

“Site and Supporting Facilities”

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IAEA

International Atomic Energy Agency

The “site”

‘Site selection and evaluation are a crucial part of establishing a nuclear power programme and can be significantly affected by costs and public acceptance.’

- **Section 3.12, NG-G-3.1**

The “*site*”

Milestone 1:

- General survey of potential sites
- Identification of possible sites

Milestone 2:

- Detailed site characterization
- A suitable site (s) for bid is (are) selected

Milestone 3:

- All site services and provisions in place and functional

Section 3.12, NG-G-3.1

DEFINITIONS

- **SITE:** The area containing the plant, defined by a boundary and under effective control of the Plant Management.
- **SITING:** The process of selecting a suitable site for a facility, including appropriate assessment and definition of the related design bases.
- **EXTERNAL EVENTS:** are events unconnected with the operation of a facility or activity which could have an effect on the safety of the facility or activity

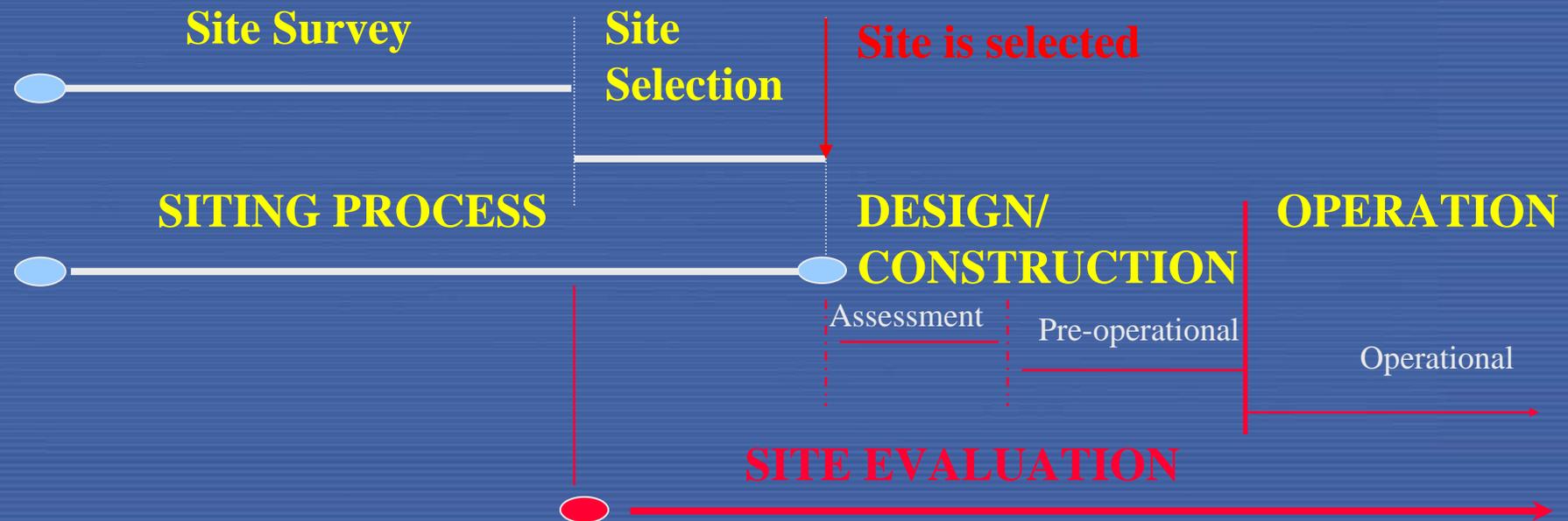
SITE SELECTION (SITING) AND EVALUATION

SITING:

1. Site Survey
2. Site Selection

SITE EVALUATION:

1. Site Selection
2. Assessment
3. Pre-operational
4. Operational



SITE SELECTION

Purpose: Identification and ranking of one or more ***“preferred candidate sites”***,

- consideration of both safety and non-safety aspects,
- regional scale,
- rejection of “unacceptable” sites,
- systematic screening, selection and comparison of the “acceptable” sites.

