection.

c) The use of the area directly surrounding the proposed site, as well as the areas of public stay and the entailed risks.

d) The influence of the economic activities in the wider environment of the site (e.g. hazardous facilities, airports, industrial plants) on the physical protection of the facility.

e) Details pertaining to the establishment of a construction site, such as the positioning of perimeter fences, access and egress points, etc.

f) Whether the off-site response forces are able to arrive at the site and respond to the adversary action in time.

3) The distance from the reactor or reactors to the site boundaries within the exclusion area should provide sufficient spatial separations to provide for the design's physical barriers and the designations of security boundaries (e.g. vital areas, protected area, isolation zones and owner controlled area).

4) The proposed site should contain sufficient spatial separations or provide for sufficient distances to allow for design, installation and implementation of engineered and administrative controls (i.e. security measures) for a physical protection system (i.e. detection, assessment, communications and security response for interdiction and neutralisation) to protect against threats.

5) Where spatial separation for a proposed site is limited because of natural topography or existing or planned manmade structures, the specific methods and approaches (e.g. engineered or administrative controls) that may be applied should be described and it should be demonstrated that the security plans and measures can be developed.

6) Highways, railroads and waterways that pass through the exclusion area, the owner controlled area or the protected area should be at sufficient distances from planned location(s) of nuclear facilities, specific site characteristics and plant operations. The routine use of these routes should not interfere or present impediments to the design of a physical protection system and affect normal and contingency security operations.

10.3 Site Evaluation

1) The site evaluation process should provide reasonable assurance that adequate physical protection plans and measures can be developed to meet the applicable requirements.

2) The site evaluation process should address the physical dimensions of the nuclear facilities and its surrounding environment, including:

   a) A description of the physical land characteristics to indicate that adequate distances exist between vital equipment and vital areas and the probable location of a security boundary.

   b) A description of the site characteristics that indicates that adequate space exists for the construction and installation of: physical barriers; isolation zones and associated intrusion detection and assessment equipment; access control portals; owner controlled area; access control points and associated owner controlled area vehicle search areas; alarm stations and the implementation of a physical protection programme.

   c) A description of the site characteristics that may require measures in order to control approaches to the facility (e.g. barge slips within the owner controlled area, main access road from the owner controlled area to the protected area, transportation routes, cliffs, depressions, hills, open waterways and roadways or railroads that penetrate the owner controlled area boundary).

   d) A description of nearby facilities and infrastructure to identify potential hazards in the site vicinity.

   e) A description of planned culverts and unattended openings that extend from outside to inside the proposed protected area, the area for power block structures and the area for safety-related water sources (e.g. cooling towers).

10.4 Security Plan and Measures

1) In order to secure a site and to prevent unauthorised access and malicious acts, the security plan for siting should include facilities and equipment such as:

   a) A physical protection system based on the threat assessment;

   b) Access control;

   c) Information security;

   d) Cyber security; and

   e) Surveillance and monitoring.

2) A communication system, with backup features, should be implemented as part of the security system.

3) Sufficiently detailed information should be provided to demonstrate that site characteristics will support the development of security plans and measures, such as the development of engineered controls (i.e. physical protection systems) and administrative controls (operational requirements) for the design of a physical protection system (i.e. detection, assessment, communications and response for interdiction and neutralisation) meeting the regulatory requirements.

4) If the proposed site is in a remote location and the availability of material, equipment or services needed (to maintain physical protection systems and operations) may be delayed, the submitted information should demonstrate that plans for organisation and management systems are capable of providing the necessary logistics and support to continue security operations. Those plans should accommodate required offsite material, equipment and services. In addition, the information submitted should demonstrate that plans and measures can be developed to overcome the remoteness of the site location for offsite contingency security responses. These must be less than the maximum available response time to meet the requirement to prevent adversaries from completing tasks that could result in theft of material and other equipment or sabotage of established physical protection systems and plant infrastructure.

