



IAEA

International Atomic Energy Agency
Atoms for Peace and Development

IAEA RTA Key Element 1: Site Specific Considerations

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Nuclear Power Technology Development Section

Regional Workshop on Technology Assessment of SMRs

VIC, Vienna, 10–14 June 2019

OUTLINE

- What is Site?
- RTA Key Element 1: Site Specific Considerations
- **RTA TABLE FOR KEY ELEMENT 1**
 - **How to complete?**
 - **Examples**

OUTLINE

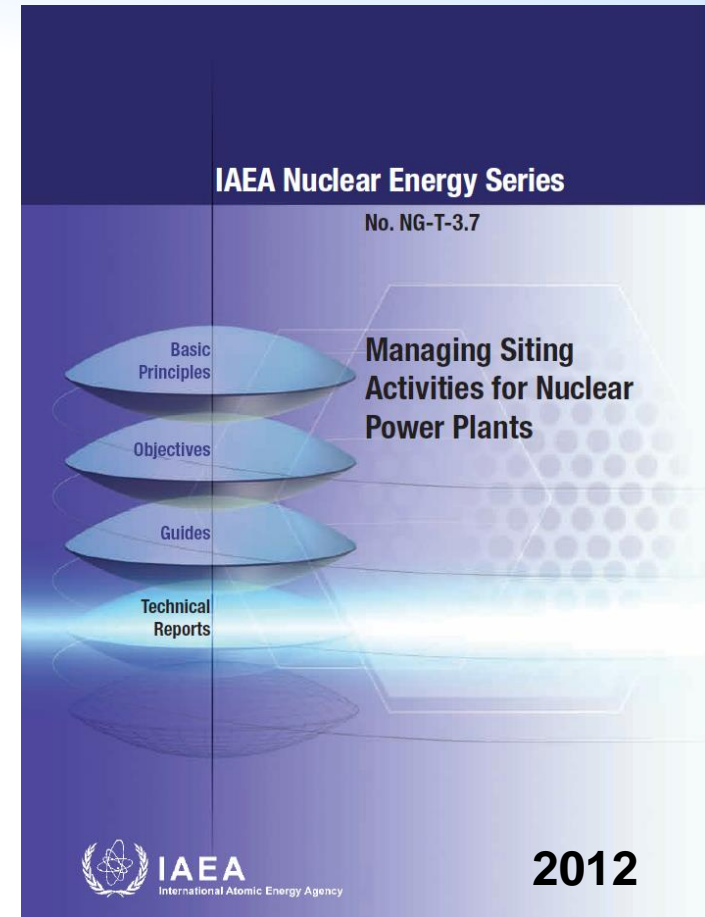
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NPP Site Selection

General 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.



Retasland has the site selected for SMR

NPP PARAMETER ENVELOPE (PPE)

- At the beginning of the siting project, the type of NPP is not usually determined → requiring to:
- **Establish a Plant Parameter Envelope (PPE) for the NPP [captured by RTA Key Elements]** such as:
 - a) Estimate of the required amount of electricity
 - b) Site characteristics that are required to support the safe and secure operation of a nuclear plant (e.g. availability of cooling water, ambient air temperature, etc.) and meet national obligations and commitment with regard to non-proliferation and safeguards
 - c) Capability of the NPP to withstand the natural and human-made environmental hazards associated with the site (e.g. earthquake, tornado, potential floods from nearby dams, snow load, rainfall, etc.) with indications of how costs vary with increasing hazard size
 - d) More than one unit might be possible on the site?
 - e) Land requirements (building height, deepest foundations, area)
 - f) Impact of the nuclear plant on the site's natural and environmental resources (e.g. potential increases in water and air temperatures, water use, gaseous and liquid releases of radioactive material)

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IAEA NP-T-1.10, Pg. 29

RTA Key element 1: Site Specific Considerations

Site specific parameters affecting the plant design:

- **Importance factor range suggested:**

High for WCRs/High to Medium for SMRs

- **Examine:** Interaction between **site characteristics** and the features of the **proposed design** may be strong differentiators:
 - *For example,* design features that have been included in the standard NPP for external events (seismic, tsunami, sand storms, human-induced hazards)
- **External events** that could cause a loss of function of systems required for the long term removal of heat from the core **shall be evaluated.**

RTA Key element 1: Site Specific Considerations

Site specific parameters affecting the plant design:

- **Evaluation expectations and relative comparisons:** Ensure that each technology holder's plant design and site configuration and characteristics are consistent with the site specific characteristics
 - Site parameters should be compared with the **site parameters envelope** offered for the proposed (standard) NPP
 - Technology evaluation and relative comparisons is to ensure that each NPP design and site configuration and characteristics are **consistent with the site specific characteristics**



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External Natural Hazards

- **Seismic Hazard** - Ground motion, earthquake effects, liquefaction, dynamic compaction...
- **Geological & Geotechnical** - settlement, landslide, faults, ground heave, mining, groundwater, bearing capacity, volcano activity....
- **Volcanic Hazard** – Ballistic projectiles, ash, lava flow...



