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# GUIDELINE FOR SITE SELECTION FOR NUCLEAR POWER PLANT

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# 1. INTRODUCTION

## Background

1.1 An important stage in the development of a nuclear power project is the selection of a suitable site to establish the site-related design inputs for Nuclear Power Plant (NPP). The selection of suitable site is the result of a process in which the costs are minimized. It is also to ensure adequate protection of site personnel, the public and the environment from the impacts of the construction and operation of NPP.

1.2 Generally, a site is considered acceptable from the safety point of view if:

- a) It cannot be affected by phenomena against which protection through the design is impracticable;
- b) The probability of occurrence and the severity of destructive phenomena against which the plant can be protected (at reasonable additional cost) are not too high; and
- c) The site characteristics (population distribution, meteorology, hydrology, etc) are such that the consequences of potential accident would be at acceptable limits.

1.3 Site selection process is not regulated under the Atomic Energy Licensing Act 1984. However, Chapter 2 of this guideline is intended to assist applicant in the site selection stages to identify preferred sites in compliance with applicable regulatory requirements for site evaluation process.

## Purpose

1.4 The purpose of this guideline is:

- a) to assist applicants in the initial stage of selecting potential sites for a NPP. Each site that appears to be compatible with the general criteria discussed in this guideline will have to be examined in greater detail before it can be considered to be a "candidate" site, i.e. one of the groups of sites that are to be considered in selecting a "proposed" or "preferred" site; and
- b) to set forth general site selection consideration for new NPPs related to public health and safety and environmental issues in determining the suitability of sites for NPPs. The decision that a plant may be built on a specific candidate site is based on a detailed evaluation of the proposed site-plant, environmental and radiological impact assessment.

1.5 However, this guide does not cover the following aspects:

- a) detailed guidance on the various relevant factors and format for ranking the relative suitability or desirability of possible sites;
- b) selection criteria for NPPs to be built in underground or offshore sites;
- c) considerations relating to the physical protection of the plant against willful actions by third parties;
- d) details of the engineering designs required ensuring the compatibility of the NPPs and the site or the detailed information required for the preparation of the safety analysis and environmental reports; and
- e) NPPs site suitability as it may be affected by the safeguards requirements for nuclear material.

## **Structure**

1.6 Chapter 2 of this guideline provides site selection criteria for NPPs, including its proposed phases, important aspects to be considered as well as depth of information should be used in the investigations. Lastly, Chapter 4 provides general recommendation in fulfilling quality assurance objectives for site selection for NPPs.

## **2. SITE SELECTION FOR NUCLEAR POWER PLANT**

### **General Consideration for Site Selection**

2.1 Siting of new NPPs should consist of site selection, which involves investigation of a large region to select preferred sites, and followed by detailed evaluation of the preferred site.

2.2 The information needed to evaluate potential sites at this initial stage of site selection is assumed to be limited to information that is obtainable from published reports, public records, public and private agencies, and individuals knowledgeable about the locality of a potential site. Although in some cases the applicants may have conducted on-the-spot investigations, it is assumed here that these investigations would be limited to reconnaissance-type surveys at this stage in the site selection process.

2.3 A significant commitment of time and resources may be required to select a suitable site for a NPP, including safety and environmental considerations. Site selection involves consideration of public health and safety, engineering and design, economics, institutional requirements, environmental impacts, and other factors. The potential impacts of the construction and operation of NPPs on the physical and biological environment and on social, cultural, and economic features (including environmental justice) are usually similar to the potential impacts of any major industrial facility, but NPPs are unique in the degree to which potential impacts of the environment on their safety and this factor shall be considered. The safety requirements are primary determinants of the suitability of a site for NPPs, but considerations of environmental impacts are also important and need to be evaluated.

2.4 In the site selection process, coordination between applicants and various Federal, State and local authorities will be useful in identifying potential problem areas.

## Phases for Site Selection

2.5 The applicant should present an initial survey of site availability using any methodology that surveys the entire region available to the applicant and that, after identifying areas containing possible sites, eliminates those whose less desirable characteristics are recognizable without extensive analysis.

2.6 The purpose of this site selection process is to identify a reasonable number of realistic siting options. To ensure that realistic alternatives are presented, two or more candidate areas should be chosen for detailed comparison with appropriate site-plant combinations. In assessing potential candidate areas, the applicant may place primary reliance on published materials and reconnaissance level information.

2.7 The applicant may wish to use the following definitions in discussing its site selection process:

- a) *Region of Interest*: The geographical area initially considered in the site selection process. This area may represent the applicant's system, the power pool or area within which the applicant's planning studies are based.
- b) *Candidate Areas*: Reasonable homogeneous areas within the region of interest investigated for potential sites. Candidate areas may be made up of a single large area or several unconnected ones. The criteria governing a candidate area are the same resources and populations on which the potential plant would have an impact and similar facility costs.
- c) *Potential Sites*: Sites within the candidate areas that have been identified through preliminary assessment in establishing candidate sites.
- d) *Candidate Sites*: Sites suitable for evaluation by the applicant during the process of selecting a preferred site. To be a candidate site, the site shall be considered to be potentially licensable and capable of being developed.

- e) *Acceptable Sites*: Sites that meet suitability criteria that are considered acceptable by the applicant for a Site License application.
- f) *Preferred Sites*: Sites for which an applicant seeks a Site License for a particular site.

2.8 Figure 1 provides a decision tree for site selection process. This decision tree illustrates the flow of the process, how the various steps incorporate and apply the three types of criteria (exclusionary, avoidance and suitability), and points of opportunity for public participation. For each of the steps, the starting point; the process employed at the step; the type of criteria to be used; the map scale likely to be most useful; the nature of the data sources; and the end product are indicated.

#### *Step 1*

2.9 The Region of Interest (ROI) is first screened using Exclusionary Criteria to eliminate those areas in which it is not feasible to site a nuclear power facility due to regulatory, institutional, facility design, and/or environmental constraints. Further screening is performed using avoidance criteria to eliminate feasible – but less favorable – areas, thus further reducing the area remaining under consideration. Should this process result in an area too small for identification of an adequate number of potential sites, the avoidance criteria can be made flexible and the process is further repeated. Conversely, if the area remaining is too large and additional avoidance criteria can be defensibly applied, the criteria may be made more stringent, and the process repeated. The avoidance screening process is repeated until the candidate areas identified are adequate (but not unreasonably large) to present multiple options or until no more restrictive avoidance criteria can be justifiably applied.

#### *Step 2*

2.10 Candidate areas identified in Step 1 are further screened using refined exclusionary and avoidance criteria to identify optimum areas for a facility. As in Step 1, screening is conducted as an iterative process with the application of refined



criteria until an appropriate number of potential sites can be identified. A key difference in the application of exclusionary and avoidance criteria in Step 2 is the introduction of data that is at a more refined scale; therefore, information at this scale may not have been considered in Step 1. A variety of protected lands, population features, ecologically protected resources (e.g. wetlands), and resources set aside for cultural or historical reasons are at such a scale that (because of their limited areal extent) they would not be considered as part of Step 1. These could, for example, include resources that are identified at the state, district, or local institutional levels. However, avoiding these “smaller” sized exclusionary and avoidance features is equally as valid as avoiding the larger features considered in Step 1. Accordingly, the consideration of these more detailed features in Step 2 will be essential to the process of reducing candidate areas to potential sites.

