GUIDE NO. AERB/NPP/SG/S-10

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GOVERNMENT OF INDIA

AERB SAFETY GUIDE

QUALITY ASSURANCE IN SITING OF NUCLEAR POWER PLANTS

ATOMIC ENERGY REGULATORY BOARD

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QUALITY ASSURANCE IN SITING

OF

NUCLEAR POWER PLANTS

Atomic Energy Regulatory Board
Mumbai - 400 094
India

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Acknowledgement

Information has been reproduced in this guide with due permission from International Atomic Energy Agency, Vienna, Austria. The sructure of this guide is generally based on IAEA publication titled 'Quality Assurance for Safety in Nuclear Power Plants and other Nuclear Installations' Code and Safety Guides Q1-Q14-Safety Series 50-C/SG/Q/ STI/Pub/1016, 364 pp, 6figures, 1996, IBSN 92-0-103696-5, English and is specific to the requirements of Indian Nuclear Power Plants. The pages of IAEA Q9-pages 213 to 218 titled 'Annex II Design, Testing, Application and Change Control for Computer Modeling' have been mostly reproduced.

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FOREWORD

Activities concerning establishment and utilisation of nuclear facilities and use of radioactive sources are to be carried out in India in accordance with the provisions of the Atomic Energy Act, 1962. In pursuance of the objective of ensuring safety of members of the public and occupational workers as well as protection of environment, the Atomic Energy Regulatory Board has been entrusted with the responsibility of laying down safety standards and framing rules and regulations for such activities. The Board has, therefore, undertaken a programme of developing safety standards, codes of practice and related guides and manuals for the purpose. While some of these documents cover aspects such as siting, design, construction, operation, quality assurance and decommissioning of nuclear and radiation facilities, other documents cover regulation aspects of these facilities.

Codes of practice and safety standards are formulated on the basis of internationally accepted safety criteria for design, construction and operation of specific equipment, systems, structures and components of nuclear and radiation facilities. Safety codes establish the objectives and set minimum requirements that shall be fulfilled to provide adequate assurance for safety. Safety guides elaborate various requirements and furnish approaches for their implementation. Safety manuals deal with specific topics and contain detailed scientific and technical information on the subject. These documents are prepared by experts in the relevant fields and are extensively reviewed by advisory committees of the Board before they are published. The documents are revised when necessary, in the light of experience and feedback from users as well as new developments in the field.

The code of practice on 'Safety in Nuclear Power Plant Siting (AERB Code No. SC/S)' states the requirements to be met during siting of nuclear power plants in India. This safety guide provides guidance for quality assurance in siting of nuclear power plants. In drafting this guide the relevant documents developed by the International Atomic Energy Agency (IAEA) under the Nuclear Safety Standards (NUSS) programme, especially the safety guide on 'Quality Assurance in Siting', have been reviewed for implementing relevant sections.

Consistent with the accepted practice, 'shall', 'should' and 'may' are used in the guide to distinguish between a firm requirement, a recommendation and a desirable option, respectively. Annexures, references/bibliography and lists of participants are included to provide information that might be helpful to the user. Approaches for implementation different to those set out in the guide may be acceptable, if they provide comparable assurance against undue risk to the health and safety of the occupational workers and the general public and protection of the environment.

For aspects not covered in this guide, applicable and acceptable national and international standards, codes and guides should be followed. Non-radiological aspects of industrial safety and environmental protection are not explicitly considered. Industrial safety is to be ensured through compliance with the applicable provisions of the Factories Act, 1948 and the Atomic Energy (Factories) Rules, 1996.

This guide has been prepared by specialists in the field drawn from Atomic Energy Regulatory Board, Bhabha Atomic Research Centre, and Nuclear Power Corporation of India Limited and other consultants. It has been reviewed by the relevant AERB Advisory Committee on Codes and Guides and the Advisory Committee on Nuclear Safety.

AERB wishes to thank all individuals and organisations who have prepared and reviewed the draft and helped in its finalisation. The list of persons, who have participated in this task, along with their affiliations, is included for information.

