

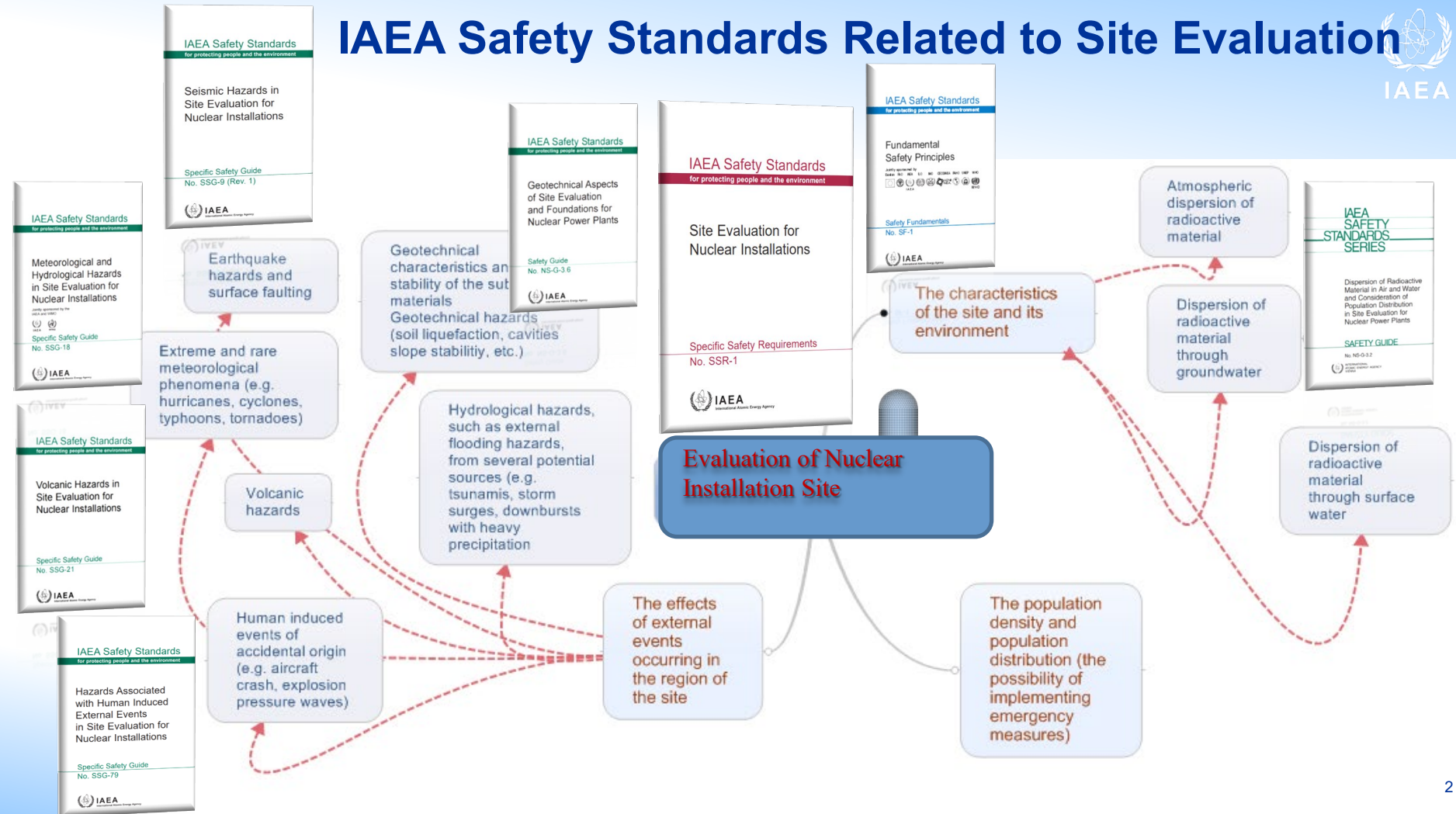
Asian Nuclear Safety Network (ANSN)
Regional Workshop on Site Evaluation for Small Modular Reactors
(SMRs)

Hosted by the Government of China
Through the
Nuclear and radiation Safety Center (NSC)
Haikou, China
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Site Evaluation for Nuclear Installations
(IAEA Safety Standard SSR-1)

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IAEA Safety Standards Related to Site Evaluation

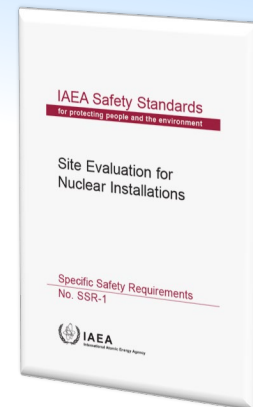


SSR-1, Site Evaluation for Nuclear Installations

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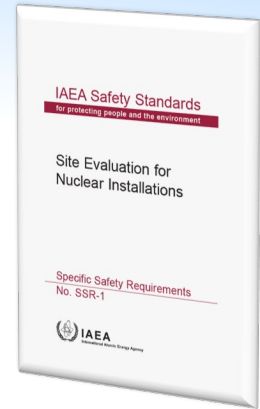
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Requirement 1: Safety objective in site evaluation for nuclear installations

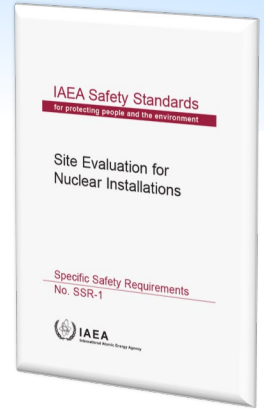
The safety objective in site evaluation for nuclear installations shall be to characterize the natural and human induced external hazards that might affect the safety of the nuclear installation, in order to provide adequate input for demonstration of protection of people and the environment from harmful effects of ionizing radiation.



