SASUNE: VTT’s Safe and Sustainable Nuclear Energy Program

Newsletter Autumn 2016

SASUNE’S OBJECTIVES

The main goals of VTT’s Safe and Sustainable Nuclear Energy programme are to create innovative solutions that meet new safety requirements, to boost economic competitiveness of nuclear power and to increase sustainability with CO2 neutral nuclear energy through closed fuel cycle and solutions for spent fuel and waste management.

The SASUNE programme focuses on the future nuclear technologies that meet the new reactor design and final disposal requirements. One of the key goals is to increase nuclear expertise to address future needs. The programme also actively works together with the different partners of the Finnish nuclear power and innovation ecosystem in order to open up new export possibilities for the technologies of the Finnish industry.

The programme includes larger partnerships such as waste management research concentrating on the final repository of spent nuclear fuel in Finland. Our nuclear power plant component research includes contributions to Jules Horowitz Research Reactor in France and the excellence of VTT’s new Centre for Nuclear Safety in Finland. Numerical simulation research comprises development of internationally widely used Apros and Serpent modelling and simulation tools. We integrate safety practices and implementation of human factors engineering throughout the program.

Contact: Erika Holt, Program Manager
See more: www.vttresearch.com/nuclear

VTT’S ORGANIZATIONAL UPDATES

VTT has simplified its organisation according to our new strategy of more custom orientation and agility. This autumn, Erja Turunen has been nominated as EVP of the Business Area of Smart industry and energy systems after retiring Jouko Suokas, and I have started as Vice President of Research Area of Nuclear Safety after soon retiring Timo Vanttola. Tarja Laitinen is VP for Research Area of Lifecycle Solutions. Most of 200 persons who are involved in our nuclear energy activities are within those two research areas.

Our business plan based on increased capabilities of Centre for Nuclear Safety and our widening competences, such as decommissioning, have been updated. In addition to increased national co-operation, international activities and collaboration are even more important in the future to develop and maintain all those competences which are relevant for Finland. The role of nuclear energy as an essential element of low-carbon energy mix has been emphasized when European Strategic Energy Technology Plan (SET Plan) is being presently updated, and future R&D targets have been identified with Finnish industry. The next Finnish stakeholder meeting will be on September 28, 2016 in Helsinki. Please contact VTT if you are interested in hearing more.

Satu Helynen, new Vice President of Research Area of Nuclear Safety
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VTT'S NEW CENTRE FOR NUCLEAR SAFETY
Wade Karlsen

VTT officially commissioned the new Centre for Nuclear Safety (CNS) on September 20, 2016, located at Kivimiehentie 3 on the Otaniemi campus in Espoo. With this facility, VTT offers flexible multi-scale experimental environments for material testing. Together with our computational capabilities and profound expertise, CNS forms a unique set of services for decision making in engineering and safety analysis. Equipment includes, for example:

- Hot cells
- Radiological labs
- Microscopy (LOM, SEM, TEM)
- Simulated primary circuit environments
- Metallography labs
- Mechanical workshops.

In recent developments, VTT accepted delivery of the completed 2360 m² laboratory wing of CNS in May of this year. The building accommodates 150 persons in 3300 m² of office space, and the first staff moved into the building in February 2016. Moving of laboratory equipment into the new facilities is well underway. The existing devices from the old radiochemistry laboratory have been mostly all moved into the new facilities, and tests on non-active specimens have resumed as each device has come on-line in their new setting. The application for the rad-facility operating license is on track to be submitted to STUK in October 2016, with a goal of approval by the end of this calendar year. The new, top-of-the line Talos transmission electron microscope has been successfully installed in the new laboratory, and the first operator training on the microscope has been held already. The moving of the new Zeiss Cross-beam scanning electron microscope is delayed while some corrections are made to the conditions of the room it is to be installed in, but the microscope is expected to be up and running in its new location before the end of the year. The Factory Acceptance Test of the first of four hot cell modules took place in August at the Isotope Technologies Dresden manufacturing site in Germany, and the FAT of the next module is scheduled for the middle of October. A pre-installation visit to the VTT site will be made by the ITD personnel in September, since the installation of the first hot cell module at VTT is on schedule for right after the Christmas/New Year's break.
NEWS FROM JULES HOROWITZ RESEARCH REACTOR
Petri Kinnunen

VTT has continued active participation in the Jules Horowitz Reactor (JHR), being built in Cadarache, France. During the past year, achievements have included the final design of the underwater gammascanning and x-ray tomography devices to be used both in the reactor pool and the storage pool. In spring 2016, Petri Kinnunen was appointed to the Chairman of the JHR International Governing Board for the next four years.

