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History

Development of national criteria started with the construction of Loviisa VVERs in early 1970s

Since then, continuous evolution

- driven by new plant prospects & desire to improve current plants
- tested in current plant license renewals (mid-80’s, mid-90’s)
- updated considering operational experience and advances in science and technology

Codified from early on in YVL Guides issued by STUK

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Rules and regulations

Law 1987: “nuclear energy utilisation shall be safe”

Decree 1987: administrative & licensing framework

Decision of Government 395/1991:

- general principles
- fundamental technical requirements
- radiological acceptance criteria

YVL Guides

- detailed technical requirements
- acceptable practices

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Licensing process

Licenses issued by Government in three stages - after favourable Safety Assessment by STUK

- 1. Decision in Principle (DiP): can it be done?
  - needs ratification by Parliament
- 2. Construction Permit (CP): how will it be done?
- 3. Operating License (OL): was it done right?

TVO filed an application for a DiP for a new plant in 11/2000, Government decision in 1/2002, Parliament final voting expected 5…6/2002

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Plant concepts assessed for DiP

Boiling water reactors

- *BWR 90+ (Westinghouse Atom)*
- *EABWR (GE Nuclear Energy)*
- *SWR 1000 (Siemens Nuclear Power/Framatome ANP)*

Pressurized water reactors

- *AP 1000 (Westinghouse Electric Company)*
- *EP 1000 (Westinghouse Electric Company)*
- *EPR (Nuclear Power International/Framatome ANP)*
- *VVER 91/99 (Atomstroyexport)*

Preliminary Safety Assessment of the DiP application notes the long time perspective

- the planned operating life of 60 years necessitates readiness to respond unpredictable challenges
- maintenance of safety with SAHARA principle: Safety As High As Reasonably Achievable
- during this period there may be a technological shift away from LWRs; hence national competence must be maintained throughout the operating life

“What we decide now should (by and large) satisfy our great-grandchildren’s needs”

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Design criteria

Start from defence-in-depth

- integrity of successive release barriers
- functional: prevention / protection / mitigation
- fundamentally deterministic criteria
- balanced design and avoidance of risks to be verified by means of PSA

Barrier protection

- built-in properties
- dedicated safety systems

Severe accident is part of design basis

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System Design

Safety classification

N+2 failure criterion for systems that deal with design basis events (redundancy, diversity, segregation)

Proven technology

- properly evaluated operational experience
- experimental demonstration & analysis for novelties, such as “passive” systems

Performance/safety margins required

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Event classification

Three levels of acceptance criteria

- anticipated transients
- postulated (design basis) accidents
- severe accidents

Some low-probability high consequence events are to be classified postulated accidents

- large primary-to-secondary leak: no radioactive releases to atmosphere allowed through steam line safety/relief valves
- ATWS

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Fuel acceptance criteria

General principle: the higher the predicted frequency of an event, the smaller the number of damaged fuel rods

Anticipated transients, $f > 10^{-2}/a$

- 95/95 confidence with respect DNB or dryout, no (internal) fuel melting, nor damage due to pellet-cladding mechanical interaction.

“Minor” postulated accidents, *$10^{-2}/a > f > 10^{-3}/a$*

- Number of rods in heat transfer crisis < 1%. PCT < 650 °C and extremely low probability of fuel damage by the mechanical interaction between fuel and cladding.

”Major" postulated accidents, *$f < 10^{-3}/a$*

- Number of damaged fuel rods < 10%. PCT <1200 °C, adequate post-oxidation ductility, and no loss of coolable geometry. Failure postulated at enthalpy 140 cal/g (230 cal/g not be exceeded).

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Severe accidents

Radiological criterion: release < 100 TBq Cs-137 equivalent, no acute health effects

- can be fulfilled only if containment integrity is maintained after severe core damage

But: explicit consideration in containment design is mandated

- requires a strategy (usually to depressurise and manage a low-pressure core melt)
- N+1 failure criterion applies for systems needed to protect containment integrity, and independence of other safety systems required

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External threats

September 11,2001: escalation of terrorist actions

Reconsideration of aircraft crash design basis, now:

- consider large passenger and military air craft
- no immediate release of significant amount of radioactive substances
- initiation and maintenance of key safety functions in spite of the direct consequences of the event (penetration of structures by impacting parts, vibration, explosion, fire) without release of significant amount of radioactive substances to the environment
- microwave and biologic weapon consideration

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Concluding remarks

Reasonably stringent requirements

Aim at low & smooth risk profile

Needed because

- very long-term commitment (design life 60 years)
- public acceptance is necessary throughout the lifetime

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