Annex III

THE IAEA FUNDAMENTAL SAFETY PRINCIPLES

Principle 1: Responsibility for safety
The prime responsibility for safety must rest with the person or organization responsible for facilities and activities that give rise to radiation risks.

Principle 2: Role of government
An effective legal and governmental framework for safety, including an independent regulatory body, must be established and sustained.

Principle 3: Leadership and management for safety
Effective leadership and management for safety must be established and sustained in organizations concerned with, and facilities and activities that give rise to, radiation risks.

Principle 4: Justification of facilities and activities
Facilities and activities that give rise to radiation risks must yield an overall benefit.

Principle 5: Optimization of protection
Protection must be optimized to provide the highest level of safety that can reasonably be achieved.

Principle 6: Limitation of risks to individuals
Measures for controlling radiation risks must ensure that no individual bears an unacceptable risk of harm.

Principle 7: Protection of present and future generations
People and the environment, present and future, must be protected against radiation risks.

Principle 8: Prevention of accidents
All practical efforts must be made to prevent and mitigate nuclear or radiation accidents.

Principle 9: Emergency preparedness and response
Arrangements must be made for emergency preparedness for and response to nuclear or radiation incidents.

Principle 10: Protective actions to reduce existing or unregulated radiation risks
Protective actions to reduce existing or unregulated radiation risks must be justified and optimized.

Annex I

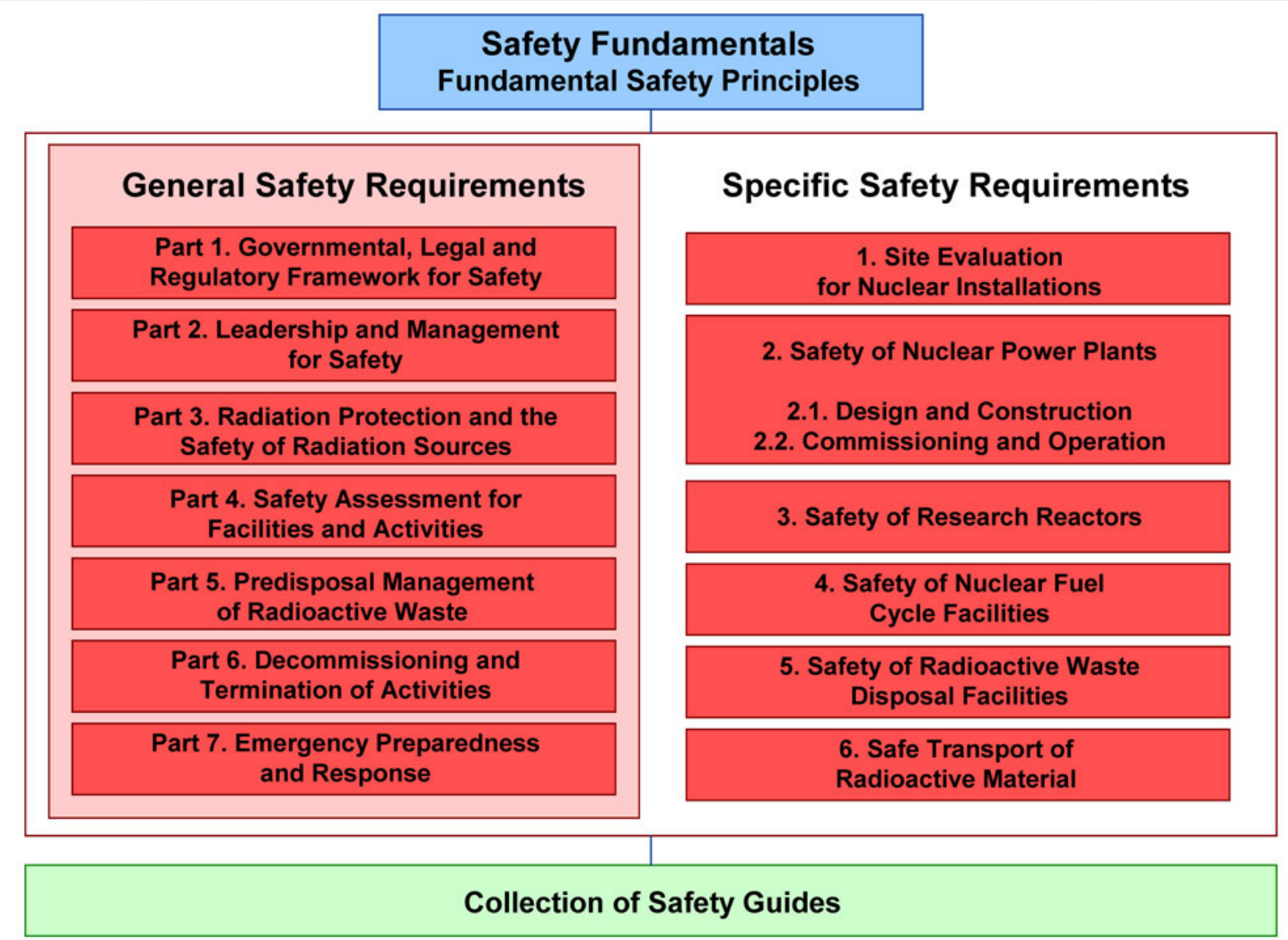
MAIN PHASES IN THE LIFETIME OF A NUCLEAR POWER PLANT