(S. K. Sharma)
Chairman AERB

DEFINITIONS

Atomic Energy Regulatory Board (AERB)

A national authority designated by the Government of India having the legal authority for issuing regulatory consent for various activities related to the nuclear and radiation facility and to perform safety and regulatory functions including enforcement for the protection of site personnel, the public and the environment against undue radiation hazards.

Nuclear Power Plant (NPP)

A nuclear reactor or a group of reactors together with all the associated structures, systems, equipment and components necessary for safe generation of electricity.

Nuclear Safety

The achievement of proper operating conditions, prevention of accidents or mitigation of accident consequences, resulting in protection of site personnel, the public and the environment from undue radiation hazards.

Quality

The totality of features and characteristics of an item or service that have the ability to satisfy stated or implied needs.

Quality Assurance

Planned and systematic actions necessary to provide the confidence that an item or service will satisfy given requirements for quality.

Responsible Organisation

An organisation having overall responsibility for siting, design, construction, commissioning, operation and decommissioning of a facility.

Site

The area containing the facility defined by a boundary and under effective control of the facility management.

Site Selection Stage

The stage at which identification of one or more preferred candidate sites for a facility are carried out to determine/demonstrate their suitability from various aspects, and in particular, from the safety point of view.

CONTENTS

1. INTRODUCTION

1.1 General

It is important to establish a quality assurance programme for safety in siting of a nuclear power plant (NPP) before commencing site selection process [1]. While determining the basic requirements, care should be taken to keep in view certain specific requirements for inland stations and coastal stations. These basic requirements apply to management activities as well as performance activities related to siting and provide guidance for the assessment of these activities. The point to be emphasized is that managers, those performing the work and those assessing the work, all should contribute in ensuring quality and achieving safety. This guide is within the frame work of the siting code and QA code [2,3] published by AERB. This guide provides briefly the guidelines to facilitate, support and ensure quality assurance (QA) in NPP siting [4].

1.2 Objective

The activities performed during siting stage of an NPP may have influence on its safety. QA in siting activities, therefore, assumes significant importance.

1.3 Scope

This guide describes the requirements of quality assurance programme (QAP) that need to be implemented at the siting stage, by the organisation having overall responsibility for the nuclear power plant. The scope of the guide covers the quality assurance aspects related to management, performance and assessment activities during siting stage of NPPs.

1.4 Structure

This safety guide comprises of four sections and three Annexures. Section 2 provides guidance on QA for the management activities of siting. Section 3 provides guidance on QA for the performance activities related to siting. Section 4 provides guidance on QA for the assessment of siting activities. Annexure I lists out some examples of the siting activities for which detailed procedures may have to be written. Annexure II gives suggestive list of models. Annexure III brings out certain aspects related to mathematical/ computer modelling.

2. MANAGEMENT

2.1 Quality Assurance Programme

The responsible organisation (RO) should develop and implement a QAP which should cover the overall arrangements for the management, performance and assessment of siting for the NPP. This programme should also provide the means to ensure that all related works are meticulously planned, correctly performed and properly assessed.

The siting process generally consists of the following:

- Site selection,
- Site evaluation, and
- Site confirmation.

The RO should establish and implement a QAP in order to ensure that studies, evaluations and analyses of site related characteristics important to safety such as seismicity, meteorology, geology, hydrology as well as human activities in the vicinity of site etc. as detailed in siting code [2], are correctly performed and provide a consistent basis for making decisions about site selection.

The RO should define procedures where necessary for controlling siting activities. Arrangements should be made to ensure that these procedures are reviewed and approved within the RO before issue and subsequent amendment of them is controlled. The general principles in QA will largely be applicable to siting activities also [3]. A list of examples of siting activities for which detailed procedures should be prepared is contained in Annexure-I.

The RO should retain the overall responsibility for the implementation and effectiveness of the QA programme. However, it may delegate responsibility to develop and implement all or part of the QA activities to agencies entrusted with siting activities.

2.2 Graded Approach in QA

Nuclear safety should be the fundamental consideration in the identification of the items, services and processes to which the QAP applies. A graded approach based on the relative importance to nuclear safety of each item, service or process should be used. The graded approach shall reflect a planned and recognised difference in applications of specific QA requirements.

