of decontamination, and how to handle radiation injuries, and by visits of delegates to Radiation Medicine Centre (RMC), Tata Memorial Hospital and BARC.

A total of forty three doctors including specialists from Mumbai top four teaching hospitals, doctors from Armed Forces Hospitals and medical officers from different units of DAE attended the workshop.

Prof. Sukhatme in his inaugural speech described various peaceful applications of ionising radiation and the regulatory role that AERB plays in the control and protection of the activities related to use of ionising radiation in the country. He also referred to an excellent safety track record of Indian nuclear power plants. In this context he said that there was no need to be alarmed about radiation accidents and emergencies. Nevertheless, inadvertent or misuse of orphan radioactive sources or threat of nuclear terrorism are some of the issues which need to be looked at. Therefore there is a need to sensitise and train medical professionals in handling radiation injuries and emergencies so as to create a pool of trained doctors.

Shri. S.K. Jain, CMD, Nuclear Power Corporation of India Limited gave an account of outstanding safety record of operating nuclear power plants in our country. He further stressed the crucial need for training doctors in this field for handling any untoward incidents or situations should they ever happen and also keeping in view the potential possibilities of the acts of nuclear terrorism.

Siting of Nuclear Installations

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Important factors affecting selection of site for major industrial installations are economics, sociological aspects, engineering and technical feasibility, infrastructure and general safety in terms of its impact on the environment. Radiological safety of the plant personnel, public and the environment is an important additional consideration for siting of nuclear installations.

Basic siting criterion for nuclear installations is to ensure that the site-installation interaction does not introduce radiological or other risks of unacceptable magnitude. Siting process involves three stages – selection, evaluation and definition of design basis related to external events. Important considerations in site selection of nuclear power plants (NPP) are topography, accessibility, infrastructure, construction facilities, township for staff, availability of power supply, transmission lines and cooling water along with other important safety aspects related to geology, seismology and meteorological events.

A large region is investigated to select one or more candidate sites on the basis of safety and other considerations. Rejection criteria, in terms of screening distance value (SDV) of site from potential sources of external events which could jeopardize safety and for which no practical protection measures are available, are applied at site selection stage to shortlist the candidate sites. This is followed by a detailed evaluation of the candidate sites. Level of detail needed for site evaluation vary according to the type of installation. NPP generally require the highest level of detail.

Basic requirements

Three basic requirements that govern siting of nuclear installation are:

- Effects of external events (natural and man-induced) on the installation.
- Effects of the installation on site environment and population.
- Factors affecting implementation of emergency measures in public domain, and evaluation of risks to individuals and the population.

Details of these requirements for nuclear power plant (NPP) are specified in “code of practice on safety in nuclear power plant siting” and related “safety guides” published by the Atomic Energy Regulatory Board (AERB). Safety guides published by the International Atomic Energy Agency (IAEA) are considered in case AERB safety guide on any related topic is not available.

Site characteristics and characteristics of natural environment in the site region which may affect safety of the nuclear installation are investigated and assessed for a projected time period encompassing the lifetime of the installation. Hazards associated with external events are characterized in terms of parameters that can be used as design basis for the installation. Effects of the combination of these hazards with ambient hydrological, hydrogeological and meteorological conditions as well as the plant internal events is given due consideration while deriving their design basis values. If evaluation indicates that the overall risk cannot be kept acceptably low by means of design features of the installation, engineering of the site

or administrative procedures, the site is deemed unsuitable. The preferred means of ensuring the risks acceptably low are design features and engineering of the site.

The site is also evaluated with respect to safety aspects of storage and transportation of input and output materials, new and spent fuel, and radioactive wastes including possible synergistic effect of nuclear and non-nuclear effluents. A site is re-evaluated if the potential risk is increased due to increased total installed nuclear capacity over previously specified value and/or due to expansion activities around the site.

Effects of external events and derivation of related design basis

Earthquakes and surface faulting

Hazards due to earthquake induced ground motion are assessed for the site considering site seismicity and seismotectonics of the region along with specific site conditions. Data and information from geological, geophysical, seismological and geotechnical investigations are collected/analysed. If adequate data for the site region are not available, data from sites with similar seismotectonics and seismic wave propagation path characteristics are used. Microseismic measurements of the site region are conducted for at least three years.

