TERMS OF REFERENCE (ToR)
OF
NUCLEAR POWER PLANT SITING
IN BANGKA ISLAND
OF BANGKA BELITUNG PROVINCE
(2011 – 2013)

CENTRE FOR NUCLEAR ENERGY DEVELOPMENT
NATIONAL NUCLEAR ENERGY AGENCY OF INDONESIA
(BATAN)
2010

APPROVAL SHEET

		Nama	Tanggal	Tandatangan
Prepared by		1. A. Sarwiyana Sastratenaya		
		2. Yarianto S.B. Susilo		
		3. Suparman		
		4. Kurnia Anzhar		
		5. Eko Rudi Iswanto		
		6. Sunarko		
Reviewed by		1. Adiwardojo		
		2. Ferhat Aziz		
Approved by		Hudi Hastowo		

TABLE OF CONTENTS

INTRODUCTION

1 INTRODUCTION

1.1 Background

Based on the long-term energy planning and assessment in the "Comprehensive Assessment of Different Energy Source" (CADES, 2003), it is concluded that the energy demand in Indonesia in year 2025 will become twofold compared to the energy demand in year 2000, and the demand for electricity is four times higher than that for year 2000. According to the result of the study, in order to supply the energy demand in 2025, the application of energy mix needs to be introduced. Nuclear Power Plant (NPP) will be introduced into the Java-Bali electricity grid in 2015-2016 (considering the current situation, it seems that the target cannot be realized on schedule) to supply electricity demand with the following considerations:

1. Diversification is necessary to maximize the utilization of various resources of energy to avoid dependence on single resource;
2. Intensification of energy to guarantee electricity supply;
3. Conservation to save energy exploitation, and;
4. Environmental sustainability.

According to Act No. 17 year 2007 on the National Long-Term Development Plant Year 2005-2025, and Presidential Decree No. 5 year 2006 on the National Energy Policy, nuclear energy is stated as a part of the national energy system. In order to undertake the above national policy, BATAN as the promotor for the utilization of nuclear energy will conduct site study, which is a part of infrastructure preparation for NPP construction, as a form of government incentive.

Act No.17 year 2007 is implemented in the Presidential Regulation No. 5 year 2010 on the National Medium-Term Development Plan 2010-2014 with a mandate that the NPP siting should be performed in year 2010 to 2014. Based on the "Blueprint on The Acceleration of NPP Construction Preparation", Bangka site

preparation, in form of the Site Evaluation Report (SER), Site Data Report (SDR), and Early Environmental Impact Analysis Report (EIAR) documents. In addition, Site Data Information and Draft of NPP Master plan will also be produced. Reports should be completed by the end of 2013. The documents will be handed over to the Owner for the purpose of site permit application. The roadmap of NPP siting project in Bangka Island is shown in Figure 1.

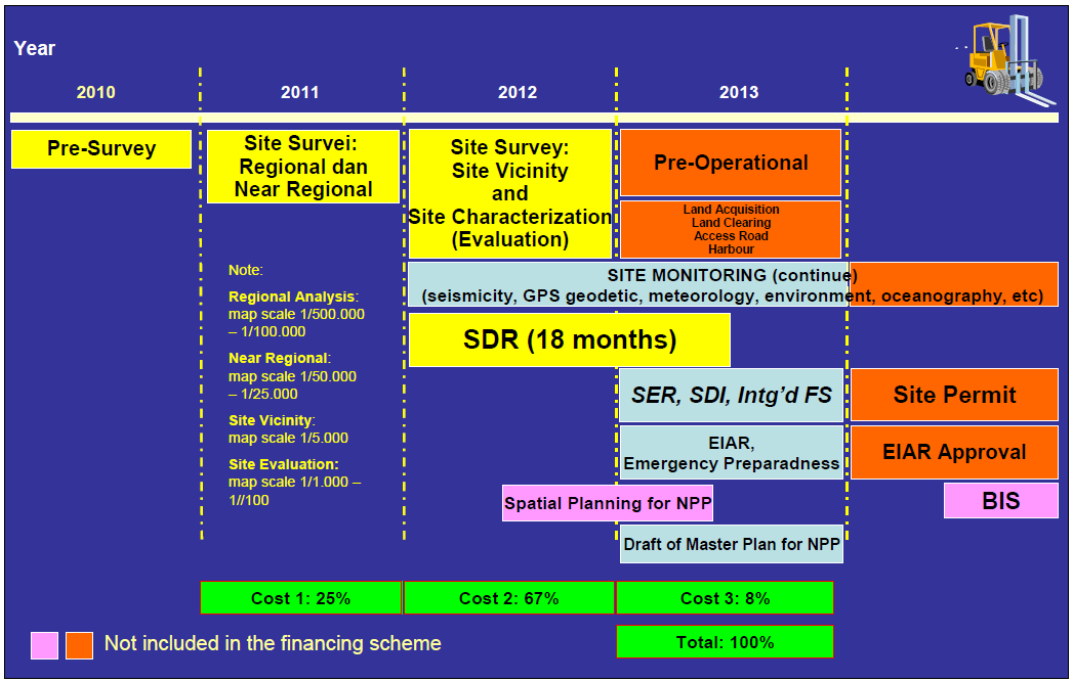

Figure 1. Roadmap of NPP Siting Project in Bangka Island

Thorough preparation and steps are needed to operate an NPP and it takes between 10 to 15 years from the preliminary study (site selection, financial study, etc.) up to project implementation (manufacturing, construction, commissioning). NPP construction requires a large amount of capital, high level of technology, well-qualified man-power, public acceptance, long preparation time, acquisition of special permits, and satisfies international requirements (IAEA Guidelines). During project implementation, it is necessary to prepare various documents relevant for permit application such as SER for site permit, PSAR (Preliminary Safety Analysis Report) and EIAR for construction permit.

Considering the continuously increasing electricity energy demand, it is necessary to prepare for alternative NPP sites. Within the framework of identifying NPP sites, site surveys are performed in West Java, Banten, and Bangka Island of Bangka-Belitung province.

1.2 Objective

The objective of the project is a compilation of documents from two candidate sites (one for each interest area). The documents are consisted of:

- Site Evaluation Report-SER
- Early Environmental Impact Analysis Report (EIAR)
- Draft of NPP Masterplan

The documents are supplemented by:

- Site Data Report-SDR
- *Site Data Information*-SDI, containing design parameters.

SER is ready to be submitted to NPP owner for application of NPP Site Permit in Bangka Island. Early EIAR document will be developed further for construction permit application. Draft of NPP Masterplan is used as the basis for NPP Detailed Plan for Spatial Planning (DPSP). SDI document will be used by the NPP Owner for NPP bidding.

Non-site Feasibility Study is performed by PT. PLN (Persero) and the Consultant within the scope postulated in Figure 2, with the objective of assessing NPP acceptability in Bangka Island from Non-site aspect.

The resulting Site Study Reports will be integrated with Non-Site Feasibility Study Report to produce a comprehensive Feasibility Study Report (FSR).

Although 2 (two) candidate sites are prepared, site ranking should be performed to determine two candidates to be nominated for the first NPP.

The yearly objectives of activities are as follows:

- The target of Year-1 is a set of report containing:

- Demonstration of acceptability, particularly from safety aspect for two interest areas,
- Integrated and systematic development of database system
- Development of non-site feasibility study document covering the determination of size and technical features, safety criteria and feature, probabilistic risk assessment, and NPP type recommendation

- The target of Year-2 is a set of report containing:
  - The result of site vicinity survey and site characteristics per December 2012,
  - Updated database per December 2012,
  - Non-site feasibility study inculding HRD requirements, project schedule, contract approach, fuel-cycle analysis, important material and services, as well as infrastructure and national participation
- The target of Year-3 is a set of report containing:
  - SER
  - Early EIAR
  - Draft of NPP Masterplan, complemented with SDR and SDI
  - Integration of site and non-site feasibility study report into a comprehensive NPP Feasibility Study Report in Bangka Island,
  - A system of Bangka Island site database.
- Implementation of each target in Year 1, 2 and 3 is guaranteed by accurate and consistent implementation of Quality Assurance Program (QAP) or Integrated Quality Assurance System Program (IQASP) to achieve qualified results satisfying national and international standards (e.g. International Atomic Energy Agency).

The complete list of reports that should be provided by the Consultant is provided in Annex-4.