Phase	Duration (years)	Major safety activities	Necessary safety structure
1. Safety infrastructure before deciding to launch a nuclear power programme	1–3	Develop and justify a nuclear power plan. Conduct a public consultation. Develop basic legislation. Create a scientific, technical and educational nuclear programme.	A formal public consultation procedure. A State organization for nuclear plan management, development and oversight.
2. Safety infrastructure preparatory work for construction of a nuclear power plant after a policy decision has been taken	3–7	Define responsibilities of the plant licensee. Establish licensing methodology and define basic requirements for siting, design and construction.	Nuclear legislation based on the fundamental safety principles and defining the regulatory infrastructure and the licensing procedure. Independent regulatory body. National system for education and development in nuclear science and technology. An organization responsible for security.
3. Safety infrastructure during implementation of the first nuclear power plant			
3(a) Site selection and characterization	2–3	Select and characterize the site. Evaluate the site specific conditions to be incorporated into the design basis.	Safety requirements for siting. National institutions with knowledge of extreme natural phenomena and human-made hazards.

Phase	Duration (years)	Major safety activities	Necessary safety structure
3(b) Design and construction	5–7	Select the technology and the plant supplier. Specify and satisfy responsibilities for site preparation, design, construction and equipment procurement. Apply for the construction permit. Initiate site preparation, equipment procurement and detail design. Construct the plant in accordance with the safety requirements. Verify quality. Establish a strong safety culture. Integrate security and safety.	Safety requirements and safety guides for design, construction and quality assurance. Competent regulatory body for safety evaluation and for inspecting equipment fabrication, plant construction and quality assurance process. Expert organizations that can provide independent technical support to the regulatory body. Security requirements that are integrated with safety.
4. Safety infrastructure during the operation phase of a nuclear power plant			
4(a) Testing and commissioning	1–2	Verify that the plant complies with safety requirements. Apply for operation permit. Perform established nuclear tests. Transfer knowledge and responsibility to operator.	Safety requirements and safety guides for commissioning. Regulatory competence for the review and approval of test results and licensing reactor operators.
4(b) Commercial operation	40–60	Operate the plant within the safety requirements. Perform periodic testing and inspection of safety related components, systems and structures. Evaluate operating experience and apply the lessons learned for enhancing safety. Conduct emergency drills.	Safety requirements and safety guides for operation. Competent regulatory body for oversight of plant operation and of radioactive waste and spent fuel management. Party to the international global safety regime and networks for safe operation and sharing operating experience.

Phase	Duration (years)	Major safety activities	Necessary safety structure
5. Safety infrastructure during decommissioning and waste management phases of a nuclear power plant			
5(a) Decommissioning	5–10	Develop and implement a plan for decommissioning, dismantling and radioactive waste management. Enhance workers internal and external dosimetry.	Safety requirements and safety guides for decommissioning. Competent regulatory body to verify safety, radiation protection and waste management during dismantling.
5(b) Long term management of spent fuel	15–100+	Establish and maintain a long term radiological control of spent fuel and high level waste.	Safety requirements and safety guides for the long term storage of spent fuel and high level waste. Regulatory competence to verify compliance with regulations on waste management.