The considerations in such an approach should include the following:

- The intended end use of the knowledge and data that result from siting activities, particularly in terms of their effect on nuclear safety.
- The ability to demonstrate, test or repeat results.
- The scale and technical complexity of the siting activity, whether it is a new or proven concept or model that is being applied, or an extension of a new application.
- The managerial complexity of the activity, the involvement and co-ordination of multiple disciplines, work units or internal and external organisations, with divided or contingent objectives and responsibilities.
- The extent to which other siting work, or later work, depends on the results of the siting activities.
- The expectations or desired use or application of the results.

2.3 Organisation

Siting is not necessarily a continuous activity. It requires diverse inputs. Therefore, expertise should be drawn from different groups within the organisation. Some of the activities may also have to be assigned to concerned departments of Central Government, State Government and other reputed institutions/research centers having specialisation in the particular field.

The RO should formally appoint an entity to be responsible for siting activities. This entity responsible for siting (ERS) should coordinate all activities of siting in a manner as intended in the siting code. In order to get diverse inputs, the organisational arrangement for siting could be in the form of a Committee with specialists from different disciplines and work coordinated by ERS.

The ERS should discharge the following responsibilities:

- Ensuring that siting work is carried out in accordance with requirements, procedures and instructions.
- Ensuring that siting work undertaken, including work by service organisation, is coordinated, conducted and completed in accordance with planned programmes of work.

The ERS should ensure that tasks such as the following are carried out:

- planning siting activities,

- identifying specific work packages and specialist services for siting,
- collection of site data, and
- writing reports.

For all the above activities QA plan should be implemented.

Since it is likely that the work could be shared between the siting organisation and various specialist services and consultants appropriate organisational links, communication channels, interfaces involved and responsibilities should be defined. The responsibility of liaison with regulatory body and local authorities lies with the RO.

2.4 Qualification of Personnel

Personnel should be qualified and experienced in their respective field so that they are competent to perform the assigned work and understand the safety consequences of their activities. Suitable experts from reputed organisations and national agencies may be considered as experienced and qualified personnel.

2.5 Planning of Activities

Siting activities should be planned. The plan should define:

- the siting activities to be performed in manageable units (work breakdown packages); and
- the sequential order and duration of these activities including resource allocation to them.

The siting organization should retain the responsibility for coordinating and planning the overall siting activities. The agencies performing siting activities should be responsible for producing detailed plans of their work and should obtain the approval of the siting organisation for such work plans.

Planning should take into account requirements of studies and evaluation leading to site selection, site evaluation and site confirmation.

2.6 Non-Conformance Control and Corrective Actions

The siting organization should first establish item wise all aspects requiring data collection. The organisation should then establish a non-conformance control and corrective action process that defines how the errors in data collection, recording or reporting; calculations, reasoning, assumptions and conclusions should be dealt with and how non-conformance with procedures and specifications should be documented and assessed.

2.7 Document Control and Records

Procedures for the preparation, review, approval, issue, modifications and control of documents should be established in accordance with AERB/SG/G-1 titled 'Consenting Process for Nuclear Power Plants and Research Reactors: Documents Submission, Regulatory Review and Assessment of Consent Applications'.

A records system should be established which includes the arrangements and responsibilities for the categorisation, receipt, indexing, storage, retrieval and disposal of siting records wherever applicable.

Appropriate records should be prepared and retained during siting work to enable the process to be repeated if necessary. Records should support final conclusions and permit tracing of results to source data and information. Permanent records for siting activities should be identified.

3. PERFORMANCE

3.1 General

3.1.1 Classification of Data

The data to be collected during site selection, site evaluation and site confirmation should be specified. The quality of data collection activity should be commensurate with end use of the same. QA during siting should ensure by appropriate planning that the quality of the data should be of level required for design, construction, operation etc.

Typically, the sources of data are:

(a) Current and historical documents: For example census, meteorological, seismological, survey maps, listing of human activities in the region.

