

The Gazette of Pakistan

PART II

Statutory Notification (S. R. O.)

GOVERNMENT OF PAKISTAN

PAKISTAN NUCLEAR REGULATORY AUTHORITY

NOTIFICATION

Islamabad, the 24th July, 2008

S. R. O. 911 (I)/2008.— In exercise of the powers conferred by section 56 of the Pakistan Nuclear Regulatory Authority Ordinance, 2001 (III of 2001), the Pakistan Nuclear Regulatory Authority is pleased to make and promulgate the following regulations.

1. Short title and commencement. — (1) These regulations may be called “Regulations on the Safety of Nuclear Installations – Site Evaluation (PAK/910) (Rev. 1)”.

(2) These regulations extend to the whole of Pakistan.

(3) These regulations shall come into force at once.

2. Definitions. — (1) In these regulations, unless there is anything repugnant in the subject or context,

(a) “a comprehensive risk analysis” includes all the sequential steps of analyzing all the initiating events, following for each initiating event all the possible sequences of subsequent events, associating a probability value with each of these sequences and ending with the consequences for individuals, the population and the environment;

(b) “Authority” means Pakistan Nuclear Regulatory Authority established under section 3 of Pakistan Nuclear Regulatory Authority Ordinance, 2001;

(c) “design basis external events” mean the external event(s) or combination(s) of external events considered in the design basis of all or any part of the installation;

(d) “external events” mean events unconnected with the operation of an installation or activity which could have an effect on the safety of the installation or activity;

(e) “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;

(f) “exclusion area boundary” means that area surrounding the reactor, in which the reactor licensee has the authority to determine all activities including exclusion or removal of personnel and property from the area, this area may be traversed by a highway, railroad, or waterway, provided these are not so close to the facility as to interfere with normal

operations of the facility and provided appropriate and effective arrangements are made to control traffic on the highway, railroad, or waterway, in case of emergency, to protect the public health and safety, residence within the exclusion area shall normally be prohibited. In any event, residents shall be subject to ready removal in case of necessity, activities unrelated to operation of the reactor may be permitted in an exclusion area under appropriate limitations, provided that no significant hazards to the public health and safety will result;

- (g) “low population zone” means the area immediately surrounding the exclusion area which contains residents, the total number and density of which are such that there is a reasonable probability that appropriate protective measures could be taken in their behalf in the event of a serious accident;
- (h) “nuclear installation” means:
 - (i) any nuclear reactor used as a source of power or for any other purpose;
 - (ii) any factory using nuclear fuel for the production of nuclear material, or any factory for the processing of nuclear material including any factory for the reprocessing of irradiated nuclear fuel; and
 - (iii) any facility where nuclear material is stored, other than storage incidental to the carriage of such material;
- (i) “population centre distance” means the distance from the reactor to the nearest boundary of a densely populated center containing more than about 25,000 residents;
- (j) “risk” means the product derived from the multiplication of the probability of a particular event that results in the release of radioactive material by a parameter corresponding to the radiological consequences of this event;
- (k) “site area” means a geographical area that contains an authorized installation, and within which the management of the authorized installation may directly initiate emergency actions;
- (l) “site survey” means the process that is used to identify preferred candidate sites for nuclear installations on the basis of safety and other considerations;

3. Interpretation - The decision of Chairman, PNRA regarding the interpretation of any word or phrase of these regulations or applicability of these regulations shall be final and binding on the licensee / applicant.

4. Scope - (1) The site evaluation requirements contained in these regulations apply to site registration for the purpose of constructing nuclear installation subject to “Regulations for the Licensing of Nuclear Installation(s) in Pakistan -PAK/909”.

(2) The scope of these regulations encompasses site related factors and site–installation interaction factors relating to plant operational states and accident conditions, including those that could lead to emergency measures, and natural and human induced events external to the installation that are important to safety. The external human induced events considered in these regulations are all of accidental origin.