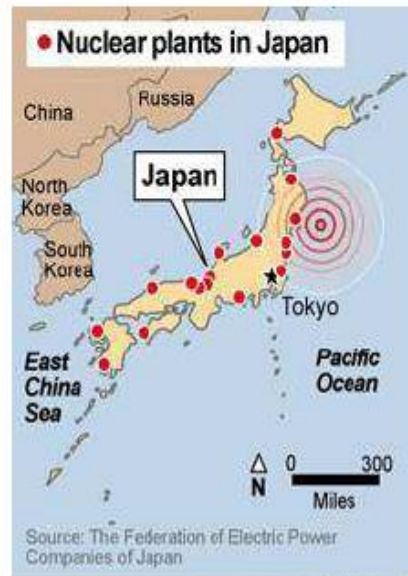
External Natural Hazards

- **Flooding** - high water, tsunami, seiche, precipitation, dam failures,.....
- **Meteorological** - high wind, extreme temperatures, snow, hail, frost, subsurface freezing, drought, sandstorms, lightening, humidity, hurricanes and tornadoes,



External Natural Hazards

- **Biological** - biological fouling, seaweed, marine growth,
- **Combination of hazards** - Earthquake and flood; earthquake and depletion of reservoir; earthquake and damage to nearby hazardous facilities; high winds and flood, etc.

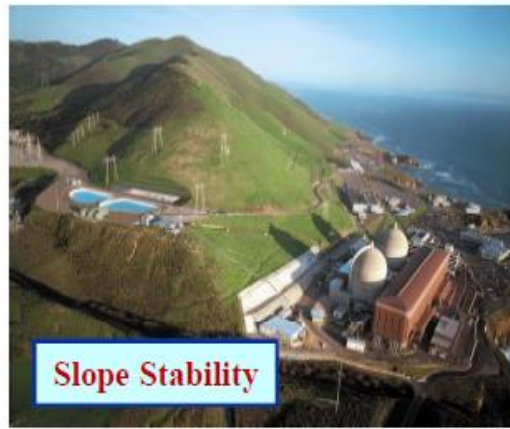


By Janet Loehrke, USA TODAY

The Fukushima nuclear facilities were damaged by an earthquake and the effects of a significant tsunami



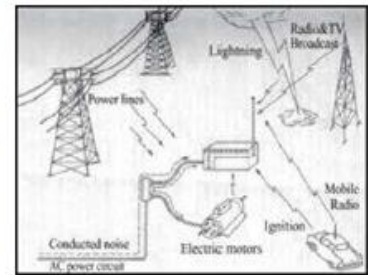
Example: Seismic Hazard Effects *L* Nucleonia?



Examples of External Human Induced Hazards

¿ Nucleonia?

- Aircraft crashes,
- Explosions,
- Release of hazardous gases, radioactive material, and corrosive gases and liquids,
- Fire,
- Collision of ships and floating debris with water intakes and ultimate heat sink (UHS) ,
- Collision of vehicle with SSCs,
- Electromagnetic interference



Example: Aircraft Crash Hazard

ℒ Nucleonia?

- Impact considerations from an aircraft crash hazards:
 - **Global structural damage** of the affected structures, including excessive structural deformations or displacements which prevent the structure from performing its function;
 - **Functional failure of SSCs** due to induced vibrations in structural members and safety related equipment;
 - **Localized structural damage** due to the effects of missile impact, including penetration, perforation, scabbing and spalling ('local effects'); and
 - The effects of **fuel initiated fires** and possibly explosion on SSCs.

¿Nucleonia?