The Jules Horowitz Reactor (JHR) will be a major infrastructure of European interest in the fission domain, open to the international collaboration. JHR is built and operated via international cooperation between several organizations bound by a Consortium Agreement. The present partners are as follows:

• Research Institutes: CIEMAT (Spain); SCK (Belgium); NRI (Czech Republic); VTT (Finland); the French Atomic Energy Commission (CEA) (France); IAEC (Israel); DAE (India); JAEA (Japan); NNL (United Kingdom), Studsvik (Sweden)
• Utilities and Industrial Partners: “Electricité de France” (EDF); AREVA
• The European Commission.

See more information at: http://www.cad.cea.fr/rjh/index.html

NEWS FROM DEVELOPMENT AND IMPLEMENTATION OF SET-PLAN
Petri Kinnunen

Over the past year, VTT has taken an active role in developing Finland’s inputs to the SET-PLAN. The European Strategic Energy Technology Plan (SET-Plan) aims to accelerate the development and deployment of low-carbon technologies. It seeks to improve new technologies and bring down costs by co-ordinating research and helping to finance projects. The SET-Plan promotes research and innovation efforts across Europe by supporting technologies with the greatest impact on the EU's transformation to a low-carbon energy system. It promotes cooperation amongst EU countries, companies, research institutions, and the EU itself.

The work so far has included collecting a group of Finnish stakeholders together and determining the Finnish initiative for the Declaration of Intent describing the future targets for research. The next steps for Finland/VTT are to move towards implementation by establishing the Finnish mirror group to discuss common efforts to reach the targets, especially with selected foreign partners. If you are interested in hearing more or being involved, please contact Petri.


NEWS FROM VTT FIR DECOMMISSIONING
Markus Airila

FiR 1 is the first nuclear facility in Finland to be decommissioned. Since the final shutdown in June 2015, VTT has been preparing for the decommissioning by carrying out various safety analyses, measuring radioactivity concentrations (waste characterization) by analysing samples from the reactor's materials, performing detailed computer simulations, and negotiating contracts related to waste management solutions. Last April the spent fuel of FiR 1 was inspected carefully by Idaho National Laboratory and the technical readiness to ship it back to the country of origin, USA, was confirmed. A specific contract for fuel return is not yet signed, however. Detailed dismantling planning of the reactor is currently in an intensive phase.

The ongoing work aims at demonstrating that the decommissioning can be carried out safely and efficiently. Based on the results, VTT is now preparing a license application to State Council and will in 2017 apply for an amendment of license to allow for decommissioning measures.
OUTCOMES FROM SOME OF OUR VTT SELF-FUNDED PROJECTS

3SMR, Sami Penttilä

Small, Safe and Sustainable Modular Reactor (3SMR) project objective is to identify open issues of Small Modular Reactors (SMR) and the particular topics in which VTT could provide expertise to the customers concerning SMRs nationally and internationally. We reviewed 6 topics relevant to SMRs, such as challenges in complex material structures inside reactor pressure vessel (RPV), licensing issues, severe accident and core melt management, passive safety systems and human factors. Possibilities to new advanced manufacturing techniques, e.g. additive manufacturing (AM) and alternative welding & joining technologies as well as aspiration to use of innovative materials, are foreseen in SMRs which further increase the knowledge in the field of material technologies. Innovative laboratory and on-line monitoring devices for close-packed and complex material systems (iPWR), e.g. new welding and non-destructive testing (NDT) procedures, have increased our knowledge and shall be used in other VTT projects and customer assignments.

3SMR project has strengthened VTT’s capabilities on developing simulation and analytical work. New calculation models Serpent and COSY have been created for the NuScale SMR core based on publically available data. This project has introduced a new field of know-how at VTT on SMR designs and it has given a valuable insight on some challenges to overcome in order to make SMRs competitive. The end results of the project will be used in supporting EU applications. Close co-operation with Fortum has started to create new joint projects and to develop Finnish know-how on open issues related to overall safety of SMRs.