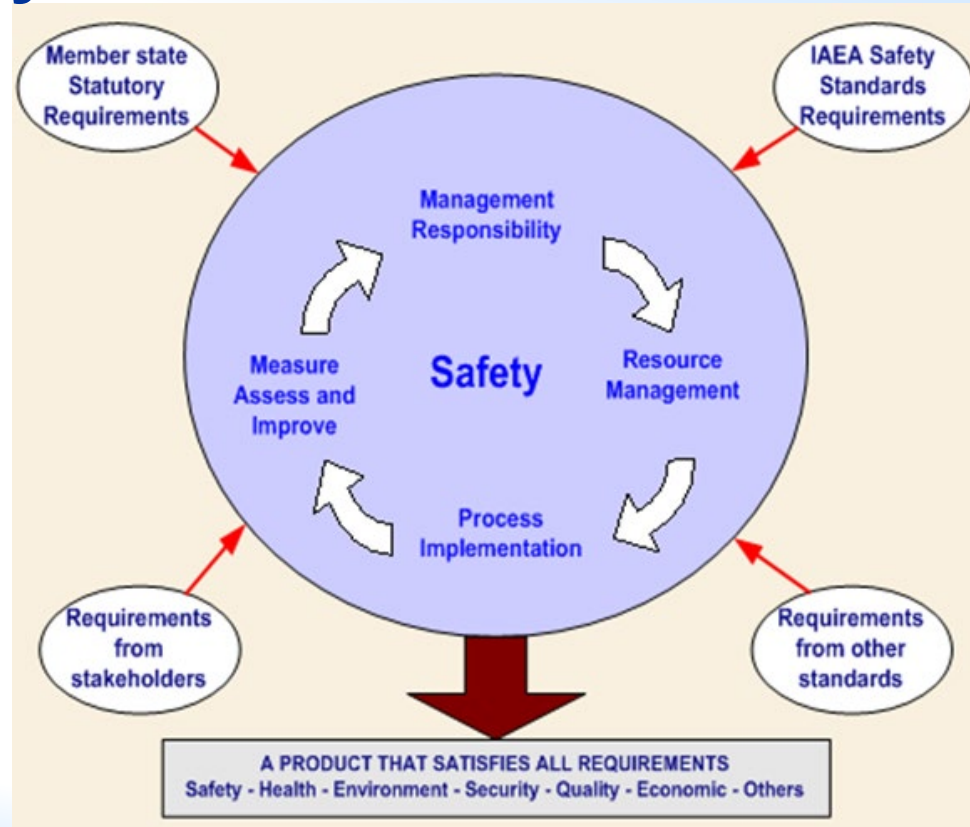
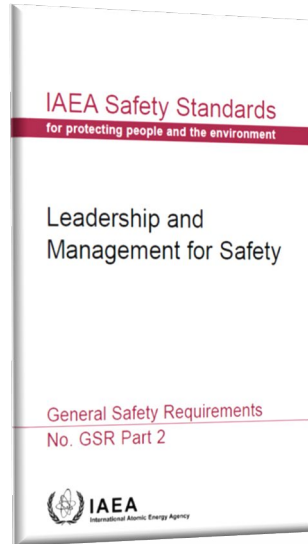


Requirement 2: Application of the management system for site evaluation

Site evaluation shall be conducted in a comprehensive, systematic, planned and documented manner **in accordance with a management system.**



Application of Management System - Management System Model



Application of management system for Site Characterization Activities

- A project work plan under management system should be prepared prior to, and as a basis for, the execution of the site characterization activities.
- The work plan should include:
 - Organization, personnel and their responsibilities;
 - work breakdown and project tasks;
 - schedule and milestones;
 - processes (e.g., control of documents, data collection, data processing, work control, procurement etc.);
 - deliverables and reports.
- The work plan should convey the complete set of general requirements for the project, including applicable regulatory requirements.

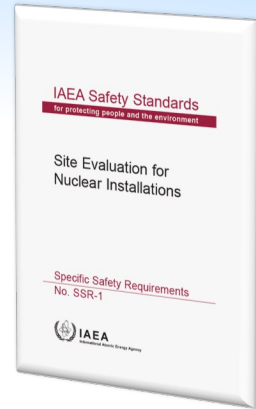
Application of management system for Site Characterization Activities

- The documentation for the site characterization activities should provide the following:
 - description of elements of the site characterization process
 - identification of the study participants and their roles;
 - background material that comprises compilation studies, field observation and exploration, maps, drawings and photographs, calculations etc.
- An independent peer review on the site evaluation/characterization report will provide assurance that a proper process has been duly followed in conducting the site selection activities and that the documentation is complete and traceable.