2.11 From the application of these exclusionary and avoidance features, potential sites are identified as discrete parcels of land approximating the size of an actual facility site (e.g. 2-5 times the minimum land area required). While areal screening is used to identify areas within which potential sites can be identified, professional judgment should be incorporated in defining potential sites to ensure that they are feasible, optimized to the degree possible, and allow some flexibility in the site layout process. Steps 1 and 2 of the siting process are based on the philosophy of driving away from those features and conditions that would not be consistent with requirements of obtaining a Site License. The emphasis is on ensuring that those areal features that should not and cannot be associated with a site are no longer being considered; the focus is on eliminating large tracts of land because they do not exhibit conditions consistent with a potential site. The remaining land areas are presumed acceptable in terms of continued consideration, because these parcels do not contain the “undesirable” features. Once potential sites are identified (at the completion of Step 2), a transition in the selection approach takes place. The emphasis becomes one of evaluating, as integrated entities, the acceptability of discrete parcels of land that could be suitable sites. The process then becomes one of comparing sites and identifying a site that possesses the most favorable set of conditions for siting a NPP.

### *Step 3*

2.12 The objective of Step 3 is to identify and rank a relatively small number of candidate sites (from the list of potential sites) for a more detailed study. This is principally performed using a series of suitability criteria based on published data and reconnaissance-level information. Application of these criteria is accompanied by the introduction of quantified judgments (or weights) regarding the relative importance of these suitability criteria to the siting process. Incorporation of these judgments enables the applicant to incorporate preferences into the process. In addition, sensitivity analysis (to the process of applying criterion weights) is performed to help decision-makers understand the impact of these preferences on the siting process, provide the basis for making critical comparisons among sites, and enhance the confidence in the Step 3 results.

2.13 As a quality check, reconnaissance-level information can be examined at this step for a variety of reasons, including to ensure that no exclusionary or avoidance criteria appear which were not identified during application of the previous steps. This quality check is part of considering the parcel as an integrated unit that shall, in the final analysis, demonstrate compliance with all applicable laws and regulations.

2.14 The more detailed data used during Step 3 allows the applicant to identify a suite of sites (the highest ranked sites) that, based on the data, are acceptable candidates for a Site License application.

### *Step 4*

2.15 The purpose of Step 4 is to select a preferred site from candidate sites identified in Step 3. To accomplish this objective, this step may involve conducting additional screening of the candidate sites and/or confirming the results of Step 3, at a higher confidence level, using more detailed site-specific data developed from on-site verification surveys (Step 4). The actual logistics of Step 4 should be designed based on the applicant's needs and the number of sites remaining after Step 3. Detailed on-site studies designed to provide verification of critical site suitability

characteristics (which have been based up to this point on published data and reconnaissance information) should be conducted first. These studies should provide additional differentiation among the candidate sites, and in doing so, will provide the basis for an issue-by-issue analysis that will allow the applicant to identify the cost and environmental tradeoffs associated with developing each of the acceptable sites during Step 4.

2.16 In contrast to the composite suitability analysis conducted in earlier steps which "roll up" all site suitability considerations into a single composite value, this analysis allows the decision-maker to consider actual trade-offs in environmental impacts and site-specific issues (e.g. hectares of wetlands and kilometers of transmission line). This provides the decision-maker with a clear basis for differentiating among candidates, and thereby selecting, a preferred site.

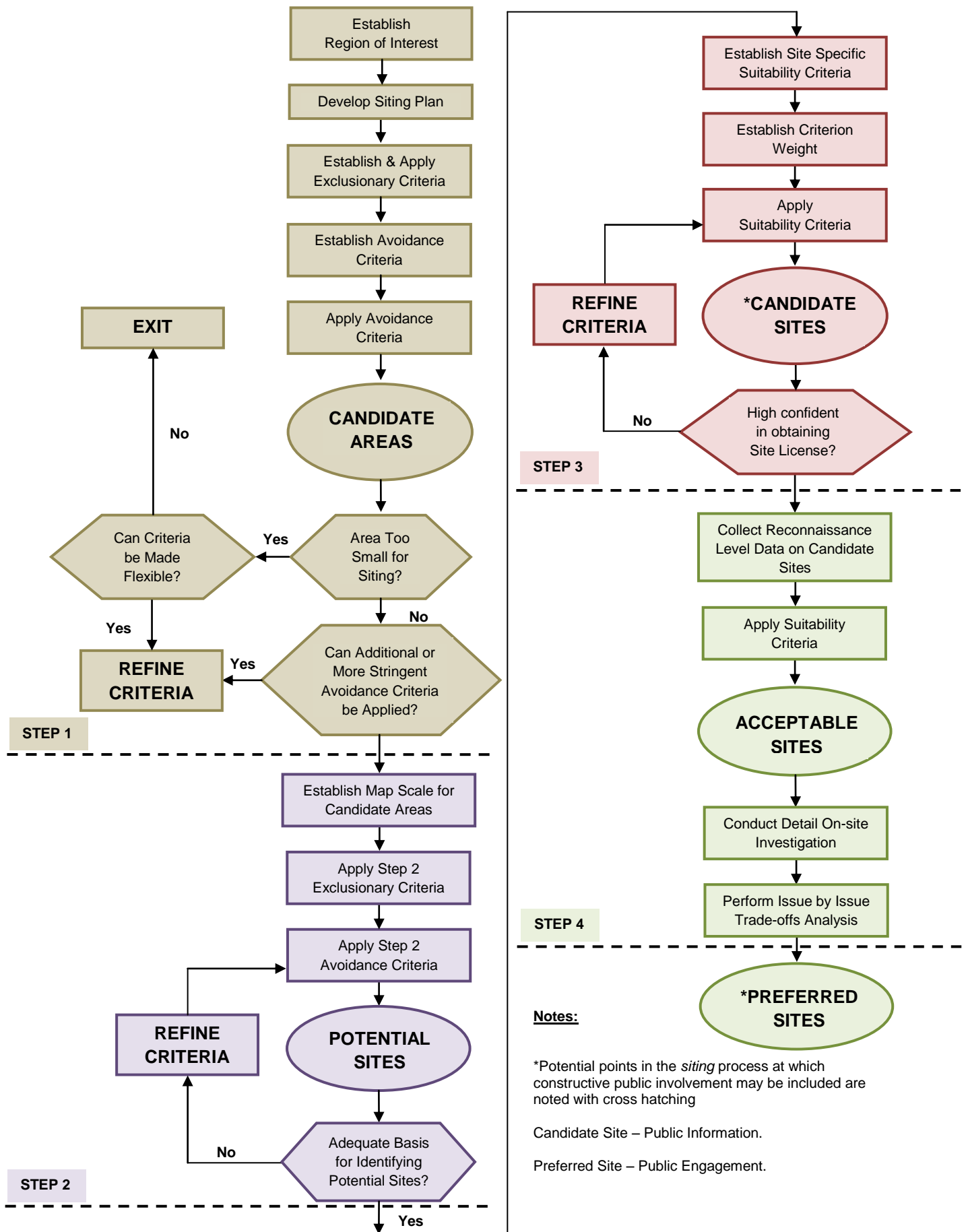


Figure 1: Site Selection Decision Tree Process

**Notes:**

\*Potential points in the *siting* process at which constructive public involvement may be included are noted with cross hatching

Candidate Site – Public Information.

Preferred Site – Public Engagement.

## **Exclusionary, Avoidance and Suitability Criteria**

2.17 For the purpose of site selection, this guide introduces the use of three main types of criteria, as follows:

- a) Exclusionary criteria;
- b) Avoidance criteria; and
- c) Suitability criteria.

2.18 These three criteria types are defined based on the severity of constraints imposed by underlying regulatory requirements. The applicant may, either use these criteria or propose similar approach to initiate its site selection process.

2.19 Exclusionary Criteria represent requirements that, if not satisfied by site conditions, would preclude Site License. Examples include site-plant design values that do not fall within applicable plant design, Environment Sensitive Area (ESA) and high population densities. Exclusionary criteria are used to eliminate certain areas based on consideration of go or no-go situations.