Outcome: New expertise on SMR design and manufacturing, licensing and assessment of techno-economic feasibility of SMR designs. Potential new offerings.

NDTMODE, Tarja Jäppinen

NDTMODE project has helped to increase our knowledge on the modelling in the field of non-destructive testing (NDT). Two software codes were used: - CIVA and COMSOL. VTT knowledge has been widened to the simulation of the phased array ultrasonic test of the dissimilar metal welds (DMW). The new CIVA 2016 version enables more precise modelling of complex welds. Simulation of phased array inspection with the same scanning setup as the real inspection and with the real data gives also verification to the simulation and the model which takes into account material properties like noise, attenuation and boundaries. The practice gives better understanding of the CIVA tool for creating and modelling probability-of-detection (POD) curves. The inspection of the DMW and the POD modelling are raising their importance in the field of the NDT of the nuclear components. We have also achieved more accurate eddy current modelling with COMSOL Multiphysics. COMSOL helps to study special simulation problems to a broader extent than CIVA.

Outcome: New expertise for NDT simulation especially in the field of DMW testing and creating POD curves with over 600 ultrasonic test simulations. New capabilities of creating flexible simulation environment.
PROSE, Atte Helminen

In the PROSE project, carried out in co-operation with Michigan Technological University (USA), we have conducted a survey on VTT’s capabilities of performing a Seismic Probabilistic Risk Assessment (SPRA). The potential improvement areas of VTT’s competence were identified. We have studied SPRA process divided in the following sequential entities: seismic hazard analysis → building modelling → seismic fragility analysis → probabilistic risk analysis modelling. We have found that VTT has strong capabilities in the seismic hazard analysis, building modelling and probabilistic risk analysis modelling entities. In order to master the whole SPRA assessment process, VTT is planning to further improve our competence on seismic fragility analysis.

Outcome: Potential new offering on Seismic Probabilistic Risk Assessment.

DeCoMAP, Atte Helminen

In the DeCoMAP project we have reviewed the level 2 PRA models of BWRs in co-operation with TVO. The common parameters of a containment PRA model have been recognised. A better use of material performance and reinforced concrete ageing models has been studied. The ageing related data obtained from the non-destructive evaluation of containment structures has been investigated. We have also identified future research topics on how NPP ageing effects can be better included in a level 2 PRA model and how to get data for it. The improved PRA models can provide risk-informed basis for the long term operation of NPPs and justifications for the possible lifetime extensions.

Outcome: Improved capabilities for modelling of material performance and reinforced concrete ageing for possible NPP lifetime extensions.

VTTBESIT, Juha Kuutti

VTTBESIT is a computer code still in extensive commercial use in evaluating the service lives of nuclear power plant (NPP) components, but the original code programmed in the 1990s cannot be executed on modern workstations. The key outcome of this project was that the core features of the outdated fracture mechanics analysis tool VTTBESIT are now implemented into the general purpose mathematics software MATLAB. The new implementation allows performing the assessments more reliably and efficiently. It also enables extending the capabilities of the fracture mechanics assessments. The most important route for future upgrade of VTTBESIT is the inclusion of probabilistic methods that are essential for risk-based assessments required by the updated YVL guidelines. Updated VTTBESIT tool will provide for more reliable and cost-effective analyses of plant remaining lifetime.

Outcome: Updated VTT software code for evaluating the service lives of NPP components.

VEERA, Rami Pohja

VEERA project aims at increasing strategic partnerships for excellent scientific knowhow, by active participation in EERA JPNM and networking with European partners. With VEERA, VTT is able to join feasible (in-kind) pilot projects leading to future H2020 projects and by taking the first steps to

Example of new materials investigated in VTT as part of VEERA.
include the Finnish industry and their interests in these efforts. EERA JPNM labelling procedure on H2020 proposals has been carried out and interaction with SNETP was introduced by JPNM Management Board. The focus of this work has been on the CREMAR project with the objective of developing a cost-effective power plant steel, which exhibits beyond state of the art mechanical properties by thermomechanical and microstructural modification. The continuation of this research path is foreseen to apply funding in H2020 Euratom Fission 2018 programme. Also, within the VEERA project scope, VTT has started a preparation of different project proposals in H2020 and Academy of Finland aiming at material development in SCWR type SMRs and in terms of accident tolerant fuel, respectively. The VEERA project utilizes the innovative high temperature testing concept CREBELLO, which is the first European research equipment capable of testing the creep properties of advanced steel tubes.

