PRESENTATION OF PROJECT

S U S E N

Sustainable Energy

PROJECT BENEFICIARY
Centrum vyzkumu Rez s.r.o.
NRI Group Member

PARTNER
University of West Bohemia

MAIN AREAS OF THE PROJECT
- Technologies of GIV nuclear power installations
- Nuclear fusion technologies
- Operational safety of GII and GIII nuclear power plants
- Nuclear fuel cycle and environment

KEY DATES

Project start:	01 / 2012
Construction completion :	09 / 2015
Maximum grant amount::	CZK 2.45 bn
• from the EU budget:	CZK 2.08 bn
• from the CR budget:	CZK 0.37 bn

LOCATION
Two centres in Czech Republic
- Rez
- Plzeň

CONTACT
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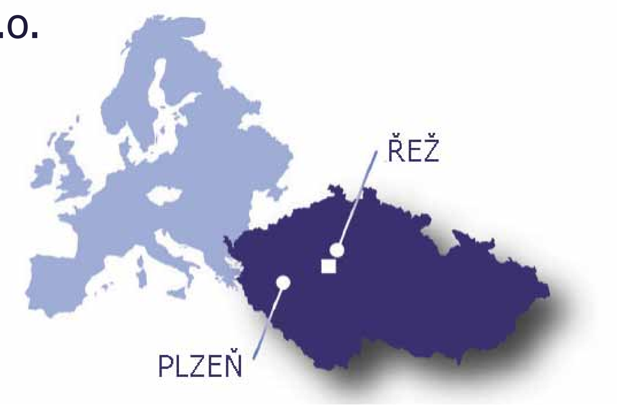
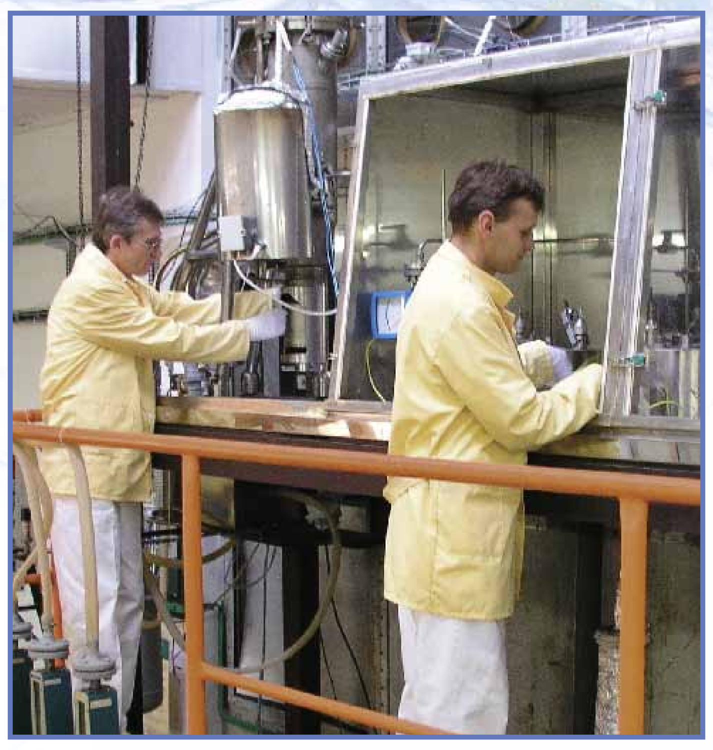


Project SUSEN represents
- new experimental opportunities for European nuclear R&D
- further development of nuclear energy technologies in the Czech Republic
- research and development support for Generation IV nuclear reactors and fusion technologies
- development of cutting edge technologies
- development of power generation research professionals

PRINCIPLE OBJECTIVES

The objective of the SUSEN project is to contribute, through research and development activities, to the safe, reliable and long-term sustainable operation of the existing energy installations, i.e. particularly nuclear power plants of GII and GIII types, by extending their life by 20–40 years. In addition, the objective of the project is to research and develop new high-efficiency technologies in the area of classical energy. Specific applications will be implemented immediately after completion of installation of the necessary technologies.