Structure of the Long Term Set of Safety Requirements



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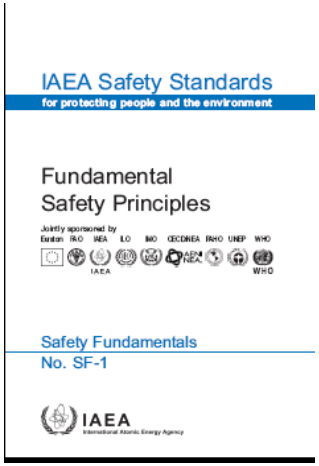
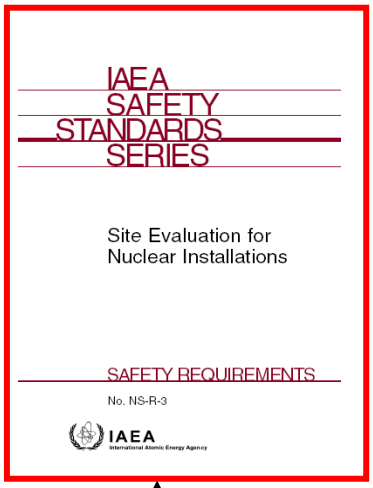
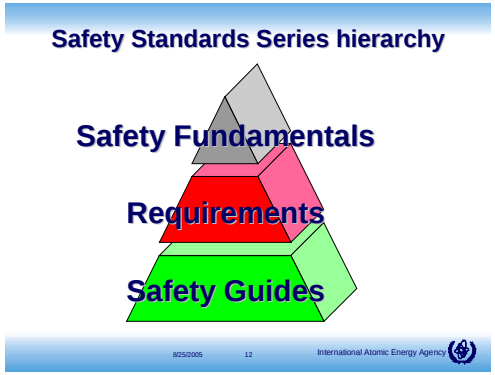
IAEA SAFETY STANDARDS ON SITE EVALUATION