(3) The siting process for a nuclear installation generally consists of an investigation of a large region to select one or more candidate sites (site survey), followed by a detailed evaluation of those candidate sites. These regulations are primarily concerned with the latter stage.

(4) These regulations are concerned mainly with severe events of low probability that relate to the siting of nuclear installations and that have to be considered in designing a particular nuclear installation. If events of lesser severity but higher probability make a significant contribution to the overall risk, they should also be considered in the design of the nuclear installation.

(5) The scope of the investigation for the site of a nuclear installation covers the entire process of the site evaluation — the selection, assessment, pre-operational and operational stages. The requirements established in these regulations do not apply to the site selection stage, for which a different series of criteria may be used.

5. General Requirements

(1) Objectives

(a) The main objective in site evaluation for nuclear installations in terms of nuclear safety is to protect the public and the environment from the radiological consequences of radioactive releases due to normal operation and accidents. In the evaluation of the suitability of a site for a nuclear installation, the following aspects shall be considered:

- (i) the effects of external events (natural origin or human induced) occurring in the region of the particular site;
- (ii) the characteristics of the site and its environment that could influence the transfer to persons and the environment of radioactive material that has been released;
- (iii) the population density and population distribution and other characteristics of the external zone in so far as they may affect the possibility of implementing emergency measures and the need to evaluate the risks to individuals and the population.

(b) If the site evaluation for the three aspects cited above indicates that the site is unacceptable and the deficiencies cannot be compensated for by means of design features, measures for site protection or administrative procedures, the site shall be deemed unsuitable.

(2) General Criteria

(a) Site characteristics that may affect the safety of the nuclear installation shall 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 shall be investigated. All these characteristics shall be observed and monitored throughout the lifetime of the installation.

(b) Proposed sites for nuclear installations shall be examined with regard to the frequency and severity of external natural and human induced events and phenomena that could affect the safety of the installation.

(c) The foreseeable evolution of natural and human made factors in the region that may have a bearing on safety shall be evaluated for a time period that encompasses the projected lifetime of the nuclear installation. These factors, particularly population growth and

population distribution, shall be monitored over the lifetime of the nuclear installation. If necessary, appropriate measures shall be taken to ensure that the overall risk remains acceptably low. There are three means available to ensure that risks are acceptably low: design features, measures for site protection (e.g. dykes for flood control) and administrative procedures. Design features and protective measures shall be the preferred means of ensuring that risks are kept acceptably low.

- (d) The hazards associated with external events that are to be considered in the design of the nuclear installation shall be determined. For an external event (or a combination of events) the parameters and the values of those parameters that are used to characterize the hazards should be chosen so that they can be used easily in the design of the installation.
 - (e) In the derivation of the hazards associated with external events, consideration shall be given to the effects of the combination of these hazards with the ambient conditions (e.g. hydrological, hydrogeological and meteorological conditions).
 - (f) In the analysis to determine the suitability of the site, consideration shall be given to additional matters relating to safety such as the storage and transport of input and output materials, fresh and spent fuel and radioactive wastes.
 - (g) The possible non-radiological impact of the installation, due to chemical or thermal releases, and the potential for explosion and the dispersion of chemical products shall be taken into account in the site evaluation process.
 - (h) The potential for interactions between nuclear and non-nuclear effluents, such as the combination of heat or chemicals with radioactive material in liquid effluents, shall be considered.
 - (i) For each proposed site, the potential radiological impacts in operational states and in accident conditions on people in the region, including impacts that could lead to emergency measures, shall be evaluated with due consideration of the relevant factors, including population distribution, dietary habits, use of land and water, and the radiological impacts of any other releases of radioactive material in the region.
 - (j) For nuclear power plants, the total nuclear capacity to be installed on the site shall be determined as far as possible at the first stages of the siting process. If it is proposed that the installed nuclear capacity be significantly increased to a level greater than that previously determined to be acceptable, the suitability of the site shall be re-evaluated, as appropriate.
- (3) Criteria for Hazards Associated with External Natural and Human Induced Events
- (a) Proposed sites shall be adequately investigated with regard to all the site characteristics that could be significant to safety in external natural and human induced events.
 - (b) Possible natural phenomena and human induced situations and activities in the region of a proposed site shall be identified and evaluated according to their significance for the safe operation of the nuclear installation. This evaluation should be used to identify the important natural phenomena or human induced situations and activities in association with which potential hazards are to be investigated.
 - (c) Foreseeable significant changes in land use shall be considered, such as the expansion of existing installations and human activities or the construction of high risk installations.

