Joint Projects and Other Co-operative Projects

NUCLEAR SAFETY

The Halden Reactor Project

The Halden Reactor Project has been in operation for more than 40 years and is the largest NEA project. It brings together an important international technical network in the areas of nuclear fuel reliability, integrity of reactor internals, plant control/monitoring and human factors. The programme is primarily based on experiments, product developments and analyses carried out at the Halden establishment in Norway, and is supported by approximately 100 organisations in 20 countries.

The 2001 programme of work in the fuel and materials area continued to focus on high burn-up fuel properties. The scope of work encompasses mixed-oxide and gadolinium fuels, in addition to UO_2, which are tested in a variety of reactor conditions. Both long-term fuel irradiations aimed at burn-up extension and short-term transients for safety assessments have been addressed. Investigations of embrittlement and cracking behaviour of reactor internals material have provided valuable data on water chemistry effects for highly irradiated materials. The programme on plant control and monitoring has provided verification and upgrades of systems for signal validation, performance monitoring and alarm handling. The latter has been investigated within the framework of the human factor programme, mainly by means of experiments in the Halden man-machine laboratory.

The Halden Project operates by way of three-year renewable mandates. The present mandate will expire at the end of 2002 and preparation for the new programme period (2003-2005) is under way. In a meeting hosted by the NEA in December 2001, all participants confirmed their strong interest in the project's technical results and their intention to continue participating in the next period.

The Project continued its summer school programme, which is supported by the NEA Nuclear Safety Division. This is in follow-up to a recommendation of the Halden Board to actively pursue the transfer of nuclear technology and know-how to the younger generation.

The Cabri Water Loop Project

The Cabri Water Loop Project is investigating the ability of high burn-up fuel to withstand the sharp power peaks that can occur in power reactors due to rapid reactivity insertion in the core (RIA accidents). It involves substantial facility modifications and upgrades and consists of 12 experiments to be performed with fuel retrieved from power reactors and refabricated to suitable length. The project began in 2000 and will run for eight years. The main lines of the programme of work and schedule have been defined, together with details of the scope and the experimental conditions for the first series of tests that will be carried out in 2002. The experimental work will be carried out at the *Institut de radioprotection et de sûreté nucléaire* (IRSN) in Cadarache, France, where the Cabri reactor is located. Programme execution also involves laboratories in participating organisations for fuel preparation, post-irradiation examinations and test channel instrumentation.

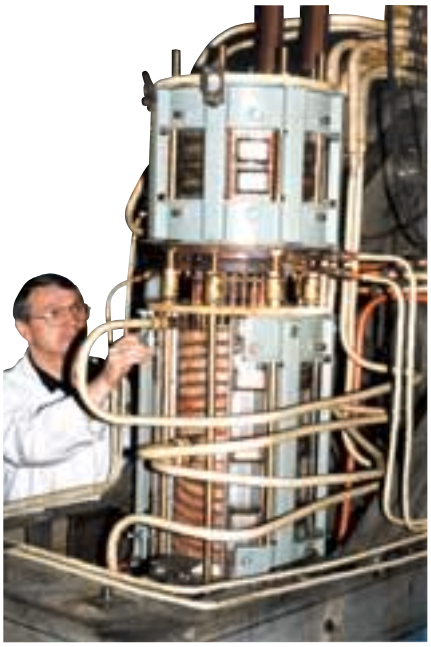
By the end of 2001, the Cabri Agreement had been signed by 14 organisations in 12 countries; considerable progress had also been made in finalising the project's bilateral agreements. Discussions were ongoing with additional potential participants.

Two meetings of the Technical Advisory Group (TAG) took place in 2001. The overall test frame, and in particular the details of the first test series, were defined. The first series will focus on very high burn-up fuels (~70 MWd/kg) having advanced cladding materials. Transportation to the Cabri site will be completed early in 2002, with the first two tests scheduled for spring and autumn. A first definition of instrumentation requirements and test channel specifications, as well as of complementary mechanical tests, has also been prepared. Two meetings of the project Steering Committee were also held in 2001 during which actions were identified for the subsequent phases of the project, especially in relation to specific test parameters that had been extensively discussed in the TAG meetings.

The MASCA Project

The MASCA Project investigates the consequences of a severe accident involving core melt. It started in mid-2000 and will be completed in three years (July 2003). The programme, which is supported by organisations in 17 countries, is based on experiments that are mainly carried out at the Kurchatov Institute and that make use of a variety of facilities in which corium compositions prototypical of power reactors can be tested. The experiments aim to resolve remaining uncertainties on heat load to the reactor vessel and thus on the possibility of retaining the melt within the vessel. These uncertainties are primarily associated with scaling effects and coupling between thermal-hydraulic and chemical behaviour of the melt. To achieve this basic objective, supporting experiments and analyses are to be performed with a view to providing an understanding of the phenomena of interest, and producing a consistent interpretation of the results by means of mechanistic models.