Outcome: New knowledge for developing a cost-effective power plant steel with advanced mechanical properties by thermomechanical and microstructural modification. New cooperative research project proposals on reactor and fuel cladding materials.

HF-TRAIN, Jari Laarni

HF-TRAIN project has 1) identified challenges and shortcomings in the current NPP operator training practices, 2) developed new methods for training, and 3) discussed with stakeholders about these shortcomings and methods. We have identified that the challenges and shortcomings include 1) the generic complexity and myriad details to be learned, 2) not learning the plant dynamics in a simulator as before due to new more exact procedures, 3) limited availability of simulator time (and therefore limited capability to handle emergencies in a routinized manner), 4) no possibilities for observing colleagues in one’s own task (and therefore lack of exchange in good work practices), 5) variance between operator shifts in motivation to learn and in handling emergency situations. New learning methods are identified by VTT for exchanging good practices, attaining holistic understanding of the plant dynamics and handling emergencies. These methods can be implemented with support from VTT. Discussions are ongoing with STUK to implement such tools and companies such as Fennovoima are seen as potential business partners in long term training development.

Outcome: Extended knowledge and potential new offerings on NPP operator training methods and practices.

ICP-MS, Tiina Lavonen

In this project, we have performed HR ICP-MS (High Resolution Mass spectrometry) tests and calibration updates. It included analysis of reference material and preparing of demonstration cases to be presented to potential customers. Multi-elemental analysis of 8 different water samples were conducted in order to measure very low concentrations. Same analysis was performed for Certified Reference Material to ensure the validity of analysis. Analysed elements were Be, B, Sr, Zr, Nb, Mo, Ag, Cd, Cs, Ba, Ta, W, Re, Ti, Pb, Bi, U, Li, Rb, Al, P, S, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, Ga, Na, Si, Ge, As, Se and measured concentrations in Certified Reference material were in a good accordance with the certified concentrations. A demo case poster was

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Photos of sampling within ICP-MS project.
presented at the 8th Nordic Conference on Plasma Spectrometry in Loen, Norway, in June 2016, and received the “Best poster”-award. Also, VTT has developed the ability to use the survey scan function of HR ICP-MS as a qualitative analysis method. Preliminary background study of analysis of radioactive samples with HR ICP-MS equipment was conducted, including the study of laboratory radioactivity limits and survey of replaceable parts which are vulnerable to contamination during HR ICP-MS analysis of radioactive samples.

**Outcome:** Improved expertise and newly-adopted methods for conducting High Resolution Mass spectrometry analyses. Demo case produced for potential customers.

**ImpactFeas, Ari Vepsä**

In the ImpactFeas project we focused on finding new applications for the VTT impact testing facility primarily used for aircraft crash type impact tests on concrete structures with velocities around 100–170 m/s. We started with identifying competitors’ similar facilities yet in most of the reference cases found, such facilities are used for military type impact tests but the tests are seldom reported publicly. We have chosen to improve our offerings for this facility to find new customers for the unique facilities. A first version of such infrastructure-centred offering is under preparation.

**Outcome:** Market knowledge for greater utilization of VTT’s high-velocity impact testing facility.

**OUTCOMES FROM SOME OF OUR JOINTLY-FUNDED PROJECTS**

**NUMPS, Jaakko Leppänen**

The Nuclear Multi-Physics (NUMPS) project was focused on developing high-fidelity numerical simulation methods for nuclear reactor core analyses. This involved coupling Monte Carlo neutron transport simulations to fuel performance, system-scale thermal hydraulics and CFD codes. The main development platforms were the Serpent Monte Carlo code, PORFLO CFD code and COSY light-weight thermal hydraulics solver, all developed at VTT. In the past four years Serpent code was developed into a versatile calculation tool for coupled core analyses that is used in 160 universities and research organizations in 37 countries around the world. The developed novel methodologies support the traditional multi-stage reactor physics scheme based on spatial homogenization, opening new possibilities, for example, in the modelling of SMR’s and other compact systems. NUMPS was funded by the Academy of Finland (2012–16) and involved the work of seven researchers, six of which were young persons working on their Master’s and Doctoral theses. The work was reported in more than 30 peer-reviewed conference papers and scientific journal articles.