1.3 Scope of the Project

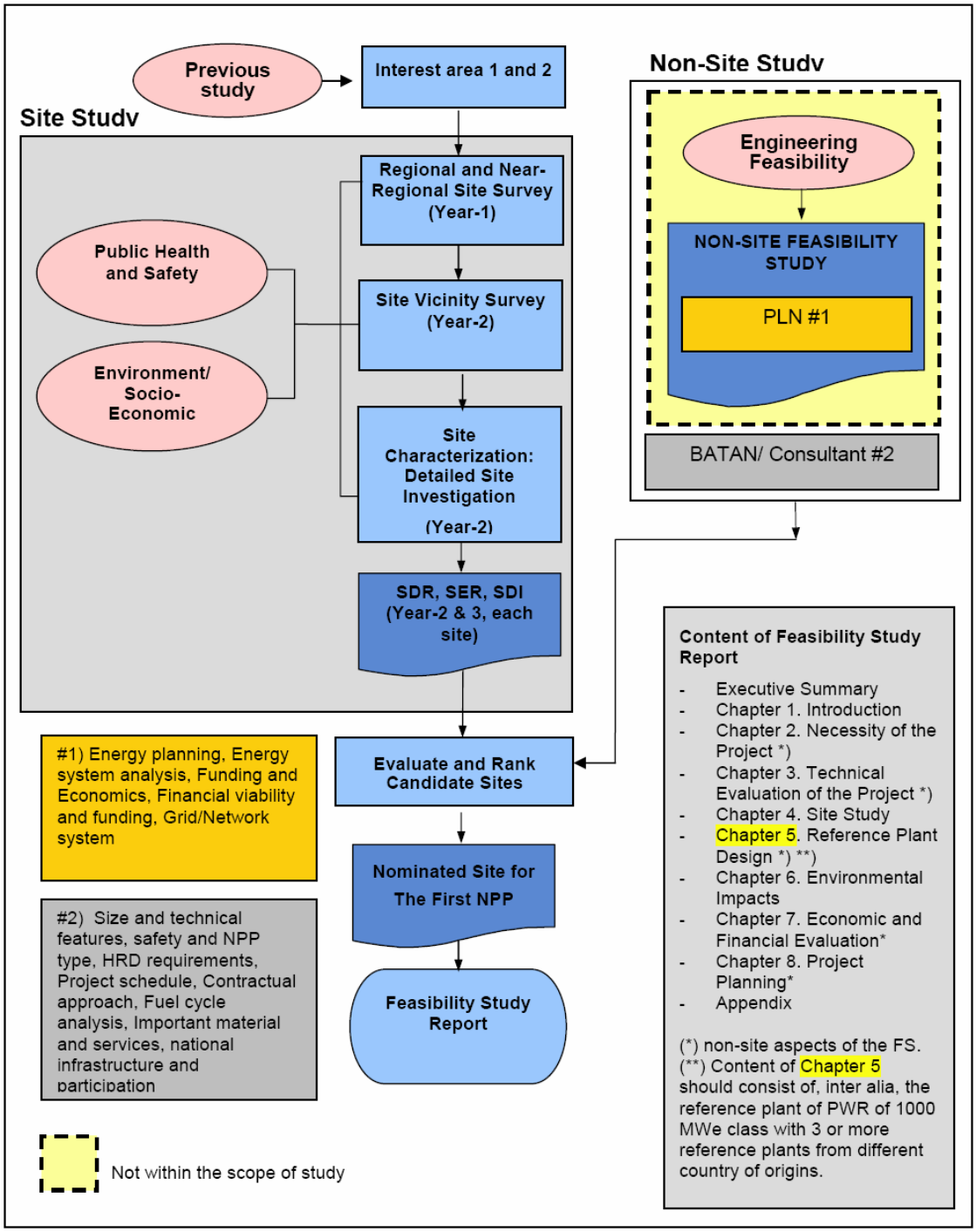

Figure 2. Scope of the Project on Preparation of NPP Site at Bangka Island, Bangka Belitung Island Province which is integrated with the result of non-site study

The scope of study is divided into 4 (four parts) namely regional, near-regional, site-vicinity and site-area. Further information is provided in Annex-3.

1.4 Source of Funding

The funding for this project is obtained from: DIPA (*Daftar Isian Pelaksanaan Anggaran*) for The Center for Nuclear Energy Development with a total budgeted amount of Rp. 159.000.000.000 for 3 years (3 years: 2011, 2012 and 2013).

1.5 Name and Work Unit of Commitment Maker Official

Commitment-maker Official (PPK): (Kurnia A.)

Work unit : The Center for Nuclear Energy Development
National Nuclear Energy Agency

1.6 General Requirements

1. All the products of the activity should be arranged in a database system (soft-copy) with the following specifications:
   - Spatial data should be put into GIS format (soft-copy).
   - Non-spatial data, references, etc., are prepared in form of hard-copy and soft-copy in a systematic manner. The important reference maps should be digitized into GIS format and can be integrated into the database. Furthermore, maps of the result of the activity is also put into a map hard-copy album in papers of appropriate sizes (A3-A0), each has 2 (two) hard-copies.
2. Executing Consultant (henceforth referred to as Consultant) should accommodate the recommendation as a result of evaluation performed by Supervising Consultant (henceforth referred to as Supervisor) appointed by PPEN-BATAN (henceforth referred to as Owner), and/or IAEA experts, without additional cost (will be accommodated as add/subtract work).

3. Any disputes between Consultant and Supervisor should be mediated by both parties, referring to the work objective and target and reported to the Owner.
4. In coherence with Chapter (article) 8 of the Government Regulation No. 43/2006, Site Evaluation Plan (SEP) and Quality Assurance Program (QAP) should be prepared and submitted to the Nuclear Regulatory Agency (BAPETEN) for evaluation and approval no longer than 45 (forty five) calendar days after the signing of the contract. SEP should, at least, contain:
   - organization of site evaluator
   - evaluation schedule
   - procedure for data acquisition and analysis
   - acceptance criteria
   - documentation and reporting
5. Within the Technical Bid Documents (Proposal), Consultant should prepare:
   - Quality Assurance Program (QAP) for, at least, level 1 and level 2 for the whole activity (three years);
   - Part of Level 2 QAP, i.e. Work Procedure, WP and Work Plan & Work Schedule (WP/S) for Year-1 in detail for each site and non-site aspects;
   - Part of Level 2 QAP, i.e. Work Procedure, WP and Work Plan & Work Schedule (WP/S) for Year-2 and Year-2 in general terms for site and non-site aspects.
6. Part of Level 2 QAP, i.e. Work Procedure, WP and Work Plan & Work Schedule (WP/S) for Year-2 and Year-2 in detail should be prepared and approved by Supervisor and to be submitted together with interim report of Year-1.
7. Revision of WP and WP/S can be performed at most three times during the contract period, as per request of Supervisor or Consultant with the consent of Supervisor.
8. Activities should be performed according to the approved WP and WP/S. In case of disagreement, Consultant should repair/repeat the work.

9. Data analysis is performed according to the proven scientific methods referring to guides published by the International Atomic Energy Agency (IAEA), credible national/international institutions, best practices and/or national regulation.
10. All consequences to the personnel and equipment used in the activity are the sole responsibility of the Consultant.
11. All result of the activities and procured equipment, if any, related to the contract is proprietary of and should be submitted to BATAN, including data from field-work activities before and after being analyzed.
12. All tests performed should be done in, at least, nationally accredited or certified institutions.
13. Consultant should provide scientific visit and on-the-job training to Owner related to particular aspects, such as, geotechnics, geology, geophysics, dose assessment, meteorology, seismology, NPP construction management, grid analysis and NPP technology, which is a part of NPP technology transfer.
14. Consultant should prepare a home office completed with adequate meeting room in Jakarta to facilitate all meetings among Consultant, Supervising Consultant and Owner for the whole duration of activity.
15. Consultant should provide a director kit in the site completed with meeting room to accommodate 15 people completed with meeting necessities (white screen, slide projector, laser pointer, personal computer, and wireless speakers), air conditioner, and equipped with internet facilities/network.
16. Consultant should provide a glossary for all terminologies used in the bidding proposal and all resulted documents thereafter.
17. All reports should be prepared in English, except those for administrative purpose which should be written in both English and Bahasa Indonesia (see Attachment TOR-4).
18. The list of report in Attachment TOR-4 is the minimum requirement for the Consultant. Modification of report title can be done only with the consent of Supervisor.

19. Consultant should conduct Project Review Meeting (PRM) on a regular basis of at least once a month including special meetings at the request of the Owner.

SITE AND ENVIRONMENTAL STUDY

2 SITE & ENVIRONMENTAL STUDY

Data collection and analysis should be performed in accordance with, but not limited to, the scope and methodologies mentioned for each study aspect described below. Consultant may make written comments and suggestions as an improvement to this Terms of Reference which can be accommodated in the technical proposal. The following study should be done for each interest area. In case there are field works which can be done for both areas, mainly in the regional scale analysis, Consultant can conduct one work for both interest areas, whenever acceptable from scientific point of view.

2.1 REGIONAL AND NEAR-REGIONAL STUDY (YEAR-1)

2.1.1 Introduction

The basic objectives of the YEAR-1 phase should cover the regional analysis activity and near-regional survey activity.

2.1.2 Geography and Topography

Geographic and topographic data should be in form of digital format and collected upon the interest area, consist of:

- existing topographic map and data (regional and near-regional scale analysis),
- existing aerial photograph,
- Exploitation of existing satellite imagery (Landsat, SPOT, DEM/SRTM) not older than 5 (five) years.

The above collected data will allow to define the site which could accommodate NPP units up to 10,000 MWe of 1000 MWe class including nuclear waste interim storage facilities, this definition being based upon geographic and topographic criteria. Information obtained will allow the estimation of the available surfaces and a first approximation of the future activities. Significant indications, inter alia,

cape effect, excavations for water structures, geology (fault detection), or soil occupation/land use may also be derived.

Data obtained as above should be used to establish a topographic and geographic map for near regional scale analysis or at 1/25 000 scale. Each map should cover about 25 km radius, and it should be prepared on the basis of aerial photography and/or satellite imagery.

In any case, either aerial photographs or standard field topography, the map contour interval for the scale of 1/25000 will be ±12.5 m. All administrative boundaries in the study area should be defined and plotted in the map.