Requirement 3: Scope of the site evaluation for nuclear installations

The scope of the site evaluation shall encompass factors relating to the site and factors relating to the interaction between the site and the installation, for all operational states and accident conditions, including accidents that could warrant emergency response actions.



Site Characterization

Investigation Areas - Distance	
Vibratory ground motion	300 km radius
Tsunami	1000 km,(50m elevation or 10 km from shore or 1 km from river are screening)
Volcano	
- Tephra flow	300 km
- Surface flow	100 km
- Basaltic lava flow	100 km
- Debris flow and lahar	150 km
Tropical cyclones, typhoons, hurricane	300-400 km radius
Airplane crash	200 km radius 7.5 km radius runway 4 km from approach 10 km from airport 16 km from large airport 30 km from military airport
Hazardous cloud	8-10 km
Explosion	5-10 km

Site Characterization

Investigation Areas - Distance

Tornado	100000 km ²
Fire	1-2 km
.....	

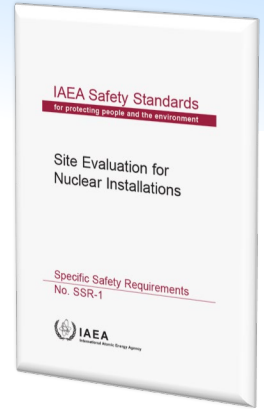
Monitoring

Meteorological data	One full year local and min 30-year data from national stations
Ground water	Two year before construction
River measurement	One year
....	



Requirement 4: Site suitability

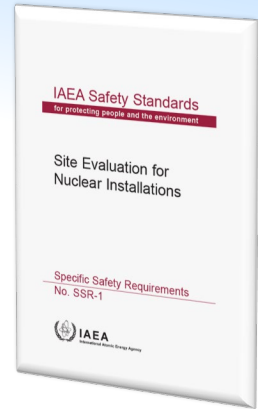
The suitability of the site shall be assessed at an early stage of the site evaluation and shall be confirmed for the lifetime of the planned nuclear installation.





Requirement 5: Site and regional characteristics

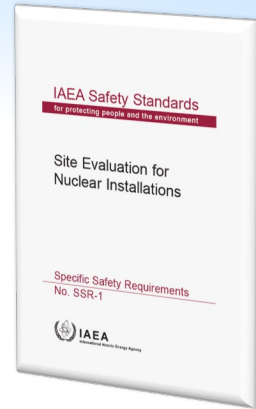
The site and the region shall be investigated with regard to the characteristics that could affect the safety of the nuclear installation and the potential radiological impact of the nuclear installation on people and the environment.





Requirement 6: Identification of site specific hazards

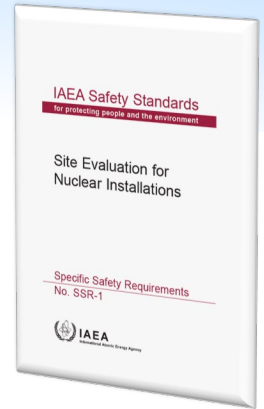
Potential external hazards associated with natural phenomena, human induced events and human activities that could affect the region shall be identified through a screening process.





Requirement 7: Evaluation of natural and human induced extremal hazards

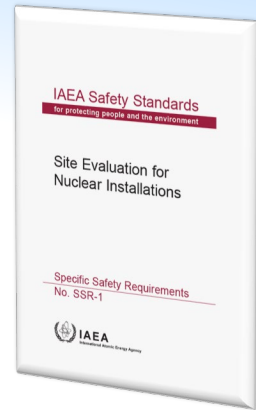
The impact of natural and human induced external hazards on the safety of the nuclear installation shall be evaluated over the lifetime of the nuclear installation.





Requirement 8: Measures for site protection

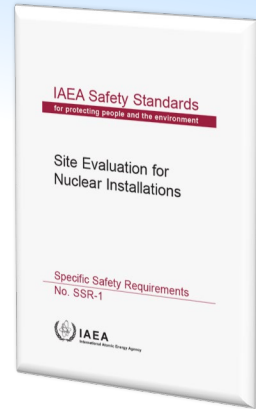
If the projected design of the nuclear installation is not able to safely withstand the impact of external natural and human induced hazards, the need for **site protection measures** shall be evaluated.





Requirement 9: Site evaluation for multiple nuclear installations on the same site or on adjacent sites

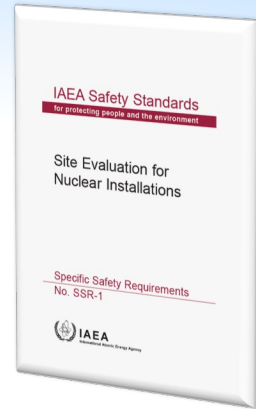
The site evaluation shall consider the potential for natural and human induced external hazards to affect **multiple nuclear installations** on the same site as well as on adjacent sites.





Requirement 10: Changes of hazards and site characterizations with time

The external hazards and the site characteristics shall be assessed in terms of their **potential for changing over time** and the potential impact of these changes shall be evaluated.