SITE SELECTION

A multidisciplinary effort:

- power engineering,
- nuclear engineering,
- radiological protection,
- ecology-radioecology,
- demography,
- emergency planning,
- civil engineering,
- soil mechanics,
- geology, geophysics
- seismology,
- hydrology, hydrogeology
- meteorology
- oceanography,

SITE SELECTION

Phases :

1. Regional analysis to identify “*potential sites*”,
2. Screening of “*potential sites*” to select “*candidate sites*”,
3. Screening, comparison and ranking of “*candidate sites*” to obtain the “*preferred candidate site(s)*”.

SITE SELECTION

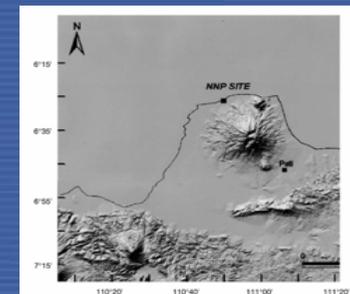
Specific safety-related site characteristics:

1. Seismicity and surface faulting,
2. Subsurface material,
3. Vulcanism,
4. Flooding,
5. Extreme meteorological phenomena,
6. Human induced events,
7. Dispersion in air and water,
8. Population distribution,
9. Emergency planning,
10. Land use,
11. Availability of cooling water
12. Others.

SITE SELECTION AND EVALUATION

Site Rejection Criteria :

1. Surface faulting and geological instability
2. Soil foundation material (liquefaction, subsidence)
3. Vulcanism
4. Flooding (areas with high flood levels)
5. Rare meteorological phenomena
6. Man-induced events
7. Dispersion in air and water
8. Population distribution and emergency planning



SITE EVALUATION

For the selected site, detailed and specific investigations and studies result in the:

- demonstration of the **acceptability of the site** on the basis of established criteria,
- derivation of the **site related design bases** for the facility.

Criteria for Potential Effects on the Region

Table: GENERAL WORK PLAN AND MILESTONE FOR NUCLEAR POWER PLANT SITE SELECTION PROCESS

	Stage	Description	Objectives	Result	Deliverables	General Milestone						
N P P A	1	Site Survey	Identification of Potential Candidate Sites	Candidate Sites	Site Survey Report							
	2	Site Selection	Ranking of Potential Candidate Sites and Selection of	Selected Site	Site Selection Report							
	3	Site Confirmation	Confirm the acceptability of Selected Site and define the	Acceptance is confirmed and Design Basis are defined	Site Evaluation Report (SER)							
	4	Revision of SER										3M
N C N S R C	1	Regulatory Requirement	Establishment of Regulatory Requirement for Site Evaluation									
	2	Review of SER										6M

IAEA SAFETY STANDARDS

IAEA's Statute authorizes the Agency to . . . establish standards of safety for the protection of

- **health,**
- **life, and**
- **property**

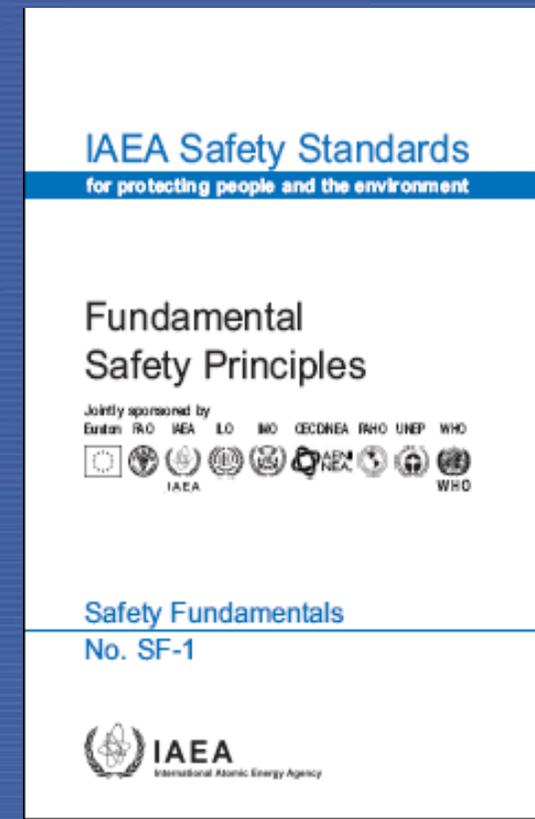
in the development and application of nuclear energy for peaceful purposes; . . .