Through the generated research and development results, the SUSEN project will contribute to a smooth transition to new generation nuclear reactors, i.e. GIII+ and GIV. These so-called advanced nuclear reactors are expected to be put into hot operation after 2030. On a long-term basis, the subject of the project is also research and development of top technologies and materials in the area of thermonuclear fusion.

The project is built on four foundation research programs

Program No. 1: Technological Experimental Loops (TEO)

The objective of this research program is to build up large-scale experimental facilities allowing research and development in the area of generation IV nuclear reactors and in the field of fusion reaction. Experimental data acquired from such facilities will extend the existing knowledge of material properties and behaviour in specific conditions, and will be used during the development of the given type of reactor. Heat in such reactors is transferred through the media, but there is a lack of information on their behaviour, specifically in the area of their effects on the materials of construction, thermodynamic and thermohydraulic properties, manufacturing technologies are not known, the necessary components are not available, etc.

Experimental data acquired from such facilities extend the existing knowledge of the behaviour of materials and components at environmental parameters. Such data will be used to improve calculation codes, material property databases, etc., and is required for the development of the given reactor. Within this program, the following media will be studied:
- Supercritical water; medium for the primary circuit of a supercritical water reactor (SCWR);
- Helium; medium for the primary circuit of a (very) high-temperature reactor (V/HTR);
- Helium; coolant for the first wall of a fusion reactor;
- Supercritical carbon dioxide – potential medium of the secondary circuit for heat transfer from the primary circuit of GIV reactor;
- Eutectic lead–lithium (Pb-Li) alloy – medium for continuous generation of fusion fuel – ^{3}H tritium.

Objectives

1st Building the experimental loop for fuel qualification and sheathing for use in a supercritical water reactor. Loop licensing.
2nd Verification of the function of emergency systems of the loop. Verification of the behaviour of fuel element including sheathing during stationary operation and during transient and emergency conditions.
3rd Building the experimental loops with high-temperature Helium with the possibility of material testing for reactor internal components with co-acting Helium with high temperatures of up to 1000 °C, radiation and mechanical stress.
4th Verification of the characteristics of circulating compressor at a model scale on a high-temperature Helium loop. Verification of the function of gaseous Helium purification and analytical system, including kinetics of the removal of trace amount of corrosive impurities.
5th Building of experimental facility for hydrogen generation by high-temperature water electrolysis using high-temperature Helium and by heat recovery.
6th Verification of the function of the whole conversion cycle with SCO2; determination of the correlations for heat transfer in the supercritical area of CO_2 at different cycle configurations (pressures, flow velocities, etc.).
7th Infrastructure construction to verify and develop remote handling procedures during erection and especially repairs and maintenance of the system with molten metal Pb-Li and to develop handling tools for hot cells in the ITER facility.
8th Building the experimental facility for cyclic stress induced by high heat flow and high-energy neutrons applied to samples of the primary first wall.
9th Research of the interactions between 14 MeV neutrons and materials for fusion applications.

Program No. 2: Structural and System Diagnostics (SSD)

This research program is focused on structural and system diagnostics of nuclear power plants. This mainly involves the life extension of current GII generation NPPs by twenty to forty years and the research activities associated therewith. Medium- to long-term objectives relate to structural and system diagnostics of GIII and GIV NPPs with very demanding requirements for functions and reliability of diagnostic systems.