(b) Indirect exploration: Data or information inferred or calculated from indirect tests/data or mock-up investigations but collected for other purposes.

(c) Direct exploration: Data or information obtained from samples, from direct observations or from in situ tests.

(d) Laboratory testing: Data or information obtained from tests conducted on samples obtained from direct exploration.

3.1.2 Data Format

The format and standards to be used for collecting, classifying and presenting the data should be predetermined. The format should be consistent and should facilitate an easy comparison of results between sites. The format should allow for prompt identification of gaps in information. To obtain the data format for specific parameters like logging of boreholes, rainfall, meteorology, seismicity, reference to relevant siting guides should be made. Wherever no format is available standard procedures as applicable should be adopted.

Requirements should be specified for classifying, logging and reporting data from field activities (for example surveys, boreholes, excavations and data collection on meteorological conditions, soil, rock, water and air samples). Data should be stored for easy retrieval.

3.1.3 Work Procedures and Instructions

Siting work should be performed in accordance with specified procedures and instructions. The primary consideration for this is to ensure that they are suitable for the people doing the work, and that they are accurate, clear, concise and unambiguous. For example, they may include checklists or refer to standards.

Work procedures and instructions should include data to be acquired along with their extent of accuracy. They should also contain information on test facilities and equipment to be used, the method of analysis, accuracy required for the equipment to be used, prerequisites and sampling protocol. The method of recording and documentation of results (both field and laboratory) , statistical analysis and quality of data should also be included in these procedures.

Any data received from concerned departments of Central and State Governments or other reputed national institutes/research centers with specialisation in a particular field should be treated as verified after scrutiny by ERS for inconsistencies. A report containing the objectives and usage of data collected should be prepared.

3.1.4 Measuring and Test Equipment

Measuring and test equipment which are used for siting activities, data collection, inspections and tests should be in good condition with proper type, range, accuracy and precision. The equipment needs to be calibrated periodically. Reports on calibration of equipment should be retained and registered. Where recalibrations are called for, they should be recorded. Frequency of checking/calibration of certain sensitive equipment should be specified to form part of routine procedures.

3.1.5 Verification

Work performed during siting should be verified to confirm that it is correct as also to assure that it conforms to specific requirements. The type and extent of verification activity will depend on the nature and importance of the activity. Verification may include an independent check of methods and instruments for field and laboratory activities, and a demonstration of their proper use by the teams performing the work. Inconsistency in data, anomalies and errors should be resolved by indirect exploration and authenticity of sources should be established, particularly where data is obtained by indirect exploration.

The field tests/in-situ tests conducted by one organisation should be verified on the spot by another organisation. The latter should also verify the results generated by the former. Such an independent agency for verification should be identified by R.O. well in advance. This verification process should be ensured wherever necessary on a case-by-case basis.

Documents that form part of, or support of siting decisions should be reviewed to confirm that they are correct, satisfactory and complete as to assumptions, support data and conclusions.

As far as possible calculations should be verified by alternative analyses wherever necessary. If differences arise which substantially modify the final results and conclusions of the original calculations, a more complete and thorough review should be carried out. The type and method of analyses, assumptions, initial conditions, boundary conditions if any and results should be documented.

3.1.6 Planning of Work

The siting activities should be organised and performed in such a way that relevant information will be obtained, collated and scrutinized. The most important factor to be considered is the effect that will be caused by an error in siting activity, or equipment malfunction affecting the choice of the site and subsequently the safety of the nuclear power plant.

Siting activities should be identified and planned so that they are carried out in proper sequence. The methods by which the results and the supporting output documents are reviewed for acceptance should also be identified.

Siting activities should be planned to ensure that

- data are adequate and are recorded correctly;
- data are correctly interpreted;
- appropriate analytical techniques, equipment and instructions are used;
- relevant computer programs are only used and are validated;
- samples are correctly and adequately identified; and
- technicians and operators of instruments or equipment are adequately trained.

The ERS should subdivide the overall siting work into discrete work packages. The scope of each work package and the individual team member or the organisation carrying it out should be identified. When changes in scope are necessary and when all or portions of the work are to be reassigned, a change control should be applied.

