March 19 2024

# Safe and reliable management of polymeric materials in Nuclear Power Plants

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# Karin Jacobson, PDS Consulting

PDS = Polymer Degradation and Stability

- Chemical engineer with focus on polymeric materials
- PhD in long term properties of polymeric materials
- More than 20 years of experience of working with polymeric materials in harsh environments
- More than 15 years at the Swedish Corrosion Institute/ Swerea Kimab/ RISE
- Consultancy services include: research projects, failure analyses, inspections, material selection, status determination, analysing FRP cut-outs, courses, etc
- Technical expert in the Energiforsk R&D program for Polymeric Materials in Nuclear Power Plants

# The New R&D program at Energiforsk funded by the Swedish and Finnish NPPs

*Karin Jacobson*

*Date March 19, 2024*

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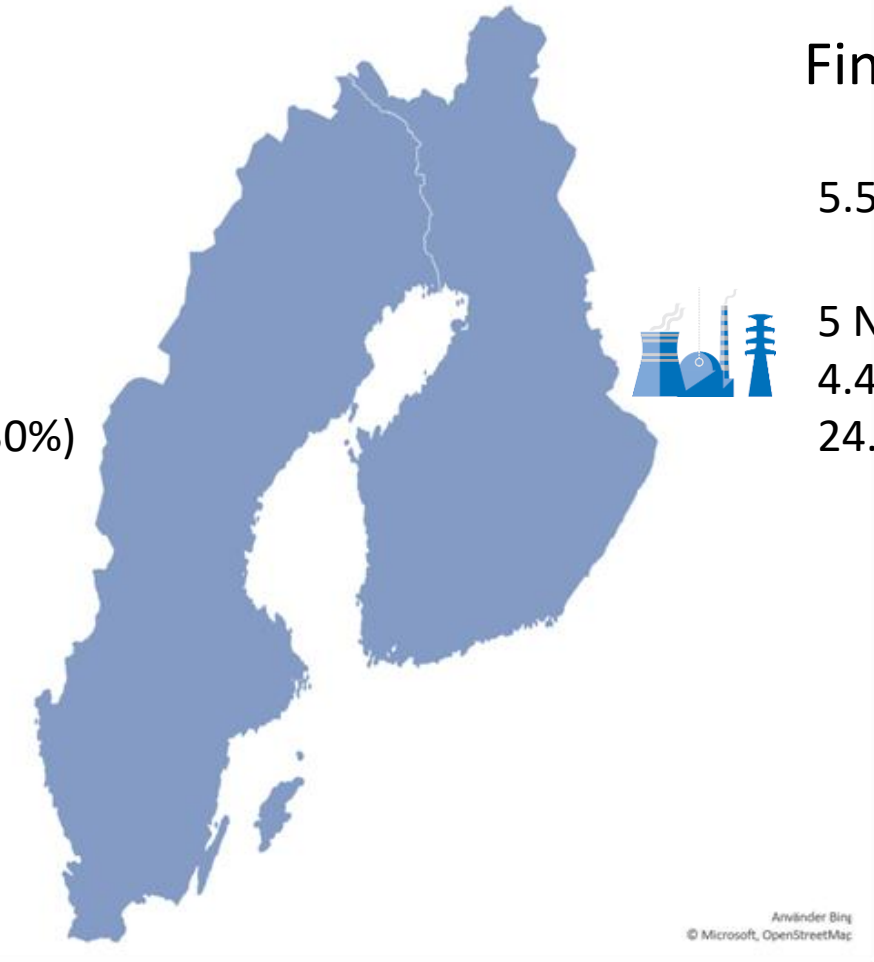
## Sweden

10.4 M

6 NPP
6.9 GW
50.0 GWh (30%)




## Finland

5.5 M

5 NPP
4.4 GW
24.2 GWh (35%)

2022 statistics (https://pris.iaea.org/;
https://ec.europa.eu/eurostat/ )

https://www.statista.com/statistics/517060/average-age-of-nuclear-reactors-worldwide/

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Vision

# We are the hub of Swedish energy research

Through collaboration and dialog, we conduct energy research so that new knowledge creates value for industry, decision-makers and the whole society.

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# What Energiforsk do

We make the world of energy smarter!

- Contributes to a robust and sustainable energy system
- Initiates, coordinates, and conducts research and analysis
- Initiates, quality assures, and manages projects
- Leverages the industry's research resources
- Provides specialist services in the field of energy
- Communicates knowledge and research results