5) Potential hazardous materials (gases, liquids, solids) in the vicinity and on the site such as chemicals, flammables, explosives or radioactive materials should not present impediments to the design of or plans for engineered and administrative controls for a physical protection system. The information submitted should demonstrate that engineered and administrative controls for physical security can be developed and planned respectively in the event of postulated maximum credible accidents involving hazardous materials in the vicinity and on the site, including on-site transportation of hazardous materials, to maintain at all times the required security postures meeting the regulatory requirements.

6) The submitted information should demonstrate that the designs, specifications and configurations of the physical protection system and plans for operational requirements can be developed so that the required security measures will be available and reliable to perform their intended functions in the event of postulated maximum credible accidents.

7) Nearby facilities (manufacturing plants, chemical plants, refineries, storage facilities, mining and quarrying operations, military bases, missile sites, transportation routes (air, land and water), transportation facilities, oil and gas pipelines, drilling operations, wells and underground gas storage facilities) should be considered for potential impediments to developing security plans and measures. At a minimum, all postulated maximum credible accidents and consequences

involving nearby hazards, facilities or associated activities assessed for safety and environmental protection should be considered for developing security plans and measures.

8) The submitted information should demonstrate that nearby hazards do not present impediments to developing security plans and measures. Similar to on-site hazards, the applicant may demonstrate that spatial separation provides protection of the nuclear facility from potential nearby off-site hazards and associated consequences. Or the applicant may demonstrate that engineered structures or systems can be designed, specified, constructed, or installed.

9) At a minimum, all postulated maximum credible external events and consequences assessed for safety and environmental protection should be considered for developing security plans and measures. It should be evaluated whether such conditions present impediments to the design of engineered and administrative controls for a physical protection system.

10) The submitted information should demonstrate that security plans and measures can be developed considering the effects of postulated maximum credible external events.

11) Physical protection systems that are exposed to anticipated weather and environmental conditions or probable maximum flood conditions should be identified and considered in determining any challenges or impediments to designs.

12) Changes to the topography of the site caused by low water conditions should be considered for determining if resulting conditions would present challenges or impediments to the design of engineered and administrative security controls. Specifically, security measures should be provided to maintain a continuous physical barrier, detection and response to protect against land-based coordinated assaults and vehicle bomb threats under potential low water conditions that result in pathways that are otherwise inaccessible.

10.5 Access Control

1) Access to the site and the nuclear facility should be controlled, at least from the time when early construction activities are authorised. The site should be surrounded by a fence, this includes offices, stores and many other facilities, and should be declared a restricted area.

2) Access gates should control the access of people, vehicles and machines. The entire fence should have adequate intrusion detection systems.

3) A perimeter road should be constructed along the perimeter of the plant for patrolling purposes. The entire facility and the perimeter should be adequately illuminated to enable surveillance and monitoring, and security personnel should carry out frequent patrols.

11 MONITORING OF SITE CONDITIONS

11.1 General

1) The site characteristics relevant to the nuclear facility that are considered in the safety requirements and that are pertinent to licensing and safe operation should be monitored for the period of applicability of the NSL, or until the NL is superseded by the construction licence.
2) Before commissioning of the nuclear facility, the ambient radioactivity of the atmosphere, hydrosphere, lithosphere and biota in the region should be assessed in order to determine the effects of the nuclear facility.
3) A plan for monitoring should be submitted with a NSL or NL to site.
4) The data obtained should be used as a baseline in future investigations.

11.2 Background Radiological Characteristics

1) Details should be provided on the pre-operational monitoring programme implemented to gather information, including which radionuclides are analysed for, sampling locations, sample type, sampling frequency, location and density of monitoring stations, and the detection limits.
2) To determine a background radiological characterisation for the safety case for a construction licence, the following should be included in the plan for monitoring:
   a) Monitoring programmes that include radionuclides monitored, sampling frequency, sampling and analysis methods, sampling location and density;
   b) Air quality stations locations consistent with the prevailing wind directions;
   c) Time periods for preoperational monitoring that allow for 12 consecutive months of sampling; and
   d) Radiological analyses of soil samples taken at 5cm and 15cm depth.
3) Site-specific radiological data should include the results of both natural background radiation levels and the results of measurements of radioactive materials occurring in important species (biota), soil, air, and in surface water, groundwater and seawater that could be affected by the proposed operations.

