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10 partners from
7 European countries



4.88 Million Euro

NOMAD

Nondestructive Evaluation (NDE) System for
the Inspection of Operation-Induced Material
Degradation in Nuclear Power Plants

Consortium

The NOMAD consortium comprises a multidisciplinary team in the field of European nuclear energy and development of the non-destructive techniques.

Fraunhofer Institute for Nondestructive Testing, Germany

The Belgian Nuclear Research Centre, Belgium

VTT Technical Research Centre of Finland LTD., Finland

Swiss Association for Technical Inspections, Switzerland

Coventry University, United Kingdom

Hepenix Technical Service LTD., Hungary

Hungarian Academy of Sciences Centre for Energy Research, Hungary

Paul Scherrer Institut, Switzerland

Tecnatom, Spain

Eurice - European Research and Project Office GmbH, Germany

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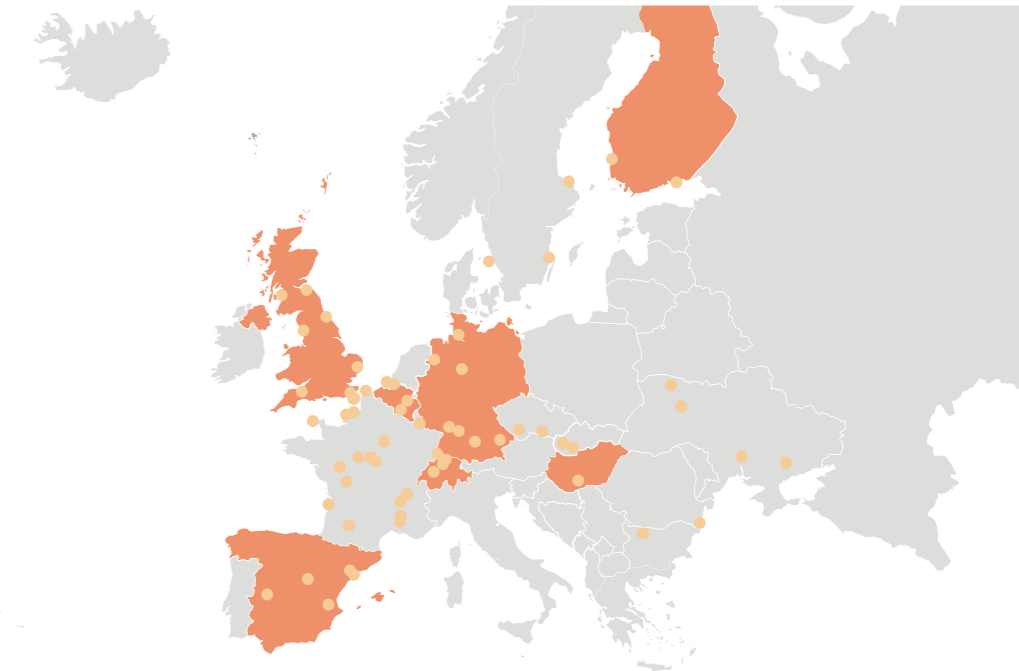
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Ensuring nuclear safety and reliability
of Generation II and III reactors in Europe

NOMAD's Vision

Since many European countries have agreed upon a lifetime extension of existing nuclear power plants, the European research project NOMAD will make a significant contribution to guarantee long-term safety of nuclear power plants.

Launched in 2017, NOMAD aims to develop a novel evaluation tool to examine reactors operating beyond their lifetime.

“Our vision within the NOMAD consortium is to continually improve reliability of Generation II and III reactors by applying innovative non-destructive evaluation methods which give insights into the actual state of material degradation of the individual power plants. NOMAD will thus contribute to ensuring a secure electricity supply for the societies in Europe in the next decades.”