3.1.7 Services

Services are of predominant importance during siting processes. Most of the siting activities are mainly performed by hiring the services of specialist agencies. For example, the services that could be obtained include review of relevant literature, collection and review of historical data and evaluation of laboratory tests, field monitoring and measurements, analyses and computations. The RO should assemble a data bank on various providers so that they are readily available.

3.1.8 Input Requirements

Requirements which have to be demonstrated in order to prove and support siting, for example those related to design basis parameters, should be identified.

These requirements should be detailed to the degree necessary to provide a reference for making decisions, interpreting data and verifying results.

3.1.9 Work Control

Siting activities, including those associated with compiling, gathering and analysing the data and reporting conclusions and recommendations, should be controlled to ensure that the results and the supporting documentation such as maps, drawings, photographs, calculations, field notes and historical information are traceable to their sources as far as possible.

Documents containing up-to-date data, its analysis and interpretation, validation, experimental results, results from field measurements or tests, and other formal documents which are produced during data gathering and data analyses should be checked and reviewed.

Studies, evaluations and analyses should be documented in sufficient detail in terms of purpose, method, assumptions, data inputs, references and units, so that a person technically qualified in the subject can independently review, understand and verify the adequacy of the results.

Conclusions should be adequately documented to permit traceability to original input requirements, and to make it possible to study information, experimental data, field measurements, and models and their interpretation.

3.1.10 Mathematical Modelling

Mathematical models should be developed in accordance with technically suitable methods and practices. The models should be able to represent the system or subsystems accurately based on the acquired data. The limitations of the models should be realised and as far as possible validated models should be used. If a model has already been validated for a site, it may be adopted for a new site, if the site characteristics are almost similar. Otherwise it is necessary to show that the characteristics of the new site will result in conservative estimates. Examples of activities requiring modelling are given in Annexure-II. Additional guidance on modelling is given in Annexure-III.

Validated models should be used keeping in view the limitations. Validation already carried out by national organisations should be considered acceptable.

3.1.11 Physical Models

Physical models may be used to scale down many natural phenomena like hydrodynamic processes (e.g. wind tunnel studies) and hydrological processes (e.g. studies on thermal discharge intake/outfall). Physical models that deliver conservative estimates should be preferred for the site characterisation studies. The limitations of the models used for the study should be clearly delineated. The models should also be designed to suit site specific characteristics such as coastal station/inland station as the case may be.

When a model conservatively represents an adequate basis for site selection, it should be preferred.

The selection of input parameters and the adjustment of models to fit specific situations can depend on the characteristics of the site and its region and on certain design features of the plant. It is particularly important, therefore, that the limitations of the model can be determined and specified.

3.1.12 Collection of Data

When contradictions in data collected from more than one source arise, they should be explained and a decision taken on the basis of technical judgement, experience, safety consequences and the authenticity of the source.

The data should be developed into a coherent, well documented description of site characteristics. Lack of confidence in the quality of the data, i.e. in their accuracy, applicability, completeness or quantity, may preclude their use. In such cases a pragmatic approach should be used, based on expert judgement. The use of such data should be declared, justified and authorised.

If statistical data on a national, continental or worldwide basis are used, the values obtained should be examined to determine whether or not they need to be adjusted to compensate for unfavourable characteristics of the site and its surroundings. Field and laboratory investigations should be carried out wherever available data is insufficient.

3.1.13 Reviewing Data, Calculations and Results

Data collected should be reviewed for its appropriateness before use. Calculations performed should be reviewed so that they are performed in accordance with approved procedures.

3.1.14 Analysis of Data

The data should be compiled, examined and analysed in an organised manner. Attention should be given specifically to:

- data that can have direct influence on the acceptability of a site;
- data that can substantially influence the compliance of design basis criteria of a site; and
- ensure that the information collected is complete, reliable and relevant for reviewing safety considerations.

Wherever all the information necessary to form conclusions is not available, such limitations and gaps in the data should be clearly identified. The need for, and the method of, filling gaps should be assessed.

At the design and pre-operational stage of a nuclear power plant, additional investigations may be required to arrive at the precise design basis and final confirmation of the site.