2.20 Avoidance criteria have the same site screening effect as Exclusionary Criteria but are more flexible in their application. They are utilized to identify broad areas with more favorable than unfavorable conditions, for example distance from population centers. Because the distinction between favorable and unfavorable areas is not well defined, applications of Avoidance Criteria will ensure that the site selection approach is effective. For example, one of the goals of an effective site selection approach is to strike a balance between having a sufficient number and diversity of potential sites for further study in Step 3; and having a large number of potential sites to practically consider in Step 3. This balance is achieved in Steps 1 and 2 through application of Avoidance Criteria. Should the use of a suite of Avoidance Criteria combined with Exclusion Criteria in Steps 1 and 2 result in too few or too many potential sites for use in Step 3, the application of the Avoidance Criteria can be refined accordingly.

2.21 Suitability Criteria represent requirements that affect the relative environmental suitability or cost of developing the site, but do not represent unacceptable environmental stress, severe licensing problems, or excessive additional cost. Examples of suitability criteria are local topographic features, access considerations, important species habitat, impingement/entrainment effects, and optimizing location of the site with respect to the load center.

### **Regulatory Considerations for Site Selection Process**

2.22 The safety issues discussed in this section includes geologic/seismic, hydrologic, and meteorological characteristics of proposed sites; determination of exclusion area and low population zone; population considerations as they relate to protecting the general public from the potential hazards of serious accidents; potential effects on a plant from accidents associated with nearby industrial, transportation, and military facilities; emergency planning; and security plans. The environmental issues discussed concern potential impacts from the construction and operation of NPP on ecological systems, water and land use, the atmosphere, aesthetics, and socio-economics.

2.23 The summary of site selection criteria discuss in this section is summarized in Appendix A.

### *Geology and Seismology*

2.24 NPPs shall be designed to prevent the loss of safety-related functions. Generally, the most restrictive safety-related site characteristics considered in determining the suitability of a site are:

- a) geologic-related hazard;
- b) capable tectonic structures;
- c) surface faulting and deformation;
- d) potential ground motion; and

- e) foundation conditions (including liquefaction, subsidence and landslide potential).

2.25 Preferred sites are those with a minimal likelihood of surface or near-surface deformation and a minimal likelihood of earthquakes on faults in the site vicinity (within a radius of 8km<sup>1</sup>). Because of the uncertainties and difficulties in mitigating the effects of permanent ground displacement phenomena such as surface faulting or folding, fault creep, subsidence or collapse, it is prudent to select an alternative site when the potential for the permanent ground displacement exists at or in the vicinity of the site.

2.26 Sites located near geologic structures, for which at the time of application, the data base is inadequate to determine their potential for causing surface deformation, are likely to be subjected to a longer licensing process in view of the need for extensive and detailed geologic and seismic investigations of the site and surrounding region and for the rigorous analyses of the site-plant combination.

2.27 Sites with competent bedrock generally have suitable foundation conditions. In regions with few or no such sites, it is prudent to select sites with competent and stable rocks or solid soils, such as dense sands and glacial tills. Other materials may also provide satisfactory foundation conditions, but a detailed geologic and geotechnical investigation would be required to determine static and dynamic engineering properties of the material underlying the site.

2.28 *Geologic-related Hazard:* The following geologic and related man-made conditions should be avoided in determining the suitability of the site:

- a) Areas of active (and dormant) volcanic activity;
- b) Subsidence areas caused by withdrawal of sub-surface fluids, such as oil or groundwater, including areas which may be effected by future withdrawals;

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<sup>1</sup> USNRC Regulatory Guide 4.7.

- c) Potential unstable slope areas, including areas demonstrating paleo-landslide characteristics;
- d) Areas of potential collapse (e.g. karstic areas in limestone, salt or other soluble formations);
- e) Mined areas, such as near-surface coal mined-out areas, as well as areas where resources are present and may be exploited in the future; and
- f) Areas subject to seismic and other induced water waves and floods.

2.29 The boundary of avoided areas noted above should be further identified based on more detail information available. Applicant should determine the distance from such adverse features based on regional conditions. Sites furthest away from these features should be selected. Site selected at this step will be re-evaluated based on site specific information.

2.30 *Capable Tectonic Structure:* At the early steps of site selection, applicant should identify areas based upon consideration of the size (length) of faults (which may be capable, and hence capable tectonic structures) and their distance to a site for various distances out to 320km from a site. Faults of less than 300m<sup>2</sup> in length within the 8km distance from a site were considered non-significant and would not require detailed investigations to determine if they were capable. Step 2 requires applicant to further investigate using approach in Step 1, but with greater detail of information. If faults or other potentially capable structures were identified in Steps 1 and/or 2, preliminary ranking of candidate sites would be based upon the available data (other criteria in this section for surface faulting and deformation, geologic hazards, and soil and rock properties should also be evaluated during this step). Particular concern should be given to the orientation of any nearby faults or other structures, and the propagation characteristics of relevant earthquakes. On-site specific study will be carried out to select Preferred Site based on site specific information.

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<sup>2</sup> USNRC 10CFR PART100, Appendix A.



2.31 *Surface Faulting and Deformation:* Applicant should identify all tectonic and non-tectonic structures and faults with a potential for surface deformation or displacement at a regional scale (in general, a 320km radius around the area of interest) based on available geologic reports. Unfavorable areas which do not meet the criteria will be avoided. Further step requires the identification of the occurrence of surface faulting and tectonic and non-tectonic structures in and within 40km of the areas identified in Step 1 & Step 2, which comply with the following criteria:

- a) Any such structures altogether (most favorable);
- b) Potential non-capable structures; and
- c) Potential capable structures (less favorable).

2.32 Further step requires the identification of the occurrence of surface faulting and tectonic and non-tectonic structures in and within 8km of the areas identified in Step 3, which comply with the following criteria:

- a) Any such structures altogether (most favorable);
- b) Potential non-capable structures;
- c) Potential capable structures;
- d) Faults exceeding 300 meters in length; and
- e) Capable faults exceeding 300 meters in length (least favorable).

2.33 *Potential Ground Motion:* At Step 1, applicant should identify and exclude all areas in regional scale which shows peak ground accelerations (PGA) exceeding  $0.10g^3$  at a probability of exceedance of 2% in 50 years. Further step requires applicant to consider the site identified in Step 1 along with rock or soil stability factor. While site specific investigations will be required to define the ultimate static and dynamic engineering properties of a particular site's soils, there are certain soil properties that, in association with vibratory ground motion, have unfavorable characteristics, such as high water table, grain size distribution, and low density. Sites with the highest values of PGA in combination with deleterious site soils would

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<sup>3</sup> Based on IAEA recommendation in NS-G-3.3, Para 5.5

be less favorable than those sites with lowest values of PGA and no known deleterious site soil conditions. Further investigation on seismic hazard should be conducted in selecting preferred sites based on detailed and site-specific information relating to geologic and geo-technical site verification. Any of the sites not meeting the applicable national standard should be eliminated from further consideration.

2.34 *Foundation Conditions*: This criterion may not apply at early steps in site selection. However, in conjunction to the determination of surface deformation in later step, applicant should identify and avoid all areas containing poor foundation conditions. Further step requires applicant to further identify potential site in relation to the range and combination of unsuitable soil properties and the nature of the foundation properties. Most suitable rocks or soils among the potential sites would be much favorable compared to the least suitable rocks or soils. An investigation of liquefaction potential for soils, subsidence and landslide should also be incorporated at this step; any area with the above potential deformations at the potential site should be excluded from further consideration.

#### *Atmospheric Extremes and Dispersion*

2.35 The potential effect of natural atmospheric extremes on the safety-related structures of a NPP shall be considered. However, the atmospheric dispersion that may occur at a site is not normally critical in determining the suitability of a site because safety-related structures, systems and components can be designed to withstand most atmospheric extreme condition.

2.36 The atmospheric characteristics at a site are an important consideration in evaluating the dispersion of radioactive effluents from both postulated accidents and routine releases in gaseous emission to meet regulatory requirements<sup>4</sup> for the dispersion of airborne radioactive material. This is unlikely to be an important consideration for NPP siting unless:

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<sup>4</sup> AELB and the Department of Environment (DOE) requirements are not met.