2.1.3 Geological, geophysical & geotechnical investigations

A. Regional geology, tectonics and neotectonics

Field investigation should be performed by a team composed of experts in geology, tectonics, neotectonics, and geomorphology, with reference to secondary data such as geological maps on the studied area, topographic maps, aerial photographs and/or satellite imagery, land geology and geophysical data (seismic reflection, gravity, magnetic) to obtain at least:

- Regional geological map at a scale of 1/100 000 and completed by lithology description.
- Near-regional geological map at a scale of 1/25 000, a tectonic map and a neo-tectonic map completed by lineaments and/or faults, both on land at sea, traverse and outcrops map. Outcrop map is accompanied with lithology and their structural elements. The maps will cover an area within the radius of 25 km around of the interest area.

GPS geodetic monitoring should be performed to monitor uplifting process in the study area in addition to morfometry analysis as stated in the “Geological Map of the South Bangka Sheet”, Margono et al. (1995). Although indication of uplifting

only occur in the southern part, the monitoring should be performed at both interest areas.

B. Geophysics investigation

1. Geophysical land survey using seismic refraction method in the interest area should be conducted to detect geological accidents (faults) and folding structure, to characterize the nature of foundation rocks and soils, and to estimate the dimension of the different geological units/formations.
2. Geophysical, PS-logging, and video down hole camera

   Subsurface data acquisition should be performed on spontaneous potential, gamma ray, resistivity, caliper, density, shear wave velocity, and video down hole camera recording.

C. Geotechnical investigation

1. Core boreholes and continuous sampling: Borings should be used to adjust the results of the geophysical survey concerning the actual nature of the geological formations and their dimension. They will also allow the recovery of undisturbed samples for laboratory tests and to permeability tests.
2. In situ measurements:

   In situ tests (pressure meter and S.P.T.) should be used to detect very compressible soils and liquefiable soils (sands or silts) in the case of earthquake.

   i. Standard penetration tests should be conducted to evaluate the risk of liquefaction of loose sands or silts under the water table level during a strong earthquake.

   ii. Pressure meter tests should be conducted to allow the detection of very compressible soils in order to prevent very strong settlements and differential settlements.

iii. Permebility

iv. Downhole camera

3. Laboratory tests on samples:

These tests include:

a. Index test

- natural water content
- dry density
- specific gravity
- grain size analysis with hydrometer test (if necessary)
- Atterberg limits
- carbonate content

b. Unconfined compression tests (R_c) and undrained shear strength measurement with laboratory vane.

c. Compressibility (oedometer): pre-consolidation pressure, compression index, immediate settlement and coefficient of consolidation.

d. Determination of maximum and minimum density.

e. Static characteristics:

- Unconsolidated undrained triaxial test (U.U)
- Consolidated undrained triaxial test with pore pressure measurement
  (CU + U)
- Consolidated drained triaxial test (CD)

D. <u>Ground Collapse</u>

As a minimum, the following indicators of potential cavities and susceptibility to ground collapse should be considered: sinks, sink ponds, caves and caverns, sinking streams, historical ground subsidence, mines, surface depressions, Rock types such as limestone, dolomite, gypsum, anhydrite, halite, etc.

E. Marine Geology

Marine geological surveys are important in providing the critical evidence for sea floor spreading and plate tectonics in the interest area.

2.1.4 Seismology

Data for regional scale analysis should be collected, both from published and unpublished geological and geophysical sources, to provide knowledge of the general geodynamic setting and to identify and characterize the geological features that have the potential for displacement and/or deformation at or near ground surface (capable faults) in a 500 km radius, extended from regional scope radius of 150 km.

Near-regional study should define the seismotectonic characteristic on the basis of a more detailed database compare to regional scale analysis for fault characterization.

Data from a micro-earthquake monitoring network comprising of at least 4 triaxial micro-seismic stations should be collected for a minimum period of 2 years with the purpose of evaluating the activity of possible faults as well as possible deep volcanic activity in the region.

Microtremor survey should be performed in the interest area for predominant period analysis.

A preliminary regional seismotectonic model should be established. The regional seismo-tectonic model should be revised on the basis of new data. In particular seismogenic structures and historical earthquakes within a radius of 150 km from the interest area should be described in detail.

Ground acceleration data should be collected on the site from the beginning of YEAR-1: Seismology and any records from this strong-motion seismometer should be processed and evaluated. A comprehensive monitoring program should

be related to seismology and other relevant ground motion parameters be recommended for the future.

2.1.5 Volcanology

Data on volcanology and volcanic activities within the 500 km radius from the site should be collected and assessed to demonstrate the acceptability of the site viewed from the aspect of volcanology. Consultant should carry out a comprehensive reconnaissance campaign and field observation.

Hot spring water phenomena in the Bangka Island should be assessed, supported by secondary data collection, field survey, and water and gas analysis to understand their geological origin (volcanism, non-volcanism, or other phenomena) and future hazard potential.

2.1.6 Oceanography, Off-Shore Geophysics & Coastal Flooding

A. Oceanography

Oceanographic survey covers measurements of water level, temperature, wave, sea current and salinity as well as bathymetric survey. It should be noted that water level measurement is necessary during the bathimetric survey, temperature measurement, and sea current as tidal reference.

– Water level measurements: It is absolutely necessary to start water level measurements at the very beginning of the studies. Long term data are necessary in order to be able to extrapolate statistically maximum and minimum water level which will be used as design values for the setting up of the NPP platform level, and of the pumping station minimum level. The sea water level should then be recorded continuously at two stations during YEAR-1 and YEAR-2, after which only one station (at the finally chosen site) will be kept for continuous measurements.

The measurements will provide in particular the characteristics of local tides, the local mean sea level, and preliminary information on the extreme water

levels. It has to be noted that these water level measurements are necessary during the bathymetric surveys, as reference level, and also during the temperature and future current measurements, for tidal references. The water levels should be analyzed in order to get first estimates of the extreme water levels (maximum and minimum) in the area.

- Secondary bathymetric data available at the P3GL-ESDM (the Center for Research and Development of Marine Geology - the Ministry of Energy and Mineral Resources) covering the whole Bangka Strait which can be utilized. Bathymetric survey should be performed covering 25 km radius from the interest area, to produce a detailed bathymetric map for preliminary study of the possible locations of the intake and discharge cooling works and as basic input in the numerical models of wave propagation and coastal flooding, for the sediment studies and for the models of thermal impact.

  During bathymetry survey, representative water salinity data should be collected.
- Water temperature measurements: To allow extrapolation to extreme water temperatures and design values for the operation of the cooling systems, long term temperature data are necessary, and must begin as soon as possible. It is also very important to know very rapidly the vertical temperature stratifications which occur in the area, and which can orientate the choice of the inlet-outlet works. The sea water temperature should be measured continuously for two years at two locations; at each location, surface, mid-depth and bottom temperatures should be measured; the measurements will provide preliminary information on the annual variation of sea water temperature and of its gradient along the vertical.
- Wave measurements: Wave measurements should be made in order to determine the design wave which will be used for the definition and protection of the intake and discharge works.

The waves should be recorded offshore at two locations (precise locations have to be determined but should be inside the area measured during the bathymetries) using wave recorders. As for the direction of waves, they should be observed twice a day. These two wave recorders should be operated for at least one complete year and will provide preliminary information on the maximum and significant wave heights and associated periods and directions.

- Marine current & salinity measurement: The knowledge of the marine currents is necessary in order to be able to predict and optimize the thermal impact and recirculation of the discharged waters, and also to evaluate and quantify the sediment processes. During the marine current measurement, water salinity should be measured. The measurements should be done twice a year, in relation with the relevant meteorological phenomena (monsoon).
- Coral mapping should be performed.

B. Marine Sedimentation

The quality of the sea bottom must be taken into account in order to avoid as much as possible problems which could occur (withdrawal of sediments into the intake, scouring and erosion near the discharge, general future evolution of the bathymetry, etc.). Samples of sea bottom sediments should be collected and analyzed in order to provide their size range distribution.

Available data concerning past evolution of the coast (satellite images of shoreline contours from the eighties) should be searched and collected in order to estimate the sediment processes and parameters governing the evolution of the coast. During the current measurements, turbidity should be measured.

Data and measurements should be processed and analyzed, in relation with the current measurements in particular, in order to evaluate and compare the sediment characteristics and processes on the site: size range distribution of the

sediments, processes involved (bed-load transport, suspension, etc.), littoral drifts, sediment transport rates etc.

C. Coastal Flooding

Data on historical coastal flooding due to tsunamis, seiches, storm surges, eustacy, storm waves wind generated waves, bores and mechanically induced events, etc., should be collected and evaluated for the interest area. These data will be used as a basis for the study of extreme water levels to be expected in the area.

- Storm wave propagation: depending on the direction, period and height of the offshore storms, the propagation of the waves on the regional bathymetry can lead, because of refraction phenomena, to areas where important wave concentrations (or attenuations) can occur.
- Tsunamis, seiches, storm surge and eustacy analysis: the data collection and analysis described above should tell if there are specific important risks of coastal flooding due to tsunamis, seiches or storm surges in the interest area. These phenomena should be analyzed in terms of search of causes and generation terms; simple calculations should be made in order to define, on a regional scale analysis, the source terms. An appropriate numerical model should be operated in the near field in order to evaluate, for schematic offshore conditions, the propagation of tsunamis and/or surges from offshore to the coast (generation terms derived from YEAR-1: Far-field Coastal Flooding), to compare the response at the various interest areas and to evaluate first estimates of the coastal flooding, Risks of seiches and eustacy should also be estimated.
- Extreme water levels: from the available data collected and measured, the water levels should be analyzed in order to get first estimates of the extreme water levels.