3.1.15 Output Documentation and Reporting

Data analyses, calculations, tests and reviews, proposals, recommendations, conclusions and decisions regarding siting should be documented to allow for evaluation.

Output documents should demonstrate that relevant aspects have been considered.

Reports describing the intermediate and final results in different areas of investigation, and an analysis of them, should be prepared and documented.

Field reports should cover all results and observations called for.

Laboratory reports should include the identification of the activity or test performed, the equipment used, the sample tested, the date of the test, and the procedure used.

3.2 Field Work and Laboratory Work

Field work includes, for example, surveying, experiments, drilling of boreholes, test excavations, trenching, seismic monitoring, geological investigations (both site and regional) and testing of model structures.

To obtain a complete understanding of site characteristics, it is necessary to select the correct locations for carrying out field work. If instrumentation is to be used or installed, its position and exposure may be important for obtaining representative data. Monitoring frequencies and recording times and the agency for monitoring should be determined and specified.

Before any equipment is installed on the site, the site terrain should be examined to ensure that the positions selected will provide data which are representative and as complete as necessary.

When drilling is to be performed, requirements should be specified for the appropriate abandonment and sealing of boreholes and wells and for recording their location.

When sampling is to be performed, the methods, places, numbers and size should be chosen on the basis of information required. Applicable existing standards or guides should be referred for this purpose.

Field sampling, in situ and laboratory testing, and the collection, classification, logging and reporting of relevant field and laboratory data should be performed in accordance with appropriate procedures or instructions specific to the activity.

Field and laboratory equipment should be maintained in good working condition. Such equipment should be checked before, during and after the performance of related activities to ensure accuracy.

During the performance of field work, controls should be implemented to ensure, for example, that:

- the location of a measurement or of an item such as geological feature is accurately recorded; and
- the type and number of borings, excavations, geophysical and geological surveys, and samplings of soil, rock ground, water and air are identified;

Similarly, during laboratory work, the preservation of sample integrity and identification should be maintained.

3.3 Siting Process

QA and data collection should be consistent with the following stages of siting process.

3.3.1 Site Selection

All potential sites for setting up of nuclear power plants should be identified by ERS in consultation with local authorities and taking into account basic criteria for selection of sites[2]. Preliminary data on essential siting characteristics which have bearing on the acceptability of the sites should be collected for all these sites [2]. Screening of the sites should be carried out based on the basic siting criteria. Sites that do not fulfil the basic criteria should be excluded. The reasons for rejection should be clearly recorded. More detailed information as per the siting requirements should be collected on the remaining sites. This data should be supplemented by actual site investigations where necessary. Regarding meteorological parameters, data from the nearby representative station can be collected and used since meteorological stations would not have been set up at the site. The seismic and flood potential at the site should be assessed by experts with respect to the design basis of the proposed plant. This work is supplemented by survey and contour plan of the sites, limited borehole investigations, etc. As regards data like population, land and water use, environmental aspects, details are collected from local authorities. Site visits are undertaken. The work done to establish the suitability of site should be documented in the form of a report. The site characteristics and the degree of suitability should be compared to arrive at a panel of suitable sites. For making this assessment, a Committee of specialists from different disciplines/functions is generally formed with ERS coordinating the activities.

3.3.2 Site Evaluation

Since basic suitability of the site is established as in 3.3.1, detailed site evaluation is carried out to arrive at the site related design bases of project proposed to be set up. At this stage detailed investigations regarding parameters such as seismicity (assessment of peak ground acceleration), detailed flood analysis to arrive at safe grade level, thermal pollution, drawal and discharge arrangements for cooling water and detailed subsoil investigations (adequate number of boreholes, tests on soil and rock samples) for determining foundation design are taken up. Meteorological stations are set up at the site to find out the site specific meteorological characteristics using data collected over a period of time. The site characteristics applicable to atmospheric dispersion, aquatic dispersion and groundwater dispersion should be analysed in detail to finalize the design parameters. Assessment on availability of start up power and power evacuation is also carried out. Prior to project implementation stage detailed investigations should be carried out to finalise the site related design basis.