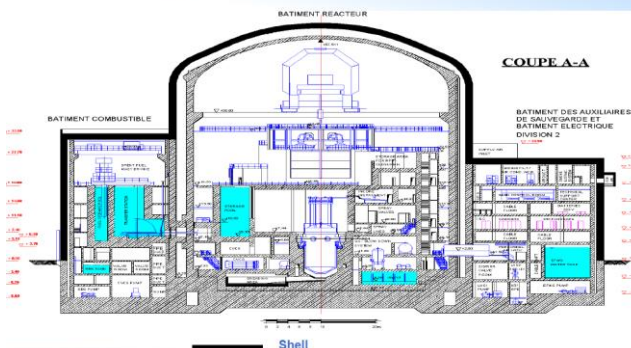
Commercial aircraft

General aircraft

Military aircraft

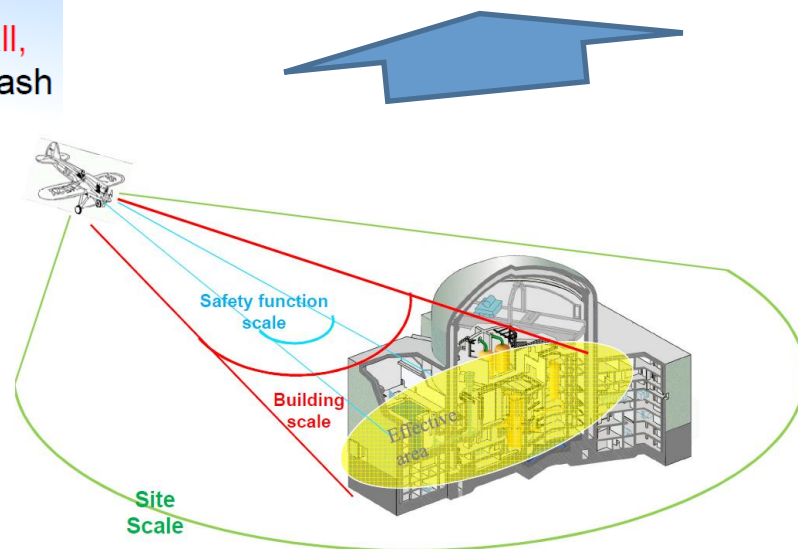


Protection against Aircraft Crash



Detailed Evaluation

- Probability should be determined for each class of aircraft (**small, medium and large civil and military aircraft**) using the aircraft crash statistics
- The estimated **probability of an aircraft crash** affecting the plant may be determined in terms of **crashes per year per unit area multiplied by an effective area** for damage to safety items
- The **size of the effective area** depends on:
 - the average angle of the trajectory relative to the horizontal;
 - the plan areas of the relevant structures and their heights;
 - other areas relating to items important to safety;
 - size of the aircraft



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RTA Key Element 1: Table

Key element: 1. Site Specific Considerations (Suggested High Importance)						%
7 Key topics	%	Rationale for percentage	HTR-PM	NuScale	SMART	Rationale for score
Ambient site environmental conditions and ecology	2	1	4	4	3	3
Heat sink temperature, condenser cooling water source						
Magnitude and frequency of all external events						
Site size requirements, population and environment						
Transportation routes/facilities and access to required infrastructure						
Site development and preparation requirements						
Site structure plan; single- or multi-unit site requirements						