Objectives

1st To secure a comprehensive description of the degradation of structural and mechanical properties of the materials of construction of nuclear reactor components after long operational exposure, which will be used to assess the life span, reliability and safety of nuclear reactors.
2nd Design, optimization and implementation of manufacturing test pieces for research of material properties and the surveillance program (tensile testing, impact testing, fracture toughness testing, crack growth rate testing at cyclic loading and at increased temperatures, small-cycle fatigue testing and creeping tests of unexposed and highly irradiated material from units) including the period of life extension.
3rd Development and optimization of tests to determine the growth rate of cracks at cyclic loading in the range from room temperature to 800 °C, development and implementation of small-cycle fatigue testing at increased temperatures (to 800 °C), with creep interaction.
4th Development of new non-destructive testing procedures (NDE) for ferritic, austenitic and heterogeneous weld joints and components of a complex configuration and their certification (NDE qualification) using test pieces with artificial non-integrities and realistic simulations of operating cracks and mathematical modelling of the non-integrity indication measurement and response process.
5th Development of new general-purpose hardware and software for manipulator control for the testing of welds of critical nodes of the primary and secondary circuits of NPP, verifying the developed technologies on a manipulator prototype.
6th Laboratory establishment for severe accident simulation at new generation NPPs.
7th Development of new verification procedures for thermal and radiation resistance and behaviour in extreme conditions of severe accidents.
8th Increasing capacities to achieve high dose rates simulating radiation conditions during severe accidents.

Program No. 3: Nuclear Fuel Cycle (JPC)

The objective of the program is to extend and build up a research infrastructure to support the back end of the nuclear fuel cycle, i.e. specifically aimed at developing radioactive waste (RAW) processing and preparation technologies, studying the conditions in a deep geological repository and their effects on the materials of construction of casks/canisters to be used for disposal of high-level RAW and spent nuclear fuel, including study of radionuclide movements through rock formations, in which the construction of a deep geological repository is planned. Another area of interest within this program will be the development of a unique technology to separate fission and activation products from spent nuclear fuel, which can be applied to close the fuel cycle of the GEN III+ and GEN IV reactors using modern oxide fuels with inert matrices, nitride fuels, carbide fuels and liquid fuels, to which the known hydrometallurgical processes implemented on an industrial scale (PUREX process and its modification) cannot be applied to the full extent. An integral part of this research program will be the chemical-analytical laboratory that will be aimed at studying the environmental impact of the back end of the fuel cycle.

Objectives

1st Development of new fuel cycle technologies for fluorite technology-based nuclear reactors of new generations.
2nd Building a technology platform for international cooperation in the area of research and development of molten salt technologies and separation technologies.
3rd Development of advanced technologies and technological procedures for RAW disposal and minimization.
4th Research and development of new materials and principles for more effective and safe disposal of RAW.
5th Building a scientific-technology platform to support the construction of a deep geological repository in the Czech Republic.
6th Development of new methods for very low activity detection of long-lived radionuclides in very small sample sizes.
7th Development of new methods for very low concentration detection of toxic substances.

Program No. 4: Material Research (MAT)

The program is aimed at building a unique workplace to support research in the area of structure and substructure of materials with regard to their degradation changes during exploitation in demanding conditions, particularly due to high temperature, static and cyclic stress, and corrosion-aggressive environments. Activity in the workplace will be mainly linked to the TEO and SSD programs in the area of inactive testing of materials for high temperatures in the applications for GIV and fusion. The results are expected to be also directly applicable in the existing energy industry.

Objectives

1st Support of development in the area of ferritic and martensitic steels with application potential in environments with temperatures to 650 °C (materials for steam turbine components with ultrasupercritical steam parameters and for inactive circuits of GIV nuclear reactors).
2nd Support of development in the area of austenitic steel- and high austenitic alloy-based materials for manufacturing of NPP components resistant at high temperatures and pressures in aggressive environments.
3rd Documentation on the impact of degradation mechanisms on properties of the materials of construction designed for components of higher generation nuclear reactors (GIII+, GIV), both in active and in inactive parts.
4th Development of new technologies for fusion welding of advanced materials for conventional and nuclear energy.

For futher information visit
www.susen2020.cz

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