3.3.3 Site Confirmation

Prior to site confirmation the characteristics of the site chosen should be well established. Studies and investigations may be continued after the start of excavation/construction but completed before commissioning and operation. Parameters which have been estimated during site selection are often verified through investigations during site confirmation.

The collection of data may continue throughout the construction stage and sometimes may be required during operation to verify information obtained prior to construction. Additional data may be available only after excavation has begun.

4. ASSESSMENT

4.1 Management Self Assessment

As a means of ensuring the adequacy of siting activities, the RO should ensure that project management performs self assessments to determine how well it is meeting its objectives. Self assessment should facilitate integrating worker performance with safety, reliability and business objectives. Known performance issues should be evaluated, the contributing management aspects should be identified and for continuous improvements. Strengths and weaknesses should be identified and meaningful actions should be taken where improvements are necessary.

4.2 Topics to be Addressed

Typical subjects to be addressed by assessment during siting are:

- Interfaces
- Work planning for field activities
- Conduct of field and laboratory work
- Methods for handling errors and non-conformances
- Reliability and traceability of data

ANNEXURE-I

EXAMPLES OF SITING ACTIVITIES WHICH MAY REQUIRE PROCEDURES

- Geotechnical investigations
- Collection of meteorological data and analysis of the data. Such data in respect of coastal stations should be more elaborate on tidal variation, cyclonic storms, their frequencies, wind speed, marine life etc. relevant to the site.
- Studies related to site seismicity
- Geological studies including borehole investigations
- Hydrological studies, estimation of design basis flood level for site and ground water studies
- Hydrogeological studies
- Conducting epidemiological studies
- Feasibility of implementation of off-site emergency response plans

ANNEXURE-II

MODELLING (TYPICAL EXAMPLES)

A. To Fix Safe Grade Elevation of Plant Site

- Mathematical model for evaluating storm surge in coastal site
- Sea wave flume studies for finding wave run-up
- Upstream dam (s) failure and consequent flood routing

Apart from modeling studies a detailed assessment of the physical features of the site shall be carried out by a specialist group taking into account flooding, submersion of land usually observed at such locations.

B Intake and Outfall Model Studies for Condenser Cooling Water System

- To find out the temperature distribution of hot sea water near outfall
- To ascertain the method of discharge of hot water
- To decide the location of intake and outfall structure
- To meet the requirements of Environment Protection Act
- Obtain details on marine growth due to temperature variations that may arise due to condenser discharge.

C Dispersions Models

- To estimate dilution capacities of the atmosphere
- To estimate dilution capacities of surface water and ground water

ANNEXURE III

DESIGN, TESTING, APPLICATION AND CHANGE CONTROL FOR MATHEMATICAL/COMPUTER MODELLING

III.1 Planning

Planning should result in identifying the data required, the system and subsystems to be modelled, the modelling methods, and the activities required to select, develop, verify and validate the models.

During planning the need for the following should also be identified:

- The analyses and reviews to be performed
- Model selection and development
- Verification requirements (verification plan)
- Validation requirements (validation plan)
- Sensitivity requirements.

III.2 Work Control

Standardised methods or instructions should be used for:

- Developing a model
- Verifying the model
- Validating the model or determining the potential for errors
- Correcting errors and non-conformances
- Performing sensitivity investigations
- Performing uncertainty estimates.

The source of the data used to develop or to select the model should be identified and maintained. Examples of sources are: existing data files, literature, laboratory experiments, tests and field observations.

III.3 Model Selection

Because of the continual evolution of models, they need to be evaluated carefully before actual application. An accepted process and technical judgement are needed in selecting the modelling approach.

The final selection of the model to be developed, or to be used, should be reviewed and approved. The justification should show that the model will adequately represent the system or subsystem and is appropriate to the current stage of the siting analysis. The justification of the selection should be documented.

If the development of a model is required, phenomena which are decisive to the final results and calculations, including those which comprise the whole system, its components and interrelationships, should be reviewed and approved prior to model development.

Phenomena which could change the state of the system and phenomena which will make a significant contribution to the overall radiological impact should be identified.

