SITE EVALUATION FOR NUCLEAR POWER PLANTS
The process of site evaluation for a NPP generally consists of large scale analysis to select one or more candidate sites (site survey), followed by a detailed evaluation of the candidate sites.
GENERAL REQUIREMENTS

• The main objective in site evaluation in terms of nuclear safety is to protect the public and the environment from the radiological consequences of radioactive releases due to accidents and normal operation conditions.

In the evaluation of the suitability of a site, the following aspects shall be considered:

• The external events occurring in the region of the particular site (natural or human induced);
• The characteristics of the site and its environment influencing the transfer of the released radioactive material
• The population density, distribution and other parameters of the near zone that affect the implementing emergency measures and risk evaluation
**EVALUATION OF EXTERNAL EVENTS**

**EARTHQUAKES**

- The seismological and geological conditions as well as engineering geological aspects and geotechnical aspects of the site shall be evaluated.
- The earthquake hazards shall be determined by means of seismotectonic evaluation of the region.
- Hazards due to earthquake induced ground motion shall be assessed taking into account the seismotectonic characteristics of the region and specific site conditions.
EVALUATION OF EXTERNAL EVENTS
SURFACE FAULTING

NPP Belene siting. Tectonic scheme of the Moesian platform
EVALUATION OF EXTERNAL EVENTS

SURFACE FAULTING (2)

NPP Belene siting. Cross section through the Moesian platform
Belene NPP – site seismic environment

EVALUATION OF EXTERNAL EVENTS

EARTHQUAKES

Epicentral map, $M>4$
EVALUATION OF EXTERNAL EVENTS

EARTHQUAKES (2)

Seismic hazard curves

DBE Design response spectra
The extreme values for wind, precipitation, snow, temperature and storm surges shall be calculated.

Rare meteorological events: Lightning, Tornadoes and Tropical cyclones.
EVALUATION OF EXTERNAL EVENTS

FLOODINGS

Tsunami after the Tohoku Earthquake, March 2011
EVALUATION OF EXTERNAL EVENTS
FLOODING SCENARIA FOR THE BELENE NPP SITE
EVALUATION OF EXTERNAL EVENTS

GEOTECHNICAL HAZARDS

- Site and Slope instability
- Soil liquefaction
- Collapse, subsidence or uplift of the site surface
- Behavior of the foundation materials

Niigata Earthquake, 1964

Christchurch Earthquake, 2011
The potential for aircraft crashes on the site shall be assessed taking into account the characteristics of future air traffic and aircraft;

If the assessment shows a potential for an aircraft crash that could affect the NPP safety, an assessment of the hazards shall be made;

The hazards associated with an aircraft crash shall include impact, fire and explosions.
Chemical explosions

Other important human induced event
  • installations with flammable, explosive, asphyxiant, toxic, corrosive or radioactive materials;
  • installations that may generate missiles that could affect the NPP;
  • effects of electromagnetic interference, eddy currents in the ground and the clogging of air or water inlets by debris.
EVALUATION OF EXTERNAL EVENTS

ASSESSMENT OF THE POSSIBLE SOURCES OF HUMAN INDUCED EVENTS
OTHER IMPORTANT CONSIDERATIONS

- The region shall be investigated for other phenomena: volcanism, sand storms, severe precipitation, snow, ice and hail;
- In the design of systems for long term heat removal, site specific parameters, should be considered: air temperature and humidity; water temperatures; available flow of water; minimum water level; the period of time when safety related sources of cooling water are at a minimum level;
- Potential external events that could affect the long term heat removal systems shall be identified: blockage or diversion of a river; the depletion of a reservoir; an excessive amount of marine organisms; the blockage of reservoir or cooling tower by freezing or the formation of ice, ship collision; oil spills and fires

If the hazards for NPP are unacceptable and no practicable solutions are available, the site shall be deemed unsuitable.
TRANSFER OR RADIOACTIVE MATERIALS

ATMOSPHERIC DISPERSION OF RADIOACTIVE MATERIALS

Annual values of the rated surface concentration $\chi/Q$
TRANSFER OR RADIOACTIVE MATERIALS

SURFACE AND GROUND WATERS

- Detail description of the surface hydrological characteristics: main parameters of water bodies, major water control structures, water intake structures and information on regional water use.
- A on site programme for study of the surface hydrology shall be carried out.
- The potential impact of the contamination of the surface water on the population shall be assessed.

- Detail description of the regional groundwater hydrology: main characteristics of the water bearing formations, their interaction with surface waters and data on the uses of groundwater.
- A program for hydrogeological investigations of radionuclide movement in hydrogeological units shall be carried out.
- The potential impact of the contamination of the groundwaters on the population shall be assessed.
 Territory division within the 30km area

Population distribution within the 30km area

Population curve (forecast) within the 10km area
USES OF LAND AND WATER

- The uses of land and water shall be characterized in order to assess the potential effects of the NPP in the region and particularly for the purposes of preparing emergency plans.

- The investigation should cover land and water bodies that may be used by the population or may serve as a habitat for organisms in the food chain.
The natural and human induced hazards as well as the demographic, meteorological and hydrological conditions shall be monitored over the lifetime of the NPP.

The monitoring shall be started no later than the start of construction and shall be continued up until decommissioning.

All the hazards and conditions that are pertinent to the licensing and safe operation of the installation shall be monitored.
A QA program shall be developed to control the execution of the site investigations and assessments and engineering activities performed for the site evaluation for the NPP.

The QA program shall cover the organization, planning, work control, personnel qualification and training, verification and documentation for the activities.

The QA program shall be implemented for all activities that may influence safety or the derivation of parameters for the design basis for the site.
At first stage of the siteing more than 20 possible sites were investigated;

Based on the assessment of the global geological, tectonic, seismic, hydrological and economical conditions 3 candidate sites were nominated;

For each of the nominated 3 sites more detail technical and economical assessments were performed and Belene site was chosen;

Detail investigation of Belene site to evaluate specific characteristics of the site and near region were carried out.
SITE EVALUATION EXPERIENCE
CONSTRUCTION OF A NEW NUCLEAR UNIT IN ARMENIA

- Phase I - Development of Bankable Feasibility Study for the project
- Phase II - Development of tender documentation and recommendations for selection of a strategic investor(s) for the project
- Phase III - organization and management of a tender and recommendations for selection of EPC contractor(s)
- Phase IV – provision of Architect Engineer services during the design, construction, and startup of the project
SITE EVALUATION EXPERIENCE

FIRST NUCLEAR POWER STATION IN VIETNAM

❖ Site selection and evaluation
SITE EVALUATION EXPERIENCE

FIRST NUCLEAR POWER STATION IN VIETNAM (2)

SOURCES OF SEISMIC ACTIVITY
SITE EVALUATION EXPERIENCE
FIRST NUCLEAR POWER STATION IN VIETNAM (3)

Scenario
Earthquake
Mw=9
Manila Trench

TSUNAMI