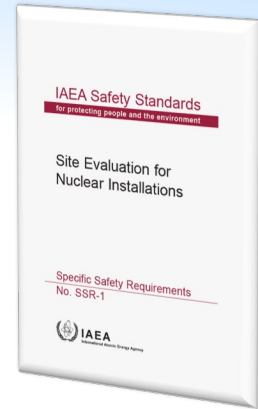




Requirement 11: Special considerations for the ultimate heat sink for nuclear installations that require an ultimate heat sink



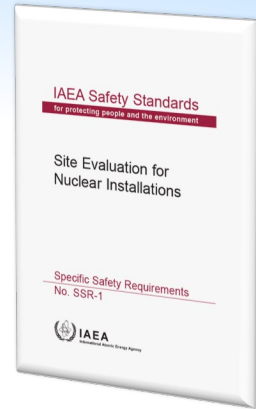
The evaluation of site specific natural and human induced external hazards for nuclear installations that require an ultimate heat sink shall consider hazards that could affect the availability and reliability of the ultimate heat sink.





Requirement 12: Potential effects of the nuclear installation on people and the environment

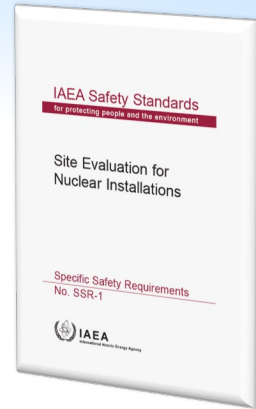
In determining the potential radiological impact of the nuclear installation on the region for operational states and accident conditions, including accidents that could warrant emergency response actions, **appropriate estimates shall be made of the potential releases of radioactive material**, with account taken of the design of the nuclear installation and its safety features.





Requirement 13: Feasibility of planning effective emergency response actions

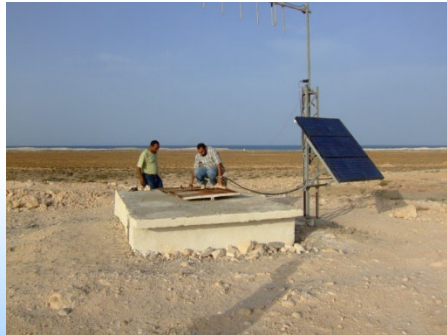
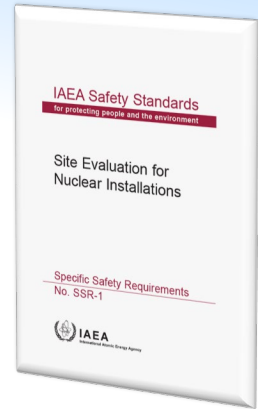
The feasibility of planning effective emergency response actions on the site and in the external zone shall be evaluated, with account taken of the characteristics of the site and the external zone as well as any external events that could hinder the establishment of complete emergency arrangements prior to operation.





Requirement 14: Data collection in site evaluation for nuclear installations

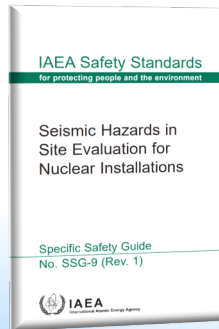
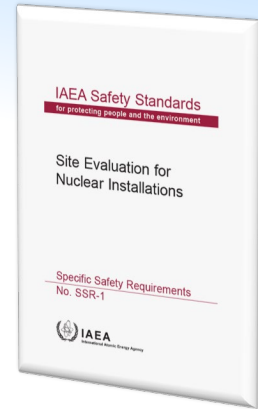
The data necessary to perform an assessment of natural and human induced external hazards and to assess both the impact of the environment on the nuclear installation safety and the impact of the nuclear installation on people and the environment shall be collected.





Requirement 15: Evaluation of fault capability

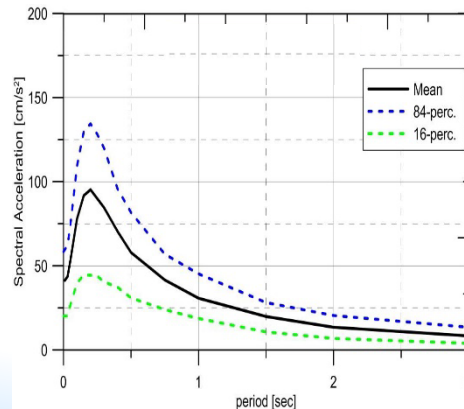
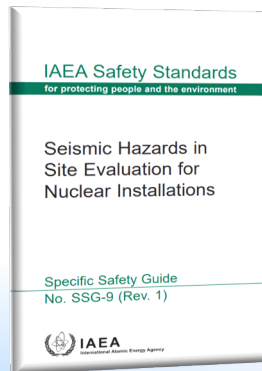
Geological faults larger than a certain size and within a certain distance of the site and that are significant to safety shall be evaluated to identify whether these faults are to be considered capable faults. **For capable faults**, potential challenges to the safety of the nuclear installation in terms of **ground motion and/or fault displacement hazards shall be evaluated.**



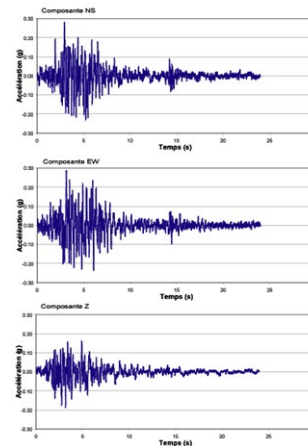


Requirement 16: Evaluation of ground motion hazards

An evaluation of ground motion hazards shall be conducted to provide the input needed for the seismic design or safety upgrading of the structures, systems and components of the nuclear installation, as well as the input for performing the deterministic and/or probabilistic safety analyses necessary during the lifetime of the nuclear installation.



