

Emergency Preparedness for SMRs

Finnish perspectives

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New nuclear projects

STUK – Radiation and Nuclear Safety Authority



**1957
Windscale**



**1979
TMI**



**1986
Tsernobył**

**2011
Fukushima**

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Background for current developments in Finland

- There is an ongoing total renewal of nuclear energy act and regulations.
- New applications for use of nuclear energy are considered.
 - NPPs for district heating or supplying heat directly to an industrial facility
 - Need to have the supply close to consumers
 - Possibly close to densely populated areas
 - Proximity to an industrial area
 - New power reactors may be smaller than the large NPPs currently in use.
 - The existing acceptance criteria for severe accidents assume the plant location in sparsely populated area.
 - New safety features, more passive features and inherent design features require goal-oriented regulation and graded approach when interpreting regulatory requirements.
- The need for modification of defining EPZs and severe accident acceptance criteria is evident.

Traditional approach to EPR

→ Fundamental regulation for EPR & siting based on large light-water nuclear reactor has not really changed

- Siting away from population
- Fixed emergency preparedness zones

”Assumptions based on 1960’s reactor designs”

Design for safety has evolved through the decades and experiences from the past.

Probabilistic assessments

Design Basis Accidents supplemented with other accident scenarios

Design extensions

Severe accident management systems

Human and organizational factors

Internal & External Hazards



What is the residual risk?

- Improved safety design
- Use of passive safety systems or inherent safety features in plant design
- Severe accident management included in the design
- Practical elimination of some accident scenarios
- Extended time available for some novel designs
- Small or medium reactor size

Uncertainties in design dominate the residual risk – “unknown unknowns”

EPR arrangements shall be last defense-in-depth –line (DiD 5)

Need for acceptability and graded approach when defining EPR planning zones !!!!

Acceptance criteria in different event categories

Event Class	Restriction on consequences	Frequency	Analysis assumptions
Normal Operation (DBC1)	0,1 mSv/a	continuous	Conservative
Anticipated Operational Occurrence (DBC2)	0,1 mSv	$f \geq 10^{-2}/a$	
Design Basis Accident	Class 1 (DBC3)	$10^{-2}/a > f \geq 10^{-3}/a$	
	Class 2 (DBC4)	$10^{-3}/a > f \geq 10^{-4}/a$	
Design Extension Conditions (DEC)	20 mSv	frequency target	Realistic
Criteria for Large Release	Dose and contamination criteria	frequency target	
Criteria for Early Release	Time criteria	frequency target	

Criteria for emergency preparedness will be additional safety layer for public protection. How to take into account stringent criteria for safety up to and including severe accident criteria – how safe is safe enough?

Defining EPZs

- STUK changed its regulation on emergency preparedness from February 2024
 - Fixed distances of 5 km for PAZ and 20 km for UPZ were removed.
 - Flexibility was given due to possible new applications for NPPs.
- PAZ – Actions may be needed to avoid or limit acute harmful deterministic effects of radiation
 - Capability for effective evacuation results in land-use restrictions within PAZ.
 - No need for evacuation outside PAZ in urgent phase.
 - For sizing of the area, the dose outside of PAZ shall not exceed 1 Sv within 10 hours.
- UPZ – Actions may be needed to avoid late harmful effects of radiation
 - No need for indoor sheltering outside UPZ.
 - External rescue plan is needed. Even with on-site-UPZ claims.
 - For sizing of the area, the dose outside UPZ shall not exceed 10 mSv within 48 hours.
 - For practical arrangements, the size can be limited to 20 km from the plant.

Grading the requirements for PAZ and UPZ

IAEA Fundamental Safety Principles SF-1

3.36. The scope and extent of arrangements for emergency preparedness and response have to reflect:

- The **likelihood and the possible consequences** of a nuclear or radiation emergency;
- The characteristics of the radiation risks;
- The nature and location of the facilities and activities.