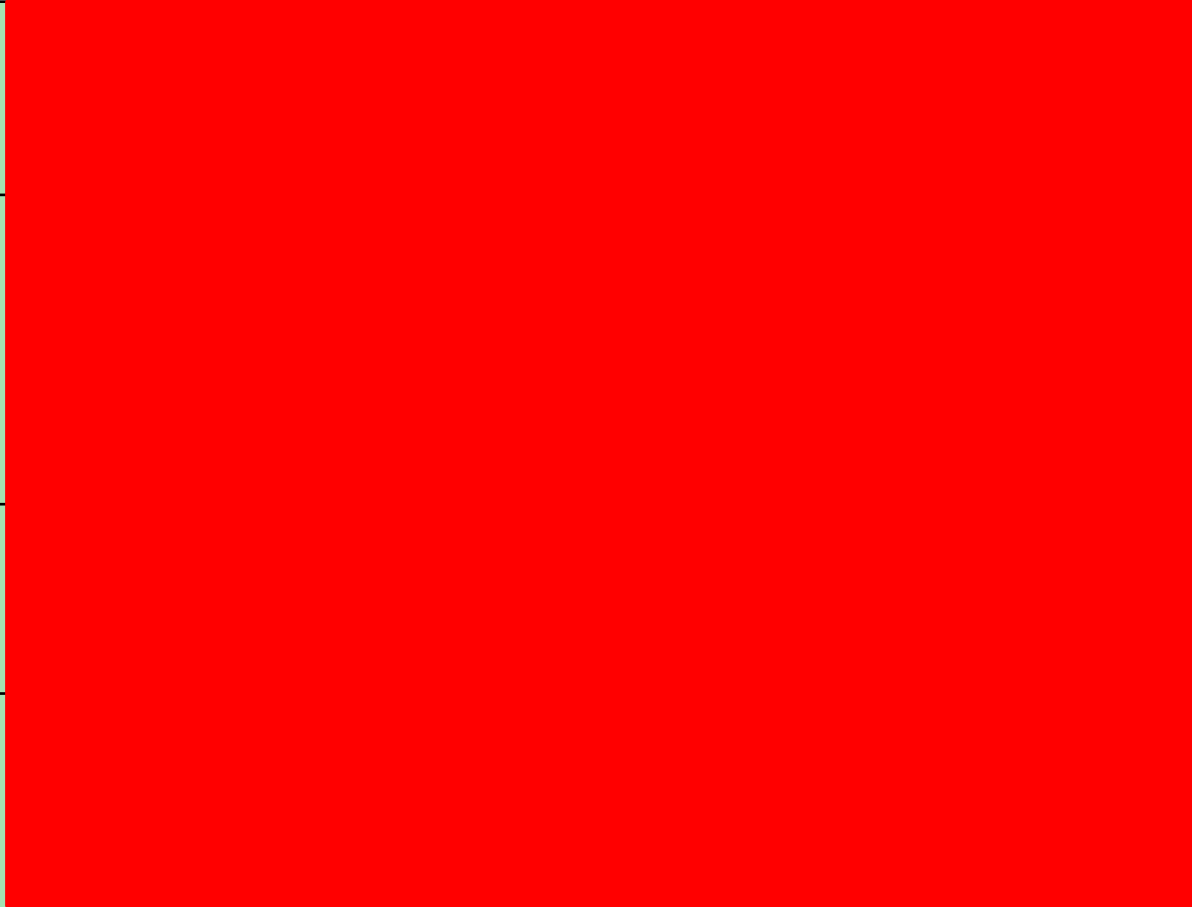
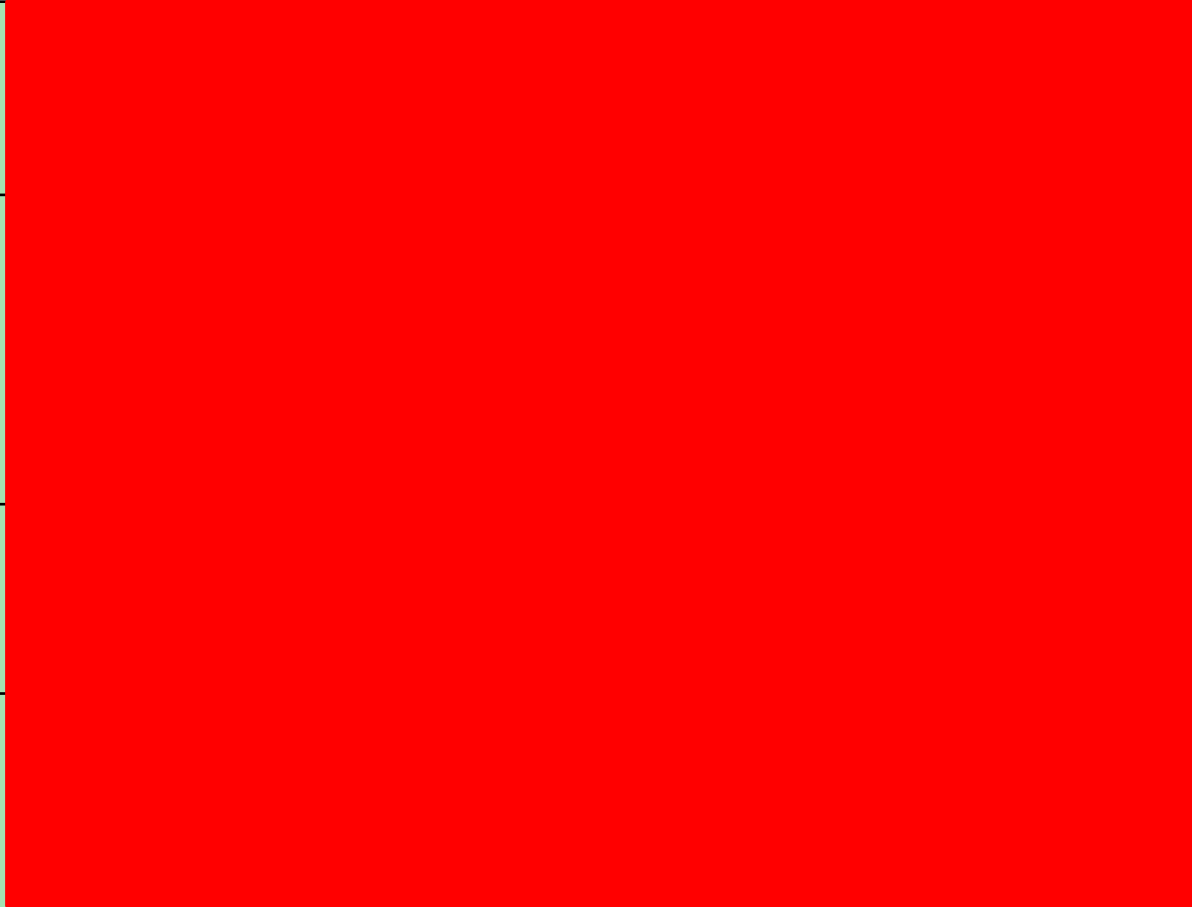
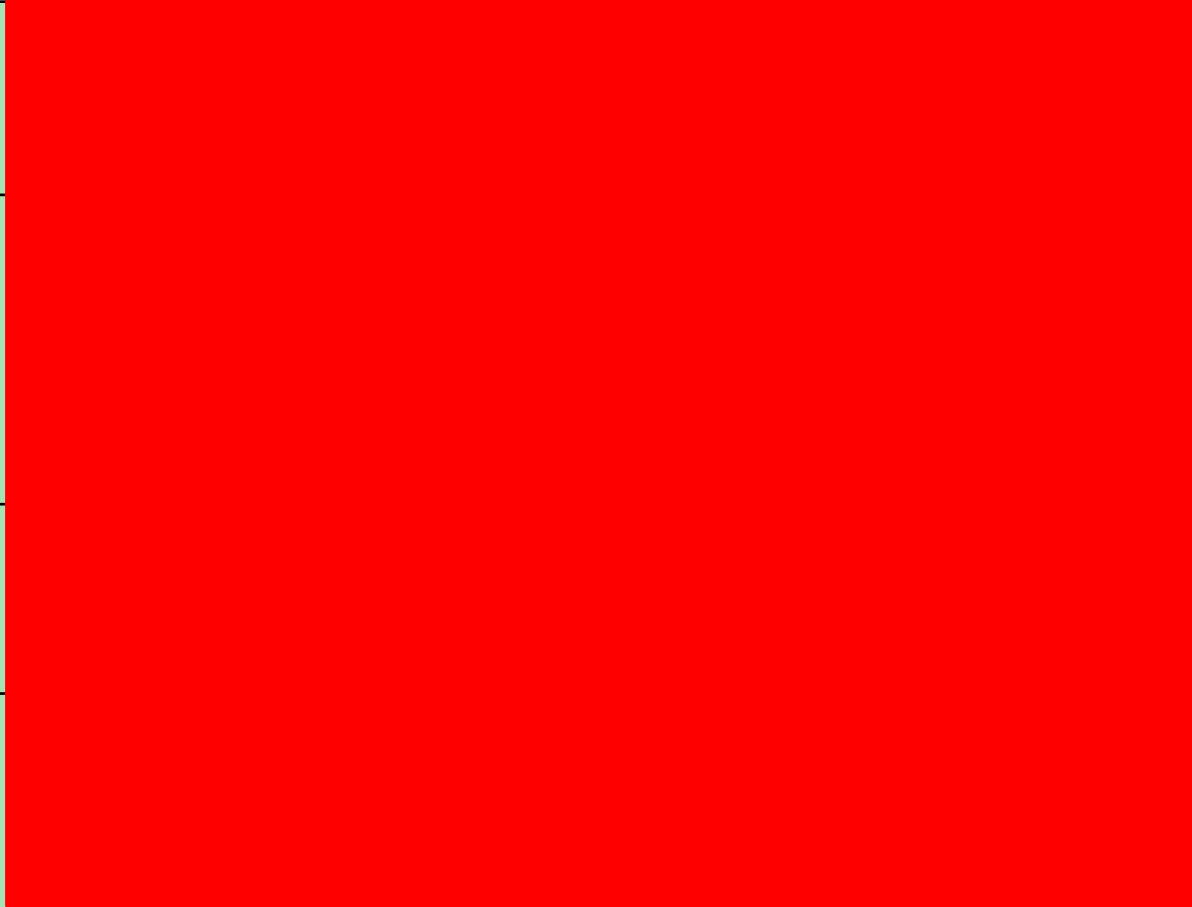
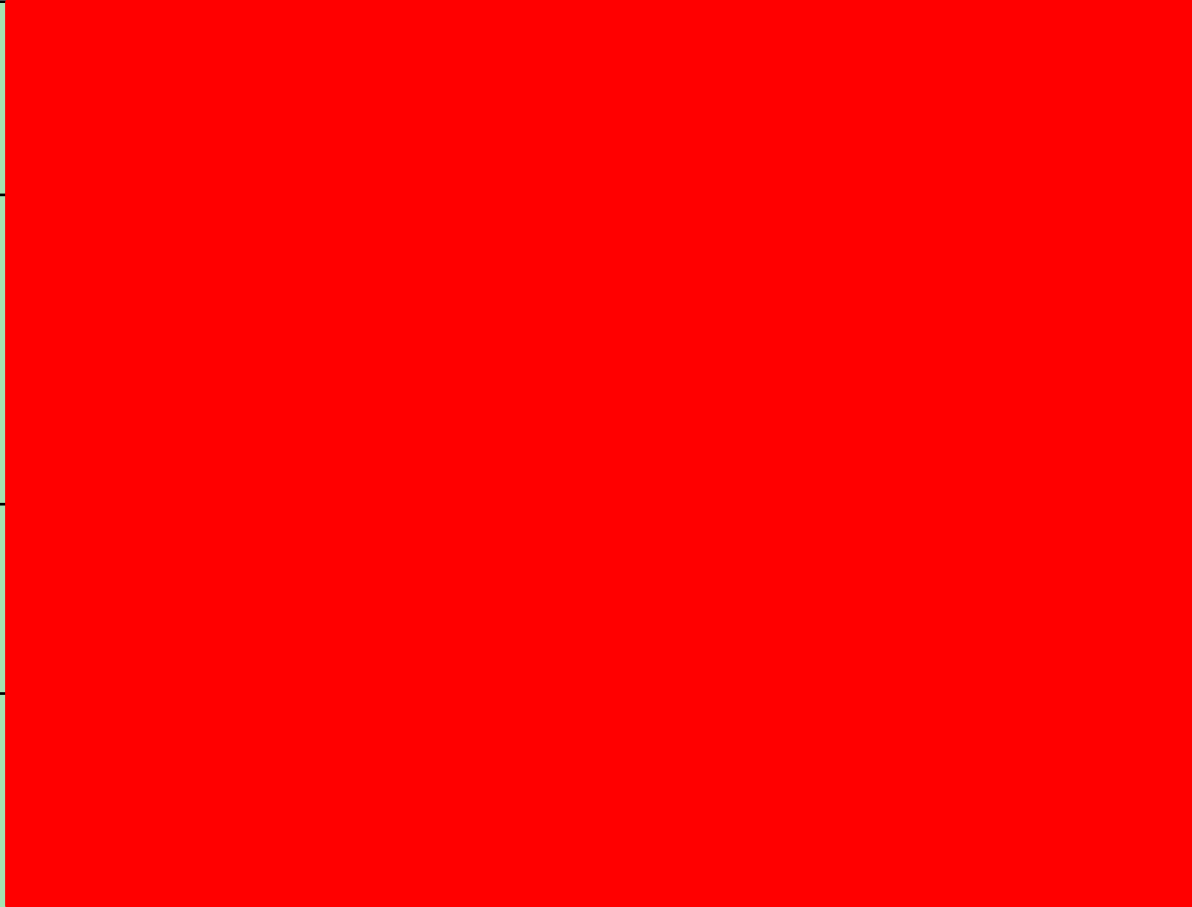
%	Represents the importance of the key topic
Rationale for percentage	Requires explanation for quantified importance
Rationale for score	Requires explanation of the scoring range:
	5 High achievement of criteria
	3 Medium achievement of criteria
	1 Low or no achievement of criteria, or no information available