. . . and to provide assistance upon request from MS for applying and using these standards



IAEA Fundamental Safety Principles

- Global reference point for the high level of safety required for use of nuclear energy
- 1 Safety Objective:
“The fundamental safety objective is to protect people and the environment from the harmful effects of ionizing radiation”
- 10 Safety Principles



The “*site*” and nuclear safety

Principle 8 – Prevention of accident

“*Defence in depth*” is provided by combination of:

1. Effective management system – safety culture
2. **Adequate site selection**, good design and engineering safety features providing safety margins, diversity and redundancy.....
3.'

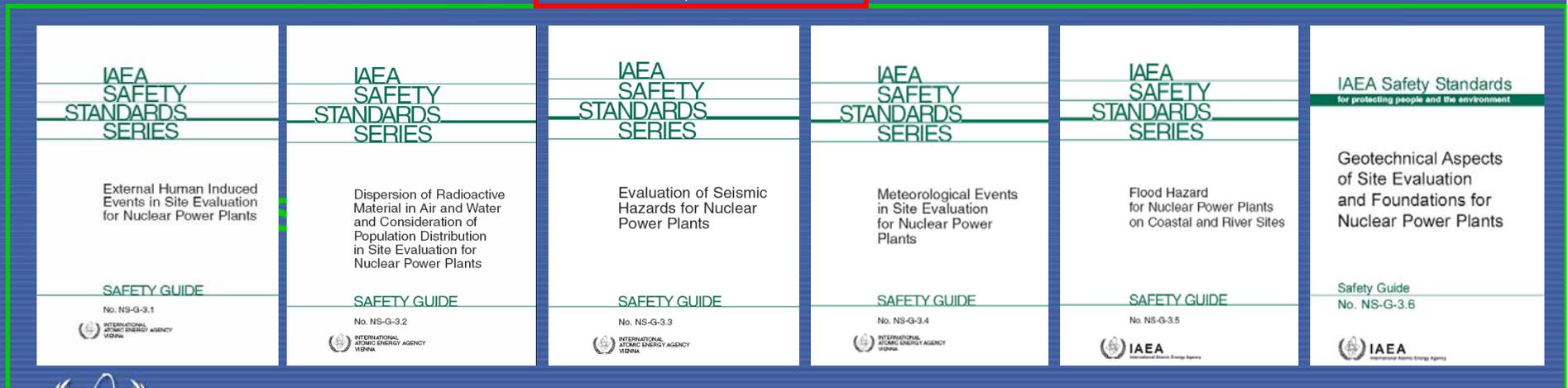
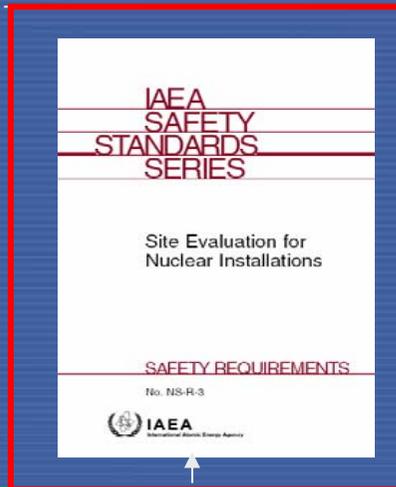
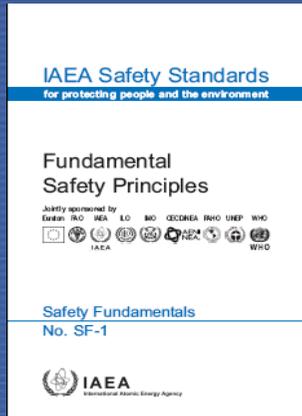
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IAEA Safety Standards on Site Evaluation

SITE EVALUATION

REQUIREMENTS

SAFETY GUIDES



Site Evaluation - General Safety Requirements

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

1. **Effects of external events** occurring in the region of the particular site (natural or human induced),
2. **Characteristics of the site and its environment** which could influence the transfer of released radioactive material to persons.
3. **Population density and distribution** and other characteristics of the external zone in relation to the possibility of implementing emergency measures and the need to evaluate the risk to individuals and the population.

Acceptability Criteria - General Requirements

If the site evaluation for these three aspects indicates that the site has serious deficiencies that cannot be compensated for by means of:

- (a) design features,
- (b) site protection measures or
- (c) administrative procedures,

the site shall be deemed unsuitable.