The influence of the chemical composition of the molten corium on stratification was addressed in a series of tests carried out during 2001. Some of these tests revealed an unexpected stratification behaviour (where the liquid metal layer separated below the oxidised corium layer), which led the participants to partly re-assess the programme. Investigations on partitioning of different chemical elements – including fission products – were also initiated. These are



Kurchatov Institute, Russia

View of the Rasplav cylindrical wall facility during the preparation for the MASCA experimental programme.

important for determining the heat transfer to the pressure vessel environment as affected by stratification phenomena of the molten pool. Finally, in recent discussions the participants came to the conclusion that a large-scale confirmatory test should be run towards the end of the programme period.

The Sandia Lower Head Failure Project

This project started in 1999 and was completed in 2001. It brought together eight Member countries for the purpose of studying the creep rupture behaviour of models of light water reactor lower heads. The information obtained is useful for the development of severe accident management strategies for coping with ex-vessel behaviour.

A total of four tests were carried out. A benchmark based on the results of the first test was also performed. The Project Committee decided to hold a seminar in June 2002, during which the overall project results would be reviewed together with participants' analyses.

The MCCI Project

Following a recommendation by the CSNI, experts convened by the NEA advised that initiatives be taken to address molten core ex-vessel phenomena. The proposal for an experimental project, denominated the Melt Coolability and Concrete Interaction (MCCI) Project, set forth by the USNRC and to be carried out at the Argonne National Laboratory (USA), was recommended.

The MCCI Project is to provide experimental data on relevant severe accident phenomena and to resolve two important accident management issues. The first one concerns the verification that the molten debris that has spread on the base of the containment can be stabilised and cooled by water flooding from the top. The second issue concerns the two-dimensional, long-term interaction of the molten mass with the concrete structure of the containment, as the kinetics of such interaction is essential for assessing the consequences of a severe accident. To achieve these basic objectives, supporting experiments and analyses will be performed, with a view to providing an understanding of the phenomena of interest, and to producing a consistent interpretation of the results relevant for accident management.

During 2001, a draft Agreement was circulated to CSNI members aimed at gathering sufficient support for the programme. This process is almost complete, with 12 countries having confirmed their interest. On these premises, the CSNI recommended to proceed with project implementation and execution starting from the beginning of 2002, while continuing the effort to expand project participation.

The SETH Project

The SETH Project is supported by 14 NEA Member countries. It started in 2001 and will run for four years. It consists of thermal-hydraulic experiments in support of accident management, which are carried out at facilities identified by the CSNI as those requiring international collaboration to sponsor their continued operation.

The tests to be carried out at Framatome's *Primär Kreislauf* (PKL) in Germany will investigate two pressurised water reactor (PWR) safety issues: boron dilution accidents that can arise from a small-break loss-of-coolant accident (LOCA) and during mid-loop operation (shutdown conditions). The first category of tests will verify if conditions can arise for core reactivity insertion due to formation of low-borated water slugs during a small-break LOCA followed by natural circulation restart. The second test series will assess whether conditions exist for a boron dilution accident as a consequence of loss of heat removal during mid-loop operation. The experiments to be carried out at the Paul Scherrer Institute (PSI) PANDA facility in Switzerland are to provide data on containment three-dimensional gas flow and distribution issues that are important for code prediction capability improvements, accident management and design of mitigating measures.

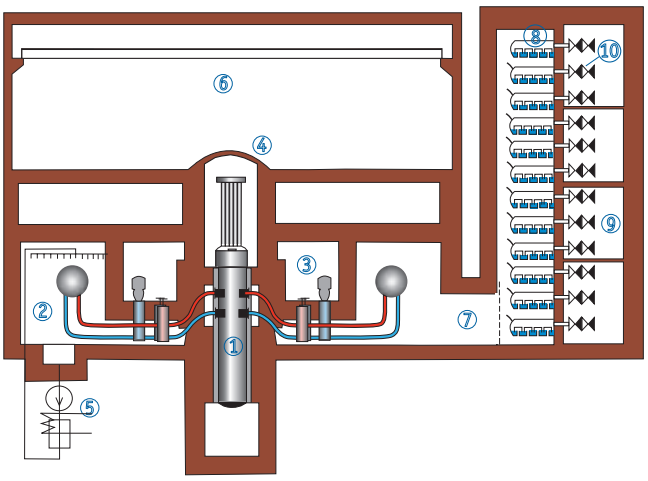
The first phase of the SETH Project has focused on the PKL tests. An experiment run in mid-2001 did not show any significant boron dilution problem. The specifications of the second PKL test were modified according to participants' requirements, and was to be run at the beginning of 2002. The remaining test sequence has also been reviewed and modified by the project participants. In particular, a mid-loop operation test has been pushed forward, while the aim of the fourth test will be finalised depending on previous test results. The PANDA tests will begin receiving increasing attention in 2002, with the next meeting of the technical review group planned to take place at the PSI premises.