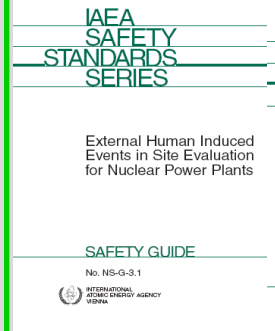


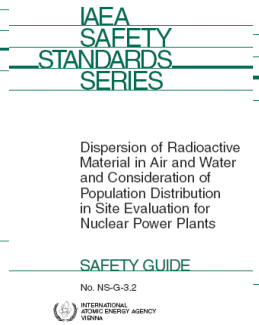


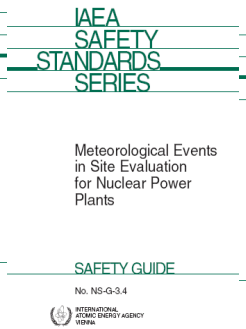
REQUIREMENTS

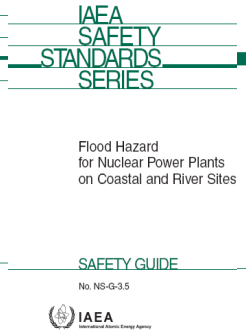


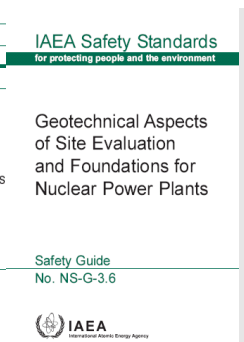
SAFETY GUIDES

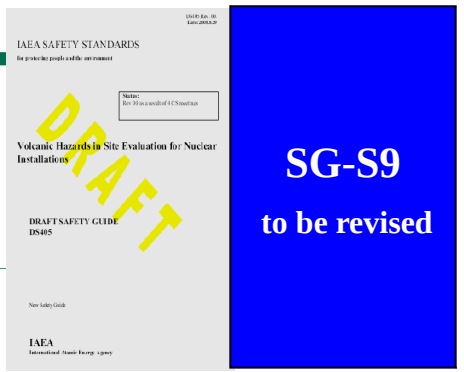












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Site Characterization

IAEA SAFETY STANDARDS ON SITE EVALUATION

SITE EVALUATION

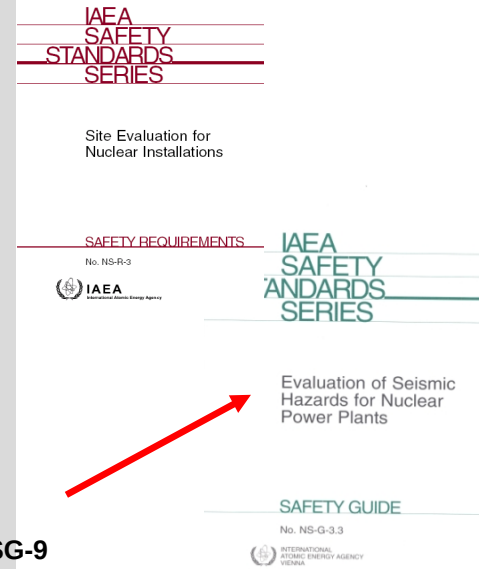
DESIGN

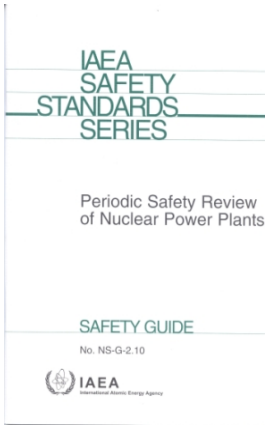
OPERATION

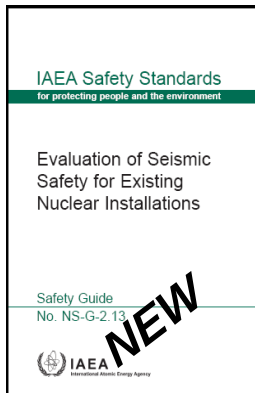
operating/ existing installations

New Installations

Evaluation of Seismic Safety - Existing NI NS-G-2.13







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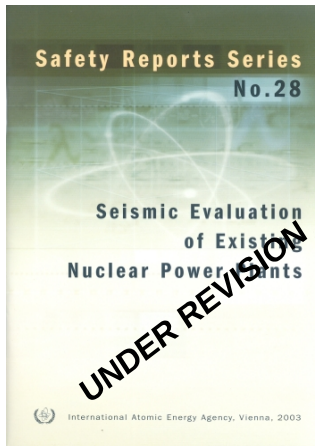
Seismic Hazard NS-G-3.3

Seismic Design and Qualification NS-G-1.6

Periodic Safety Review



Site Characterization

REVISION DS422

(t)

The complete lifetime of the installation

IAEA Site Selection and Evaluation Documents

SAFETY

1) **NS-R-3 Site Requirement**
2) **NS-G-3.1 Human Induced Hazards**
3) **NS-G-3.2 Dispersion air and water**
4) **NS-G-3.3 Seismic Hazards**
5) **NS-G-3.4 Meteorological Hazards**
6) **NS-G-3.5 Flooding Hazards**
7) **NS-G-3.6 Geotechnical Aspects**
8) **DS – 405 Volcanic Hazards**

Site Characterization IAEA NS-R-3

Requirements for site evaluation are intended to ensure adequate protection of site personnel, the public and the environment from the effects of ionizing radiation arising from nuclear installations.

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

Site Characterization IAEA NS-R-3

The siting process for a nuclear installation generally consists of an investigation of a large region to select one or more candidate sites (site survey), followed by a detailed evaluation of those candidate sites.

The IAEA NS-R-3 is concerned mainly with severe events of low probability that relate to the siting of nuclear installations and that have to be considered in designing a particular nuclear installation.

The scope of the investigation for the site of a nuclear installation covers the entire process of the site evaluation