Design features (a), and site protection measures (b), are the preferred methods for compensating for the deficiencies.

Criteria for External Events

Proposed sites shall be adequately investigated with respect to all the characteristics that could affect safety in relation to **natural and human induced events**.

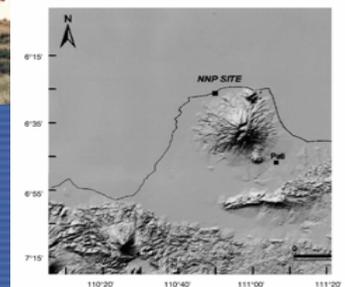
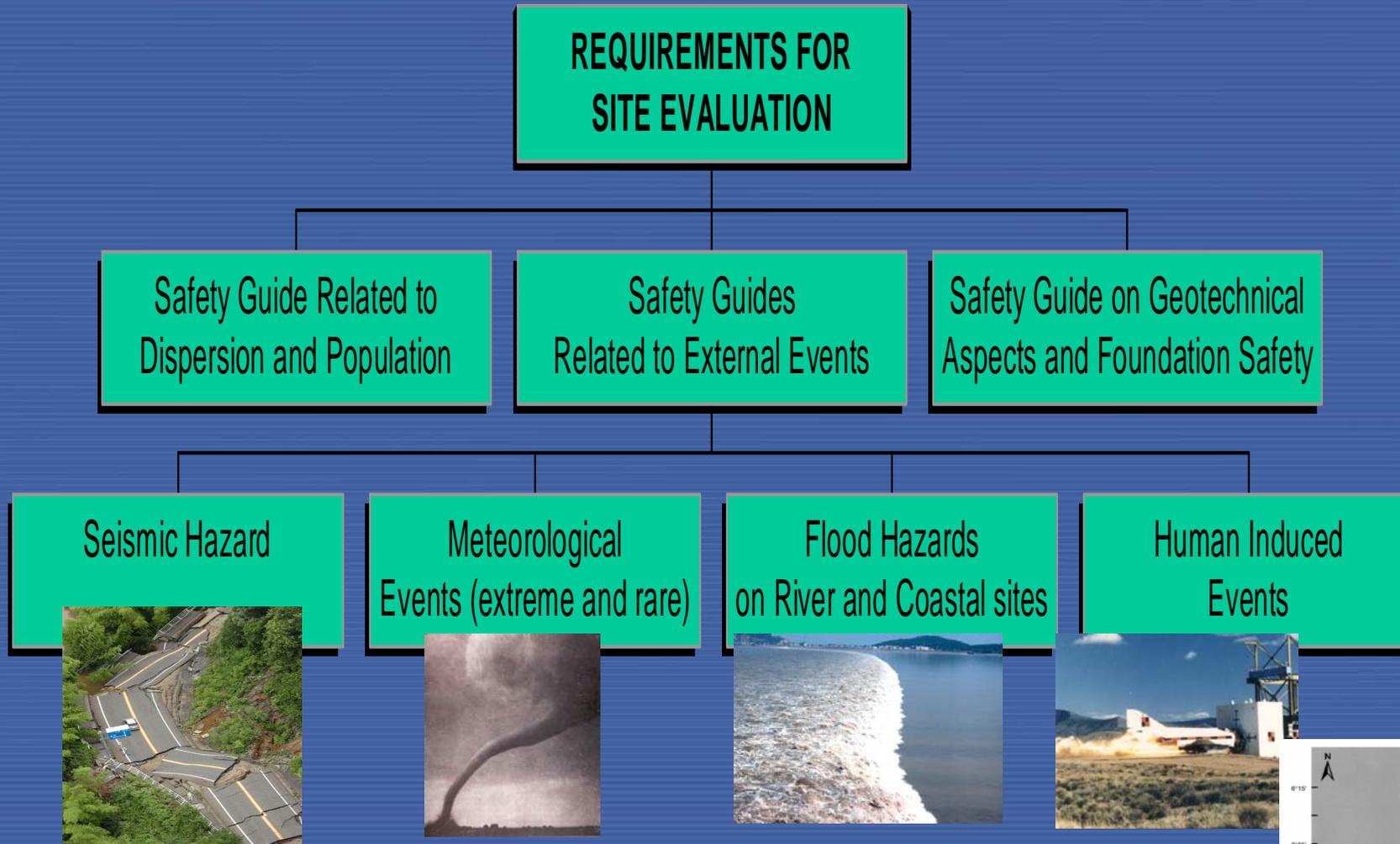
The foreseeable significant changes in land use, such as expansion of existing facilities and human activities or the construction of high risk installations, shall be considered.