**Outcome:** Improved capability to perform complex reactor core analyses with advanced calculation tools and the associated expertise. Support to development of internationally-recognised Serpent code.

**BELBaR, Veli-Matti Pulkkainen**

EU-BELBaR project (2012–16) was aimed at enhancing the long-term safety assessments for the geological spent nuclear fuel disposal concepts combining a clay engineered barrier system (EBS) with fractured rock. This jointly funded, Euratom FP7 collaborative project involved 14 partners co-ordinated by SKB. The project had a specific focus on the effects of the bentonite erosion in dilute water on the long term performance of the EBS and the radionuclide transport.
The work performed has improved the understanding of the phenomenology of the erosion process and the chemical conditions of the clay and the groundwater where the erosion may occur. The new findings suggested how the erosion could be considered in the safety assessments by the nuclear waste management organizations such as Posiva Oy. VTT carried out analysis and development of previously used models for erosion, and also developed a new strongly coupled model for bentonite. Novel techniques of small angle X-ray scattering (SAXS) and nuclear magnetic resonance (NMR) for solid bentonite were used by VTT to study how the nano- and microstructure of bentonite clay evolves when the density of compacted bentonite lowers towards conditions for possible erosion by dilute waters.

**Outcome:** New know-how on bentonite performance modelling, new competitive offerings for nuclear waste disposal.

http://www.skb.se/belbar/

**EU-DOPAS, Erika Holt**

Jointly-funded EU-DOPAS project (FP7, 2012–16) with 14 organization and coordinated by Posiva Oy achieved the first full-scale in-situ demonstration at the underground ONKALO facility at Olkiluoto. The full-scale concrete tunnel end plug was designed, modelled and constructed. In spring 2016 the structure was subjected to accelerated pressurization to simulate 100 years service life, with VTT responsible for performance assessment of the structural integrity, watertightness and safety. Within the overall project, VTT has also been responsible for developing of the specialty structural materials and for the detailed monitoring system within integration of IoT for nuclear repository safety. New technologies have been demonstrated including low-pH self compacting concrete and wireless sensing technology. The results from the project are being used as the first-in-the-world example of an operational nuclear waste repository demonstration. The results will be used within Posiva’s application for the repository operational license and VTT has new business offerings based on developed know-how for specialty concrete materials and infrastructure monitoring in demanding environments.

**Outcome:** New expertise and offerings on repository concrete materials, monitoring in demanding environments, service life performance of underground structures.

**EU-F4E – Remote Handling, Ali Muhammad**

Jointly funded project “EU-F4E-Grant: Development of Remote Diagnostics and Computer-Aided-Teleoperation Tools for Remote Handling” is performed in collaboration between VTT and Tampere University of Technology (TUT), also supported by Tekes. The purpose is to promote future innovations in the field of telerobotics by identifying how the ITER Remote Handling Control System (RHCS) modules can benefit from the latest developments in ICT and how these new modules could be adopted for general applications in industry. The project includes development of two components of the RHCS, namely Remote Diagnostic (RD) and Computer Aided Teleoperation (CAT). VTT leads the development of RD application that has a purpose of (1) collecting of equipment performance data for archiving, (2) pre-emptive detection/diagnosis of faults in real-time and (3)
investigative tool for isolating failures. TUT leads the development of CAT component that provides the visual tools based on virtual and augmented reality to assist the operator during the maintenance operations.

Outcome: New solutions to help the earlier-developed Remote Handling technology getting a wider spread in the general industry market.

Mikko Siuko, DEMO

DEMO project is European project funded and managed by Eurofusion. DEMO is a fusion device following ITER and using the experience obtained from ITER. DEMO is still to be an experimental device, aiming to commercial plant performance, like high power and high availability. DEMO fusion power is expected to be 4–8 times more than in ITER (500 mW => 2000–4000 mW), which reflects also to the remaining activation during the maintenance. Due to the radiation effects to materials, all the divertor components are planned to be replaced and not re-used after the maintenance.

VTT is working to develop the reactor remote maintenance procedures and the devices for the maintenance and the DEMO divertor replacement. VTT has developed operation sequences and device concepts for maintenance operations. This is a demanding work as the operation reliability and availability are of the highest priority for DEMO. VTT applies experience got from ITER reactor maintenance. VTT has also performed the task of arranging the tendering process for a qualified industrial expert to review the DEMO’s current remote maintenance requirements and provide nuclear maintenance experience to planned DEMO maintenance processes. The work to be done in 2017–2018 includes designing of maintenance device and a facility for testing of maintenance sequence. Its manufacturing is to follow after 2018, so that the DEMO-project will continue into the next decade(s).