Potential for surface faulting (presence of capable fault) is assessed from geological, geophysical, geodetic and seismological data. If there exists an evidence of a capable fault within the screening distance value, the site is deemed unacceptable.

Geotechnical hazards

Potentials for slope instability (land/rock slides, land erosion, snow avalanches) and collapse, subsidence or uplift of the site surface are assessed. In case such potentials exist and no practical engineering solutions are available to mitigate their effects, the site is deemed unsuitable. Otherwise related hazards are determined using reliable methods of investigation and appropriate analyses. Liquefaction potential at the site is evaluated for the highest design basis vibratory ground motion. If such potential exists, the site is rejected.

Meterorological events

Meteorological and climatological characteristics of site region are investigated to derive extreme values of the meteorological variables such as wind, precipitation, snow, temperature, storm surges, and rare meteorological phenomena such lightning, tornadoes and tropical cyclones. Potential missile hazard associated with tornadoes and tropical cyclones is also considered.

Flooding

The site is assessed for flooding potential due to natural causes such as run-off from precipitation, snow melt, high tide, storm surge or from earthquake induced water waves (tsunamis and seiches) to determine whether safety of the installation is affected.

A suitable meteorological and hydrological model is developed to characterize hazard due to surface run-off with due consideration of limitations of available data and past changes in relevant characteristics of the region. Hazards associated with tsunamis or seiches are derived from seismological data, seismotectonics of the region and physical and/or analytical modeling. Floods and waves caused by failure of upstream dams/barrages or due to possibility of temporary blockage of rivers upstream/downstream caused by landslides/ice are also assessed with respect to the safety of the installation.

Shoreline and river bank erosion

In case of coastal sites, studies are carried out to establish that there is no potential for shore instability that could affect safety. Incase of inland sites, possible erosion of river banks and/or change of river course are given due consideration with regard to the installation safety.

Aircraft crash

A probabilistic study of aircraft crashing on the installation is made considering flight frequencies at the nearest airfield if the site falls within the screening distance value (SDV) for different types of airfields. If this probability is not acceptably low, an assessment of the hazards is made including the effects of impact, fire and explosion. If the hazards are unacceptable and no practical solutions are available, the site is unsuitable.

Chemical explosions

Plants in the site region involved in handling, processing and storage of chemicals having potential for explosion or for production of gas clouds capable of deflagration/detonation, and/or the transportation routes for such chemicals are identified, and associated hazards in terms of over pressure and toxicity are assessed. A site is considered unacceptable if such activities take place in its vicinity and no practical solutions are available.

Other important man-induced events

Information on blasting operations in the site vicinity and activities related to mining, drilling and sub-surface extraction/injection of fluids are carefully studied to assess their impact on safety of the installation. The region is also investigated for plants/activities either within or outside the installation boundary in which flammable, explosive, asphyxiate,

toxic, corrosive or radioactive materials are stored, processed, handled or transported such that if released under normal or accident conditions, could jeopardize safety of the installation. The plants that could give rise to missiles are also assessed with respect to the installation safety.

Other important considerations

Foundation strata

Adequate subsurface investigations are carried out to establish competency of the foundation medium for the installation structures under all static and seismic loading conditions. The ground water regime and its chemical properties are also studied.

Loss of ultimate heat sink

Possibility of failure of down stream dam/barrage that may result in loss of heat sink functions for a nuclear power plant is scrutinized. If the probability and consequences of such events cannot be reduced to acceptable levels, such events are included in the design basis for the plant. Availability of alternate heat sink is also an important consideration.

Other potential natural and man-induced events which could cause a loss of heat sink function for a nuclear power plant, such as the blockage/diversion of a river, depletion of a reservoir, excessive marine organism, ship collisions, oil spills and fires, are assessed and related hazards are established. If no practical solution is available to mitigate the hazards, the site is rejected.

Impact of nuclear installation on site

The main objective of this assessment is to minimise individual doses as well as total population dose. For this purpose, details of site characteristics affecting dispersion of radioactive materials, population distribution in the site region including their dietary habits, and use of land and water bodies are required.