– Abrasion: observation and identification of abrasion phenomena should be conducted using assessment of secondary data, satellite imagery interpretation & field survey.

D. Offshore & Marine Geophysics

– Secondary single-channel seismic reflection data available at P3GL-ESDM can be used. The data covers the whole Bangka Strait and is based on a survey done in 1996.

– Geophysical investigation for structure identification at the off-shore of interest area should be conducted.

– Maps at 1/25 000 scale should be established with:

- Mapping of Substratum top/roof
- Contour line of thickness of marine sediments

– Evaluation of location and thickness of marine sediments

2.1.7 Hydrogeology and hydrology

A. Hydrogeology

Available data concerning rivers characteristics in the near regional area should be gathered, as well as ground water characteristics (height, general flow direction, relations with surface waters (river, sea)). Characteristics and interconnection of the major hydrogeologic units and movement of groundwater within them should be determined by drilling test holes and constructing groundwater monitoring wells.

Selected drill holes will be developed as groundwater monitoring wells. Water analysis should be performed for the samples.

B. Hydrology

The extent of saltwater intrusion should be determined using hydrogeological model. The impact of surface waters on the extent of saltwater intrusion should be assessed with a numerical groundwater flow accounting for density-driven flows.

Analysis and evaluation of flood potential in the iterest areas from surface water, rain, and other causes should be performed.

2.1.8 Meteorology

The purpose of this part of the study is to study the local and regional meteorological conditions of the interest areas, with particular emphasis on atmospheric dispersion and extreme meteorological condition as well as meteorological rare events. The activity covers:

Consultant should conduct an investigation to determine the appropriate location of meteorological monitoring, provide land, installation of meteorological towers and adequate equipment which are meet the standards of measurement, perform data collection, processing data, maintenance and calibration of equipment regularly.

a. Collection of data on extreme conditions of the regions
b. Meteorological data collection of the interest area
c. Data processing
d. Data analysis

Data collected from meteorological stations should be analyzed periodically. Site meteorological characteristics are determined by focusing on atmospheric dispersion (frequency table, wind-rose diagram, atmospheric stability, triple-joint frequency, etc.). extreme meteorological parameters such as Probable Maximum Precipitation (PMP), extreme wind speed and temperature should be analyzed.

Analysis of meteorological rare events such as whirlwind, storm, smog and other phenomena occuring in the study area should be performed.

2.1.9 Human-induced events

Data related to present and planned stationary and mobile source (nearby industrial, transportation, storage, military facilities, etc.) should be collected to

the extent that these data are available. Information about present and planned future facilities and activities in the study area should be sought from maps, published reports, public and private agencies and knowledgeable individuals about the characteristics of local areas. The sources of risk should be shown on a map at an appropriate scale.

The distance to be considered and determined (Screening Distance Value, SDV) for each source should depend on the threat that the source may pose to the plant.

a. Aircraft crashes risk

Three aircraft types are considered:

- commercial aviation is taken as covering civil aircraft with a mass greater than 5.7 tons,
- general aviation, taken as covering civil aircraft with a mass lesser than 5.7 tons,
- military aviation.

Taking into account data as distances from the interest area and airports or air traffic corridors, traffics and number of crashes (per movement or per square km), the probability of an air crash occurring in the region will be determined for each class of air crash considered.

b. Industrial, military and natural environment and traffic routes (except air route) risk

Potential sources that may lead to the effect stipulated in the IAEA NS-G-3.1 ”External Human Induced Events in Site Evaluation for Nuclear Power Plants” should be assessed.

The probability of impact for each accident category should be evaluated for each interes area.

2.1.10 Demography

Data on population in regional and near regional scale analyses should be collected from the Statistical Agency (BPS) and processed in a systematic way and

complemented by new available data. Data on population distribution in regional and near-regional scale analyses should be assessed by interpretation of appropriate satellite imagery. Identification of critical population group, population center, center of activities should be conducted. Population projection with 10-year step, starting from 2010 as the base data and continue to 2080 should be carried out. Absolute population and density distribution, whether base and projection population, should be mapped.

Transient and permanent population, population pyramid, sex ratio, educational level, economic level, occupation, stc., should be informed in regional and near regional scale. Data processing and analysis should be performed to evaluate radiological impact to the population for normal and accidental release and to demonstrate the feasibility of nuclear emergency planning (discussed in nuclear emergency planning topic in Year-2).

2.1.11 Land, Water and Marine use

The objective of study is to produce land, water, and marine use maps in regional and near regional scale. The map produced should be based on official publication and improved by appropriate recent satellite imagery as well as ground checking.

The studies below must be carried out for the interest area.

a. Agriculture

The study covers:

- to define the regional general outlines of agriculture in regional and near regional scale: cultivation practice, culture or breeding types, production per species, yields.
- to define the agriculture characteristics of the interest area in regional and near-regional area: localization of farming yards, grown and/or bred species, with the estimated production. The grid for main agricultural crop yields should be made in accordance with the map grid scale.

Agricultural characteristics of regional scale mapping and near-regional must be complemented by ground checking.

b. Livestock

This study includes:

- Characterization of regional-scale patterns of animal husbandry in regional and near-regional scale, including types of farms are developed, the total production of meat, milk, as well eggs, livestock food source and pattern of cultivation.
- Mapping of livestock production in accordance with the input data required for dose assessment.

c. Fishing

The study comprises the following points:

– The main regional characteristics contribution of the fishing activity, namely ports, fleets, occupations, species caught, local part in the national production. Data collection was conducted, among other, through interviews with local and national competent agencies.

– The fishing activity at the study area: ports (shelters), fleet, exploitable resources, fishing area, spawning or breeding areas. The data were collected, among others, through interviews with local fisheries experts in the area and direct observation.

– The major piscicultural/aquacultural activities in the study area

– Characteristics of fishing activities mapping of the study area should be confirmed by ground checking.

d. Water utilization

The study should comprise the following points:

– calculation or estimate of large categories of water users (industry, agriculture, food trade, tourism).

– Determination of the sampling points in river and in the ground water

– irrigation network

- ex-mining pond and other major ponds

e. Other important land and water uses

Land and water use such as settlements, plantations, production forests, protected forests, swamps, fields / moor, recreation, mining, industry, and others that are considered essential should be recorded and made the maps in appropriate scale. Land and water use maps produced by consultant should be based on the official publication land use map modified by interpretation of the recent satellite imagery and field confirmation result.

2.1.12 Spatial Planning and Infrastructure

The purpose of this study was to assess the suitability of nuclear power plant development planning with the regional spatial planning as well as to assess availability of existing infrastructure to support nuclear power plant construction. Spatial planning (RTRW) in the level of national, province as well as regency need to be analyzed and studied in depth for the preparation of the draft Master Plan that will be done in YEAR-3 to be able to conduct a comprehensive study of spatial planning.

Availability of infrastructure is very important for the analysis of suitability, especially during NPP construction. Analysis of infrastructure, among others, should include:

- The availability of road network (and their supporting facilities) and their ability to support the burden of road vehicles must be analyzed, especially related to heavy equipment and construction materials transportation during NPP construction. Road network should be mapped with their attributes that describe the ability of the road network.
- Distance of major ports and the ability of its access to the interest area should also be analyzed. Consultant should provide recommendations of the most effective transportation problems in the construction of nuclear power plants.

- Availability of electricity and its network is also very important for nuclear power plants during construction. Consultant should provide the analysis of power supply capability and the alternative solutions for the construction of nuclear power plant.
- Availability of water, either for construction or construction-worker activities
- Availability of communications networks
- Other infrastructure deemed important for consideration

2.1.13 Endangered species and historical monuments

The objective of the study is to identify and map endangered species and their stratification, spread, and protection. In addition, the study will also identify and map historical monuments, historical areas, etc., with strong historical relation. Consultant should provide analysis and assessment such as suitability analysis and positive/negative impacts related to NPP construction.

All the historical monuments should be mapped in appropriate scale.

2.1.14 Ecology

Ecology study comprises terrestrial, fresh water, estuaries, coastal and marine ecosystem. Specific ecosystem identified in the study area should be assessed in detail in accordance with change possibility affected by NPP project. Background environmental quality representing all ecosystems should be mapped as a baseline data in order to anticipate all changing possibility during the NPP project. Data should be collected from the result of previous research (secondary data) as well as primary data.

The study consists of:

a. Estuaries, coastal, and sea ecosystem

The study on marine ecosystem should include but not limited to plankton, benthic, nekton, etc, which complement the data collected during fishery data collection campaigns.

Main characteristics of the relevant ecosystem:

- Phytoplankton and zooplankton including biomass measurement, main species, abundance and diversity.
- hydrology/water quality: temperature, salinity, turbidity, dissolved oxygen, nutrients, and other chemical and physical relevant parameter as stated in the regulation.
- nektons: important local fish, migration fish, their distribution, abundance and fish catch
- research of toxic or harmful species (for example, species responsible for red tides)
- Littoral and sub-littoral ecosystem including the important biota that live in the ecosystem
- distribution of large benthic populations
- food chain associated with dose assessment, especially for ingestion pathway
- mapping of populations with their main species

b. Terrestrial and freshwater ecosystem

This study aims at defining the general outlines of vegetal and animal populations (macro and micro-fauna) in regional and near regional area around the interest area. Mapping of the main vegetal associations with the characteristic prevailing species, from the study of aerial photographs associated with soil surveys.