- the selection,

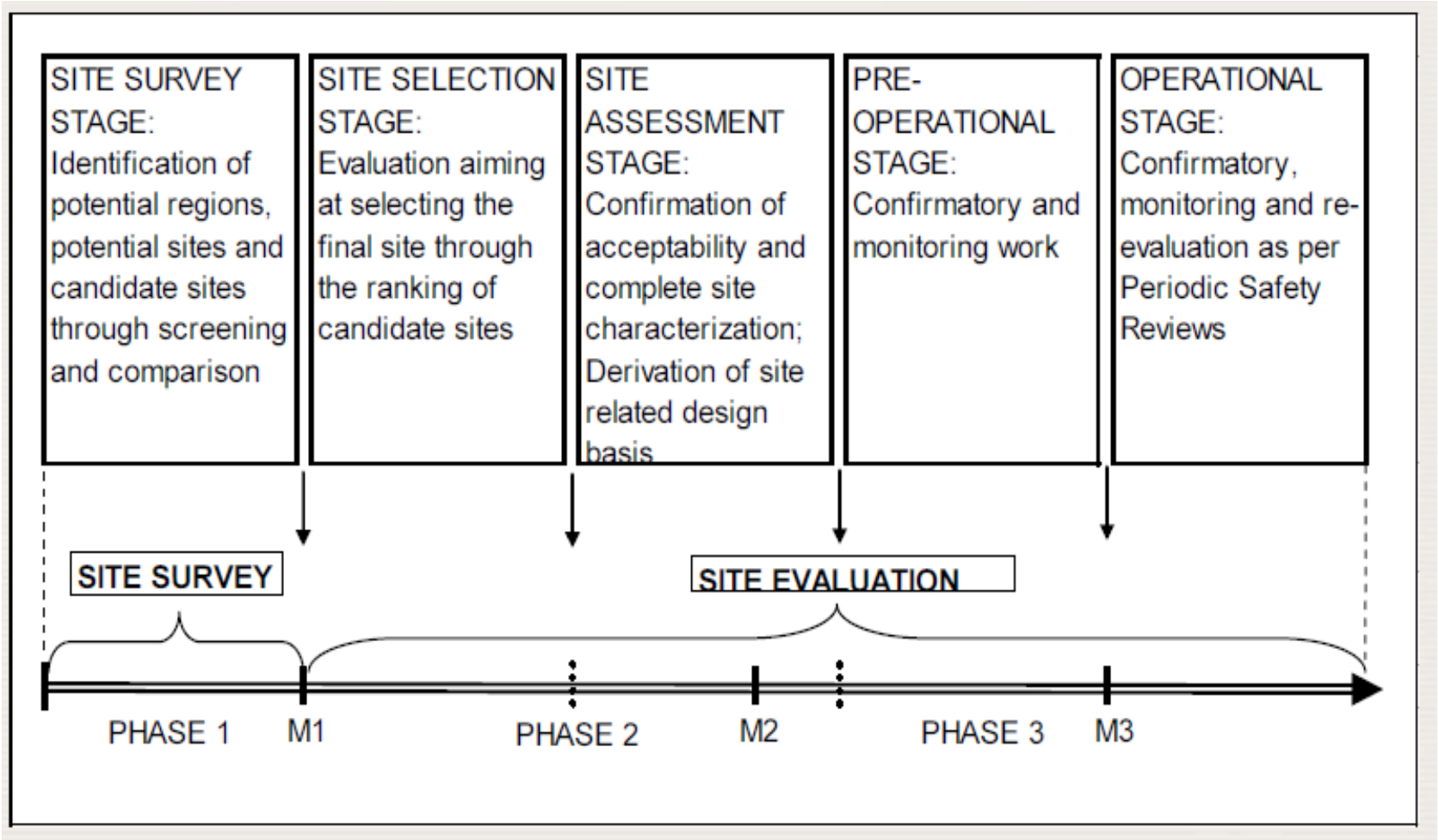
- assessment,

- pre-operational

- operational stages

Note: Site survey is the process that is used to identify preferred candidate sites for nuclear installations on the basis of safety and other considerations.

Site Characterization IAEA NS-R-3



Note: Site survey is the process that is used to identify preferred candidate sites for nuclear installations on the basis of safety and other considerations.