Studies related to activity dispersion through air

General meteorological data such as wind speed and direction, air temperature, precipitation, humidity, atmospheric stability parameters, and prolonged inversion conditions are collected from nearby meteorological stations for at least one full year and supplemented with any other relevant data from other sources. Atmospheric dispersion of radioactive materials is assessed using appropriate models which include all significant site specific and regional topographic features (river valleys, bowls, etc.) and characteristics of the installation (thermal interference from cooling towers etc.) affecting atmospheric dispersion.

A programme of meteorological measurement is initiated and carried out at the site at least three years in advance of commissioning of the installation.

Studies related to activity dispersion through surface water

A programme of investigations and measurements of surface hydrology of the site region is carried out to determine dilution and dispersion characteristics of water bodies, pick up of radioactivity by sediment and biota, transfer mechanisms of radionuclides, identification of exposure pathways to man through hydrosphere and indication of exposure pathways for the most significant nuclide. The above data are used to evaluate the impact of surface water contamination on population using suitable hydrological and radiological models.

Studies related to activity dispersion through sub-surface water

Hydrogeological investigations are carried out to study migration and retention characteristics of soils, dilution and dispersion characteristics of aquifers, and physical and physicochemical properties of underground materials, mainly related to radionuclides transfer mechanisms in ground water and their exposure pathways. Data and information obtained from the above investigations are used in a suitable model to assess potential impact of ground water contamination on the population.

Population distribution

The most recent census data for the site region are analysed to give population distribution in terms of direction and distance from the installation. An evaluation of potential radiological impacts of normal discharges and accidental releases of radioactive material, including reasonable assessment of releases due to severe accidents, is performed.

Land and water use

Land and water use in the site region are characterised to assess potential effects of the nuclear installation and prepare plans for implementation of emergency measures under accident conditions.

Ambient radioactivity

Ambient radioactivity of the atmosphere, hydrosphere, lithosphere and biota in the site region is assessed prior to commissioning so as to be able to determine the effects of the installation. The data also serve as a baseline in future investigations.

Quality assurance

An adequate quality assurance programme is established to control effectiveness of execution of site investigations, assessment and engineering activities performed in different stages of site evaluation and derivation of relevant design basis.

1. the siting, construction, commissioning, operation, reconstruction and decommissioning of nuclear installations; 2. designing nuclear installations; 3. designing, manufacturing, repairs and verification of nuclear installation systems or. their components, including materials used for their production; 4. designing, manufacturing, repairs and verification of packaging assemblies for the. transport, storage or disposal of nuclear materials; 5. handling of nuclear materials and of selected items and, in the case of their use in the. he scale of future nuclear installation decom-missioning challenges may be judged from the fact that over 500 nuclear power plants have been constructed and operated worldwide. OECD/ NEA member countries account for more than 80% of the total number of plants, and most of these (some 350 plants with an average age of about 20 years) will need to be decommissioned in the next few decades.Â Some sites may be released using a phased approach. This means that a substantial part of the site will be released prior to the end of insti-tutional control of the whole site, for example to enable the setting-up of new (non-nuclear) com-panies there or to reduce the size of the licensed nuclear site. Professor Michael I. Ojovan is the Chief Editor of the journal, and is currently based at the University of Sheffield, UK. He is known for many innovations in nuclear research, including metallic and glass-composite materials for nuclear waste immobilisation. Meet the editorial board. Special Issues. Do you think there is an emerging area of research that really needs to be highlighted? Or an existing research area that has been overlooked or would benefit from deeper investigation? Raise the profile of a research area by leading a Special Issue. Submit your proposal. Decommissioning costs for nuclear power plants, including disposal of associated wastes, contribute only a small fraction of the total cost of electricity generation. Proven techniques and equipment are available to dismantle nuclear facilities.Â Over 180 commercial, experimental or prototype reactors, over 500 research reactors, and several fuel cycle facilities have been retired from operation. Some of these have been fully dismantled. Most parts of a nuclear power plant do not become radioactive, or are contaminated at only very low levels. Most of the metal can be recycled. Proven techniques and equipment are available to dismantle nuclear facilities safely and these have now been well demonstrated in several parts of the world.