Origin of external events:

1. Natural

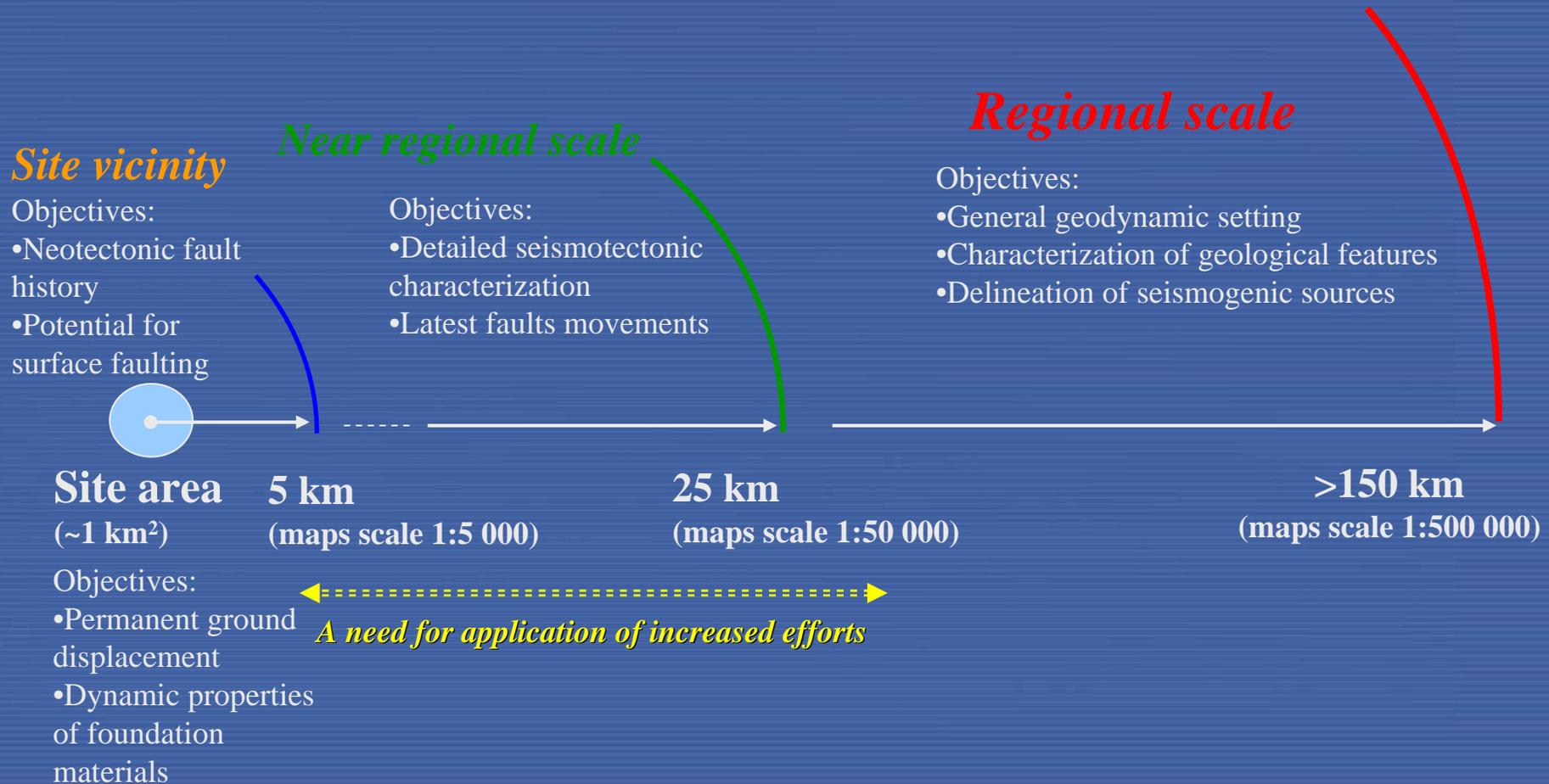
2. Human induced

Site Evaluation Safety Standards



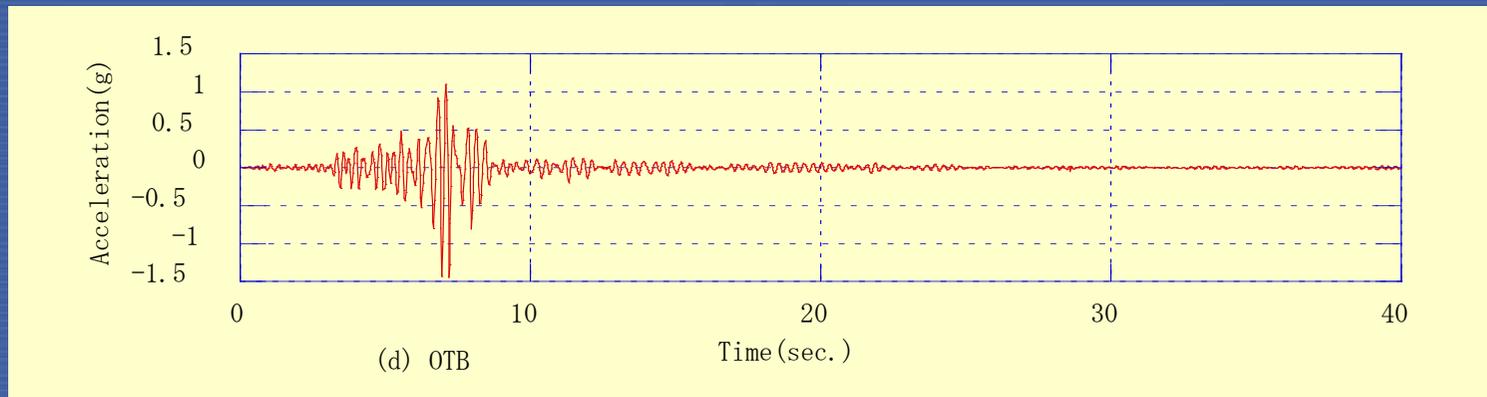
Seismic Hazard Evaluation – Scales of investigations

Geological, geophysical and geotechnical databases



SEISMIC SAFETY

- **New experience from the occurrence of actual earthquakes** – better recorded ground motion data and the observed performance of structures, systems, and components (SSCs);



- To address the issue of **installation performance for beyond design basis earthquake ground motions**;
i.e. to provide confidence that a “cliff edge” effect does not exist: if an earthquake occurs greater than the design basis earthquake, demonstrate that significant failures in the installation do not occur.

Free-Field Surface Accelerations Approx. 1 g PGA

Kashiwazaki-Kariwa Nuclear Power Plant (7 Units)

Unit	Observed Maximum Acceleration Top of RB Basemat (-45m)			Design Values (S2)
	NS	EW	UD	NS/EW
1	311	<u>680</u>	408	274
2	304	606	282	167
3	308	384	311	192
4	310	492	337	193
5	277	442	205	249
6	271	322	<u>488</u>	263
7	267	356	355	263

External Human Induced Events

Human induced 'accidental' origin:

- Aircraft Crashes
- Release of Hazardous Fluids
- Explosions
- Fires
- Ship Collision
- Electromagnetic Interference

Criteria for Potential Effects on the Region

In the evaluation of a site for its radiological impact on the region for normal operational conditions and accident states which could lead to emergency measures, appropriate estimates shall be made of expected or potential releases of radioactive material, taking into account the design of the installation and its safety features.

Specific requirements for dispersion of radioactive material in air and water and the population distribution in site evaluation pertain to topics covered in one new safety guide: “Dispersion of radioactive material in air and water and the population distribution in site evaluation for nuclear power plants”.

SUMMARY

- **A well recognized set of safety standards in the areas of site evaluation of NPPs that were or are being applied by numerous MSs.**
- **A well established and known Site Safety Review Services, ~223 missions, since 1981, for assisting in the application of the safety standards.**
- **In site evaluation and design against external events the need to learn lessons and feedback from recent extreme events, as well as from the application and use of probabilistic approach.**
- **Increased interest in earthquakes, tsunamis, floods and hurricanes, including possible effects of climate change.**
- **Review and revision process of several safety guides is currently ongoing.**

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Thank you for your attention