- a) a site is in an area where existing air quality is near or exceeds ambient standards;<sup>5</sup>
- b) there is a potential for interaction of the cooling system plume with a plume containing noxious or toxic substances from a nearby facility; or
- c) the auxiliary generators are expected to operate routinely.

2.37 In the evaluation of potential sites, on-site meteorological monitoring can determine if the atmospheric conditions at a site are adequately represented by the available atmospheric data for the area. Topographical features, such as hills, mountain ranges, valley and lake or ocean shorelines, can affect the local atmospheric conditions at a site and may cause the dispersion characteristics at the site to be less favorable than those in the general area or region.

2.38 If the case of dispersion of radioactive material released caused by a design basis accident is insufficient at the boundary of the exclusion area or at the outer boundary of the low population zone, the design of the NPP would be required to include appropriate and adequate as well as compensating safety-engineered features.

2.39 A cooling system designed with special consideration for reducing drift may be required because of the sensitivity of the natural vegetation or the crops in the vicinity of the site to damage from airborne salt particles. The vulnerability of existing industries or other facilities in the vicinity of the site to corrosion by drift from cooling tower or spray system drift should be considered. Not only are the amount, direction and distance of the drift from the cooling system important, but the salt concentration above the natural background salt deposition at the site is also important in assessing drift effects. None of these considerations are critical in evaluating the suitability of a site, but they could result in special cooling system design requirements or in the need for a larger site to confine the effects of drift within the site boundary. The environmental effects of salt drift are most severe where saline water or water with high mineral content is used for condenser cooling.

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<sup>5</sup> Standard for air quality are stipulated as in Malaysia Ambient Air Quality Standard & Guideline.

2.40 At Step 1 and 2, the applicant may, to the degree allowed by available meteorological data, identify any areas of the ROI where short-term atmospheric diffusion factors do not satisfy the standard NPP design value. This may be mapped as exclusionary and the Candidate Sites may be eliminated from further consideration in the site selection process. At later steps, the applicant should estimate the short-term atmospheric diffusion factors corresponding to the standard NPP design value for each of the Candidate Sites. In addition to the analysis discussed, this evaluation should also take into account site-specific characteristics (e.g. topography and coastal effects) that could affect dispersion of accidental releases. In the absence of on-site meteorological data, professional judgment will be required to adopt regional data to account for these local effects. Any sites whose estimated dispersion characteristics do not satisfy the NPP standard design value would be eliminated from further consideration.

#### *Exclusion Area and Low Population Zone*

2.41 An applicant should designate an exclusion area and have the authority to determine all activities within that area, including removal of personnel and property. In selecting a site for a NPP, it is necessary to provide for an exclusion area in which the applicant has such authority. Transportation corridors such as highways, railroads and waterways are permitted to traverse the exclusion area, provided:

- a) these are not so close to the facility as to interfere with normal operation of the facility; and
- b) appropriate and effective arrangements are made to control traffic on the highway, railroad or waterway in case of emergency to protect public health and safety.

2.42 An Exclusion Area of such size that an individual located at any point on this boundary for two hours immediately following onset of the postulated fission product release shall not receive a total radiation dose to the whole body in excess of 25 rem or total radiation dose in excess of 300 rem to the thyroid from iodine exposure.

2.43 In addition to the establishment of exclusion area, an applicant should designate an area immediately beyond the exclusion area, known as a low population zone (LPZ). The size of the LPZ should be such that the distance to the boundary of the nearest densely populated center containing more than about 25,000 residents shall be at least one and one-third times the distance from the NPP to the outer boundary of the LPZ. The boundary of the population center should be determined upon consideration of population distribution, not political boundaries. The size of the LPZ depends on atmospheric dispersion characteristics and population characteristics of the site as well as aspect of proposed NPP design.

2.44 The LPZ of such size that an individual located at any point on its outer boundary who is exposed to the radioactive cloud resulting from the postulated fission product release (during the entire period of its passage) shall not receive a total radiation dose to the whole body in excess of 25 rem or total radiation dose in excess of 300 rem to the thyroid from iodine exposure.

2.45 At Step 1 and Step 2, applicant may use established census data on population distribution and density within ROI to select Potential Site among identified Candidate Area. As further steps, the applicant should determine and refine the analysis of the total population density within 32km of each Candidate Area as identified in Step 2 with more detailed site location mapping.

#### *Population Consideration*

2.46 NPP sites should be located away from very densely populated centers. Areas of low population density are generally preferred. However, in determining the acceptability of a particular site located away from a very densely populated center but not in an area of low density, consideration will be given to safety and environmental factors, which may result in the site being found acceptable.

2.47 The transient population should be included in the population figures for those sites where a significant number of people (other than those just passing through the area) work, reside part time or engage in recreational activities and are not

permanent residents of the area. The transient population should be weighted according to the fraction of time the transients are in the area. If the population density of the proposed site exceeds, but is not well in excess of the above, and with 200 people per square kilometer, the applicant should consider alternative sites having a lower population density. However, consideration will be given to other factors, such as safety and environment, which may result in the site with the higher population density being found acceptable.

### *Emergency Planning*

2.48 Physical characteristics unique to the proposed site that could pose significant impediment to the development of emergency plans should be identified.

2.49 In particular, adequate plans shall be established for appropriate emergency zone. The plume exposure pathway for emergency planning of NPP generally consists of an area of about 16km in radius, and the ingestion pathway covers an area about 80km in radius. The exact size and configuration of the emergency planning zone should be determined in relation to local emergency response needs and capabilities as they are affected by such conditions as demography, topography, land characteristics, access routes and jurisdictional boundaries.

2.50 An assessment and evaluation of the site and its vicinity, including the population distribution and transportation routes, should be conducted to determine whether there are any characteristics that would pose a significant impediment to taking protective actions to protect the public in the event of emergency.

2.51 Special consideration should be given to population groups such as those in hospitals, prisons or other facilities that could require special needs during an emergency.

2.52 Initial stage of site selection does not require the application of this criterion. However, in selecting Candidate Site, an applicant should conduct an analysis

considering the "significant impediments" to the effectiveness of emergency plan that are present. Site characteristics to be considered in this analysis include:

- a) Traffic capacity;
- b) Number of egress alternatives;
- c) Network type (e.g. freeway or expressway, urban streets or rural roads);
- d) On ramp capacities for freeways;
- e) Number of traffic control points per network segment;
- f) Terrain characteristics (curves, steep slopes); and
- g) Climatic conditions.

2.53 This analysis could also incorporate an investigation of external events, such as earthquakes or floods that might affect both the NPP and the evacuation routes and evacuation network.

#### *Security Plan*

2.54 Site characteristics should be such that adequate security plans and measures can be established and implemented.

#### *Hydrology*

2.55 In this section, three main requirements will be described, and these are flooding, water availability and water quality.

##### *(A) Flooding*

2.56 The effects of a probable maximum flood, seiche, surge or seismically induced flood, such as might be caused by dam failures or tsunamis on plant safety functions, can generally be controlled by engineering design or protection of the safety-related structures, systems and components. For some river valleys and flood-prone areas along coastlines, there may not be sufficient information to make

the investigations needed to satisfy the criteria for seismically induced flooding. In such cases, study of the potential for dam failure, river blockage or diversion in the river system or distantly and locally generated sea waves may be needed to determine the suitability of a site.