The study comprises:

- Identification of the macro fauna which occupy the vegetal groups (vertebrates, arthropods), by means of inquiries with experts jointly with soil surveys.
- Identification of freshwater biota
- background air quality, soil quality and freshwater (ground water, pond, river). Data collection based on secondary data and primary data in

regional and near regional scale. Environmental quality parameter data collected should refer to Indonesian Regulation of environmental protection, including noise background.

2.1.15 Socio-economy and Socio-culture

The objective of this study is to identify possible serious social concerns and problems that could develop from the construction or operation of the plant at the site and to make recommendation for avoiding them or solving them. These problems include inter-alia, adverse impacts of resettlement, effects of concerns and misunderstandings about radiation hazards in areas around the plant and on safety for consumption of commodities produced in these areas, concerns about the distribution of project benefits and project costs, interventions of anti-nuclear activities, effects of the construction labor force on nearby communities both during and after construction, effects of project construction on scarce commodities or labor, and the social feasibility of emergency plans including evacuation, in communities around the sites.

This study should involve the review and description of the socio-economic and socio-cultural condition in the study area and in host communities in potential resettlement areas, the identification of possible problems based on the conditions in the area and experience with nuclear projects in other countries, and the recommendation of measures for dealing effectively with these problems. Survey methodology for the following year should be defined, including the list of proposed questionnaire.

2.1.16 Radioactivity Background and Dose Parameter

Tin mining is the main economic activities in the Bangka-Belitung Islands Province. Monazite mineral is one of the side products in the tin mining process in Bangka. In the monazite, there are radioactive elements such as thorium, uranium.

These mining activities have increased the level of natural radioactivity in the environment (TENORM).

The objective of the study in Year-1 are:

- Obtaining data / initial environmental radioactivity map in the study area before NPP construction, which can be obtained as secondary data
- Develop a dose parameter database based on secondary and primary data

The result of Year-1 activity will be used to determine the dose constraint according to the regulation. The determination of release and dose constraint will be done in Year-2.

2.1.17 Preliminary Site Data Report (PSDR)

Consultant should start the preparation of Site Data Report document containing all data on important site parameters and their database. The database system should be constructed in an integrated and systematically manner.

2.2 SITE VICINITY STUDY AND SITE EVALUATION (CHARACTERIZATION) (YEAR-2)

2.2.1 Topography

Based on field measurement (ground survey), topography map of the site should be drawn at 1/5000 scale for site vicinity and 1/1000 up to 1/100 for site area as necessary. The contour interval of the topographic map should be of the order of 2 m for 1/5,000 scale and 0.25 m for 1/1,000 scale or more accurate using for example LIDAR survey technology.

The map should cover the study area and allow leveling of the platform and implementation of site component elements:

- Power block and auxiliary buildings
- Sea water intake/discharge structures, circulation water feed/discharge piping,
- Other structures

Spatial analysis covering, for example, cut and fill, land clearing, and NPP building layout is performed by considering national and international safety guides, spatial regulations, and other relevant national and local regulations.

2.2.2 Geological, geophysical and geotechnical investigations

A. Geological & geophysical investigation

- Consultant should collect secondary data taken from relevant national and/or local government institution, mining company, and other relevant sources related to geophysics data, aerial photograph, geological map, microseismic records, etc.
- Consultant should performed field survey on structural geology in the site vicinity and site area.
- Rock samples are taken for petrographic, geochemistry, and dating analysis.
- All the geological structure including capable fault should be identified and characterized.
- It should be demonstrated that in the site area is free from surface faulting, and in the site vicinity there is no capable fault direct to the site.
- Consultant should produce geological map in the 1/5,000 scale for site vicinity and 1/1,000 scale for site area, completed with outcrop nature.
- Consultant should define neotectonical history from existing faults, in particular to identify and characterize capable faults and to identify geological unstability in the site area.

B. Geophysical Investigation

- Consultant should perform geophysical survey to provide understanding on the condition of subsurface material and confirm the existence of faults with appropriate grid.
- Sea-bottom geological structure survey is necessary for intake and discharge design taking into account the result of bathymetric survey and off-shore geophysics.

C. Geotechnical Investigation

Consultant should provide intesive boring pattern and perform the boring based on geological characteristics.

1) Core boreholes and continuous core sampling

Continuous core samples should be collected in the rock portion of the holes. Selected cores should be laboratory-tested for strength, deformability, permeability, and other engineering properties. Core data should be described and documented and Core data should be taken, i.e. description should be given, and documented. Core should be stored in rust-resistant boxes, labeled, put in metal racks, and delivered to the storage room/area determined.

Boring parameters should be recorded such as: pressure on tool, water pressure, boring, speed rotation torque, etc.

- On land :

  Core boreholes should be made. The distribution of boreholes should systematically represent all site area, while for the proposed location for the reactor the space between boreholes should be denser. The consultant should determine the location of boreholes and the configuration should be drawn on a map.

- On sea bottom :

Consultant should perform sea-bottom geological structure survey and boring for the underwater intake and discharge design.

2) Geophysical logging
   - Logging should be performed for representative holes for the following parameters: Spontaneous potential, Gamma ray, Resistivity, Caliper Density, Shear wave velocity, Video down hole camera recording of boreholes.

3) Standard penetration tests (SPT)

   SPT should be performed on the boreholes.

4) Laboratory tests on samples

   Altogether the following test should be considered:
   - Index test: natural water content, dry density, specific gravity, grain size analysis with hydrometer test if necessary, Atterberg limits, and Carbonate content.
   - Static characteristics : Unconfined compression test and undrained shear strength measurement, Unconsolidated undrained triaxial test, Consolidated undrained triaxial test and pore pressure measurement, Consolidated chained triaxial test (CD) with back pressure, Compressibility, Dynamic characteristics (cyclic loading triaxial): variation of shear modulus versus state of stresses and distortion, damping factor versus distortion, determination of maximum and minimum density of sands.

5) Cross holes

   The cross-hole method should be used to measure compression and shear wave velocities.

Analyses should be carried out of the response of soil and rock to dynamic loading, liquefaction potential, static stability, design criteria, techniques to improve subsurface conditions, and stability of slopes and embankments. The

analyses will be based on subsurface exploration and will make use of laboratory testing data.

Proposal of the type of foundation contemplated for the nuclear power plant should be provided.

D. Geodetic GPS survey

Consultant should perform geodetic GPS survey as a continuation of activity in Year-1.

2.2.3 Seismology

Design basis parameters (peak ground motion values, response spectra, time histories) should be evaluated for the two levels, SL-1 and SL-2, on the basis of the seismo-tectonic model, evaluation and detailed knowledge of the geology and engineering parameters of the strata beneath the site area. SL-1 and SL-2 should be defined by means of appropriate response spectra and time histories. The motion is defined for free field conditions at the surface of the ground, at the level of the foundation or on bedrock, and at the surface level. Standardized, site-specific, and uniform confidence response spectrum should be made as appropriate. Time histories used should satisfactorily reflect all of the prescribed ground motion parameters.

SSE (Safe Shutdown Earthquake) design should be assessed in the site, and the value should be determined.

2.2.4 Oceanography, off-shore geophysics and coastal flooding

The objectives of this aspect are to assess, inter-alia, coastal flooding potential hazard, appropriate coastal management of the site, thermal dispersion, and for intake and outlet design purpose.

A. Local bathymetry

A series of sea-bottom profiles should be surveyed, with an appropriate interval between the profiles. The bathymetry should be mapped on 1/5000 scale of survey and every 1 m of contour interval. Especially in front of the site, the bathymetric map should be on 1/1000 scale and 1 m of contour interval. This local bathymetric map used in particular for the sediment analysis, the study on effluents and thermal dispersion and recirculation and the study on near-and far-field coastal flooding, intake and outlet design, as well as coastal management planning.

B. Marine substratum

A map of 1/5000 scale should be prepared in the site vicinity area based on geophysical survey Year-1, showing the contour lines of thickness of marine sediments. Mapping of Substratum top/roof with 1 m of contour interval should also be performed.

C. Oceanographic surveys and analysis

Monitoring should be made (using the equipment installed at Year-1):

- Tide level
- Waves
- Marine currents
- Water temperature
- Water salinity

Data analysis:

- Extreme water levels
- Design wave
- Current analysis
- Design water temperatures
- Water salinity
- Abrasion, and, if any, coastal management for protecting the coast from abrasion threatening.

D. Sediment-analysis

The rates and directions of scouring and sedimentation should be estimated, and the results will serve as basis for the choice of the optimum configuration of intake and discharge works.

E. Effluent dispersion and recirculation

An optimum intake-discharge configuration should be defined so as to optimize the effluents dilution and to minimize the thermal impact and recirculation on the site. Early optimum configuration should be planned at this stage of the studies, by considering the wave agitation (literature study) and breakwaters stability.

For the effluents dilution, the studies should be as follows:

- Jet plume calculations using appropriate numerical model
- Effluent balance model

F. Thermal dispersion in the sea

The same numerical models as used for the effluents (See step E. Effluent dispersion and recirculation above) should be operated for the thermal dispersion studies, the only difference being the degradation processes, the exchanges of heat between the sea and the atmosphere being the final sink of the calories:

- Jet plume calculations
- Thermal balance model

G. Near and far-field coastal flooding - Design values of run-ups and draw-downs

- Wave propagation: Complementary detailed calculations of wave propagation should be made on the basis of the precise bathymetry measured at the beginning of YEAR-2.
- Seiches: complementary calculations of seiches on the site should be made, if such risks have appeared to be important.