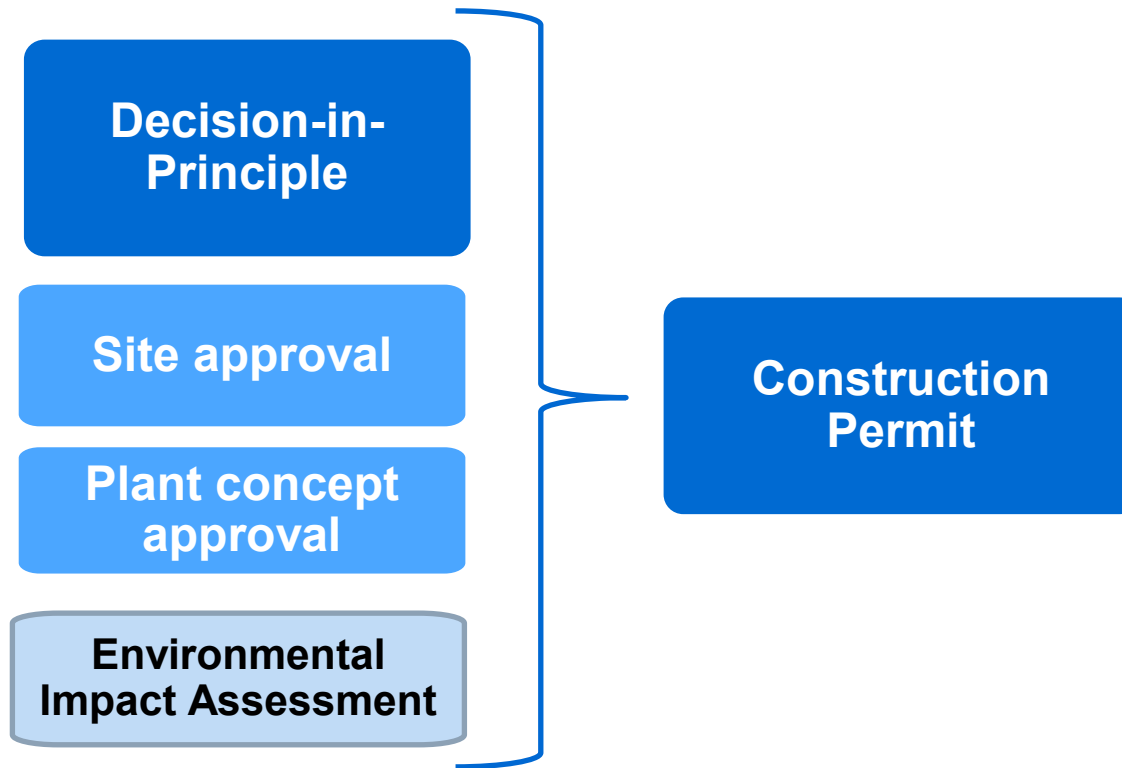
Grading the requirements for PAZ and UPZ

How STUK will evaluate

- EPR is DiD level 5. Events to be considered are more severe than events with functional severe accident management systems.
- PAZ is seen as "bounding" event, so that severe deterministic effects are avoided with great certainty. UPZ is evaluated with more realistic assumptions, but still more severe events than severe accident criteria.
- PAZ case and UPZ case are different
- There are catastrophic events that are outside of planning basis for EPR zones. Public protective actions are expanded in those unforeseen events.

Revision of Nuclear Energy Act

- Splitting the first steps as separate issues.



”What are consequences from an accident”

- Land use planning - restrictions for land use, mainly PAZ
- Environmental impact assessment - ”Accident release”
- Siting approval - ”feasible emergency preparedness arrangements”
- Decision in Principle – political approval, overall benefit for society

Construction Licence – Approval of EPR arrangements and zones according to detailed application, deterministic and probabilistic assessments with detailed plant design

Use of nuclear energy shall be for **overall benefit for society** with all aspects considered





Thank you!

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Nuclear Reactor Regulations

STUK