2.57 At the early step to determine Candidate Area, the applicant may use a large-scale topographic map and appropriate Exclusion Criteria to exclude major flood-prone area. The next step may require the applicant to refine the analysis to avoid areas within the 100-year and 500-year flood-prone level. In selecting Candidate Site, applicant should review historical data related to the degree of exceedance of the 100-year flood level elevations on an areal percentage basis. Usually, sites that minimally exceed flood-level elevations would be favorable than those that have the highest degree of exceedance of flood level elevations. Consideration should also be given to the site which is located in coastal areas, and near estuaries and rivers and the impact of sea level rise due to climate change. At the end of the selection steps, the applicant should compare data established from the analysis mentioned and compare with on-site specific data.

2.58 Specific manual published by Malaysian Drainage & Irrigation Department may be referred in conducting analysis relating to flood and coastal management.

(B) *Water Availability*

2.59 NPP requires reliable sources of water for steam condensation, service water, emergency core cooling system and other functions. Where water is in short supply, the recirculation of the hot cooling water through cooling towers, artificial pond, or impoundments has been practised.

2.60 Applicant should ensure adequate and highly dependable system of water supply sources shall be shown to be available under postulated occurrences of natural and site-related accidental phenomena or combinations of such phenomena. The adequacy of water supply should also be considered for the entire lifetime of NPPs.



2.61 To evaluate the suitability of sites, there should be reasonable assurance that permits for consumptive use of water in the quantities needed for NPPs of the stated approximate capacity and type of cooling system can be obtained by the applicant from the appropriate state or local authority.

2.62 The availability of essential water during periods of low flow or low water level is an important initial consideration for identifying potential sites on rivers, small shallow lakes or along coastlines. Both the frequency and duration of low flow or low-level periods should be determined from the historical record and, if the cooling water is to be drawn from impoundments, they should be determined from projected operating practices.

2.63 In determining the adequacy of water supply, the following characteristic of water supply should be taken into account, in relation to proposed NPPs design:

- a) Water supply flow rate (Make-up Flow Rate for Close Cycle System and Cooling Water Flow Rate for Once-through System);
- b) Maximum consumption of water supply; and
- c) Monthly average consumption of water supply.

2.64 At the initial steps of site selection, the investigation for the adequacy of water supply involves the comparison of water supply characteristics associated with low-flow conditions with the design basis facility water consumption rate in the operating condition of NPPs. Appropriate Exclusion Criteria and/or Avoidance Criteria should be applied to the unique physical of the ROI and using proposed NPPs standard design value. By using available data, rivers or streams that indicate a minimum flow of record of less than the total of the facility consumption rate and the future non-facility consumption rate would be mapped as avoidance areas. Areas along segments of streams or rivers which meet the criteria and which are located beyond realistic pumping distances will also be avoided. It is assumed that an adequate water supply can be provided at estuarine and ocean sites with similar pumping distance constraints. For lakes, the supply capacity would be evaluated considering

the capacity and water level of the lake, as well as historic low levels and refill (inflow) rates, together with the potential for conflict with lake usage, such as recreation.

2.65 If this investigation results in inadequate availability of areas for further analysis, groundwater supply sources can be included in the evaluation as independent sources or as supplemental sources to the surface water supply. The same conservative approach to future projections of non-facility consumptive use would be applied for groundwater use. Assuming the existence of reasonably sized well fields based on cost considerations, the groundwater supply component can be estimated based on the aquifer yield characteristics. As with the surface water supply, the areas that do not meet the total of the facility consumption rate and projected future non-facility consumptive uses would be mapped as avoidance areas. Groundwater source areas that meet the supply requirements will be bounded by the aquifer areal distribution plus reasonable pumping distances from the margin of the aquifer. In cases where both surface and groundwater sources are considered, the source and pumping constraints would be overlain and combined.

2.66 For selection of Candidate Site, the potential sites identified in Step 2 should be investigated with regard to the degree with which the supply at low-flow conditions, based on 7-day, 10-year low-flows and historical drought stages or water level elevations, exceeds the design basis consumption rate and the projected future use requirements. The potential effects of cooling water withdrawals on water quality will be evaluated on the basis of the likelihood of conflicts, based on minimum flow availability, in areas with existing or expected wastewater discharges or other potentially significant water quality constraints. Generally, sites with the highest degree of excess supply and/or the least potential for water quality effects would be much favorable than sites with the lowest degree of excess supply and/or the greatest potential for water quality effects.

(C) *Water Quality*

2.67 Applicant should conduct investigation of the dispersion and dilution capabilities and potential contamination pathways of the groundwater environment under operating and accident conditions with respect to present and future uses of water sources. Potential radiological and non-radiological of existing contaminants in groundwater should also be considered. The suitability of sites for a specific plant design in areas with a complex hydrogeology or of sites located over aquifers that are or may be used by large populations for domestic or industrial water supplies or for irrigation water can only be determined after reliable assessments have been made of the potential impacts of the NPPs on the groundwater quality.

2.68 This criterion may not applicable in initial step in NPPs site selection. As for selection of Candidate Site, the following factor should be taken into account in investigation of impact to water quality:

- a) baseline thermal loadings (from upstream facilities);
- b) baseline ambient water temperature;
- c) baseline chemical and physical properties;
- d) stream flow rate and width;
- e) the sensitivity of the species present;
- f) baseline concentrations of dissolved oxygen, dissolved solids, and nutrients;
- g) beneficial uses downstream;
- h) the worst case of accidental or normal operational releases; and
- i) baseline concentration of radioactive materials.

2.69 Based on investigation mentioned, a site with minimal impact to water quality will be most favorable than a site which gives maximum impact to water quality. The result of this investigation would be further refined based on site-specific data to select most preferable sites.

### *Industrial, Military and Transportation Facility*

2.70 Potential hazards associated with nearby transportation routes, industrial and military facilities should be investigated and site characteristics established such that potential hazards from such routes and facilities should pose no undue risk to the type of facility proposed to be located at the site. In addition, applicant should also address mitigation of such hazards via modification of activities at these facilities, evaluation of accident frequencies and impacts, and incorporation of design features to mitigate impacts on the NPPs from accidents at nearby hazardous facilities.

2.71 In determining the suitability of a site, the applicant should consider the existing and projected facility on the ROI. For initial step on site selection, applicant should identify and avoid those areas within 16km of major airports and/or within 8km of hazardous facilities, including the following:

- a) Military bases, ammunitions storage areas and ordinance test ranges, missile bases, firing or bombing ranges;
- b) Oil pipelines;
- c) Oil or gas wells;
- d) Oil and gas storage areas;
- e) Significant manufacturing facilities;
- f) Chemical facilities;
- g) Refineries;
- h) Mining and quarrying operations;
- i) Dams;
- j) Land and water transportation routes for hazardous materials; and
- k) Docks and anchorages for hazardous materials.

2.72 For a site with hazardous facilities within the specified distances as in Para 2.69, the applicant should demonstrate the suitability of a site by conducting an evaluation of the degree of risk imposed by each potential hazard. The acceptability of a site depends on the following:

- a) An accident at a nearby industrial, military or transportation facility would not result in radiological consequences that exceed the dose specified in Atomic Energy Licensing (Basic Safety Radiation Protection) Regulations 2010; or
- b) The accident poses no undue risk because it is sufficiently unlikely to occur (probability less than about  $10^{-7}$  per year); or
- c) The NPPs can be designed so its safety will not be affected by the accident.

### *Ecological System and Biota*

2.73 The ecological systems and biota at potential sites and their environs should be sufficiently well known to allow reasonably certain predictions that there would be no unacceptable or unnecessary deleterious impacts on populations of important species or on ecological systems with which they are associated from the construction or operation of a NPP at the site.

2.74 When early site investigation indicate that critical or exceptionally complex ecological systems will have to be studied in detail to determine the appropriate plant designs, proposals to use such sites should be deferred unless sites with less complex characteristics are not available.

2.75 Applicant should be determined whether there are any important ecological systems at a site or in its environs. If so, determination should be made as to whether the ecological systems are especially vulnerable to change or if they contain important species habitats, such as breeding areas (e.g. nesting and spawning areas), nursery, feeding, resting or other areas of seasonally high concentrations of individuals of important species.