- Tsunamis and surge propagation: complementary calculations of tsunamis and surge propagation in the near and far-field should be made on the site with the appropriate code and tsunami source.
- Run-up and draw-down synthesis: the results of the above mentioned propagation calculations and studies should be analyzed in relation with the analysis of extreme water levels performed in (sub section D. Sediment Analysis). The combination of these extreme events with recurrent event such as tides should be analyzed, and design basis values of run-ups and draw-downs should be established at the end of this synthesis.
- Other coastal flooding potential such as from astronomical tides, eustacy, sea-storm etc. should be analyzed and demonstrated in the site area.

H. Coastline and coral survey

Consultant should perform coastline sruvey to analyze changes in coastline based on high or medium-resolution imagery for at least the past 2 decades (time series).

Consultant should also perform coral mapping based on survey data.

I. Recommendation for monitoring

Comprehensive monitoring program for the marine dispersion characteristic, wave measurements, tide and sea-water characteristics should be recommended for future activities.

2.2.5 Hydrogeology and hydrology

Consultant should perform assessment on:

- river flooding potential hazard, flooding caused by structural failure (i.e. dam), river flood from small watershed, groundwater raising etc.

- groundwater parameter (such as water table, permeability, etc), nature of river (geometry, debit, etc), natural and artificial ponds or lake, availability of freshwater, etc.
- underground channels surrounding the site should be assessed of their flow and network in order to construct appropriate dispersion model.

Design basis flood should be estimated by consultant based on various causes.

A. Field investigation

A detailed investigation on the site should be conducted to evaluate physicochemical characteristics of the ground water, hydraulic gradients, and hydro-dynamic dispersion.

The following measurements should be made:

- Permeability measurements: Lugeon and/or Lefranc tests, pumping tests
- Surface water level measurement

  The destructive boreholes should be equipped with piezometric lining.
- Water analysis

  Water analysis should be made on ground water collected in the piezometers to measure resistivity, temperature, pH, total hardness, total alkalinity, total caustic alkalinity, calcium, sodium, potassium, magnesium, sulphate and chloride content.
- Flow of the ground water

  A tracing test should be proposed in order to determine the flow and direction, and the dispersion coefficients.

It will be necessary to carry out a test for each unit to detect any heterogeneous foundations.

1. <u>Nuclear unit near to the shore</u>

   The experiment plot located downstream of the reactor, depending in the direction of ground water flow.

2. Nuclear island far from the shore

There, the test should be carried out in two steps.

a. Step 1 or study of transfers over short distances

b. Step 2 or study of transfers over long distances

B. Travel time of possible releases

Consultant should determine a mathematic model simulating the transfer of a pollutant into the ground water to obtain flow rate and direction and the pollutant transfer time from the plant to the surface water (sea or river) .

C. Monitoring program

In view of the possible pollutant transfer into the ground water in case of accidental reject (recommended in future).

D. Dewatering analysis

Consultant should perform dewatering analysis and its mitigation during the NPP construction in particular at soil excavation stage.

2.2.6 Meteorology

Consultant should determine the scope of parameters related to extreme atmospheric phenomena and dispersion and perform monitoring on those parameters.

A. Meteorology data collection of the selected site

Secondary data related to the determination of materological extreme parameters (probable maximum parameters) and rare events should be collected.

Data will be collected started at YEAR-1 after installing the equipments and continuing at YER-2 and YEAR 3 and will include horizontal wind speed, horizontal wind direction, and standard deviation of wind direction, (sigma theta) temperature, delta T/ temperature lapse rate, solar radiation, relative humidity, barometric pressure, precipitation and lightning.

B. Atmosphere dispersion and stability characteristics

Analysis of the data should be carried out and appropriate mathematical models will be used for dispersion calculations for normal use and for accidental cases.

To support characterization of upper air layer, some parameters of upper air observation should be should be performed by GPS sonde/radiosonde method twice a day (night and day) representing dry and wet season. In the radiosonde observation, the following parameters should be measured: temperature, pressure , and relative humidity. Data should be used to determine the upper-level stability of the atmosphere.

C. Design basis value

Determination of extreme meteorological values for the design (design basis value) of the power plant should be carried out on the basis of exploitation and data analysis.

Design basis wind extreme and precipitation should be provided by consultant with appropriate return period.

Lightning events data collected during the project should be analyzed to obtain the probability level at certain area per year of the site as the regulation/guidance stated.

Site acceptance from extreme meteorological hazard and rare events should be demonstrated by the Consultant using both deterministic and probabilistic approaches.

D. Monitoring program

A comprehensive monitoring program should be related to atmospheric and other relevant meteorological parameters should be recommended for the future.

2.2.7 Human-induced Events

Data of potential human-induced events source in considered radius that collected at YEAR-1 should be completed by ground checking and survey in order to estimate the potential source, risk, and protection system in accordance with their potential as initial events.

Design basis parameters for human induced events should be established. In particular, the design basis events to be taken into account for the construction of the installation should be defined. These events will be defined following the results obtained in (YEAR-1: Human-induced Events). For each event such as airplane crash, explosion or toxic and corrosive drifting clouds, etc should be assessed by both deterministic and probabilistic approach and site acceptability should be determined by comparing with developed acceptance criteria.

If the probability is less than this allowable value, it will not necessary to take any care of such event. In a contrary case, the design must take this event into account. All hazard potentials from the identified human-induced events should be provided with their design basis parameters.

2.2.8 Demography

All data on population collected during (YEAR-1: Demography), should be processed in a systematical way and complemented by new available data.

The analysis should include:

- Data on population distribution in the site vicinity and site area scale study should be assessed using high resolution satellite imagery interpretation.
- Location and estimation of daily transients in large employment centers.
- Analysis of residential patterns (urban and rural), as well as changes in those patterns.
- The determination of average food intakes for people living within a 50 km radius (amount and type) around the site.

- Analysis of transportation systems, focusing on those systems that will be used in an evacuation procedure.
- General population characteristics, such as age distribution, occupation, education, and place of work, the information to be derived largely from the 2010 census of Indonesia.
- The total population.
- The projected growth of the population by decade for the life of the facility (i.e., up to Year-2050), taking into account the impact from economy and migration from the NPP operation in Bangka Island.
- Examination of land use trends in the vicinity of the site.
- Data on permanent and temporary population should be identified and mapped.
- Demonstration of demographical feasibility at the construction and its projection to NPP lifetime.

2.2.9 Land, Water and Marine use

The objective of study is the same with YEAR-1, but in the map produced should be in appropriate with study scale (site vicinity and site area).

A. <u>Agriculture</u>

The study consists in making an inventory of agricultural activities within a 50 km radius around the site. It rests upon elements should be collected during YEAR-1 and comprises:

- The counting of farming yards, made using aerial photographs and/or satellite imagery in conjunction with soil surveys and inquiries with professional bodies. The study will cover:
  - The localization of farming yards and cultivated land
  - The cultivation or breeding practices
  - The production per species.

– The counting of food-agricultural industries (localization, nature of activity, production, origin and destination of the end products).
– The research of distribution and consumption for local agricultural products, in particular, exchanges with the next regions.

B. Livestock

The study covers:

- Characterization of farming pattern in the site vicinity and site area scale and its extension up to 50 km radius including the kind of farming, amount of production for meat, milk and egg, livestock food source and nurturing pattern.
- Mapping of farm production according to required scale for input in dose assessment

C. Fishing

The data collected during (YEAR-1: Fishing) should be completed and detailed, with particular regard to spawning and nursing areas in three different sectors:

– Complementary information upon statistic fishing data collected during Year-1.
– Research of spawning and nursing areas within a 10 km radius around the site with the aid of fishery data collection campaign.
  If such areas are detected, location and quantitative estimation of the area should be mapped.
– Aquaculture activities
  Consultant should perform data acquisition for aquaculture activities.
  Consultant should perform fishing and aquaculture activity analysis in the study area.

D. Water utilization (fresh and sea water)

The study should comprise a complement to the information collected during YEAR-1, which will allow an evaluation of the future needs up to year 2050, and a detailed study of the water utilization procedures for irrigation purposes.

- The present and future needs
- The study of irrigation procedures
- Locating existing wells and pump stations within study area for groundwater and surface water.
- Data acquisition and production of water use and its characteristics in the study area .

E. Other land and water use

Data on land and water utilization for settlement, farming, production forest, protected forest, reservoir, recreational spots, mining, industry, etc., should be obtained and mapped in appropriate scale.

F. Land ownership and acquisition

Land ownership should be identified with convincing accuracy. Data on land ownership up to 10 km radius from the site will be used in the land acquisition analysis. Land requirement for NPP area and its infrastructure such as road, water channel, employee housing, energy farm, etc., should be identified and calculated.

2.2.10 Spatial Planning and infrastructure

Consultant should focus more on the development of conceptual spatial and infrastructure of NPP area its surrounding to accommodate the need for NPP construction and operation as well as other activities. The development of NPP spatial plan, environmental bearing capacity and NPP safety principals should be considered in the planning of zonation, nuclear emergency mitigation

infrastructure (road, shelter, evacuation route, etc.) and the placement of social/general facility, hinterland plan, green area, etc.

In addition, consultant should also analyze the projection of NPP operation to the surrounding space and its solution to the spatial problem.

The result of assessment in this topic will become the base for the development of Draft of Masterplan to be performed in Year-3.