Site Characterization IAEA NS-R-3

Decision Steps

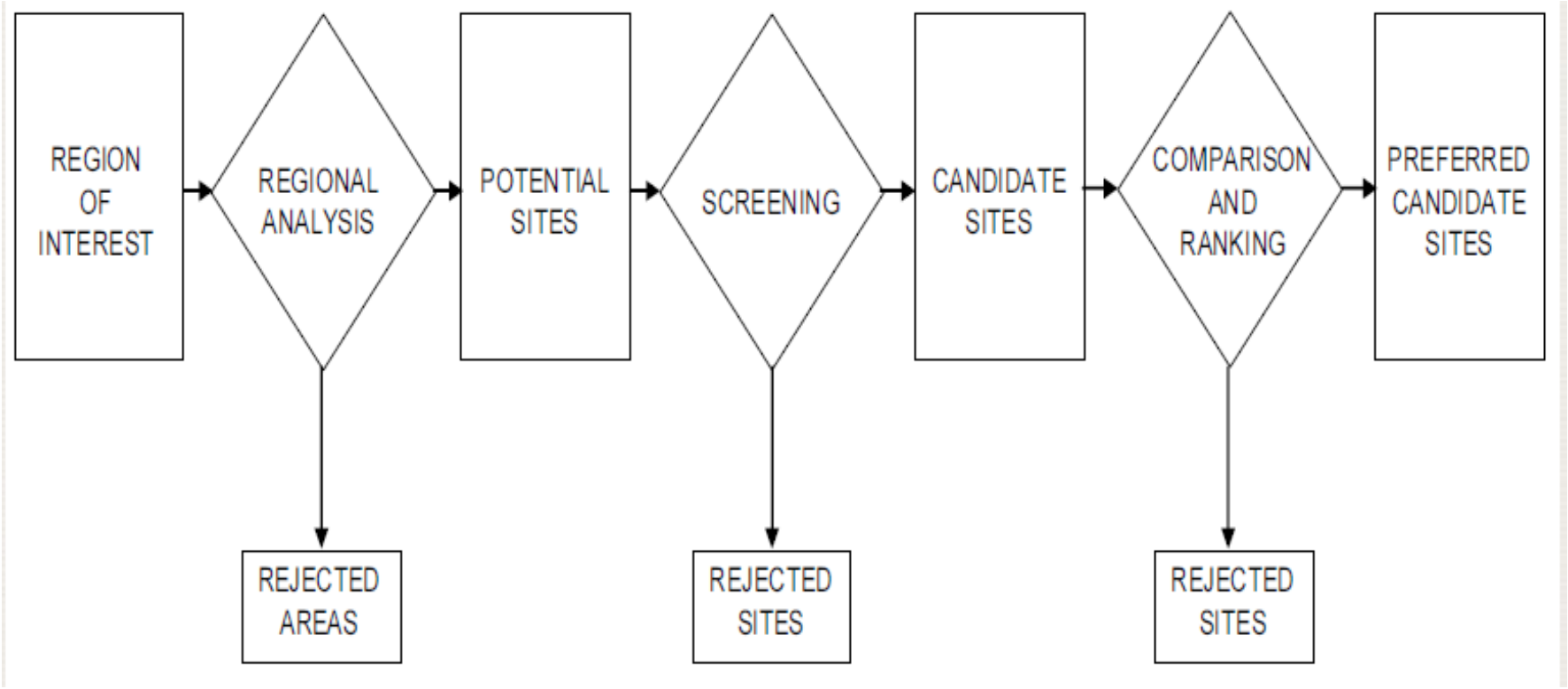
- **Decision regarding the "suitability" of the preferred candidate, i.e. confirmation that the site has no characteristics that would preclude the safe operation of a nuclear installation**

- **Decision related design basis parameters (e.g. to be used in tender documents)**

- **The approval of the PSAR (Preliminary Safety Analysis Report) which, inter alia, demonstrates that the site related design basis paramenters have been appropriately accounted for through conservative design, site protection measures or administrative means.**

Site Characterization IAEA NS-R-3

Site Selection Process



Site Characterization IAEA NS-R-3

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

- The effects of external events occurring in the region of the particular site (these events could be of natural origin or human induced);

- The characteristics of the site and its environment that could influence the transfer to persons and the environment of radioactive material that has been released;

- The population density and population distribution and other characteristics of the external zone in so far as they may affect the possibility of implementing emergency measures and the need to evaluate the risks to individuals and the population.

Factors to be considered when evaluating sites

- Proposed Nuclear Power Plant design
- Site characteristics peculiar for the NPP installation

Factors to be considered when evaluating sites

Proposed Nuclear Power Plant Design

(1) the reactor design characteristics (maximum power level, the nature and inventory of contained radioactive materials, the design basis adopted for natural and man-made external events, required installation area etc..)