11.3 Groundwater and Surface Water

1) A monitoring programme should be established for both surface water and groundwater. The purpose of such a programme is to provide a baseline for site evaluation and to determine

whether the hydrological characteristics of the region have altered since the site evaluation and before the commencement of plant operation.

2) A list of the constituents to be sampled for baseline concentrations should be identified (Attachment C). The list of constituents should be tailored to a particular location.

3) The monitoring programme for groundwater should be initiated about two years before the start of plant construction. The site area should be monitored before the foundation work is begun in order to verify possible changes in the groundwater regime, and monitoring should be continued after construction has finished.

4) Groundwater should be monitored by means of samples taken from boreholes and wells. The samples can also be taken from groundwater reaching the surface in springs or in natural depressions. The monitoring programme should be continued throughout the lifetime of the plant. Boreholes and wells should be kept in an operable state for the same period of time.

5) The monitoring programme for surface water should also commence well before the start of construction of the plant, and should continue for its lifetime.

6) All surface water and groundwater in the site region should be sampled regularly at intervals that will depend on the half-lives of the radionuclides that could potentially be discharged.

11.4 Background Non-radiological Characteristics

1) Site-specific non-radiological characteristics, particularly those that are related to expected site-related effluents, should be reported. Data should include indicators such as heavy metals and other potentially toxic substances in surface water and groundwater, atmospheric pollutants, dust, etc., that could affect water or air quality. Other regional sources of these same materials should be noted along with a discussion of the possible incremental contribution to the existing levels found at the site.

2) A water quality assessment should be performed in accordance with acceptable standards. Data analysis and presentations should include:

   a) References to water quality standards, baseline or excursion levels, sampled depths, water level elevation and data measured.

   b) Graphical trending of water quality and water level elevation changes with time with reference to the applicable standards, such as the water quality standards, baseline or excursion levels, or maximum permissible concentrations.

c) A short summary of the data interpretation noting any anomalies and explaining the anomalies.

d) The water quality data reports should include a map that shows where all water quality sampling points are located.

12 REFERENCES

The following references were consulted during the compilation of this document:

[1] Act No. 47 of 1999, National Nuclear Regulator Act.

[2] Regulations in terms of section 36 of the National Nuclear Regulator Act (Act No. 47 of 1999), on Safety Standards and Regulatory Practices (GN R388).

[3] Site Evaluation for Nuclear Installations, IAEA Safety Standard NS-R-3 or as amended from time to time.

[4] Seismic Hazards in Site Evaluation for Nuclear Installations, IAEA Safety Guide No. SSG-9 or as amended from time to time.

[5] Meteorological and Hydrological Hazards in Site Evaluation for Nuclear Installations, IAEA Safety Guide No. SSG-18 or as amended from time to time.

[6] Seismic Hazards in Site Evaluation for Nuclear Installations, IAEA Safety Guide No. SSG-21 or as amended from time to time.

[7] External Human Induced Events in Site Evaluation for Nuclear Power Plants, IAEA Safety Guide No. NS-G-3.1 or as amended from time to time.