2.2.11 Ecology

Consultant should acquire data and perform the following ecological analysis:

A. Aquatic and land ecology

1. Description of aquatic & marine flora and fauna

   In general, the study covers:

   – Data acquisition and analysis for Planktonic field including biomass.
   – Hydrology/water quality: temperature, salinity, turbidity, dissolved oxygen, nutrients and other chemical and physical relevant parameter as stated in the regulation.
   – Characteristic species (in particular, research of toxic or harmful species)
   – Benthic field: Consultant should perform population mapping with the main species, the estimated biomass and productivity, the population stability

2. Description of terrestrial flora and fauna

   In general the study covers:

   – Cartography of the vegetal groups with determination of the main species covering their diversity and abundance.

– Counting of the fauna including the macro-fauna and the micro-fauna with the estimation quantities.

B. Water quality survey

The quality of potable water should be monitored from the potable water distribution network supplying large built-up areas, and from wells and springs supplying the villages near to the site.

Water monitoring involves weekly samplings over one year in all these places. The analyses will cover:

– Physical parameters: Temperature, TDS, TSS, limpidity, color, odor
– Chemical parameters: BOD, COD, conductivity, hardness, dissolved salts, pH, chemical contents inter-alia, Hg, As, etc.
– Bacteriological parameters: research and counting of fecal coli forms and streptococci.

C. Air quality survey

The quality of air should be monitored from the site area and site vicinity, comprises the following parameters:

– Ambient air quality: SO_2, CO, NO_2, Pb, particulate
– Noise level

D. Landscape

Consultant should illustrate initial landscape surroundings the site and analysis the change for the proposed layout.

2.2.12 Socio-economic impact

The socio-economic impact of the power plant should be defined from data upon the existing conditions of the socio-economic texture and its future development. Consultant should assess the possibility of public involvement in the NPP

construction and operation. Data on public involvement should be assessed by the consultant covering:

- Education facilities (level, type, pupil/teacher ratio, classroom use)
- Health care (hospitals, clinics, doctors, nurses, emergency services, public health)
- Housing (permanent, transient)
- Water supplies (capacity, level of treatment, quality, type)
- Waste handling (solid waste, sewerage, local problems)
- Transportation facilities (roads, railroads, barges, etc.)
- Religious and social facilites
- Trade facilities
- Etc.

2.2.13 Dispersion and Dose Assessment

The purpose of this part of study is to establish an appropriate dispersion model both for atmosphere and aquatic medium, taking into account the result of hydrologic model (YEAR-1 and YEAR-2) and to estimate the individual and collective dose surrounding the NPP both on normal release and accident scenario.

The assessment for this activity covers the following:

1. Individual exposure estimation (mainly for critical group) as well as collective dose estimates.
2. A range of reference accidents should be selected and source terms should be determined based on PWR of 1,000 MWe class NPP from 3 (three) different countries.
3. Mathematical models should be selected based on the data obtained through meteorology, hydrology, hydrogeology as well as oceanography study.
4. application of no dilution model, generic model and site specific model

5. Radionuclide concentration and radiation calculation using deterministic and probabilistic approaches.
6. Dose calculation should cover areas with significant impact.
7. Individual and collective dose estimates should be made using relevant aspects.
8. Determination of discharge limit of major radionuclides both for atmospheric and fluid release based on above dose calculation and current background radiation.
9. Critical group around the sites should be given more attention and more detail in the dose calculation, using local parameters.
10. assessment for ventilation system design including stack using calculation result for concentration and radiation dose.
11. proposal on radioactivity monitoring program.
12. Consultant should assess and propose the area for exclusion zone and low population zone or also known as PAZ (*Precautionary Action Zone*), UPZ (*Urgent Protective Action Planning Zone*) dan LPZ (*Long Term Protective Action Planning Zone*).

2.2.14 Emergency preparedness

Consultant should be able to demonstrate the implementation of nuclear emergency preparedness in the site and the surrounding area up to a relevant radius. The performed study should refer to population, meteorology, infrastructure, land, water and marine use, and other data as necessary.

The emergency preparedness program should assess the following items:

- Estimation of individual and collective doses of population surrounding the site
- Estimation of early and late effects

- Countermeasure, such as, Iodine stable distribution, sheltering, evacuation, relocation, food ban, decontamination and resettlement
- Etc.

Consultant should propose an emergency preparedness organization. In addition, the location and numbers of emergency personnel, police, fire departments, and medical care facilities should also be assessed in terms of adequacy to respond to an emergency situation.

Strengths and weaknesses of regional capacity for successful response to an emergency should be evaluated and recommendations made regarding necessary improvements, if any.

2.2.15 Other considerations

Consultant should asses the sources of energy and raw material (electricity, water, building materials) needed for building the power plant, in particular, an inventory of existing quarries and of rocky zones near the site should be carried out for construction materials. Building material research should probably need core boreholes or other equivalent activities (trenching, test pit, etc).

The means of access (roads, bridges and ports) for transportation of heavy materials to the site should be counted and indicated on the map.

Since, in the study area, there are many open pit mining ponds filled by rain water, therefore it should be analyzed for the utilization of the water. In addition, consultant should give a recommendation of pond reclamation.

NON-SITE STUDY

3 NON-SITE STUDY

3.1 Background

In the long term development plan, energy demand was projected to increase very rapidly. In order to meet the rapid increase of the domestic energy demand, it is becoming more difficult to depend on the existing resources which are now getting more limited. The selection of alternative of energy supply shall be deliberated from various aspects including ones of energy availability and security, technology, safety, social economic and environment.

To support the national development an approach was taken based on the fact that most of Indonesian energy resources are non renewable reserves and limited. Thereby, the three policy measures adopted are diversification, along with intensification and conservation. In accordance with this approach, the introduction of nuclear power plant in Indonesia is not only to reach an optimal energy mix (for Java-Madura-Bali-Sumatera) based on costs and environmental protection, but also to relieve the pressure arising from increasing domestic demand for oil and gas as well as to support sustainable development in Indonesia.

Energy plays an important role in reaching dimensions of sustainable development, covering economic, social, environmental and institutional aspects. To meet the energy demand in the 21st century in a sustainable manner (sustainable energy supply), a large scale deployment of energy sources including nuclear energy is necessary. The Presidential Decree Number 5 Year 2006 has been enacted to guide the development of sustainable energy supply, specified the share of new and renewable energy, especially biomass, nuclear, hydro, solar and wind in the national energy mix should reach more than 5% in the year 2025.

3.2 Objective

The objective of Non-Site Feasibility Study is to assess the acceptability of NPP construction from non-site aspects (Technical and Safety Aspects, Fuel Cycle and Waste Management, and Management Aspects).

3.3 Scope of Study

The non-site study should cover the following:

1. Review and update studies on the appraisal of the long term energy and power growth requirements performed in Sumatera and Java for period up to year 2050
2. Perform energy system analysis especially in electric energy sector using proven models
3. Carry out detailed cost and economic evaluations and compare the cost of generation (includes the costs of investment, fuel, decommissioning and spent fuel handling) of NPP with other alternative options (such as coal, natural gas, and geothermal)
4. Determine the break even value of NPP capital costs compared to coal fired and combined cycle with several coal and natural gas prices. Discount Rate 4, 6, 8, 10, 12%. Planning period is up to year 2050
5. Determine financial viability of the project and the possible sources for financing.
6. Evaluate in detail the integration of nuclear power plant to the electric power system, in regard to the load flow, short circuit and stability of the electrical grid of Sumatera-Java System especially on the technical, economic and financial roles
7. Determine the size and main technical features of the nuclear power plants systems, including the timing of the introduction (commercial operation) of the NPP
8. Define the nuclear safety criteria to be applied

9. Define the safety features and assess the probabilistic risks
10. Advise which types of reactor should be the basis for bids
11. Determine the organizational and manpower requirement to implement the project and to operate the plant as well as relating activities
12. Determine the overall project schedule
13. Determine the contractual approach to be adopted for the acquisition of the plant
14. Analyze the international market for nuclear power plants, fuel cycle and essential materials and services as well as how to obtain these essential materials and services in more reliable ways
15. Define Indonesia's infrastructure requirements and survey as well as analyze the national participation possibilities to achieve optimum role of national industries to support the construction and operation of nuclear power plant within the framework of national programme of industrialization.

Notes:

a) Points 1 through 6 will be performed by PT. PLN (Persero)
b) Points 7 through 10 will be performed by Consultant in Year-1
c) Points 11 through 16 will be performed by Consultant in Year-2
d) Consultant should integrate the result of study performed by PT. PLN (Persero) and Consultant in Year-3. In this case Consultant should be able to coordinate and cooperate with PLN and/or the consultant appointed by PT. PLN.

The study should provide detailed analysis and information on all these aspects, with specific recommendations to enable the authorities concerned to make appropriate decisions for the implementation of the nuclear power project.

3.4 Scope of the STUDY

3.4.1 Technical And Safety Aspects of Nuclear Power

Technical Aspects

The Consultant should evaluate the supply market and identify nuclear and non-nuclear alternative energy sources, types and sizes that are available and that offer distinct economic or technical attractiveness for the case under consideration and to analyze how fuel cycle and logistic requirements can be met.

Various types of PWR power reactors should be studied along with their advanced versions with sizes class of 1,000 MWe.