(2) the extent to which the reactor incorporates unique or unusual features (prototype design features)

(3) the safety features engineered into the facility

Proposed Nuclear Power Plant Design can be:

(1) Specific Design (e.g. AP1000)

(2) Envelope of potential NPP candidates for a specific site (in case of an early site certification)

Factors to be considered when evaluating sites

Site Characteristics

(a) Population density and use characteristics of the site environs

(b) Physical characteristics of the site:

- seismology and geology
- meteorology
- hydrology

(c) The nature and proximity of man-related hazards (e.g., airports, dams, transportation routes, military and chemical facilities)

(d) Existing Infrastructures (routes, electrical network etc.) and site accessibility

(e) Political and socio-economic aspects of the site environs

(f) The nature and proximity of environmental protected areas, naturalistic parks and any historical and architectural values

Site Characteristics

Population density and use characteristics of the site environs

- factor affecting the **radiological impact** of the plant for individuals and the population as a whole during **normal operation** as well as **emergency** situations.

The evaluation shall consider:

- **present** and **foreseeable future characteristics** and the **distribution** of the population
- present and future **uses of land** and **water** in the region

Site Characteristics

Population density and use characteristics of the site environs

Exclusion area

Area surrounding the reactor, in which the reactor licensee has the authority to determine all activities including exclusion or removal of personnel and property from the area

Protective zone

The protective zone is the area beyond the exclusion zone that needs to be considered with respect to implementing emergency measures.

Site Characteristics

Population and Emergency Planning

1. Population density and distribution within the protective zone, with particular focus on existing and projected population densities and distributions in the region including resident populations and transient populations—this data is kept up to date over the lifetime of the NPP
2. Present and future use of land and resources
3. Physical site characteristics that could impede the development and implementation of emergency plans
4. Populations in the vicinity of the NPP that are difficult to evacuate or shelter (for example, schools, prisons, hospitals) and
5. Ability to maintain population and land-use activities in the protective zone at levels that will not impede implementation of the emergency plans.

Site Characteristics

Seismology and geology

Factors investigated for their potential to induce **hazard for safe operation** of a nuclear power plant

- vibratory ground motion
- earthquake recurrence rates
- site foundation materials
- surface deformation
- seismically induced floods and water waves
- surface faulting (i.e. the fault capability)
- geotechnical hazards (soil liquefaction, behavior of foundation materials, slope instability, site surface collapse, subsidence or uplift)

  * existence of natural features such as caverns, karstic formations and human made features such as mines, water wells and oil wells.

Site Characteristics

Meteorology

- **hazard for safe operation** of a nuclear power plant
- factor affecting the **radiological impact** in case of an escape of radioactive material from the facility .

Basic meteorological variables investigated include:

1. Regional topography
2. Wind speed and direction
3. Air temperature
4. Precipitation
5. Humidity
6. Atmospheric pressure

Where unfavorable physical characteristics of the site exist, the proposed site may nevertheless be found to be acceptable if the design of the facility includes appropriate and adequate compensating engineering safeguards

Site Characteristics

Hydrology

- **hazard for safe operation** of a nuclear power plant (flooding and drought hazards)
- factor affecting the **radiological impact** in case of an escape of radioactive material from the facility

Where unfavorable physical characteristics of the site exist, the proposed site may nevertheless be found to be acceptable if the design of the facility includes appropriate and adequate compensating engineering safeguards

Site Characteristics

Hydrology:

Surface Water information

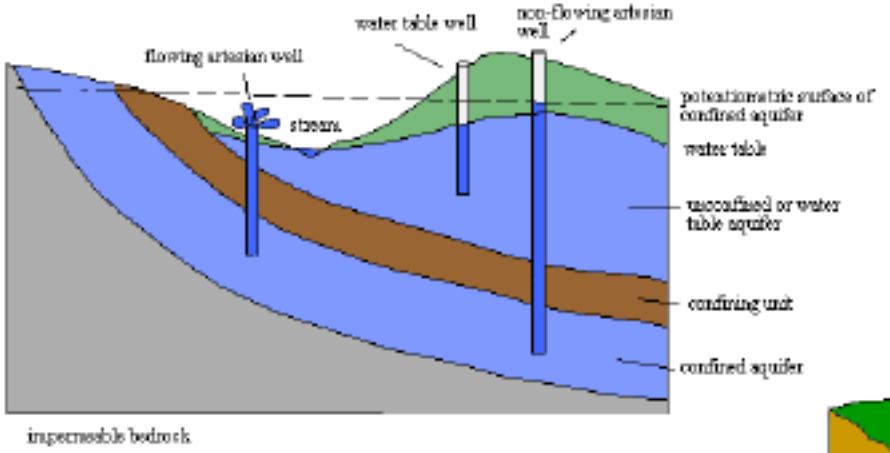
- surface water hydrology, including drainage basins and data on water levels and flow rates.
- normal flow, flooding, and drought properties of water bodies, as well as the interactions between surface water and groundwater flow systems. This program includes predictions of changes to site surface water hydrology (flows and chemistry) that are expected from foreseeable changes in upstream land use.

