Energiforsk

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Strategy plan

Energiforsk Nuclear power concrete structures R&D program

Program period 4

Period: 2016-01-01 to 2018-12-31

Summary

The Nuclear power concrete structures R&D program is in its 3rd program period, with this strategy plan covering period 4. Its vision is to ensure having civil works that support safe operation of NP throughout the life-length of the power plants, and to ensure that the license holders and the regulator stay well informed on civil works aspects of permits and LTO.

The primary target receivers are the license holder's departments and teams responsible for civil works design, maintenance and operation of nuclear power plants, as well as their regulatory counterparts. All of the program period activities have been formulated to reduce short-term risks as identified by a joint NPP civil works risk assessment. The expected benefits include direct support on the readiness to meet license conditions and IAEA SALTO reviews on civil works aspects of LTO and ageing management, and to considerably ease the transfer and the overall maintaining of key competences and expertise.

The main focus of 2016-2018 will be to:

1. Investigate local environments of reactor containments that could cause degradation affecting its leak-tightness
2. Develop tools for the assessment of RC pre-stressed tendons and liners
3. Validity of advanced calculation tools applied to RC
4. Investigate specific safety issues of cooling waterways

1. Vision

The vision of the nuclear concrete research program is to ensure having civil works that support safe operation of NP throughout the life-length of the power plants, and to ensure that the license holders and the regulator stay well informed on civil works aspects of permits and LTO.

2. Benefits and deliverables

2.1. Receivers of expected benefits/deliverables

The primary target receivers are the license holder's departments and teams responsible for civil works design, maintenance and operation of nuclear power plants, as well as their regulatory counterparts. Receivers are also universities, institutes, service providers and stakeholder organisations that all carry and contribute to the exchange of the knowledge base of interest, and its continued development.

2.2. Expected benefits

The results obtained will in the short-term contribute to the license-holders readiness to meet license conditions and IAEA SALTO reviews on civil works aspects of LTO and ageing management. The continued improvements achieved through the R&D contribute to meeting permit requirements.

The program's collaborative way of working ensures that jointly agreed unified solutions are brought forward, thereby avoiding implementation of patchiness solutions that are complex to compare and assess.

Jointly identified R&D challenges throughout the fleet of NPP in Sweden and Finland are cost-efficiently dealt with through joint forces, with increased possibilities of attracting co-funding from other stakeholders.

The work considerably eases the transfer and the overall maintaining of key competences and expertise in respect of the ongoing generation shift and shorter employment stays within organisations.

The program period will, for cost reasons, not support education of a new PhD. Post-doc research will be supported.

The program provides an arena for a series of technical seminars with comprehensive reviews of key topics, with active inputs from targeted receivers of the program results (listed in section 2.1).

2.3. Expected deliverables

Project reports and guidelines that will be utilised as outlined above (section 2.2). The structured risk-based approach used to identify the focus areas below assure that the resulting deliverables will meet prioritised short-term needs brought forward by the end-users (see section 3.1 to 3.3 for further details). The outreach of result is also handled through the series of open technical seminars.

3. Focus areas and activity plan

The needs of the nuclear industry have been assessed through a license holder's inventory of needs, together with a risk assessment. Risks were assessed for the main functional requirements "production", "containment" and "cooling". Short-term risk-mitigation through R&D measures were identified, prioritised, and merged into four focus areas (FA).

Were possible, the activities will be part of the "R&D Arena Barsebäck".

3.1. Investigation of local environments of RC that could cause degradation affecting its leak-tightness (FA1)

3.1.1. Introduction (FA1)

Damages to the embedded liner have occasionally occurred during the past decades, due to incorrect workmanship or design at the time of construction. One lesson learnt is that the verification of the containment function is closely linked to the understanding of the actual ambient conditions that specific liners and its surrounding concrete are exposed to.

3.1.2. Objectives (FA1)

The objectives of this FA are to i) support license holders in their work to reduce the likelihood of damages to key structural elements of RC, and ii) to support the regulator and stakeholders with facts.

3.1.3. Activities (FA1)

Activity	Prio	Result
Follow up of the NOG project "Reactor containments in SE and FI", and its assessment of concrete RC problem areas	H	Report
Assess the consequences of having very high moisture content in the RC concrete (cont. of PhD)	H	Report
Guidance on license holder's acceptance criteria of mapped defects to civil works	H	Guidance material
Monitoring of lessons learnt by the IAEA program on Int. generic ageing lessons learned (IGALL) for NPPs	M	Report

3.2. Develop tools for the assessment of RC pre-stressed tendons and liners (FA2)

3.2.1. Introduction (FA2)

Sustained licences for long-term operation of NPPs are linked to the licence holder's work on keeping its civil structures in continued good shape. Doing so requires a range of assessment tools fit for purpose. This FA covers work on i) continued development of non-destructive testing methods that can cope with detecting defects in embedded structural parts, and ii) development of a method to assess the status of tendons based on tests on the RC of Barsebäck, and iii) pilot-testing of real-time condition monitoring of RC.