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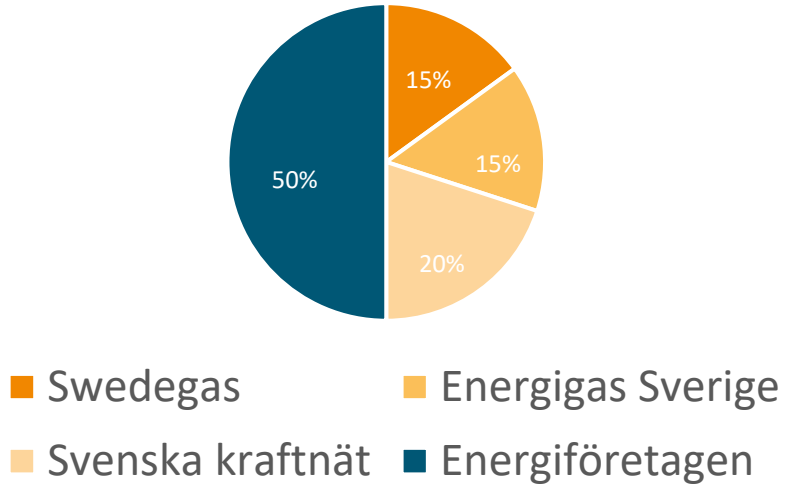
# This is Energiforsk

- Politically neutral
- Non-profit making limited liability company
- Four owners

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# Our research areas







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# Portfolio stakeholders:

VATTENFALL

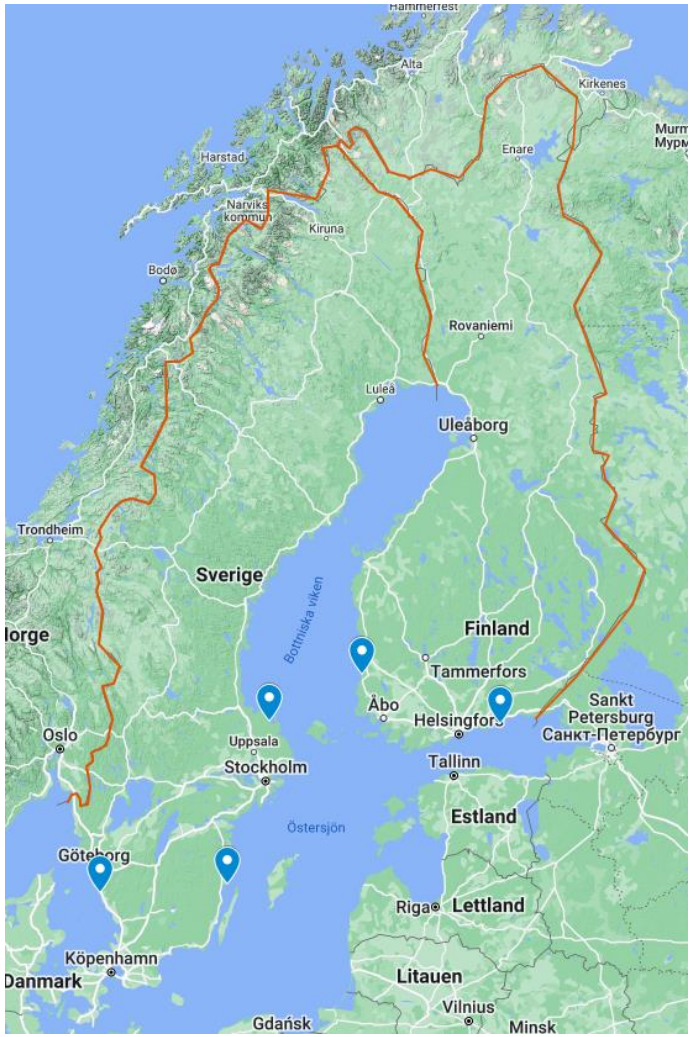
uniper

fortum

Skellefteå Kraft

TVO

ENERGI karlstadsenergi.se




# Additional program members:

Strål säkerhets myndigheten
Swedish Radiation Safety Authority

SVENSKA KRAFTNÄT

SKB

SAFO
Swedish Atomic Forum

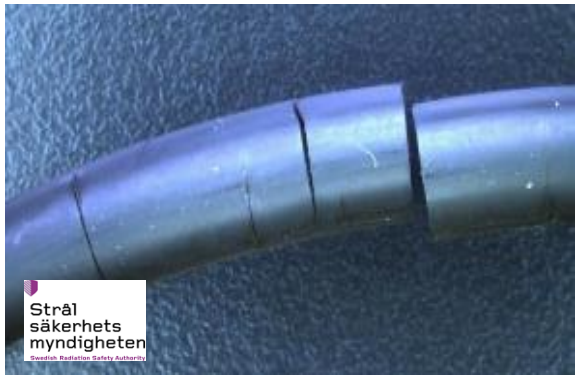
Energiforsk

Digitalization

Outlook & technology

**Concrete & civil works**

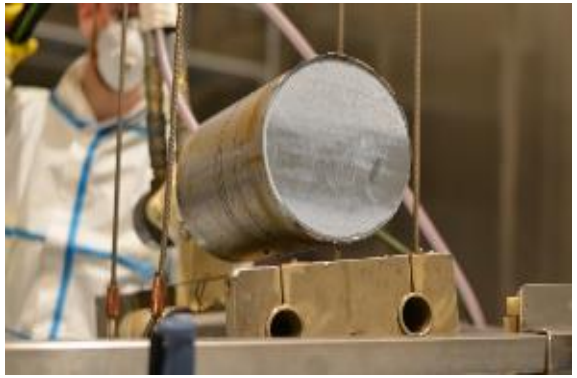
Polymers



**GINO- grid interaction**

Instrumentation & Control systems

Vibrations



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# Polymers

Various projects on polymers have been sponsored over the last >10 years, including two SAFIR projects on polymeric materials in NPPs

The dedicated R&D program on Polymeric Material in NPPs started in March 2023

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# Vision

The vision of the program is to increase the knowledge about polymeric materials in Nuclear Power Plants (NPPs) and to form a strong competence network.