Uniform Hazard Spectra

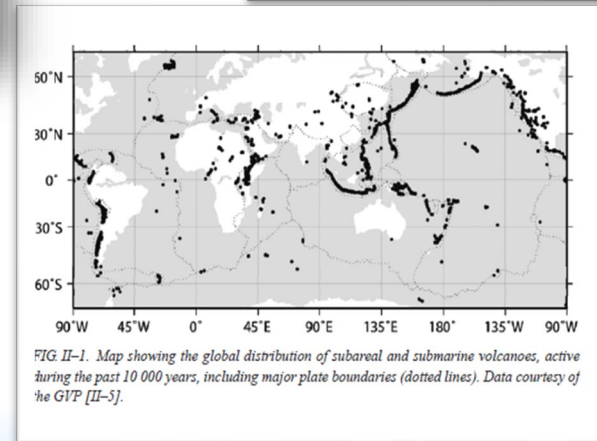
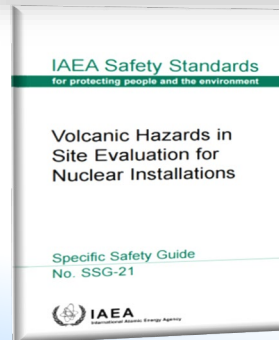
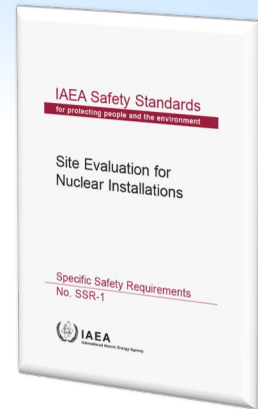
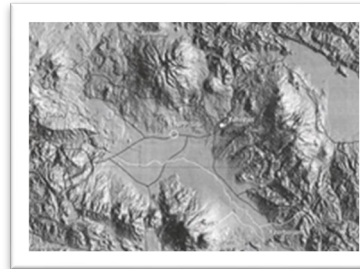


Time histories



Requirement 17: Evaluation of volcanic hazards

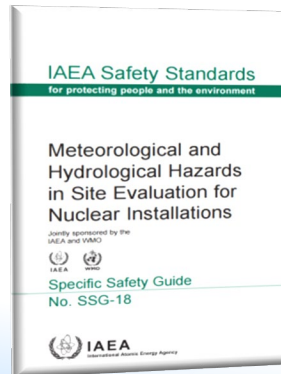
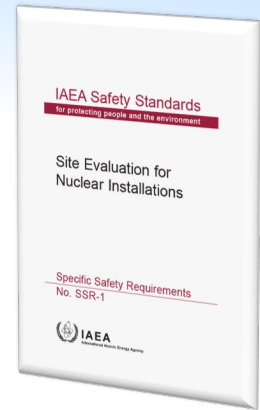
Hazards due to volcanic activity that have the potential to affect the safety of the nuclear installation shall be evaluated.





Requirement 18: Evaluation of extreme meteorological hazards

Extreme meteorological hazards and their possible combinations that have the potential to affect the safety of the nuclear installation shall be evaluated.



High Wind Speed Missiles

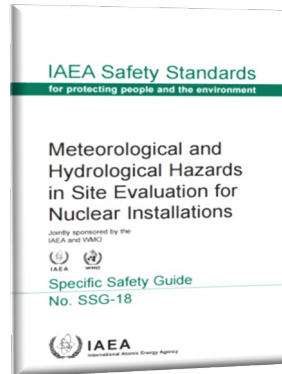


Waterspouts



Requirement 19: Evaluation of rare meteorological events

The potential for the occurrence of **rare meteorological events** such as lightning, tornadoes and cyclones, including information on their severity and frequency, **shall be evaluated.**

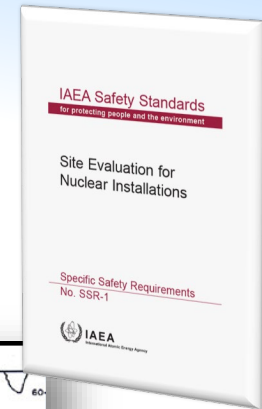
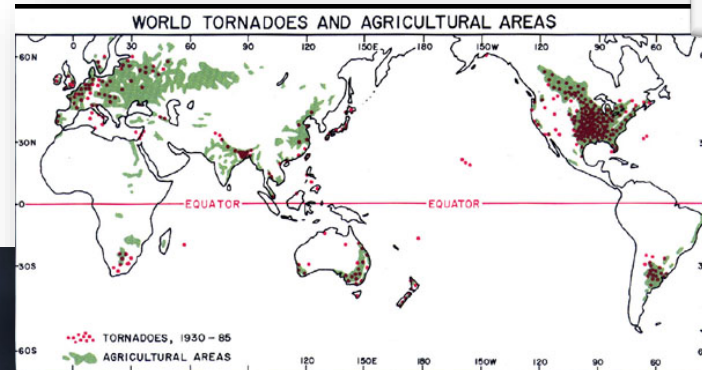