RTA Key Element 1: Table



Key Element 1: Retasland site specific considerations
 (Suggested High to Medium Importance) 

%

<i>Key topics</i>	%	Rationale for percentage	HTR-PM	NuScale	SMART	Rationale for score
Ambient site environmental conditions and ecology		<ul style="list-style-type: none"> Seasonal temperature variation and wind conditions Earthquakes (up to 0.12 g) 				
Heat sink temperature, condenser cooling water source		<ul style="list-style-type: none"> Strict requirement for temperature at exhaust (27 C) River used as heat sink 				
Magnitude and frequency of all external events		<ul style="list-style-type: none"> No major airline flights over the site No volcanos Sand storms 				
Site size requirements, population and environment		<ul style="list-style-type: none"> 5 km x 5 km (25000000 m²) 100000 population area 10 km from the site 				

1

RTA Key Element 1: Table



Key Element 1: Retasland site specific considerations
 (Suggested High to Medium Importance) 

%


<i>Key topics</i>	%	Rationale for percentage	HTR-PM	NuScale	SMART	Rationale for score
Ambient site environmental conditions and ecology	20	<ul style="list-style-type: none"> Seasonal temperature variation and wind conditions Earthquakes (up to 0.12 g) 				
Heat sink temperature, condenser cooling water source	20	<ul style="list-style-type: none"> Strict requirement for temperature at exhaust (27 C) River used as heat sink 				
Magnitude and frequency of all external events	5	<ul style="list-style-type: none"> No major airline flights over the site Sand storms No volcanos 				
Site size requirements, population and environment	10	<ul style="list-style-type: none"> 5 km x 5 km (25000000 m²) 100000 population area 10 km from the site 				

2

1

RTA Key Element 1: Table



Key Element 1: Retasland site specific considerations
(Suggested High to Medium Importance) 

%

<i>Key topics</i>	%	Rationale for percentage	HTR-PM	NuScale	SMART	Rationale for score
Ambient site environmental conditions and ecology	15	<ul style="list-style-type: none"> Seasonal temperature variation and wind conditions Earthquakes (up to 0.12 g) 				<ol style="list-style-type: none"> Does not meet seismic design requirements. Considers seismic design, but information is limited or inconsistent with other designs. Is at the seismic design requirement limit. Meets seismic design requirements, to a lesser degree. Greatly exceeds seismic design requirements.
Heat sink temperature, condenser cooling water source	20	<ul style="list-style-type: none"> Strict requirement for temperature at exhaust (27 C) River used as heat sink 				<ol style="list-style-type: none"> Exhaust temperatures render the plant inoperable for long periods of time, or no information is provided. Exhaust temperatures render the plant inoperable only during record highs. Exhaust temperatures meet the requirements, including the current record high temperatures. Exhaust temperatures are at the required level, including record high temperature conditions with substantial margin. Exhaust temperatures have no foreseeable effects on river temperature and aquatic life.
Magnitude and frequency of all external events	10	<ul style="list-style-type: none"> No major airline flights over the site No volcanos Sand storms 				<ol style="list-style-type: none"> No information provided or no systems designed indicating protection from noted external events. Operational experience. Contains features which offer some protection from noted external events; design takes into account sand storms but no Considers all noted external events including sand storms (design proven in sand storm areas). 5. Considers all noted external events including sand storms (design proven in sand storm areas).
Site size requirements, population and environment	10	<ul style="list-style-type: none"> 5 km x 5 km (25000000 m²) 100000 population area 10 km from the site 				<ol style="list-style-type: none"> Plant size exceeds the site area beyond solution. Plant size exceeds the site area but can be solved through minor land purchases or allocation. Plant size fits within site. Plant size significantly below site size requirement. Plant size significant smaller than others meeting site size requirements.