By this, the plants will benefit from more safe, reliable and cost-effective management related to service life of polymeric materials.

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# Focus areas and activity plan

1. Build-up of R&D program and competence network
2. Technical challenges
3. Knowledge transfer

Annual open physical workshop to be held once a year

The activity planning should be regularly reviewed throughout the program period in strategy discussions within the steering group with input from technical expert(s)

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# Technical challenges

- The request from the license holders is that the program shall focus on practical applications rather than just scientific advancement
- There is a need for running smaller more focused projects, preferably with clear safety and/or cost saving improvements for the plants

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# Technical challenges – identified areas

- **LTO and ageing management – accelerated ageing and harvesting**
- Low dose rates – threshold level?
- **Cables and Online-monitoring**
- **Acceptance control of new materials**
- Storage control
- Polymers and lubricants
- Environmental qualification

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# LTO and ageing management

- Very difficult area
- Accelerated ageing often needed using e.g. increased temperature, total dose or dose rates
- The degradation mechanisms can vary depending on the temperature or nature of the irradiation due to e.g. changes in activation energies and DLO/DLH (diffusion limited oxidation/hydrolysis)
- Historically very high temperatures and/or does rates have been used. There is a need for using lower acceleration factors
- Investigating components from real service

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# Cables and Online-monitoring

- The scientific research on polymeric materials in NPPs has mainly been focused on cables due to volume and cost
- Prolonging the time in service and predicting failures are of large economic importance
- Previous extrapolations from accelerated ageing, in terms of temperature, dose level and rate, are being questioned
- There is a need for more relevant exposure conditions to be investigated
- More sensitive measuring techniques are being developed
- Development of condition monitoring and non-destructive testing of cables
- A state-of-the art summary translating the latest knowledge to the practical use in the NPPs to be made as a starting point for this topic

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# Acceptance control of new materials

- Some manufacturers announce changes in composition, but not always.
- US manufacturers of nuclear grade materials usually announce changes in their products since the NRC demands that. However, often only a few parameters are provided, not a full description
- The larger more quality oriented suppliers already have systems for this
- A compilation of the methodology used for this is to be initiated

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# Funding received from SSM:

Analysis of the international state of knowledge in the aging of polymeric materials based on Swedish conditions and identification of research needs relevant to the development of radiation safety

- State-of-the-art knowledge about aging of polymeric materials in NPPs
- Environmental qualifications
- Future research needs

Work comprises of a literature study, attending workshops and seminars plus interviews with the Swedish NPPs, scientists and suppliers
Final report due May 10, 2024

13:15 **An outlook on nuclear developments around the world from a global supplier**

**Tomas Nälsén**
*Habia Cables*

13:45 **Coffee Break**

14:15 **Life time assessment of rubber seals in heavy trucks**

**Martin Bellander**
*Scania*

14:45 **Cable condition monitoring methods in nuclear power plants – A review**

**Konsta Sipilä**
*VTT*

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15:45 **Cable Condition Monitoring for Aging Management and Life Extensio**

**Trevor Toll**
*AMS Technology Center*

16:15 **Cable ageing in NPP's over decades - from qualification to condition monitoring: A perspective on current status**

**Mathew Celina**
*Los Alamos Nat. Lab.*

16:45 **Polymer Challenges in Waste Management**

**Victoria Smith**
*Jacobs*

17:15 **End of Day 1**

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MARCH 20TH

08:15 **Welcome**

**Urban Andersson**
*Energiforsk*

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08:30 **Estimating remaining lifetime of used polymer materials from NPPs**

**Anna Bondeson**
*RISE*

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09:00 **Realife, a new project on the ageing of polymers in NPP's**

**Mikael Hedenqvist**
*KTH Royal Institute of Technology*

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09:30 **Coffee Break**

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10:00

## Megapol, 1st international Nonmetallic Research Program for the nuclear sector

**Marc Kuntz**
*Megapol*

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10:30

## Lifetime Extension Project for Polymeric Gasket Materials in Heat Exchangers

**Isaac Wacha**
*Westinghouse Electric Sweden AB*

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11:00

## Proposal for a broad PFAS restriction in EU

**Jenny Ivarsson**
*Kemikalieinspektionen*

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11:30

## Wrap up of Conference

**Urban Andersson**
*Energiforsk*

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11:45

## Lunch

At Radisson Blue Viking (included in conference ticket)

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# Thank you!