Outcome: Utilization of R&D expertise and previous experience in international ITER project. New expertise on design and maintenance of future reactor types.

DEMO prototype power plant, 3000 MW.


NUGENIA, Eija Karita Puska

The ultimate goal of the Euratom FP7 project NUGENIA-PLUS (NUGENIA+) is strengthening of the role of NUGENIA to become the reference association able to structure the R&D at the European level integrating private and public efforts, and to initiate international collaboration creating added value in its activity fields.

The 3-year project started with 18 original partners in September 2013. In fall 2014 an open call for small research proposals in the area of cross-cutting R&D need according to the NUGENIA Roadmap of 2013 was launched. The proposals were evaluated by independent external experts and 14 small R&D tasks were launched. The R&D projects were able to start from the March 2015 and via this call the number of partners in NUGENIA+ grew to over 50. VTT has coordinated NUGENIA+ from the very beginning, actually on behalf of the NUGENIA Association for the past two years, as decided by the NUGENIA ExCom. VTT successfully participated in 3 out of the 14 R&D tasks. VTT was also involved into most of the other work packages of the project although with fairly small shares. The final seminar of NUGENIA+ project was held in Helsinki on 29–31 August 2016. NUGENIA and the Ministry of Economic Affairs and Employment of Finland have signed a Memorandum of Understanding to collaborate and promote research, development and innovation in the safety and efficiency of nuclear power generation. Satu Helynen serves as the Vice President of NUGENIA.
Outcome: Improved collaboration and better funding opportunities in EU jointly-funded research projects. Greater visibility of VTT in the international nuclear R&D community.

SOTERIA, Wade Karlsen and Caitlin Hurley

The jointly-funded Horizon 2020 project EU-SOTERIA is focused on safe long term operation of light water reactors based upon improved understanding of radiation effects in nuclear structural materials. The project started in September 2015. The consortium is made up of 24 European organizations from a total of 11 different countries. The project is aimed at improving the understanding, and prediction, of aging phenomena in the reactor pressure vessel (RPV) and reactor internals of pressurized water reactor (PWR) NPPs. The aging of reactor internals is being studied through coupled microstructural characterization and autoclave testing. VTT has a major role in the microstructural characterization (transmission electron microscopy (TEM) and scanning electron microscopy (SEM) of neutron irradiated RPV and in the autoclave testing and characterization (TEM and SEM) of neutron irradiated reactor internals materials. VTT will perform tests and characterizations of the radioactive materials in the newly constructed Centre for Nuclear Safety (CNS) facilities. As of today, we have managed to identify the most significant uncertainties for RPV embrittlement in order to finalize the materials characterization matrix (MCM). The MCM has been finalized, and now the radioactive specimen transport is being arranged for the tests to proceed.

Outcome: Project work in progress.
http://www.soteria-project.eu/

EU-Modern2020, Edgar Bohner

The EU-Modern2020 project (2016–2020) is developing and implementing an effective and efficient nuclear repository operational monitoring programme, that will be driven by safety case needs, and that will take into account the requirements of specific national contexts and public stakeholder expectations. The project is funded by Euratom and includes 27 partners, of which 8 are the waste management organizations of Europe. VTT is developing new technologies to improve wireless data transmission systems (WDT), power supply sources capable of extending the expected life time of the WDT, chemical sensor technologies in bentonite, electrical resistance tomography combined with induced polarisation tomography and establishing a common methodology for qualifying the components of the monitoring system intended for repository use. VTT works in close cooperation with Posiva Oy in order to demonstrate the applicability of EBS (Engineered Barrier Systems) monitoring strategies for long-term monitoring setups used for the operation of spent fuel deposition in ONKALO. VTT’s contribution in demonstration focuses on the development and design of a detailed monitoring plan for a deposition tunnel.

Outcome: Project work in progress.
http://www.modern2020.eu/

EVENTS


VTT is hosting a seminar between research and industry NUCCON 2016 – Concrete for Nuclear Structures, in Espoo on 31.10.–1.11.2016. Contact Miguel Ferreira (miguel.ferreira@vtt.fi) for more information.