- (d) Pre-historical, historical and instrumentally recorded information and records, as applicable, of the occurrences and severity of important natural phenomena or human induced situations and activities shall be collected for the region and shall be carefully analysed for reliability, accuracy and completeness.
 - (e) Appropriate methods shall be adopted for establishing the hazards that are associated with major external phenomena. The methods shall be justified in terms of being up to date and compatible with the characteristics of the region. Special consideration should be given to applicable probabilistic methodologies.
 - (f) The size of the region to which a method for establishing the hazards associated with major external phenomena is to be applied shall 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.
 - (g) Major natural and human induced phenomena shall be expressed in terms that can be used as input for deriving the hazards associated with the nuclear installation; that is, appropriate parameters for describing the hazard should be selected or developed.
 - (h) In the determination of hazards, site specific data shall be used, unless such data are unobtainable. In this case, data from other regions that are sufficiently relevant to the region of interest may be used in the determination of hazards. Appropriate and acceptable simulation techniques may also be used. In general, data obtained for similar regions and simulation techniques may also be used to augment the site specific data.
- (4) Criteria for Determining the Potential Effects of the Nuclear Installation in the Region
- (a) In the evaluation of a site to determine its potential radiological impact on the region for operational states and accident conditions that could lead to emergency measures, appropriate estimates shall be made of expected or potential releases of radioactive material, with account taken of the design of the nuclear installation and its safety features. These estimates shall be confirmed when the design and its safety features have been confirmed.
 - (b) The direct and indirect pathways by which radioactive material released from the nuclear installation could potentially reach and affect people and the environment shall be identified and evaluated; in such an evaluation specific regional and site characteristics shall be taken into account, with special attention paid to the function of the biosphere in the accumulation and transport of radionuclides.
 - (c) The site and the design for the nuclear installation shall be examined in conjunction to ensure that the radiological risk to the public and the environment associated with radioactive releases is acceptably low.
 - (d) The design of nuclear installation shall be such as to compensate for any unacceptable potential effects of the installation on the region, or otherwise the site shall be deemed unsuitable.
- (5) Criteria Derived from Considerations of Population and Emergency Planning
- (a) The proposed region shall be studied to evaluate the present and foreseeable future characteristics and the distribution of the population of the region. Such a study shall include the evaluation of present and future uses of land and water in the region and

account shall be taken of any special characteristics that may affect the potential consequences of radioactive releases for individuals and the population as a whole.

- (b) In relation to the characteristics and distribution of the population, the combined effects of the site and the nuclear installation shall be such that:
 - (i) for operational states of the installation the radiological exposure of the population remains as low as reasonably achievable and in any case is in compliance with national regulations;
 - (ii) the radiological risk to the population associated with accident conditions, including those that could lead to emergency measures being taken, is acceptably low.
- (c) If, after thorough evaluation, it is shown that no appropriate measures can be developed to meet the above mentioned requirements, the site shall be deemed unsuitable for the location of a nuclear installation of the type proposed.
- (d) The external zone for a proposed site shall be established with account taken of the potential for radiological consequences for people and the feasibility of implementing emergency plans, and of any external events or phenomena that may hinder their implementation. Before construction of the plant is started, it shall be confirmed that there will be no insurmountable difficulties in establishing an emergency plan for the external zone before the start of operation of the plant.
- (6) Criteria for Determination of Exclusion Area Boundary, Low Population Zone and Population Centre Distance
 - (a) As an aid in evaluating a proposed site, a fission product release from the core, the expected demonstrable leak rate from the containment and the meteorological conditions pertinent to the site shall be assumed to derive an exclusion area, a low population zone and population center distance. For the purpose of this analysis, which shall set forth the basis for the numerical values used, the following shall be determined.
 - (i) An exclusion area of such size that an individual located at any point on its boundary for two hours immediately following onset of the postulated fission product release would not receive a total radiation dose to the whole body in excess of 250 mSv or a total radiation dose in excess of 3000 mSv to the thyroid from iodine exposure.
 - (ii) A low population zone 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) would not receive a total radiation dose to the whole body in excess of 250 mSv or a total radiation dose in excess of 3000 mSv to the thyroid from iodine exposure.