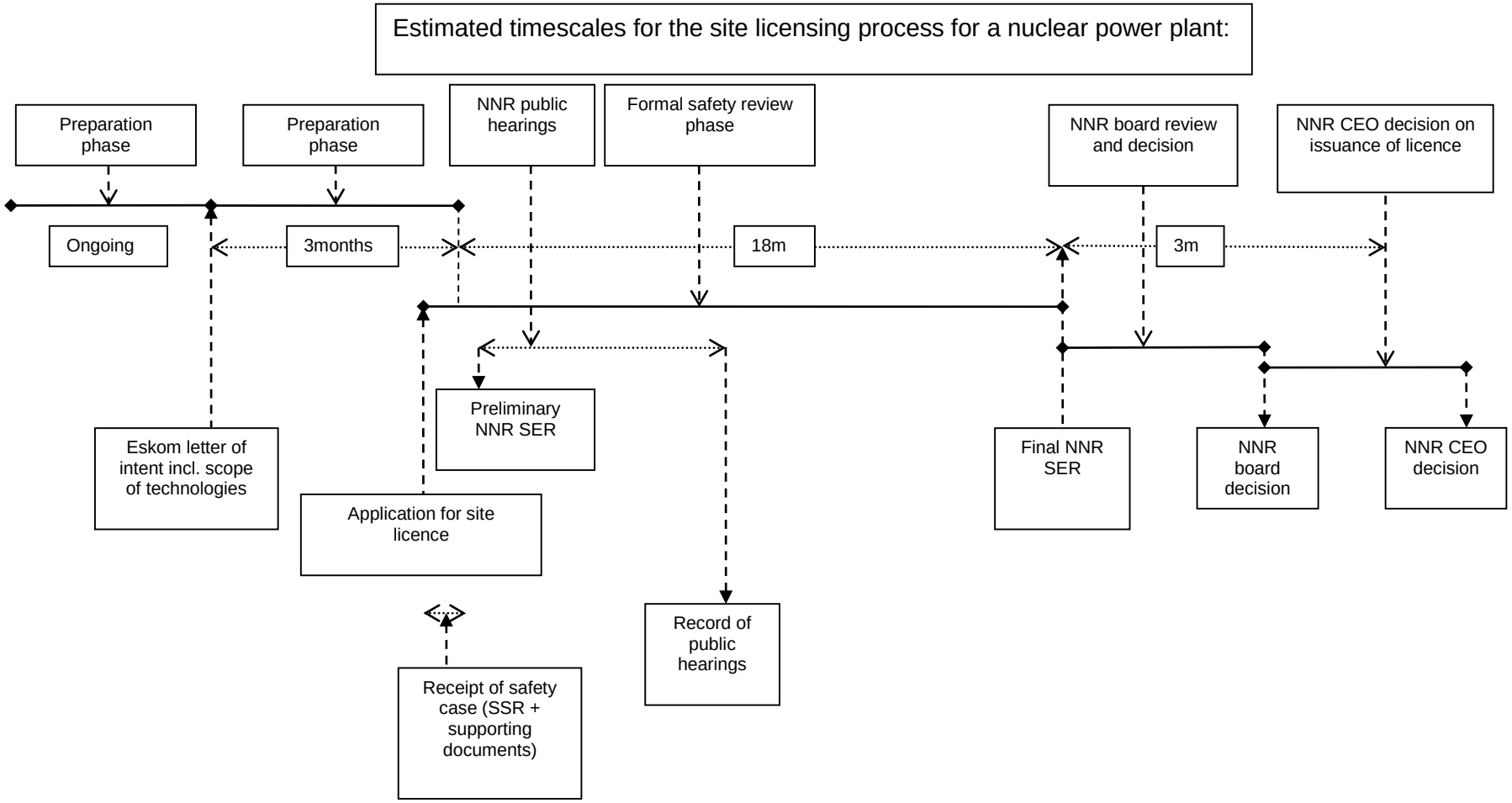
[8] Dispersion of Radioactive Material in Air and Water and Consideration of Population Distribution in Site Evaluation for Nuclear Power Plants, IAEA Safety Guide No. NS-G-3.2 or as amended from time to time.

[9] Geotechnical Aspects of Site Evaluations and Foundations for Nuclear Power Plants, IAEA Safety Guide No. NS-G-3.6 or as amended from time to time.