Groundwater Information

- groundwater hydrology of the environment, including the physical and geochemical properties of water-bearing formations and their interactions with surface waters.
- predictions of changes to site groundwater hydrology (flows and chemistry) that are expected to result from foreseeable changes in upstream land use or migration of existing contaminant plumes.

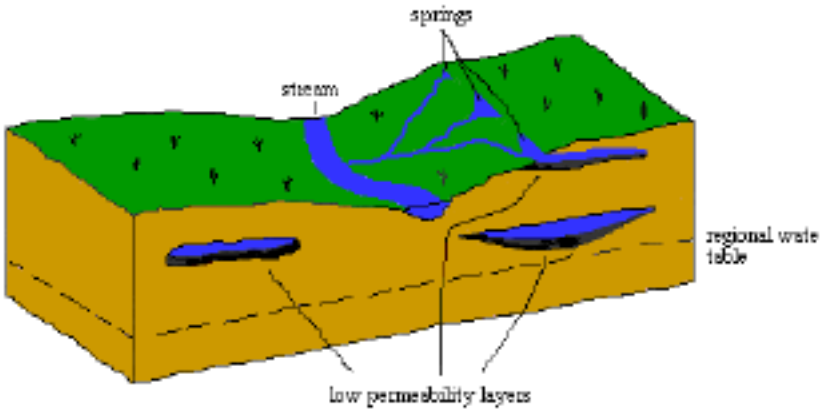
Site Characteristics

Hydrology - Water-bearing formations



Confined Aquifer

Perched Aquifer



Site Characteristics

Man-related hazards

Human activities posing **hazards to the safe operation** of a nuclear power plant

- airports (aircraft impact hazard)
- dams (flooding hazard)
- transportation routes (flammable, explosive or toxic transported material hazards)
- military and chemical facilities (missiles, explosion or chemical releases hazards)

Site Characteristics

Existing Infrastructures

Mainly Economical Factors

- Transportation network and characteristics (Road-Rail Roads and Sea-River Shipping Routes)
  - site accessibility of heavy and large component during construction, new and spent fuel transportation
  - factor relevant also for Emergency Planning
- Electrical Grid Interconnection (distance of a suitable connection node)

Site Characteristics

- Political and socio-economic aspects of the site environs

  ↳ *Factor affecting the public acceptance of NPP installation*

- Nature and proximity of environmental protected areas, naturalistic parks and any historical and architectural values

  ↳ *Factor affecting the **environmental impact** of the plant*

Site Characteristics

OTHER IMPORTANT CONSIDERATIONS

Additional factors that have the potential to give rise to adverse effects on the safety of the nuclear installation, such as:

- volcanism,
- sand storms,
- snow, ice, hail, and subsurface freezing of sub-cooled water

to be collected and assessed. If necessary design bases for these events shall be derived

Process for NPP site selection

Site survey to identify **one or more** candidate sites, and then performing a detailed evaluation of those **preferred sites** to:

1. Minimize the effects of NPP on the environment
2. Minimize the effects of the environment on the ability of the NPP to operate within the defined safe operating envelope
3. Minimize the cost of NPP installation

Process for NPP site selection - Selection process phases

Phase 1 – Identification of candidate areas

- Scope: First screening of the national territory in order to select areas candidates to a more focused analysis (local area analysis)
- Screen out of inappropriate areas using exclusionary criteria
- Survey based on national territory information system

Phase 2 – Selection of potential areas

- Scope: Reduction of candidate areas to be finally selected
- Selection using attention (non-exclusionary) criteria and qualitative comparisons

Phase 3 – Selected areas

- Scope: Prioritization and selection of best options
- Selection using comparisons criteria and cost-benefit analyses