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Experiences from Olkiluoto 3 (EPR) design review and licensing in Finland

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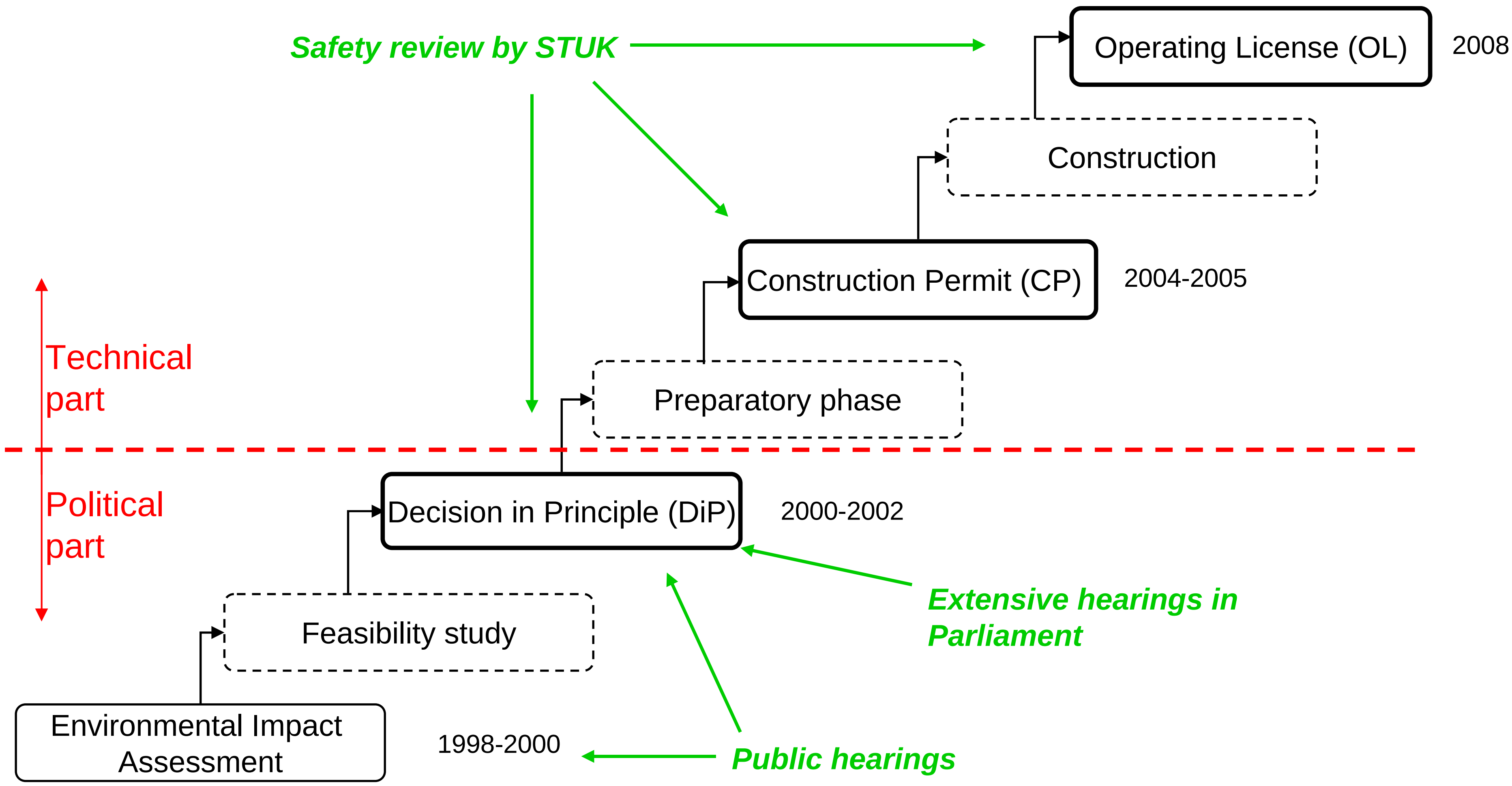
Olkiluoto 3 licensing phases



STUK's resources spent for Olkiluoto 3 review and inspections

Preparatory part and DiP review, in years 1999-2003:

- 8 man-years
- 0,6 Meuros contracted expert work (about 6 man-years)

CP review and inspections in 2004:

- 23 man-years divided among 60 persons
- 2,0 Meuros contracted expert work (about 20 man-years)

Inspections in first year of construction 2005:

- 22 man-years divided among 80 persons

Construction Permit (CP) schedule

Application for CP was submitted on
January 8, 2004

STUK issued its statement and safety evaluation on
January 21, 2005

Government granted the Construction Permit on
February 17, 2005

STUK main activities during CP stage (1)

Review and discussions on submitted CP documentation

- much of the initially given information (PSAR, PSA, etc.) was at conceptual level – caused increased workload to reviewers
- gradually improving revisions of were submitted to STUK from Jan 2004 to Jan 2005, at the request by STUK
- due to tight schedule, several meetings were held every week on technical and management issues involved in the CP review
- CP review could be completed in planned schedule – STUK achieved sufficient confidence on safety although a lot of detailed design and related review was left to the construction stage

STUK main activities during CP stage (2)

Independent studies to validate design calculations and accident analysis

- this was done partly in-house and partly contracted to independent expert organizations
- studies comprised both analysis and tests to validate the analysis

Auditing of activities of plant vendor and subcontractors

- STUK joint some audits of the license applicant as observer, some audits STUK conducted on its own
- topics: design processes, project management, equipment manufacturing, interaction between different design organizations