3.2.2. Objectives (FA2)

The objectives of this FA are to i) support license holders in their work prepare for continued operation over +40 years, and ii) to support the regulator and stakeholders with facts. R&D deliverables will be used in LTO-plans, in PSRs, and for SALTO review mitigation work.

3.2.3. Activities (FA2)

Activity	Prio	Result
Prioritized tendons activities based on the R&D program underway for R&D Arena Barsebäck	H	Methodology & report
Non-destructive testing: Integrity of embedded steel liner	H	Pilot tool & report
Condition monitoring of nuclear concrete structures	H	Installations & report

3.3. Validity of advanced calculation tools applied to RC (FA3)

3.3.1. Introduction (FA3)

Further work is motivated by the need for better understanding of advanced calculation tools strengths and weaknesses through verifications. The main activity include wide active participation of utilities along with the academy provides a national skills-building through continued industry-wide collaboration becomes publicly available.

3.3.2. Objectives (FA3)

The objective of this FA is to go further in the understandings of benefits and shortcomings of numerical modelling tools applied to the assessment of RI. The deliverables will enable license holders and authorities to work on increased reliability of the results obtained in the application of computational tools for planning LTO, as well as the recurring outages.

3.3.3. Activities (FA3)

Activity	Prio	Result
FEM benchmark exercise Vercors, EDF test RC Step 2	H	Report
Load-carrying capacity of fastening systems in concrete structures. Ongoing commitment PhD. from Program period 3	-	Thesis

3.4. Investigation of safety issues of cooling waterways (FA4)

3.4.1. Introduction (FA4)

Cooling waterways can be part of or directly adjacent to safety-classed areas of NPPs, meaning that loss of its bearing capacity could lead to adverse flooding, with shutdown and repair works needed. This FA covers work on corrosion initiating processes.

3.4.2. Objectives (FA4)

The objectives of this FA are to i) support license holders in their work to reduce the likelihood of damages to cooling waterways, and ii) to support the regulator and stakeholders with facts.

3.4.3. Activities (FA4)

Activity	Prio	Result
Investigation of corrosion-initiating processes of waterways reinforced concrete structures	H	Report
Investigation of stray-currents on corrosion of reinforced concrete structures (waterways)	H	Report

4. Governance

The steering group consists of Monika Adsten Energiforsk (chairman), Christian Bernstone, Vattenfall (vice chairman), Anders Bergkvist (Forsmark), Johanna Spåls (Ringhals), Jonas Bergfors (Oskarshamns Kraftgrupp), Ulrik Brandin (E.On), Timo Kukkola (TVO), Joonas Koskinen (Fortum), and Kostas Xanthopoulos (SSM). The SG is supported by a technical expert. Additional staff representation is normally the case.

5. Background

5.1. Needs and challenges of the nuclear industry

Three different R&D strategies have been assessed: 1) Minimised R&D costs, 2) Enable development of improved tools and methodologies, and 3) Minimise deployment risks of strategy "2". The outcomes would be:

1) R&D efforts work focus on fulfilling commitments only, and that risk for delays in deployment of improved tools & methodologies are accepted.
2) R&D work is selective and focused on eliminating showstoppers for deployment of improved tools & methodologies, and that deployment delays are accepted due to slow progress.
3) R&D efforts are directed at minimizing risks for the deployment, that delays for the deployment are not acceptable, and that R&D program is a driving force for deployment.

The outcome of a strategy workshop 150609 concluded that meeting the vision of the program leads to that at least strategy "2" must be executed.

5.2. Previous achievements

The Nuclear power concrete structures R&D program is in its 3rd program period. The ongoing period is being assessed with respect to the benefits that have materialised (ready autumn 2015). Recent top-three results are:

- Measurements of the moisture profile in the concrete cylinder walls of reactor containments with results that have led to important new understandings on the structures behaviour over time. The results have been incorporated into modelling codes, and validated.
- State-of-the art review of recent development on non-destructive testing tools for concrete applications, and field tests of selected promising such with promising results that are planned taken forward.
- Outreach through technical seminar on reactor containments tendons.