Explanation:-

- (1) The fission product release assumed for these calculations should be based upon a major accident, hypothesized for purposes of site analysis or postulated from consideration of possible accidental events, that would result in potential hazards not exceeded by those from any accident considered credible. Such

accidents have generally been assumed to result in substantial meltdown of the core with subsequent release of appreciable quantities of fission products.

- (2) The whole body dose of 250 mSv referred to above corresponds numerically to the once in a lifetime accidental or emergency dose for radiation workers. However, neither its use nor that of the 3000 mSv value for thyroid exposure as set forth in these regulations are intended to imply that these numbers constitute acceptable limits for emergency doses to the public under accident conditions. Rather, this 250 mSv whole body value and the 3000 mSv thyroid value have been set forth as reference values, which can be used in the evaluation of nuclear installation sites with respect to potential accidents of exceedingly low probability of occurrence, and low risk of public exposure to radiation.
 - (iii) A population center distance of at least one and one-third times the distance from the installation to the outer boundary of the low population zone. For this purpose, the boundary of the population center shall be determined upon consideration of population distribution. Political boundaries are not controlling in the application of this requirement. Where very large cities are involved, a greater distance may be necessary because of total integrated population dose consideration.
- (b) For sites of multiple nuclear installations, consideration shall be given to the following:
- (i) if the installations are independent to the extent that an accident in one plant would not initiate an accident in another, the size of the exclusion area, low population zone and population center distance shall be fulfilled with respect to each plant individually, the envelopes of the plan overlay of the areas so calculated shall then be taken as their respective boundaries;
 - (ii) if the installations are interconnected to the extent that an accident in one plant could affect the safety of operation of any other, the size of the exclusion area, low population zone and population center distance shall be based upon the assumption that all interconnected installations emit their postulated fission product releases simultaneously, this requirement may be reduced in relation to the degree of coupling between installations, the probability of concomitant accidents and the probability that an individual would not be exposed to the radiation effects from simultaneous releases, however, the basis for such a reduction in the source term shall be justified to the satisfaction of the Authority;
 - (iii) the applicant is expected to show that the simultaneous operation of multiple reactors at a site will not result in total radioactive effluent releases beyond the allowable limits of national regulations.

6. Specific Requirements for Evaluation of External Events

(1) Earthquakes and Surface Faulting

(a) Earthquakes

- (i) The seismological and geological conditions in the region and the engineering geological aspects and geotechnical aspects of the proposed site area shall be evaluated.