Support to STUK from experts organisations (1)

Finnish organisations

- VTT: advice and independent analysis of several topics including PRA, water chemistry, manufacturing methods, transients, postulated accidents, severe accidents and I&C validation; tests including simulation of aircraft crash and of cable fires
- Lappeenranta Technical University: tests and assessment of core melt coolability
- Other consultants: advice on electrical and electromagnetic issues, including protection against microwaves, electromagnetic pulse, and thunder

Support to STUK from experts organisations (2)

Foreign organisations

- DGSRN and IRSN France: exchange of information on assessment of several design topics – this has become even more important after Flamanville 3 review started
- GRS Germany: assessment of Break Preclusion concept for primary and secondary systems; independent analysis and assessment of aircraft crash protection approach
- ISaR Germany: independent analysis of specified accidents, assessment of the ECCS
- Belgian consultant: digital I&C issues

General observations from the safety review

It is evident that the design has evolved to safe direction compared with current PWR generation

- somewhat higher safety margins (fuel, thermal loads) than the German (KONVOI) and French (N4) designs preceding EPR
- more systematic Defense in Depth approach supported by multiple redundancies, extensive diversity (functional and equipment diversity) and strict physical separation
- improved prevention of primary circuit leaks and at least same level of mitigation of leaks
- state-of-the-art instrumentation and control technology
- improved protection against malevolent acts
- designed to contain severe accidents - up to core meltdown

Notes from the review and its results (1)

Interaction between vendor - licensee - STUK resulted in a number of improvements in the design, as compared with the plans presented in the first version of PSAR.

In the following slides, there are some examples of issues that were discussed during the safety review, and consequently improved

Notes from the review and its results (2)

Examples of systems improvements:

- main control room air intake (MCR HVAC) system was equipped with a system for detection and filtering of poisonous gases

- diversity was added to a number of systems; e.g., primary circuit pressure release, containment isolation, power supply, reactor protection system

- strainer back-flushing system was provided to containment sumps (both ECC recirculation sumps and SAM sumps)

Notes from the review and its results (3)

Examples of fire protection improvements

- vertical and horizontal walls were added to the annulus to provide adequate physical separation between all four redundancies
- main coolant pumps (MCP) and MCP rooms were modified to limit oil spreading and consequences of possible fire
- cables of different redundancies were separated from each other by walls in the room below the MCR
- cable spreading space below the MCR floor was provided with a fire suppression system (gas system, manual start from the MCR)
- turbine hall was provided with a sprinkler system

Notes from the review and its results (4)

Protection from air craft crash

- distances between inner and outer walls of safeguard and fuel buildings were increased to avoid wall-to-wall contact and consequent vibrations after crash
  - vendor had already in the original design suggested very strong outer walls to the containment and some other buildings, to avoid wall-through penetration of any type of plane
  - STUK contracted extensive independent analysis (on structural strength and vibrations) in two different expert organizations
  - scaled tests were made simulating air craft crashes at full speed to qualify analytical tools
- ventilation air intake to safety system buildings and some other building details were modified to prevent kerosene fuel entry and fire inside the buildings

Notes from the review and its results (5)

A number of small improvements were made in systems designed for severe accident management

- Main severe accident mitigation systems
  - dedicated redundant primary system depressurization
  - improved reliability of core melt stabilization and cooling
  - improved containment heat removal reliability
  - provision of reliable hydrogen distribution to entire containment volume (two compartment containment)
- Supporting and other systems
  - containment filtered venting (for non-condensable gases)
  - more extensive I&C for monitoring accident progress, dedicated to severe accidents

Notes from the review and its results (6)

- General observation from QM audits is that all audited organizations need to pay more attention to systematic quality management (license applicant, vendor, contractors)
  - quality management improvements were made based on remarks given in the audits

- Quality systems of equipment suppliers are generally far from meeting quality management guides of the IAEA’s Safety Standards
  - obvious explanation is the very limited amount of business with the nuclear industry
  - tailor-made quality plans have been required as a compensatory measure for nuclear equipment supplies

Lessons learned (1)

Design is based on deterministic approach but it was also verified with a design phase PRA study as required by STUK

- many details of the design were still missing but appropriate reliability data (or minimum targets) had been assigned for conceptually designed systems and equipment

PRA review by STUK, including independent parallel analysis made in-house, was found most valuable

- STUK staff achieved good understanding of the safety importance of various plant parts
- a few vulnerable points were revealed and addressed by improved design

Lessons learned (2)

- Design review, including close communication with independent expert organizations who have provided reference analysis and expert advice, has been most valuable on-the-job training for the entire staff and especially for young generation.
  - experience and knowledge from the design review gives a sound basis for efficient regulatory measures during construction and operation
  - any future MDAP needs to be planned so that it does not reduce the learning opportunities of the national regulatory bodies

Lessons learned (3)

A requirement management system using computerized data base is most useful and should be available to the regulator from the beginning of the review

- the regulator must know his own requirements through the life cycle of the plant, and be able to follow how these are incorporated into the contracts between the licensee, the vendor and other organizations involved in the project implementation

Lessons learned (4)

A good preparation is essential for a successful project

- organization and resources
- planning of the review and ensuring availability of external experts who can provide independent analysis for the regulator
- ensuring the current state of the safety regulations
- adequate information on the state of design documentation and other licensing documents at the time of starting the review - this is necessary for meaningful planning the review schedule


Thank You!