[10] PP-0014: Consideration of External Events for New Nuclear Installations

[11] RG-0002: Guidelines on the Assessment of Radiation Hazards to Members of the Public from NORM Activities

ATTACHMENT A: TYPICAL LICENSING SCHEDULE



ATTACHMENT B: TYPICAL CONTENT AND STRUCTURE OF A SITE SAFETY REPORT

1. INTRODUCTION

- Background, Objectives, Scope
- Structure of the report (SSR)

2. LEGAL AND REGULATORY BASIS

- Laws and regulations for siting of nuclear facilities
- Safety requirements and criteria related to siting
- General criteria
- Specific criteria
- Consideration of international standards and good practice
- Demonstration of compliance with the safety requirements and criteria

3. OVERVIEW OF PLANNED ACTIVITIES AT THE SITE

- General description of the site
- Motivation for the site
- Overview of range of technologies and facilities on and planned for the site
- Location and use
- Site development
- Site Parameter Envelope
- Experience to date of events important to safety

4. SITE INVESTIGATION APPROACH

- Approach to site investigation
- Site selection criteria
- Demonstration of compliance with site selection criteria
- Monitoring programme
- Identification and management of uncertainty

5. SITE CHARACTERISTICS

- Geography
- Site location and description
- Exclusion area authority and control
- Demography

- Land and water use
- Adjacent sea use
- Nearby transportation
- Industrial and military facilities
- Meteorology
- Oceanography and coastal engineering
- Hydrology and hydraulics
- Geohydrology
- Water supply
- Geology
- Seismology
- Geotechnical engineering
- Ecology

6. EVALUATION OF EXTERNAL EVENTS

- Events of natural origin
  - ✓ Earthquakes and surface faulting
  - ✓ Meteorological events
  - ✓ Flooding
  - ✓ Geotechnical hazards, etc.
- Human-induced events
  - ✓ Aircraft crashes
  - ✓ External Fire
  - ✓ Chemical explosions and Gas release
  - ✓ Loss of power supplies
  - ✓ Loss of cooling water, etc.
- Other important considerations (if applicable)

7. EVALUATION OF POTENTIAL EFFECTS ON THE NUCLEAR FACILITY

- Normal operation
  - ✓ Suitable terrace location
  - ✓ Foundation suitability
  - ✓ Access for materials and large components
  - ✓ Integrity of cooling water supplies
  - ✓ Off-site power lines

- Accident conditions

8. POTENTIAL IMPACT ON THE PUBLIC AND ENVIRONMENT

- General
- Population distribution
- Uses of land and water in the region
- Ambient radioactivity
- Normal operation
- Hazards screening
- Pathways
- Analysis of consequences
- Comparison with safety criteria
- Proposed safety measures to be considered in design, operation and decommissioning
- Uncertainty analysis
- Accident conditions and accident management strategy

9. EMERGENCY PLANNING

- Methodology
- Main pathways for public exposure
- Planning measures corresponding to hazards
- Viability
- Population density and distribution
- Infrastructure
- Emergency zones
- Agreement with national government, provincial and local authorities
- Arrangements for controlling developments

10. PHYSICAL PROTECTION AND SECURITY

11. CONCLUSIONS

ATTACHMENT C: TYPICAL BASELINE WATER QUALITY INDICATORS TO BE DETERMINED DURING PREOPERATIONAL DATA COLLECTION

A. Trace and Minor Elements

Arsenic	Iron	Selenium
Barium	Lead	Silver
Boron	Manganese	Uranium
Cadmium	Mercury	Vanadium
Chromium	Molybdenum	Zinc
Copper	Nickel	
Fluoride	Radium-226	

If initial sampling at the site indicates the presence of Th-232, then Ra-228 should be considered in the baseline sampling or an alternative may be proposed.

B. Common Constituents

Alkalinity	Chloride	Sodium
Bicarbonate	Magnesium	Sulfate
Calcium	Nitrate	
Carbonate	Potassium	

C. Physical Indicators

Specific Conductivity	Total Dissolved Solids	pH

D. Radiological Parameters

Gross Alpha	Gross Beta