- (ii) Information on pre-historical, historical and instrumentally recorded earthquakes in the region shall be collected and documented.
 - (iii) The hazards associated with earthquakes shall be determined by means of seismotectonic evaluation of the region with the use to the greatest possible extent of the information collected.
 - (iv) Hazards due to earthquake induced ground motion shall be assessed for the site with account taken of the seismotectonic characteristics of the region and specific site conditions. A thorough uncertainty analysis shall be performed as part of the evaluation of seismic hazards.
- (b) Surface faulting
- (i) The potential for surface faulting (i.e. the fault capability) shall be assessed for the site. The methods to be used and the investigations to be made shall be sufficiently detailed that a reasonable decision can be reached.
 - (ii) A fault shall be considered capable if, on the basis of geological, geophysical, geodetic or seismological data, one or more of the following conditions applies:
 - (1) 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 of the order of tens of thousands of years may be appropriate for the assessment of capable faults, in less active areas, it is likely that much longer periods may be required;
 - (2) 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;
 - (3) 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.
 - (iii) Where reliable evidence shows the existence of a capable fault that has the potential to affect the safety of the nuclear installation, an alternative site shall be considered.
- (2) Meteorological Events - The extreme values of meteorological variables and rare meteorological phenomena listed below shall be investigated for the site of any nuclear installation. The meteorological and climatological characteristics for the region around the site shall be investigated.
- (a) Extreme values of meteorological phenomena
- (i) In order to evaluate their possible extreme values, the following meteorological phenomena shall be documented for an appropriate period of time: wind, precipitation, snow, temperature and storm surges.

- (ii) The output of the site evaluation shall be described in a way that is suitable for design purposes for the installation, such as the probability of exceedance values relevant to design parameters. Uncertainties in the data shall be taken into account in this evaluation.
- (b) Rare meteorological events
 - (i) Lightning -The potential for the occurrence and the frequency and severity of lightning shall be evaluated for the site.
 - (ii) Tornadoes
 - (1) The potential for the occurrence of tornadoes in the region of interest shall be assessed on the basis of detailed historical and instrumentally recorded data for the region.
 - (2) The hazards associated with tornadoes shall be derived and expressed in terms of parameters such as rotational wind speed, translational wind speed, radius of maximum rotational wind speed, pressure differentials and rate of change of pressure.
 - (3) In the assessment of the hazard, missiles that could be associated with tornadoes shall be considered.
 - (iii) Tropical cyclones
 - (1) The potential for tropical cyclones in the region of the site shall be evaluated. If this evaluation shows that there is evidence of tropical cyclones or a potential for tropical cyclones, related data shall be collected.
 - (2) On the basis of the available data and the appropriate physical models, the hazards associated with tropical cyclones shall be determined in relation to the site. Hazards for tropical cyclones include factors such as extreme wind speed, pressure and precipitation.
 - (3) In the assessment of the hazards, missiles that could be associated with tropical cyclones shall be considered.
- (3) Flooding
 - (a) Floods due to precipitation and other causes
 - (i) The region shall be assessed to determine the potential for flooding due to one or more natural causes such as runoff resulting from precipitation or snow melt, high tide, storm surge, seiche and wind waves that may affect the safety of the nuclear installation. If there is a potential for flooding, then all pertinent data, including historical data, both meteorological and hydrological, shall be collected and critically examined.
 - (ii) A suitable meteorological and hydrological model shall be developed with account taken of the limits on the accuracy and quantity of the data, the length of the historical period over which the data were accumulated, and all known past changes in relevant characteristics of the region.

- (iii) The possible combinations of the effects of several causes shall be examined. For example, for coastal sites and sites on estuaries, the potential for flooding by a combination of high tide, wind effects on bodies of water and wave actions, such as those due to cyclones, shall be assessed and taken into account in the hazard model.
 - (iv) The hazards for the site due to flooding shall be derived from the model.
 - (v) The parameters used to characterize the hazards due to flooding shall include the height of the water, the height and period of the waves (if relevant), the warning time for the flood, the duration of the flood and the flow conditions.
 - (vi) The potential for instability of the coastal area or river channel due to erosion or sedimentation shall be investigated.
- (b) Water waves induced by earthquakes or other geological phenomena
- (i) The region shall be evaluated to determine the potential for tsunamis or seiches that could affect the safety of a nuclear installation on the site.
 - (ii) If there is found to be such a potential, prehistorical and historical data relating to tsunamis or seiches affecting the shore region around the site shall be collected and critically evaluated for their relevance to the evaluation of the site and their reliability.
 - (iii) On the basis of the available prehistorical and historical data for the region and comparison with similar regions that have been well studied with regard to these phenomena, the frequency of occurrence, magnitude and height of regional tsunamis or seiches shall be estimated and shall be used in determining the hazards associated with tsunamis or seiches, with account taken of any amplification due to the coastal configuration at the site.
 - (iv) The potential for tsunamis or seiches to be generated by regional offshore seismic events shall be evaluated on the basis of known seismic records and seismotectonic characteristics.
 - (v) The hazards associated with tsunamis or seiches shall be derived from known seismic records and seismotectonic characteristics as well as from physical and/or analytical modelling. These include potential draw-down and runup that may result in physical effects on the site.
- (c) Floods and waves caused by failure of water control structures
- (i) Information relating to upstream water control structures shall be analysed to determine whether the nuclear installation would be able to withstand the effects resulting from the failure of one or more of the upstream structures.
 - (ii) If the nuclear installation could safely withstand all the effects of the massive failure of one or more of the upstream structures, then the structures need be examined no further in this regard.
 - (iii) If a preliminary examination of the nuclear installation indicates that it might not be able to withstand safely all the effects of the massive failure of one or more of the upstream structures, then the hazards associated with the nuclear installation