2.76 Special consideration should be given to the uniqueness of a habitat or ecological system within the region under consideration, the amount of the habitat or ecological system destroyed or disrupted relative to the total amount in the region

and the vulnerability of the reproductive capacity of important species populations to the effects of construction and operation of NPPs.

2.77 If sites identified are adjacent to, or may impact on important ecological systems or habitats that are unique, limited in extent or necessary to the productivity of populations of important species (e.g. wetlands and estuaries), in particular *Environment Sensitive Area* (ESA)<sup>6</sup> in National Physical Plan, they should be avoided from Candidate Areas.

2.78 Migrations of important species and migration routes that pass through the site or its environs should be identified. Generally, the most critical migratory routes relative to NPP siting are those of aquatic species in water bodies associated with the cooling systems. Site conditions that should be identified and evaluated in assessing potential impacts on important aquatic migratory species include:

- a) narrow zones of passage;
- b) migration periods that are coincident with maximum ambient temperatures;
- c) the potential for major modification of currents by station structures;
- d) the potential for increased turbidity during construction; and
- e) the potential for entrapment, entrainment or impingement by or in the cooling water system or for blocking of migration by facility structures or effluents.

2.79 The potential for blockage of movements of important terrestrial animal populations caused by the use of the site for a NPP and the availability of alternative routes that would provide for maintenance of the species' breeding population should be assessed.

2.80 At Step 1, applicant should identify and exclude all areas known as *Environment Sensitive Area*, which gazette for critical habitats and endangered species. As the process continues, applicant should refine the result at Step 1 to

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<sup>6</sup> Define ESA Rank 1, 2, 3.

avoid any area with the likely presence of threatened or endangered species. Special attention should also be given to areas with the presence of important species habitats, such as marine grasses and commercial shellfish beds, as well as spawning, nursing and feeding areas. Based on an investigation of the relative proportion of comparable habitat at the site to the surrounding region, and considering the importance of reproductive capacity, a potential site where no potential impact is expected will be much favorable than those sites where a potential severe impact is expected. In selecting most preferred sites, those candidate sites identified will be re-evaluated and updated with on-site specific information.

#### *Land Use and Aesthetics*

2.81 Many impacts on land use at the site and in the site neighborhood arising from construction and operation of the plant, transmission lines and transportation corridors can be mitigated by appropriate designs and practices. Aesthetic impacts can be reduced by selecting sites where existing topography and forests can be utilized for screening plant structures from nearby scenic, historical or recreational resources. Restoration of natural vegetation, creative landscaping and the integration of structures with the environment can mitigate adverse visual impacts.

2.82 Land use plans adopted by Federal, State and Local Authorities should be examined, and any conflict between these plans and use of a potential site should be resolved by consultation with the relevant authorities.

2.83 Sites adjacent to lands devoted to public use may be considered unsuitable. In particular, the use of some sites or transmission lines or transportation corridors close to special areas administered by Federal, State or local authorities for scenic or recreational use may cause unacceptable impacts regardless of design parameters. Such cases are most apt to arise in areas adjacent to natural-resource-oriented areas as opposed to recreation-oriented areas. Some historical and archeological sites may also fall into this category. The acceptability of sites near

special areas of public use should be determined by consulting with relevant authorities.

2.84 As for the initial step in site selection using this criterion, applicant should identify and exclude all protected areas, particularly those areas gazetted within definition of Convention on Biological Diversity and International Union for the Conservative of Nature. Examples of protected areas important for consideration at this stage include, but not limited to all National and State Parks, Wildlife and River Sanctuaries, Nature Reserves and Marine Parks. The following Federal, State and Local Authorities should be consulted for the special and protected areas:

- a) Department of Wildlife and National Parks, Peninsular Malaysia.
- b) Department of Marine Parks.
- c) Ministry of Communication, Culture and Heritage.
- d) Ministry of Housing and Local Government.
- e) Department of Forestry.
- f) Department of National Museum.
- g) Ministry of Natural Resources and Environment.
- h) Department of Aboriginal Affairs Malaysia.
- i) Department of Fishery.
- j) Department of Agriculture.
- k) Federal Department of Town & Country Planning, Peninsular Malaysia.
- l) Department of Environment.

2.85 Areas identified in Step 1 will be re-evaluated and avoided, for which special consideration should be given to the following nearby facilities:

- a) Hospitals;
- b) Schools;
- c) Prime agricultural lands;
- d) Historic, Cultural and Archaeological sites;
- e) Commercially exploitable mineral resources;
- f) Transportation and utility corridors; and
- g) Recreational and tourism areas.



2.86 At Step 3 of site selection process, applicants should begin to address local land use issues and individual site conditions for each Potential Site identified above. Consideration should be given to issues related to proximity to designated amenity areas, land use compatibility and consistency with applicable National Physical Plan, State Structure Plans, Local Plans and Special Area Plans in that particular area. Selection of most preferred site requires applicant to refine results in Step 3 using more detailed on-site specific information, as available.

2.87 It should be recognized that some areas may be unsuitable for siting because of public interest in future dedication to public scenic, recreational or cultural use. Relatively rare land types such as sand dunes and wetlands are examples. However, the acceptability of sites for NPPs at some future time in these areas will depend on the existing impacts from industrial, commercial and other developments.

#### *Social Impacts*

2.89 The suitability of NPP sites near existing community clusters should take into consideration the social impacts from the construction, operations, including transmission and transportation corridors of NPPs that will not affect demography, community and individual well-being and the provision of the community infrastructure of services. Examples of social impact are shown in Table 1. For this purpose, applicant should conduct social impact assessment (SIA) study for preferred site, as a tool to address social implications of the NPPs and to identify adverse social impacts that may arise from construction and operation of NPPs on existing and surrounding communities. The applicant should consult with all the stakeholders and integrated into site evaluation process. The consultation process associated with site evaluation demonstrates involvement of stakeholders in good faith, openness, respect and fairness with a genuine desire to utilize the input received.

Table 1: Potential Social Impact related to NPP Project Development

<b>Types of Potential Social Impact</b>	<b>Impacts (Planning Stage/Construction/Operation)</b>
Demographic Impacts	<ol style="list-style-type: none"> <li>1. Significant population change</li> <li>2. Influx or out flux of temporary workers</li> <li>3. Presence of seasonal (leisure) residents</li> <li>4. Relocation of individual and families</li> </ol>
Community/institutional arrangements	<ol style="list-style-type: none"> <li>1. Formation of negative attitudes towards project</li> <li>2. Monopoly of interest group activity</li> <li>3. Alteration in size and structure of local government</li> <li>4. Enhanced economic inequities</li> <li>5. Change in employment equity of minority groups</li> <li>6. Change in occupational opportunities</li> <li>7. Political stability</li> <li>8. Aesthetics and visual physical changes\statutory acts and laws</li> </ol>
Conflicts between Local Residents and Newcomers/ Communities in Transition	<ol style="list-style-type: none"> <li>1. Presence of outside agency or community</li> <li>2. Introduction of new or different social class</li> <li>3. Change in the commercial/industrial focus of the community</li> <li>4. Presence of weekend residence</li> <li>5. Property value</li> </ol>
Individual and Family Level Impacts	<ol style="list-style-type: none"> <li>1. Disruption in daily living and movement patterns</li> <li>2. Dissimilarity in cultural or religious practices/impacts on religious practices</li> <li>3. Alteration in family structure</li> <li>4. Disruption in social networks</li> <li>5. Increased concern on public health</li> <li>6. Increased concern on public safety</li> <li>7. Change in leisure opportunities</li> <li>8. Change in social lifestyle</li> </ol>

	<ul style="list-style-type: none"> <li>9. Alienation</li> <li>10. Congestion</li> <li>11. Technology</li> </ul>
<p style="text-align: center;">Community Infrastructure Needs</p>	<ul style="list-style-type: none"> <li>1. Decreased capacity of community amenities</li> <li>2. Decreased capacity of community infrastructure</li> <li>3. Land acquisition and disposal</li> <li>4. Effects on known cultural, heritage, historical and archaeological resources</li> </ul>

### **3. QUALITY ASSURANCE FOR SITE SELECTION**

3.1 An adequate quality assurance program should be established to control the effectiveness of the execution of investigations and assessments and engineering activities performed in the different stages of the site selection for NPPs.