Tornadoes



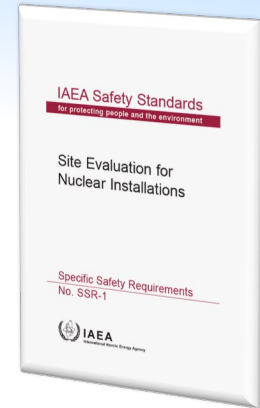
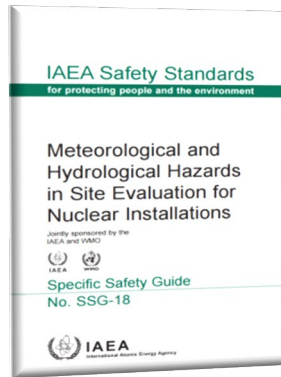
Lightning

World Map of Tornado Occurrence



Requirement 20: Evaluation of flooding hazards

Hazards due to flooding, considering natural and human induced events including their possible combinations, shall be evaluated.



River
Sea, Estuary
Lake

Water retaining structures

Circuits & Equipment

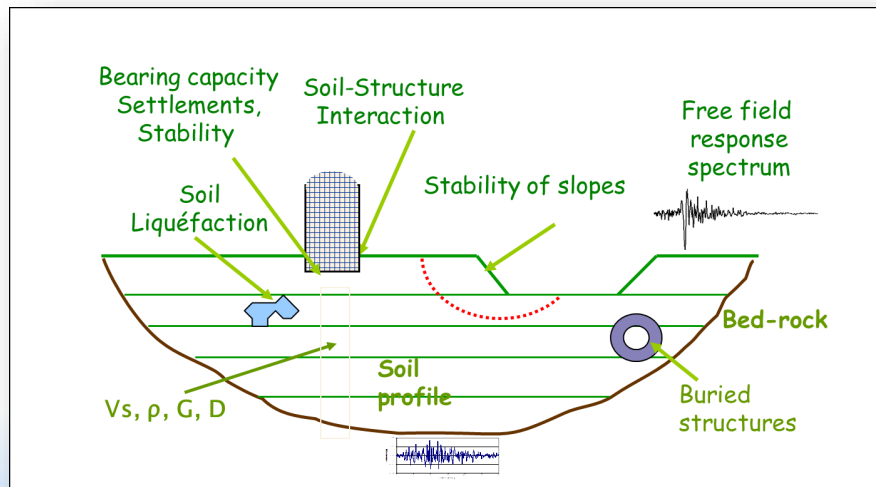
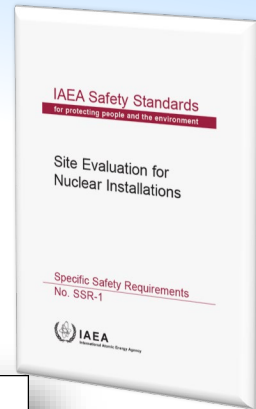
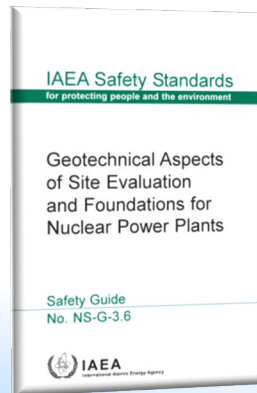
Water retaining structures,
Canal

Groundwater

Water bodies - Sources for Flooding

Requirement 21: Geotechnical characteristics and geological features of subsurface materials

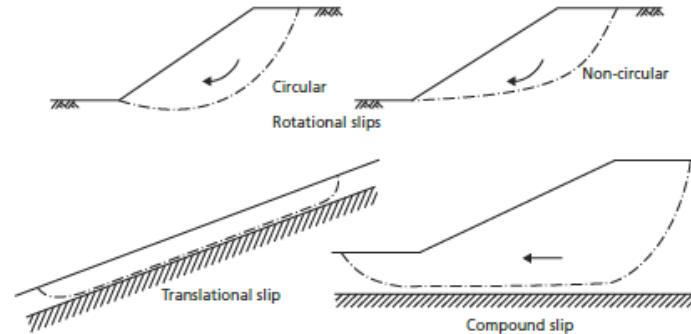
The geotechnical characteristics and geological features of subsurface materials shall be investigated, and a soil and rock profile for the site that considers the variability and uncertainty in subsurface materials shall be derived.



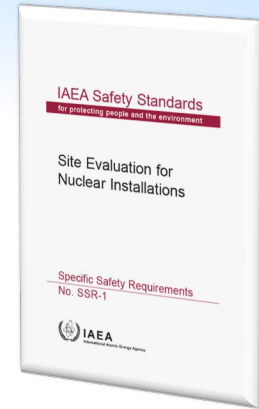


Requirement 22: Evaluation of geotechnical hazards and geological hazards

Geotechnical hazards and geological hazards, including slope instability, collapse, subsidence or uplift, and soil liquefaction, and their effect on the safety of the nuclear installation, shall be evaluated.