For each plant and/or its multi-unit programme, the following documents should be referred to : "Pedoman Penerapan dan Pengembangan Sistem Energi Nuklir Berkelanjutan di Indonesia" (Chairman of BATAN Regulation No. 144/KA/X/2006)[1] and considering the following:

a) description of reference power plant
b) inventory of commercial units, and all relevant information
c) plant design, lay-out and general characteristics including common process and miscellaneous system
d) commissioning, operational characteristics, electrical output and plant grid interaction, characteristics manning, maintenance and audit/inspection requirements
e) nuclear fuel characteristics, its cycle and fuel performance

[1] Can be downloaded from http://www.batan.go.id/ref_utama/pedoman_penerapan_dan_pengembangan_sen_berkelanjutan_di_indonesia.pdf or http://serpong6.batan.go.id/ref_utama/guidance_NES.pdf

f) solid, liquid and gaseous in plant waste management

g) safety features and requirements

h) codes and standards to be used

i) schedule and methods on civil work, construction, transportation of assembly of equipment

j) economic data, cost component breakdown of erection, commissioning, operation and maintenance

k) operational characteristics of multi-unit station at the given site

l) accident management which include strategy procedure and engineered features

m) emergency preparedness which include emergency plants, emergency response facilities and assessment of accident consequences and radiological monitoring

n) decommissioning technology status

o) reference documents to be provided.

The STUDY also includes the discussion and explanation of:

a) The effect of NPP size and numbers on source term criteria and probabilistic risk analysis

b) The advantages and disadvantages of each NPP-type in each section.

Safety Aspects

Safety Philosophy, Criteria, and Standard

The Consultant should describe the current safety philosophy recommended by IAEA and the philosophy implemented in the reference NPP. The differences in safety philosophy based on lessons learnt from Three Mile Island and Chernobyl accidents should be explained. The report should bring out the measures taken in the new designs to avoid similar accidents.

The safety criteria for critical components of the NPP during design, construction and operation must be discussed.

Safety Features

The safety features of various NPPs should be explained. It should show that during the worst accident radioactive release to the environment and radiation exposure of station personnel and the Public are not higher than the permitted dose. The emergency cooling provisions, the accident prevention and the accident mitigation must be highlighted.

The report must describe reactor protection systems provided to bring the reactor into a safe shutdown condition whenever operating limits are violated.

An analysis of various hypothetical accidents and the protection systems to prevent the reactor from reaching a dangerous condition should be included in the study.

Complete description should be given on advanced instrumentation and control system which also takes into account ergonomics and human factors engineering.

Probabilistic Risk Analysis

Probabilistic risk analysis must be described for each type of reactor being considered also including probability of various accidents, accident mitigation systems and its impacts.

3.4.2 Fuel Cycle and Waste Management

The Fuel Cycle and Waste Management Study should cover the analysis of the whole aspects of fuel cycles, supply of the essential materials and services relating to the introduction and operation of the candidate NPPs In Indonesia. It should accommodate the optimum participation of national industries in support

to the national industrialization programme. Industries should be involved and developed in such a way that the local content may be increased stepwisely in an optimal way.

The study should give the detail strategy as how to develop national industrial capabilities in various aspects of fuel cycle services. The first fuel loading of the NPP is however still to be supplied by foreign fuel fabricator (vendor). The study should also take into account that the fuel cycle strategies are to be open cycles until a couple of decades after the operation of the first NPP, unless the development of the technology and or the economics favors to close the cycle.

The front-end of the fuel cycles relating to the candidate NPPs should be analyzed observing the up-to-date data, of national and international, about uranium resources, yellow cake production, conversion, enrichment and fabrication services. The data considered should cover the current status and near future development on their technology, prices, capacities and demands, limitation and flexibilities. The enrichment service which may be needed is to rely on the international market; however the study should foresee the possibility of having domestic service when it is economical and technologically feasible.

Analogous to the front-end, the back-end of the fuel cycles of the candidate NPPs should be analyzed. The study should cover the strategy for these back-end services and recommend the solution using appropriate technology covering the interim storage, final disposal, the spent fuel management, waste management and decommissioning.

Considering the above, the scope should cover, but not limited to, the following:

- Evaluate the fuel cycles relating to the technical, safety, environmental and nuclear cost aspects of the candidate NPPs

- Evaluate the waste management and decommissioning activities relating to the candidate NPPs
- Survey and analyze the international market for the fuel cycles and essential materials and services relating to the fuel as well as fuel component costs, their safety and technological aspects for the introduction and operation for the candidate NPPs
- Survey and analyze the national capability relating to the whole aspects of the fuel cycles of the candidate NPPs taking into account the current status and near future programmes as well as capabilities in support to the national programmes on industrialization
- Define Indonesia's infrastructure requirements to implement the stepwise integration of the domestic participation possibilities in the front as well as back-ends of the fuel cycles
- Evaluate the economical aspects of the integration of the domestic fuel cycle services using general industrial criteria such as, but not limited to, benefit cost ratio (BCR), internal rate of return (IRR), return of investment (ROI), and break even point (BEP).
- Define the requirement of manpower, training and staffing for the technology transfer covering project management, construction, commissioning, operation and maintenance
- Give recommendations in a report as a part of the final report of the study covering above mentioned work.

3.4.3 The Management Aspects

1. Project Development

a. Project Organization

For each particular project, every country have its own special characteristics in determining the most appropriate organizational structure, the Consultant shall therefore indicate and propose the project

organization most suitable for Indonesian conditions. The Consultant must establish the directive principles and the organization diagram, especially to comply to the requirement of Quality Assurance (QA) in constructing and operating nuclear power plants.

This diagram must set out the basic actions and verification to be carried out for the various bodies participating in the construction and operation of the nuclear power plants.

The Consultant must establish the directive principles and practical ways and means for filing the study, construction and operation documents (including license application, emergency preparedness) for the plant relating to the organization.

b. Project Development Schedule

The Consultant shall study and draft the preliminary programme schedule for the construction of the power plants, consisting of the construction tasks, including but not limited to the followings:

- drawing up the invitations to tender, including the technical specifications.
- preparation of a quality assurance programme.
- assessing the tender bids.
- negotiating the contracts.
- provisional assistance in obtaining the government authorizations.
- ordering the equipment, services and materials.
- preparing the site.
- production of the component parts and equipment.
- civil engineering works, and assembly of the component parts and equipment.
- tests, including the contractual verification tests for the performance level guaranteed.

– loading the fuel.
– critically tests and commissioning operations.

The Consultant shall update and provide details of the preliminary programme schedule, taking into account the studies already conducted and, in particular, the choice of the reactor type.

The Consultant shall draft this programme schedule, indicating the relationship existing between the different construction tasks, e.g. by using the critical path Method.

c. Contractual Approach

Basically, there are many types of contract approach that have been applied for nuclear power plant construction. The Consultant shall study the nature and content of the contracts or agreements between the parties involved. This study must be conducted taking into account the personnel, the equipment and services available in Indonesia, Indonesian industrial policy constraints, and the general schedule for the Indonesian nuclear programme.

The Consultant shall study examine the advantage and drawbacks of the various possible contractual forms, and must put forward recommendations concerning the choice of the types of contracts.

The Consultant shall provide the list of the different works, equipment and service lots which are the subject of Market contracts or agreements to be concluded, subsequent to the invitations to tender with the various parties involved.

The Consultant shall then study the distribution of tasks allocated to the various parties and the determination of the corresponding responsibilities for the different works.

d. Legal Framework

Nuclear programme consequences concerning the regulatory aspects should be analyzed, including laws and regulations to be implemented in Indonesia to license and control the nuclear power programme. The study will be based upon the regulations in effect in Indonesia and also upon the regulatory system applied in countries already well-experienced in the nuclear field.

2. Staffing and Training Requirements

The Consultant shall study and draw up the organization chart for the teams responsible for the project, the construction and the operation of the nuclear power plant during its various phases, specifying the number, qualification and description of the tasks of the personnel involved. The organization charts for the teams responsible for the project during the study and consultation phases must be drawn up.

On the basis of the above data, the Consultant must study the programme for training the staff responsible for the project and construction, as well as operation and maintenance, of the nuclear power plant, the training needs arising therefrom, and the possibilities for training domestically.

This programme must specify:

- the training and improvement cycles for the various categories of personnel;
- the programme schedules for these cycles;
- the training activities to be anticipated in Indonesia and abroad;
- a general description of the installations and equipment required for implementing these programmes and lists of these educational documents;

– responsibility and role of NPP vendor in manpower training and transfer of technology.

3. National Participation

The Consultant shall, in consultation with the owner specify the qualification and participation programme for Indonesian bodies and industrial firms. These qualification and participation programmes prepared by the consultant shall further be subject to the approval of the owner. This programme must concentrate on selecting Indonesian bodies and industrial firms which are likely to participate in the construction of the nuclear power plants and on defining the areas of their participation. These industrial firms and bodies may thus be consulted either directly, or as sub-contractors, depending on the organization chosen for the construction, with a view to allocating them for all or part of certain study tasks, or for supply of equipment or services.

The programme must be suitable both for the specific features of the Indonesian industrial base and for the particular requirements of nuclear technology. It must draw on increased contacts with the industrial firms and bodies which will be selected as suitable to participate in the construction of the nuclear power plants, and which must be examined during visits to Indonesia.

FEASIBILITY STUDY

REPORT INTEGRATION

4 Feasibility Study Report Integration

Constultant should integrate all Site and Non-Site Feasibility Study reports resulting from the activity into a comprehensive Feasibility Study Report (FSR). The report should be developed according to the Guidance for Feasibility Study Report of the First Indonesian NPP provided in Attachment-2.

Reports of Site and Non-site Feasibility Study are assembled into a document integrated with the QAP or IQAPS and resulting documents as a support for quality assurance for records of activity in Year-1, Year-2, and Year-3.