shall be assessed with the inclusion of all such effects; otherwise such upstream structures shall be analysed by means of methods equivalent to those used in determining the hazards associated with the nuclear installation to show that the structures could survive the event concerned.

- (iv) The possibility of storage of water as a result of the temporary blockage of rivers upstream or downstream (e.g. caused by landslides or ice) so as to cause flooding and associated phenomena at the proposed site shall be examined.
- (4) Geotechnical Hazards
- (a) Slope instability
 - (i) The site and its vicinity shall be evaluated to determine the potential for slope instability (such as land and rock slides and snow avalanches) that could affect the safety of the nuclear installation.
 - (ii) If there is found to be a potential for slope instability that could affect the safety of the nuclear installation, the hazard shall be evaluated by using parameters and values for the site specific ground motion.
 - (b) Collapse, subsidence or uplift of the site surface
 - (i) Geological maps and other appropriate information for the region shall be examined for the existence of natural features such as caverns, karstic formations and human made features such as mines, water wells and oil wells. The potential for collapse, subsidence or uplift of the site surface shall be evaluated.
 - (ii) If the evaluation shows that there is a potential for collapse, subsidence or uplift of the surface that could affect the safety of the nuclear installation, practicable engineering solutions shall be provided or otherwise the site shall be deemed unsuitable.
 - (iii) If there do seem to be practicable engineering solutions available, a detailed description of subsurface conditions obtained by reliable methods of investigation shall be developed for the purposes of determination of the hazards.
 - (c) Soil liquefaction
 - (i) The potential for liquefaction of the subsurface materials of the proposed site shall be evaluated by using parameters and values for the site specific ground motion.
 - (ii) The evaluation shall include the use of accepted methods of soil investigation and analytical methods to determine the hazards.
 - (iii) If the potential for soil liquefaction is found to be unacceptable, the site shall be deemed unsuitable unless practicable engineering solutions are demonstrated to be available.
 - (d) Behaviour of foundation materials
 - (i) The geotechnical characteristics of the subsurface materials, including the uncertainties in them, shall be investigated and a soil profile for the site in a form suitable for design purposes shall be determined.