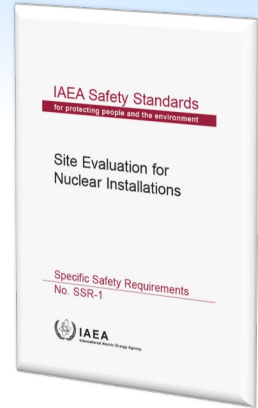
Failure Modes of slopes





Requirement 23: Evaluation of other natural hazards

Other natural phenomena that are specific to the region and which have the potential to affect the safety of the nuclear installation shall be investigated.



Dust Storms and Sandstorms



Hail

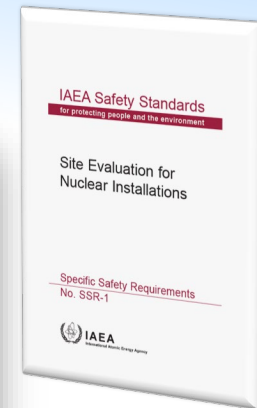
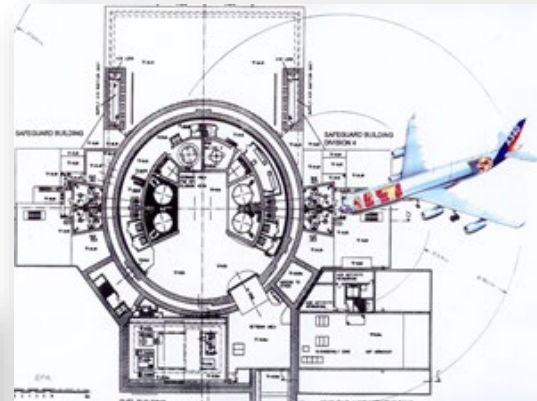
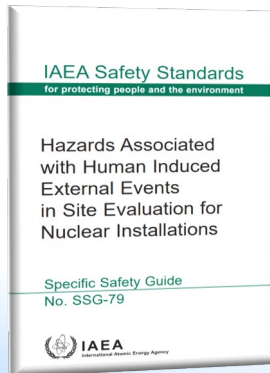


Freezing Precipitation - Ice Storm



Requirement 24: Evaluation of hazards associated with human induced events

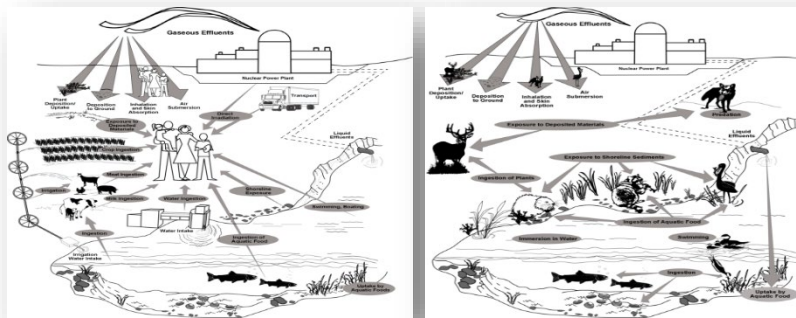
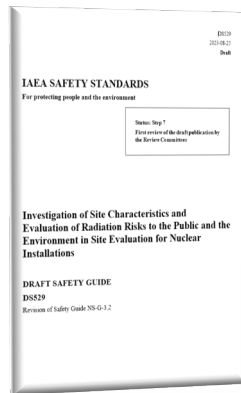
The hazards associated with human induced events on the site or in the region shall be evaluated.



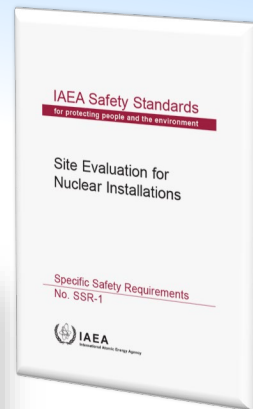


Requirement 25: Dispersion of radioactive material

The dispersion in air and water of radioactive material released from the nuclear installation in operational states and in accident conditions shall be assessed.



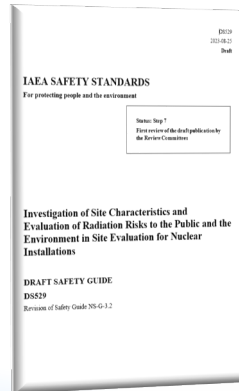
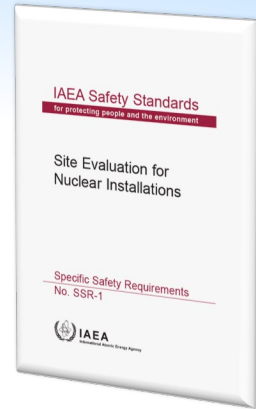
Exposure Pathways to Humans and biota





Requirement 26: Population distribution and public exposure

The existing and projected population distribution within the region over the lifetime of the nuclear installation shall be determined and the potential impact of radioactive releases on the public, in both operational states and accident conditions, shall be evaluated and periodically updated.