III.4 Model Development

When a new model is to be developed, the requirements identified during planning should be followed.

A development plan should define the development sequencing, the reviews, verification and validation that are to be performed.

When a subsystem analysis is necessary, a strategy and specific criteria for the selection of subsystem models should be identified and subjected to review and approval. Conformation that these criteria have been satisfied should be recorded.

The correlation between theory and experiment should be demonstrated.

Changes to models due to increased knowledge of the system, or resulting from conditions not considered early enough in development or during development, should be controlled and should be subjected to the above requirements.

III.5 Model Sensitivity

The sensitivity of model calculations to input variation should be investigated. The method to be used should be specified. The models should be verified prior to investigations of their sensitivity.

The strategy, technique, sample size, analyses and results should be reviewed to confirm that they are appropriate and accurate.

III.6 Uncertainty Analysis

All causes of uncertainties in the data and analyses should be identified and quantified.

The method of performing analysis and presenting the results should be specified.

Reviews should be performed to confirm the adequacy of the method and the accuracy of the results and calculations.

III.7 Model Verification

A method for carrying out model verification should be developed. The extent of verification should be determined during planning and should be performed by individuals other than those who developed the model being verified.

The verification should confirm and demonstrate that:

- the mathematical model or corresponding computer program is a representation of the conceptual model/phenomenon involved;
- the equations have been correctly encoded and solved; and
- the programme functions correctly under the set of conditions that bound its intended usage.

III.8 Model Validation

A thorough understanding of the model and its range of applicability should be obtained and where possible the expected level of error determined and recorded.

The test plan should identify the validation method, for example comparison with field and laboratory data or comparison with natural systems, and should define the model features to be tested and the data to be used to test them. After validation, a programme of investigations should be carried out at the candidate site to determine key model parameters for matching the model to the site.

Descriptions for each validation test case should be prepared and reviewed for approval.

III.9 Model Review and Update

Models should be reviewed at specified intervals, updated and revalidated as required.

The review process should ensure that the models represent the latest field data and laboratory results, and represent the current revision of the system or sub-system during modelling.

III.10 Change Control

The integrity and configuration of the model should be maintained and protected identifying and controlling model software components and changes to the software and the supporting software documentation.

III.11 Traceability of Data

The source of data which, when used in modelling, will affect or support conclusions on siting should be retained throughout the development of the model. Intermediate iterations and the final model should be traceable.

Adequate cross-reference to specific data should be provided. The data format should be such that it can be reviewed and checked.

III.12 Records

The following are examples of records and documents that should be retained:

- justification of model selection,
- confirmation that selection criteria have been satisfied,
- experimental data related to the model,
- results of sensitivity and uncertainty analysis,
- report showing that the required tests, verification and validation were performed, and
- records which show what the current program version is.

REFERENCES

1 INTERNATIONAL ATOMIC ENERGY AGENCY, Safety Series No. 50-C/SG-Q 'Quality Assurance for Safety in Nuclear Power Plants and Other Nuclear Installations-Code and Safety Guides Q1-Q14', Vienna (1996)

2 ATOMIC ENERGY REGULATORY BOARD, 'Code of Practice on Safety in Nuclear Power Plant Siting', AERB Code No. SC/S, Mumbai, India (1990)

3 ATOMIC ENERGY REGULATORY BOARD, 'Code of Practice on Quality Assurance for Safety in Nuclear Power Plants', AERB Code No. SC/QA, Mumbai, India (1988)

4 INTERNATIONAL ATOMIC ENERGY AGENCY, 'Code on the Safety of Nuclear Power Plants Siting', IAEA-SS-50-C (Rev-1), Vienna (1988)

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Safety Series No.	Title
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AERB/SG/S-6B	Design Basis Flood for Nuclear Power Plants at Coastal Sites
AERB/SG/S-7	Man-Induced Events and Establishment of Design Basis
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AERB/SG/S-11	Seismic Studies and Design Basis Ground Motion for Nuclear Power Plant Sites

AERB SAFETY GUIDE NO. AERB/NPP/SG/S-10

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