- (ii) The stability of the foundation material under static and seismic loading shall be assessed.
 - (iii) The groundwater regime and the chemical properties of the groundwater shall be studied.
- (5) External Human Induced Events
 - (a) Aircraft crashes
 - (i) The potential for aircraft crashes on the site shall be assessed with account taken, to the extent practicable, of characteristics of future air traffic and aircraft.
 - (ii) If the assessment shows that there is a potential for an aircraft crash on the site that could affect the safety of the nuclear installation, then an assessment of the hazards shall be made.
 - (iii) The hazards associated with an aircraft crash to be considered shall include impact, fire and explosions.
 - (iv) If the assessment indicates that the hazards are unacceptable and if no practicable solutions are available, then the site shall be deemed unsuitable.
 - (b) Chemical explosions
 - (i) Activities in the region that involve the handling, processing, transport and storage of chemicals having a potential for explosions or for the production of gas clouds capable of deflagration or detonation shall be identified.
 - (ii) Hazards associated with chemical explosions shall be expressed in terms of overpressure and toxicity (if applicable), with account taken of the effect of distance.
 - (iii) A site shall be considered unsuitable if such activities take place in its vicinity and there are no practicable solutions available.
 - (c) Other important human induced events - The region shall be investigated for installations (including installations within the site boundary) in which flammable, explosive, asphyxiant, toxic, corrosive or radioactive materials are stored, processed, transported and otherwise dealt with that, if released under normal or accident conditions, could jeopardize the safety of the nuclear installation. This investigation shall also include installations that may give rise to missiles of any type that could affect the safety of the nuclear installation. The potential effects of electromagnetic interference, eddy currents in the ground and the clogging of air or water inlets by debris shall also be evaluated. If the effects of such phenomena and occurrences would produce an unacceptable hazard and if no practicable solution is available, the site shall be deemed unsuitable.
- (6) Other Important Considerations
 - (a) Historical data concerning phenomena that have the potential to give rise to adverse effects on the safety of the nuclear installation, such as volcanism, sand storms, severe precipitation, snow, ice, hail, and subsurface freezing of subcooled water (frazil), shall be collected and assessed. If the potential is confirmed, the hazard shall be assessed and design bases for these events shall be derived.

(b) In the design of systems for long term heat removal from the core, site related parameters, such as the following, shall be considered:

- (i) air temperature and humidity;
- (ii) water temperatures;
- (iii) available flow of water, minimum water level and the period of time for which safety related sources of cooling water are at a minimum level, with account taken of the potential for failure of water control structures.

(c) Potential natural and human induced events that could cause a loss of function of systems required for the long term removal of heat from the core shall be identified, such as the blockage or diversion of a river, the depletion of a reservoir, an excessive amount of marine organisms, the blockage of a reservoir or cooling tower by freezing or the formation of ice, ship collisions, oil spills and fires. If the probabilities and consequences of such events cannot be reduced to acceptable levels, then the hazards for the nuclear installation associated with such events shall be established.

(d) If the hazards for the nuclear installation are unacceptable and no practicable solution is available, the site shall be deemed unsuitable.

7. Site Characteristics and the Potential Effects of the Nuclear Installation in the Region

(1) Atmospheric Dispersion of Radioactive Material

- (a) A meteorological description of the region shall be developed, including descriptions of the basic meteorological parameters, regional orography and phenomena such as wind speed and direction, air temperature, precipitation, humidity, atmospheric stability parameters, and prolonged inversions.
- (b) A programme for meteorological measurements shall be prepared and carried out at or near the site with the use of instrumentation capable of measuring and recording the main meteorological parameters at appropriate elevations and locations. Data from at least one full year shall be collected, together with any other relevant data that may be available from other sources.
- (c) On the basis of the data obtained from the investigation of the region, the atmospheric dispersion of radioactive material released shall be assessed with the use of appropriate models. These models shall include all significant site specific and regional topographic features and characteristics of the nuclear installation that may affect atmospheric dispersion.

(2) Dispersion of Radioactive Material through Surface Water

- (a) A description of the surface hydrological characteristics of the region shall be developed, including descriptions of the main characteristics of water bodies, both natural and artificial, the major structures for water control, the locations of water intake structures and information on water use in the region.
- (b) A programme of investigation and measurements of the surface hydrology shall be carried out to determine to the extent necessary the dilution and dispersion characteristics

for water bodies, the reconcentration ability of sediments and biota, and the determination of transfer mechanisms of radionuclides in the hydrosphere and of exposure pathways.