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RTA Key Element 1: Table



Key Element 1: Retasland site specific considerations
(Suggested High to Medium Importance)

%

Key topics	%	Rationale for percentage	HTR-PM	NuScale	SMART	Rationale for score
Ambient site environmental conditions and ecology	15	<ul style="list-style-type: none"> Seasonal temperature variation and wind conditions Earthquakes (up to 0.12 g) 		5 (0.5g)	2 (>0.18g shutdown)	<ol style="list-style-type: none"> Does not meet seismic design requirements. Considers seismic design, but information is limited or inconsistent with other designs. Is at the seismic design requirement limit. Meets seismic design requirements, to a lesser degree. Greatly exceeds seismic design requirements.
			Ask the vendor: questions 1, 2			
Heat sink temperature, condenser cooling water source	20	<ul style="list-style-type: none"> Strict requirement for temperature at exhaust (27 C) River used as heat sink 		1 (no info)	1 (no info)	<ol style="list-style-type: none"> Exhaust temperatures render the plant inoperable for long periods of time, or no information is provided. Exhaust temperatures render the plant inoperable only during record highs. Exhaust temperatures meet the requirements, including the current record high temperatures. Exhaust temperatures are at the required level, including record high temperature conditions with substantial margin. Exhaust temperatures have no foreseeable effects on river temperature and aquatic life.
			Ask the vendor: question 3			
Magnitude and frequency of all external events	10	<ul style="list-style-type: none"> No major airline flights over the site Sand storms No volcanos 		5 (underground, airplane crash considered)	1 (no info)	<ol style="list-style-type: none"> No information provided or no systems designed indicating protection from noted external events. Contains features which offer some protection from noted external events; design takes into account sand storms but no operational experience. Considers all noted external events including sand storms (design proven in sand storm areas). Considers all noted external events including sand storms (design proven in sand storm areas).
			Ask the vendor: question 4			
Site size requirements, population and environment	10	<ul style="list-style-type: none"> 5 km x 5 km (25000000 m²) 100000 population area 10 km from the site 		4 (140000 m ²)	5 (90000 m ²)	<ol style="list-style-type: none"> Plant size exceeds the site area beyond solution. Plant size exceeds the site area but can be solved through minor land purchases or allocation. Plant size fits within site. Plant size significantly below site size requirement. Plant size significant smaller than others meeting site size requirements.

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Key topics	%	Rationale for percentage	HTR-PM	NuScale	SMART	Rationale for score
Ambient site environmental conditions and ecology	15	<ul style="list-style-type: none"> Seasonal temperature variation and wind conditions Earthquakes (up to 0.12 g) 		5 (0.5g)	2 (>0.18g shutdown)	5. Greatly exceeds seismic design requirements. 4. Meets seismic design requirements, to a lesser degree. 3. Is at the seismic design requirement limit. 2. Considers seismic design, but information is limited or inconsistent with other designs. 1. Does not meet seismic design requirements.

Ask the vendor: questions 1, 2

- (1) **All:** What effect will drastically different seasonal weather conditions have in regard to maintenance (additional or increased frequency) and operability of the plant?
 - Site climate is characterized with a strong wind blowing east-west 6 months in a year; the winter is characterized with heavy snow and ice; summers are hot and humid

- (2) **SMART:** The design information also noted that automatic shutdown occurs on detection of 0.18 g seismic events. Please provide additional information for the resistance of the plant to damage from seismic events.
 - Site parameter limiting value of a peak ground acceleration is 0.12 g. This value was obtained as an average of historical data over the last 200 years.

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Key topics	%	Rationale for percentage	HTR-PM	NuScale	SMART	Rationale for score
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			Ask the vendor: question 3			

(3) All: Strict heat sink exhaust requirements are in place. Please provide information regarding exhaust from condenser cooling to the water source, for both averages and record heat sink temperatures.

- Reta river is the only source of water to be available for the site
- There are some fish species that show sensitivity to high water temperature
- Reta river can be used as a heat sink if its temperature at the plant's exhaust is not increased above 27 C; historical data show that the average river water temperature is between 23 C and 30 C, with record high of 35 C and record lows of 15 C

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Key topics	%	Rationale for percentage	HTR-PM	NuScale	SMART	Rationale for score
Magnitude and frequency of all external events	10	<ul style="list-style-type: none"> No major airline flights over the site Sand storms No volcanos 		3 (underground, airplane crash considered, no info on sand storms)	1 (no info)	5. Considers all noted external events including sand storms (design proven in sand storm areas). 3. Contains features which offer some protection from noted external events; design takes into account sand storms but no operational experience. 1. No information provided or no systems designed indicating protection from noted external events.
			Ask the vendor: question 4			

(4) All: What considerations are made for protection from sand storms?

- Site is exposed to frequent sandstorms occurring in the summer, carrying sand from the north desert to the Northern region of the country. The sandstorms can reach heights of approximately 20 m with speeds of at least 45 km/hour.

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Case Study Toolkit

Teams



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Thank you!