3.2 The quality assurance program should cover the organization, planning, work control, personnel qualification and training, as well as verification and documentation for the activities to ensure that the required quality of the work is achieved.

3.3 The quality assurance program for site selection is a part of the overall quality assurance program for the NPPs. However, since activities for site investigation are normally initiated long before the establishment of a nuclear project, the quality assurance program should be established at the earliest possible time consistent with its application in the conduct of selection activities.

3.4 The results of the activities for assessment during site selection of NPPs should be compiled in a report that documents the results of all in-situ work, laboratory tests and geotechnical analyses and evaluations.

3.5 The results of studies and investigations shall be documented in sufficient detail to permit comprehensive regulatory review.

3.6 A quality assurance program should be implemented for all activities that may influence safety or the derivation of parameters for the design basis for the site. The quality assurance program may be graded in accordance with the importance to safety of the individual siting activity under consideration.

3.7 In accordance with the importance of engineering judgment and expertise in geo-technical engineering, the feedback of experience is an important aspect. For the assessment of matters, such as the liquefaction potential, the stability of slopes and the safety in general of earth and of buried structures, information from the feedback of experience of failures in comparable situations shall be documented and analyzed in order to be able to provide evidence that similar failures will not occur.

3.8 Records of the work carried out in the activities for site selection for NPPs should be properly maintained and kept.

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## GLOSSARY

**design basis external events** means the external event(s) or combination(s) of external events considered in the design basis of all or any part of a facility.

**external events** means events unconnected with the operation of a facility or activity which could have an effect on the safety of the facility or activity.

**external zone** means the area immediately surrounding a proposed site area in which population distribution and density, and land and water uses, are considered with respect to their effects on the possible implementation of emergency measures.

**site area** means a geographical area that contains an authorized facility, and within which the management of the authorized facility may directly initiate emergency actions.

**site personnel** means all persons working in the site area of an authorized facility, either permanently or temporarily.

**siting** means the process of selecting a suitable site for a facility, including appropriate assessment and definition of the related design bases.

**conditional probability value (CPV)**. The upper bound for the conditional probability that a particular type of event will cause unacceptable radiological consequences. The term is used in the detailed event screening process for site evaluation.

**design basis probability value (DBPV)**. A value of the annual probability for a particular type of event to cause unacceptable radiological consequences. It is the ratio between the SPL and the CPV. The term is used in the detailed event screening process for site evaluation.

**initiating event.** An identified event that leads to anticipated operational occurrences or accident conditions and challenges safety functions.

**interacting event.** An event or a sequence of associated events that, interacting with a facility, affect site personnel or items important to safety in a manner which could adversely influence safety.

**postulated initiating events.** An event identified during design as capable of leading to anticipated operational occurrences or accident conditions. The primary causes of postulated initiating events may be credible equipment failures and operator errors (both within and external to the facility), human induced or natural events.

**screening distance value (SDV).** The distance from a facility beyond which, for screening purposes, potential sources of a particular type of external event can be ignored.

**screening probability level (SPL).** A value of the annual probability of occurrence of a particular type of event below which, for screening purposes, such an event can be ignored.

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## APPENDIX A

### SUMMARY OF GUIDELINES FOR SITE SELECTION CRITERIA OF NUCLEAR POWER PLANT

SCOPE	ASPECT	STEPS	TYPE OF CRITERIA			CRITERIA	REFERENCE <sup>7</sup>	REMARKS
			E	A	S			
GEOLOGY / SEISMOLOGY	Geologic-related hazard	1	√			Avoided these area with the following characteristic: a) Areas of active (and dormant) volcanic activity; b) Subsidence areas caused by withdrawal of sub-surface fluids such as oil or groundwater, including areas which may be affected by future withdrawals; c) Potential unstable slope areas, including areas demonstrating paleo-landslide characteristics; d) Areas of potential collapse (e.g. karstic areas in limestone, salt, or other soluble formations); e) Mined areas, such as near-surface coal mined-out areas, as well as areas where resources are present and may be exploited in the future; f) Areas subject to seismic and other induced water waves and floods.	EPRI Technical Report; RG 1.29	
		2				N/A		
		3				N/A		
		4			√	Assessment based on site-specific data.		
	Capable tectonic structures	1	√			Identify and avoid area with capable fault for various distance out to 320km from interest region.	10 CFR 100, EPRI Technical Report	
		2	√	√		Further investigation conducted using approach in Step 1, with greater detail of information (potential of capable fault, nearby fault).		
		3		√		Preliminary ranking based on consideration on surface faulting & deformation, geologic-related hazard, potential ground motion and foundation condition.		
		4			√	Assessment based on site-specific data		
	Surface	1	√			Identify and avoid area with tectonic & non-tectonic for various	10 CFR 100, EPRI	

<sup>7</sup> Reference document adopted by AELB Board on June 2010.

**Note:**

Step: 1 (candidate Area), Step 2 (Potential Site), Step 3 (Candidate Site), Step 4 (Preferred Site)  
 Type of Criteria: Exclusive (E), Avoidance (A), Suitability (S)

SCOPE	ASPECT	STEPS	TYPE OF CRITERIA			CRITERIA	REFERENCE <sup>7</sup>	REMARKS
			E	A	S			
	faulting and deformation					distance out to 320km from interest region.	Technical Report.	
		2		√		Identify and avoid area with tectonic & non-tectonic for various distance out to 40km from interest region, and also consider the following criteria: a) Any such structures altogether (most favorable); b) Potential non-capable structures; and c) Potential capable structures (less favorable).		
		3		√		Identify and avoid area with tectonic & non-tectonic for various distance out to 8km from interest region, and also consider the following criteria: a) Any such structures altogether (most favorable); b) Potential non-capable structures; c) Potential capable structures; d) Faults exceeding 300 meters in length; and e) Capable faults exceeding 300 meters in length (least favorable).		
		4			√	Assessment based on site-specific data		
	Potential ground motion	1	√			Identify and exclude area with peak ground motion exceeding 0.1g at probability of exceedance of 2% in 50 years	10 CFR 100, EPRI Technical Report, RG 1.165	
		2		√		Identify and avoid area with consideration of soil properties (grain size, water table, density)		
		3			√	Assessment of seismic hazard based on available seismic data		
		4			√	Assessment based on site-specific data, in the scope of geologic and geo-technical aspects		
	Foundation conditions	1				N/A	EPRI Technical Report	
		2				N/A		
		3		√		Avoidance of area with combination of poor soil condition		
		4		√	√	Exclude area with potential of liquefaction, subsidence and landslide		
	ATMOSPHERIC DISPERSION	Short-term radiological exposure	1	√			10 CFR 100, EPRI Technical Report, RG 1.3, RG 1.4, RG 1.5, RG 1.23	
2				√				
3					√	Estimate of short-term radiological exposure corresponding to the standard NPP design value for each of the Candidate Sites. Analysis must be further conducted to exclude an area with potential site characteristic (e.g. topography and coastal effect) which can affect the		

**Note:**

Step: 1 (candidate Area), Step 2 (Potential Site), Step 3 (Candidate Site), Step 4 (Preferred Site)  
Type of Criteria: Exclusive (E), Avoidance (A), Suitability (S)