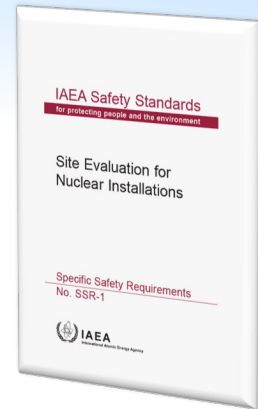
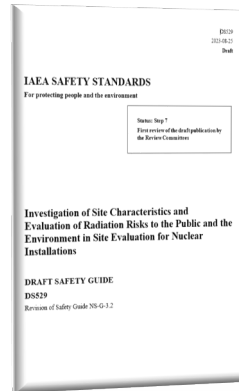




Requirement 27: Uses of land and water in the region



The uses of land and water shall be characterized in order to assess the potential effects of the nuclear installation on the region.





Requirement 28: Monitoring of external hazards and site conditions

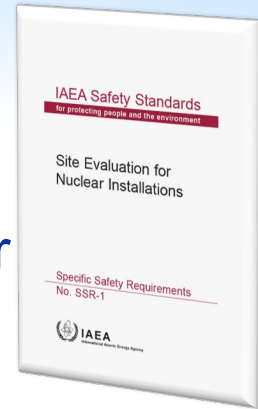
All natural and human induced external hazards and site conditions that are pertinent to the licensing and safe operation of the nuclear installation shall be monitored over the entire lifetime of the nuclear installation.





Requirement 29: Review of external hazards and site conditions

All natural and human induced external hazards and site conditions shall be periodically reviewed by the operating organization as part of periodic safety review and as appropriate throughout the operating lifetime of the nuclear installation, with due account taken of operating experience and new safety related information.



Example : Site Related Design Parameters

Site Characteristic / Parameter	Site Characteristic / Parameter
Precaution Action Zone (PAZ)	100- year 3 second Wind gust speed
Urgent Protection Action Zone (UPZ)	Tornado Parameters
Population centre distance	Maximum horizontal Wind speed
External human induced events in the region of the NPP site (e.g. explosions, fires, release of toxic chemicals and flammable clouds, pressure effects)	Translational speed
	Rotational Speed
	Radius of Maximum Rotational Speed
	Maximum Pressure Differential
	Maximum Rate of Pressure Drop
Weight of 100-Year Snowpack	Dry-Bulb Temperature and Coincident Wet-Bulb Temperature
Weight of 48-hour Probable maximum winter precipitation (PMWP)	2% Annual Exceedance
Conditions resulting in the maximum evaporation and drift loss of water from the UHS	1% Annual Exceedance
During any consecutive 30 days	100-Year Maximum
Conditions resulting in the Minimum Water Cooling in the UHS	Dry-Bulb Temperature
During 1 day	98% Annual Exceedance
During Any consecutive 5 Days	99% Annual Exceedance
	100-Year Minimum
	Wet-Bulb Temperature (Non-concurrent)
	2% Annual Exceedance
	1% Annual Exceedance
	100-Year Maximum

Example : Site Related Design Parameters

Site Characteristic / Parameter
Accident Release χ/Q values at PAZ 0-2 hr
Accident Release χ/Q values at UPZ Population Zone 0-8 hr 8-24 hr 24-96 hr 96-720 hr
Routine Release χ/Q values at site boundary Undepleted/No Decay Undepleted/2.26-Day Decay Depleted/8.00-Day Decay D/Q
Routine Release χ/Q Values at Locations of Interest Undepleted/No Decay Undepleted/2.26-Day Decay Depleted/8.00-Day Decay D/Q

Site Characteristic / Parameter
Maximum Flood Elevation Probable Maximum Flood Coincident Wind Wave and Other Effects on Max Flood Level
Maximum Precipitation Rate
Potential for Water Freezing in the UHS Water Storage Facility Potential Frazil and Anchor Ice Maximum Ice Thickness Maximum Cumulative Degree-Days Below Freezing
Maximum Elevation of Groundwater
Travel Time for Groundwater Flow
Travel Time for Radionuclide Transport in the Groundwater
Inventory of Radionuclides Which Could Potentially Seep into the Groundwater

Example : Site Related Design Parameters

Site Characteristic / Parameter
Ground Motion Response Spectra (GMRS)/Safe Shutdown Earthquake (SSE)
Fault Displacement Potential (yes/no)
Minimum Static Bearing Capacity
Minimum Shear Wave Velocity
Liquefaction Potential (yes/no)
Maximum Settlement
Slope Failure Potential (yes/no)
Tornado Missile Spectra
Aircraft Hazards on Plant SSCs

Concluding remark

- Suitability of a site for a nuclear installation be evaluated with regard to the following:
 - (a) The effects of external events occurring in the region of the site,
 - (b) The characteristics of the site and its environment that could influence the transfer to persons and the environment of radioactive material,
 - (c) 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.
- Evaluation of the nuclear installation site is on-going process over the operating lifetime of the nuclear installation (monitoring programme).
- Site related aspects need to be re-assessed during operational life in response to new knowledge, new hazards, new regulations and new practices, as part of periodic safety reviews.



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Thank you!
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