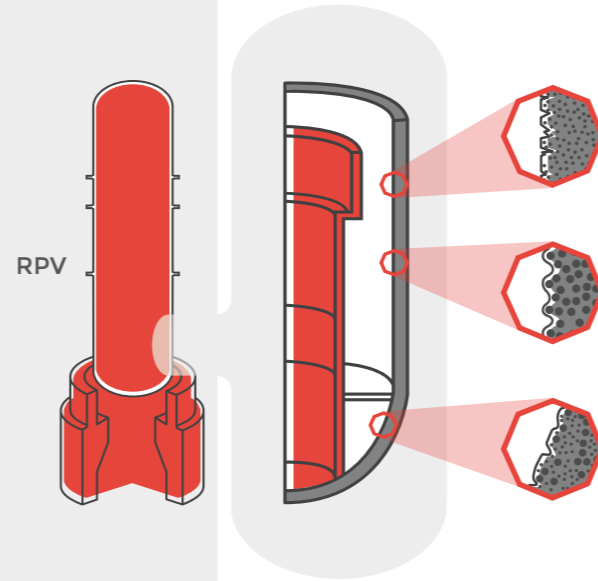


Dr. Ing. Madalina Rabung, Fraunhofer IZFP and NOMAD coordinator

The Project's Goals


One of the irreplaceable parts protecting the environment from radioactive radiation and limiting the lifetime of the nuclear power plants, is the reactor pressure vessel (RPV). The overall goal of NOMAD is to develop a **non-destructive evaluation (NDE) system** for nuclear power plants to assess RPV materials.

The project thus aims at creating, demonstrating and validating a NDE tool for the local and volumetric characterisation of the embrittlement in operational RPVs. The long-term perspective is to use this tool for periodic safety reviews of the RPV complementary to the standardised destructive methods.



The embrittlement of RPVs differs in each nuclear power plant depending on material parameters. To identify the degradation of RPV materials by neutrons, a synergetic combination of NDE methods is required.

The development of a multi-parametric NDE tool for the in-situ inspection of cladded RPV material shall allow detecting microstructure heterogeneities in the RPV wall.

 microstructure heterogeneities

Goals In Detail

- Design optimal sensors to characterise the changes of microstructure and mechanical properties induced by neutron irradiation on the materials.
- Extend the existing database of RPV material properties by adding correlations of mechanical and NDE parameters for a variety of microstructures/materials.
- Develop a software-based multi-parametric NDE tool that may allow the in-situ inspection of cladded RPV material.
- Complement current destructive tests on surveillance samples by optimised non-destructive tests.
- Compare, correlate and validate the results in the novel intelligent multiparameter tool comprising a prototype sensor setup and software.
- Enable knowledge transfer and the exploitation of the obtained results by nuclear power plant operators through European networks.
- Adjust laboratory conditions to imitate inspections under real field conditions.

Evaluation Methods

NOMAD partners will implement different **NDE methods** including electrical, ultrasonic, acoustic and micromagnetic techniques. By applying these methods, NOMAD will be able to identify the level of neutron degradation of the RPV and to make a statement about the possible operation time of the nuclear power plant. The examination of the RPV material will be realised by a synergetic combination of NDE methods taking into account local heterogeneities.



Micromagnetic methods

- Micromagnetic Multiparameter Microstructure and Stress Analysis (3MA)
- Magnetic Adaptive Testing (MAT)
- Micromagnetic Inductive Response & Barkhausen Emission (MIRBE)



Electrical methods

- Direct Current-Reversal Potential Drop (DCRPD)
- Thermoelectric Power Measuring Method (TEPMM)



Ultrasound and acoustic emission methods

- Piezoelectric Ultrasound (Piezo-US)
- Electromagnetic Acoustic Transducer based Ultrasound (EMAT-US)
- Acoustic Emission (AE)

The NDE techniques showing the best sensitivity for neutron irradiation-induced degradation deliver data to be collected in the software, which then determines common trends that can be transferred to through-cladding measurements of RPV material. The advantage of having a common trend in NDE data is the possibility to re-adjust it for practical application with few reference measurements instead of a large calibration sample set. The NOMAD tool will rely on a database of material behavior, which is built during the project.