SCOPE	ASPECT	STEPS	TYPE OF CRITERIA			CRITERIA	REFERENCE <sup>7</sup>	REMARKS
			E	A	S			
						dispersion of accidental releases.		
		4				N/A		
EXCLUSION AREA & LOW POPULATION ZONE		1	√			Determine population distribution and density within ROI and Potential Sites based on available census data.	10 CFR 100, EPRI Technical Report	
		2		√				
		3			√	Refine population distribution within 30km from Candidate Site		
		4				Assessment based on site-specific data		
POPULATION CONSIDERATION		1	√			Consideration should be given to sites located away from very densely populated centers. Areas of low population density are generally preferred.	10 CFR 100, EPRI Technical Report, NUREG 654	
		2		√		Identification of the transient population (other than those just passing through the area) work, reside part time or engage in recreational activities and are not permanent residents of the area.		
		3				N/A		
		4				N/A		
EMERGENCY PLANNING		1				N/A	10 CFR 100, EPRI Technical Report, NUREG 654	
		2				N/A		
		3		√		Consideration to the significant impediments to the implementation of emergency planning, such as: a) Traffic capacity; b) Number of egress alternatives; c) Network type (e.g. freeway or expressway, urban streets, or rural roads); d) On ramp capacities for freeways; e) Number of traffic control points per network segment; f) Terrain characteristics (curves, steep slopes); and g) Climatic conditions.		
		4				N/A		
SECURITY PLAN					√	Site characteristics should be such that adequate security plans and measures can be established and implemented. Particularly, applicant should provide special measures or analyses needed to show that adequate security plans can be developed	10 CFR 100, 10 CFR 73, EPRI Technical Report	
HYDROLOGY	Flooding	1	√			Identify and exclude major flood-prone area within ROI	10 CFR 100, EPRI Technical Report, RG 1.59	
		2		√		Refine the analysis to exclude areas within the 100-year and 500-year flood-prone level		

**Note:**

Step: 1 (candidate Area), Step 2 (Potential Site), Step 3 (Candidate Site), Step 4 (Preferred Site)  
Type of Criteria: Exclusive (E), Avoidance (A), Suitability (S)

SCOPE	ASPECT	STEPS	TYPE OF CRITERIA			CRITERIA	REFERENCE <sup>7</sup>	REMARKS			
			E	A	S						
		3		√	√	Review historical data related to the degree of exceedance of the 100-year flood level elevations on an areal percentage basis. Sites that minimally exceed flood-level elevations would be much favorable than those that have the highest degree of exceedance of flood level elevations.		Consideration to the sites which are near coastal areas, estuaries and rivers should also be given.			
		4			√	Assessment based on site-specific data					
		Water Availability	1	√					Identify and compare site supply characteristics associated with low-flow conditions as modified by other use allocations as projected into the period of facility operations with the design basis facility water consumption rate	10 CFR 100, EPRI Technical Report, RG 1.27	Consideration should also be given to underground water sources
			2		√						
	3		√		Investigation with regard to the degree with which the supply at low-flow conditions, based on 7-day, 10-year low-flows and historical drought stages or water surface elevations, exceeds the design basis consumption rate and the projected future use requirements						
	4			√	Assessment based on site-specific data						
	Water Quality	1				N/A	10 CFR 100, EPRI Technical Report, RG 4.2				
		2				N/A					
		3		√		The following factor should be taken into account in investigation of impact to water quality:  a) baseline thermal loadings (from upstream facilities); b) baseline ambient water temperature; c) baseline chemical properties; d) stream flow rate and width; e) the sensitivity of the species present; and f) baseline concentrations of dissolved oxygen, dissolved solids and nutrients.					
		4				N/A					
	INDUSTRIAL, MILITARY AND TRANSPORTATION FACILITIES		1	√		Identify and avoid an area within 16km from major airport	10 CFR 100, EPRI Technical Report, RG 4.2				
			2		√				Consideration to existing and projected of the following facility within 8km from interest ROI:  a) Military bases, ammunitions storage areas and ordinance test ranges, missile bases, firing or bombing ranges b) Oil pipelines		

**Note:**

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SCOPE	ASPECT	STEPS	TYPE OF CRITERIA			CRITERIA	REFERENCE <sup>7</sup>	REMARKS	
			E	A	S				
						<ul style="list-style-type: none"> <li>c) Oil or gas wells</li> <li>d) Oil and gas storage areas</li> <li>e) Significant manufacturing facilities</li> <li>f) Chemical facilities</li> <li>g) Refineries</li> <li>h) Mining and quarrying operations</li> <li>i) Dams</li> <li>j) Land and water transportation routes for hazardous materials</li> <li>k) Docks and anchorages for hazardous materials</li> </ul>			
		3		√	√	<p>The acceptability of a site depends on establishing that:</p> <ul style="list-style-type: none"> <li>a) An accident at a nearby industrial, military or transportation facility would not result in radiological consequences that exceed the dose specified in Radiation Protection (Basic Safety Standard) Regulation 1989; or</li> <li>b) The accident poses no undue risk because it is sufficiently unlikely to occur (probability less than about 10<sup>-7</sup> per year); or</li> <li>c) The NPP can be designed so its safety will not be affected by the accident</li> </ul>			Site for which acceptability does not meet the regulatory criteria mentioned should be excluded. A preferred site is selected based on the predicted magnitude of impact of hazardous facilities to the NPP
		4			√	Assessment based on site-specific data			
		1	√			Identify and exclude all areas categorized as <u>Environment Sensitive Area</u> Rank 1, which is gazetted for critical habitats and endangered species			10 CFR 100, EPRI Technical Report
ECOLOGICAL SYSTEM & ABIOTA		2		√		Avoid any area with likely presence of threatened or endangered species		Special attention should also be given to areas with presence of important species habitats, such as marine grasses and commercial shellfish beds, as well as spawning, nursing, and feeding areas	
		3		√	√	<p>Site conditions that should be identified and evaluated in assessing potential impacts on important aquatic migratory species include:</p> <ul style="list-style-type: none"> <li>a) narrow zones of passage;</li> <li>b) migration periods that are coincident with maximum ambient temperatures;</li> <li>c) the potential for major modification of currents by station structures;</li> <li>d) the potential for increased turbidity during construction; and</li> <li>e) the potential for entrapment, entrainment or impingement by or in the cooling water system or for blocking of migration by</li> </ul>			

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SCOPE	ASPECT	STEPS	TYPE OF CRITERIA			CRITERIA	REFERENCE <sup>7</sup>	REMARKS
			E	A	S			
						facility structures or effluents.		
		4			√	Assessment based on site-specific data		
LAND USE AND AESTHETICS		1	√			Identify and exclude all protected areas, particularly those areas gazetted within definition of Convention on Biological Diversity and International Union for the Conservative of Nature	10 CFR 100, EPRI Technical Report, National Physical Plan	
		2		√		Identify, avoid and give special consideration to the following nearby facilities:  a) Hospitals; b) Schools; c) Prime agricultural lands; d) Historic, cultural and archaeological sites; e) Commercially exploitable mineral resources; f) Transportation and utility corridors; and g) Recreational areas (e.g. golf courses, swimming, fishing and boating areas).		
		3			√	Address local land use issues and individual site conditions for each Potential Site identified. Consideration should be given to issues related to proximity to designated amenity areas, land use compatibility and consistency with applicable National Physical Plan, State Structure Plan, Local Plan and Special Area Plan in the particular area.		
		4				N/A		
SOCIOECONOMICS		1			√	Conduct social impact assessment (SIA) study which is required by Town and Country Planning Act, 1976 (Act 172) as a tool to address social implications of the NPP's and to identify adverse social impacts, that may arise from development and operation of NPP to existing and surrounding communities. <i>(Refer Table 1 for example of potential social impacts that may arise from NPP project)</i>	10 CFR 100, EPRI Technical Report, SIA Guideline	
		2				N/A		
		3				N/A		
		4				N/A		

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