- (c) An assessment of the potential impact of the contamination of surface water on the population shall be performed by using the collected data and information in a suitable model.
- (3) Dispersion of Radioactive Material through Groundwater
 - (a) A description of the groundwater hydrology of the region shall be developed, including descriptions of the main characteristics of the water bearing formations, their interaction with surface waters and data on the uses of groundwater in the region.
 - (b) A programme of hydrogeological investigations shall be carried out to permit the assessment of radionuclide movement in hydrogeological units. This programme shall include investigations of the migration and retention characteristics of the soils, the dilution and dispersion characteristics of the aquifers, and the physical and physicochemical properties of underground materials, mainly related to transfer mechanisms of radionuclides in groundwater and their exposure pathways.
 - (c) An assessment of the potential impact of the contamination of groundwater on the population shall be performed by using the data and information collected in a suitable model.
- (4) Population Distribution
 - (a) The distribution of the population within the region shall be determined.
 - (b) In particular, information on existing and projected population distributions in the region, including resident populations and to the extent possible transient populations, shall be collected and kept up to date over the lifetime of the nuclear installation. Special attention shall be paid to the population living in the immediate vicinity of the nuclear installation, to densely populated areas and population centres in the region, and to residential institutions such as schools, hospitals and prisons.
 - (c) The most recent census data for the region, or information obtained by extrapolation of the most recent census data, shall be used in obtaining the population distribution. In the absence of reliable data, a special study shall be carried out.
 - (d) The data shall be analysed to give the population distribution in terms of the direction and distance from the installation. An evaluation shall be performed of the potential radiological impacts of normal discharges and accidental releases of radioactive material, including reasonable consideration of releases due to severe accidents, with the use of site specific parameters as appropriate.
- (5) Uses of Land and Water in the Region - The uses of land and water shall be characterized in order to assess the potential effects of the nuclear installation in the region and particularly for the purposes of preparing emergency plans. The investigation shall cover land and water bodies that may be used by the population or may serve as a habitat for organisms in the food chain.
- (6) Ambient Radioactivity - Before commissioning of the nuclear installation the ambient radioactivity of the atmosphere, hydrosphere, lithosphere and biota in the region shall be

assessed so as to be able to determine the effects of the installation. The data obtained are intended for use as a baseline in future investigations.

8. Monitoring of Hazards –The characteristics of the natural and human induced hazards as well as the demographic, meteorological and hydrological conditions of relevance to the nuclear installation shall be monitored over the lifetime of the nuclear installation. This monitoring shall be commenced no later than the start of construction and shall be continued up until decommissioning. All the hazards and conditions that are considered in these regulations and that are pertinent to the licensing and safe operation of the nuclear installation shall be monitored.

9. Quality Assurance - (1) An adequate quality assurance programme shall be established to control the effectiveness of the execution of site investigations and assessments, and engineering activities performed in different stages of the site evaluation for nuclear installation.

(2) The quality assurance programme shall be a part of the overall quality assurance programme for the nuclear installation. The quality assurance programme shall be established at the earliest possible time consistent with its application in the conduct of site evaluation activities for the nuclear installation since site investigation are normally initiated long before the establishment of a nuclear project. The quality assurance program shall comply with the requirements of national regulations PAK/912 (Regulations on the Safety of Nuclear Power Plants- Quality Assurance) and shall be implemented for all activities that may influence safety or the derivation of parameters for design basis for the site.

(3) The results of the activities for site investigation should be compiled in a report that documents the results of all in situ work, laboratory tests and geotechnical analyses and evaluations.

(4) The results of studies and investigations shall be documented in sufficient detail to permit an independent review.

(5) The process of establishing site related parameters and evaluations involve technical and engineering analyses and judgments that require extensive experience and knowledge. In many cases the parameters and analyses may not lend themselves to direct verification by inspections, tests or other techniques that can be precisely defined and controlled. These evaluations shall be reviewed and verified by individuals or groups (e.g. by peer review) who are separate from those who did the work and having expertise in relevant areas.

(6) In accordance with the importance of engineering judgment and expertise in geotechnical 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 analysed in order to be able to provide evidence that similar failures will not occur.

Mohammad Anwar Habib
Member Corporate