The Bubbler Condenser Project

Following a CSNI recommendation in June 2001, the NEA has proceeded with the constitution of a project to resolve remaining issues on bubbler-condenser performance under accident conditions. The bubbler condenser is a system for VVER 440/213 reactors which is devised to reduce the pressure build-up in the reactor building during a loss-of-coolant accident. The project intends to provide answers to remaining issues by means of experiments carried out at the Electrogorsk Research Center (EREC) in Russia. The project should be completed in approximately one year. Experts from the Czech Republic, France, Germany, Hungary, the Slovak Republic and the USA participate in the project. The European Union is also participating. Czech, Hungarian and Slovak utilities are providing the financing for the test programme.

A first project meeting was held in December 2001 and addressed the current status of research on the subject, the preliminary plans of the experiments and the co-ordination of these plans with other initiatives, notably those taken by the European Union. During this meeting, participants also discussed and agreed upon the project objectives and the programme of work for the year ahead.

Schematic diagram of a VVER 440/213 reactor and its bubbler condenser unit.



1. Reactor pressure vessel
2. Steam generator compartment (SG)
3. Main circulation pumps room
4. Removable hatch in the reactor hall
5. Emergency core cooling system and spray system
6. Reactor hall
7. Corridor
8. Bubbler condenser unit
9. Air trap
10. Check valve

The ICDE Project

The International Common-cause Data Exchange (ICDE) Project collects and analyses operating data related to "common-cause" failures (CCF), which have the potential to affect several systems, including safety systems. The project has been in operation since 1998, and a new agreement covering the period 2002-2005 has been prepared.

The participating countries are Canada, Finland, France, Germany, Spain, Sweden, Switzerland, the United Kingdom and the United States. Other countries have recently expressed their interest to participate in the Project from 2002.

The ICDE Project is envisaged to include all possible events of interest, comprising complete, partial and incipient CCF events, called "ICDE events". The project covers the key components of the main safety systems, such as centrifugal pumps, diesel generators, motor-operated valves, power-operated relief valves, safety relief valves, check valves, reactor protection system circuit breakers, batteries and transmitters.

These components have been selected because probabilistic safety assessments have identified them as major risk contributors in the case of common-cause failures. Qualitative insights from analysis of the data will help reduce the number of CCF events that are risk contributors. In the long-term, the Project will provide a broad basis which would enable the quantification of CCF events.

RADIATION PROTECTION

ISOE: The Information System on Occupational Exposure

To facilitate a global approach to reducing operational radiation exposure through the exchange of techniques and experiences in exposure reduction, the NEA launched the Information System on Occupational Exposure (ISOE) in 1992. This programme is jointly sponsored by the IAEA, and supplies data to the European Commission and to UNSCEAR. At the end of 2001, data in the ISOE programme had grown to include 405 operating commercial nuclear reactors and 54 commercial nuclear reactors in cold-shutdown or some stage of decommissioning, representing 74 utilities from 29 countries. Regulatory authorities from 25 countries participate in

the ISOE programme. During 2001, the software used to manage and analyse the information in the three ISOE databases was improved and issued. An international "ALARA" (as low as reasonably achievable) Symposium was held in the United States to exchange operational dose reduction experience. The ISOE data, and the information exchanges made possible through the programme and its associated workshops and symposia, has contributed to the 50 per cent decline in occupational exposure since 1990.

RADIOACTIVE WASTE MANAGEMENT

Sorption Project

The NEA Sorption II Project was launched in October 2000 with the objective of demonstrating the applicability of different chemical thermodynamic modelling approaches to support the selection of sorption parameters for radioactive waste repository safety assessments. The project is taking the form of a "benchmarking" exercise for the different modelling approaches being pursued by the participating organisations. The overall aim is to interpret selected, well-characterised data sets for sorption in complex materials. By applying the various modelling approaches in a systematic way to the same measured data, an evaluation of the merits and limitations of the approaches will be possible and thus recommendations on their use.

In June 2001, the evaluation criteria, organisation of the exercise and data sets selected for the benchmarking exercise were finalised. Seven cases were selected for modelling in order to reduce the potential bias that could be introduced from a smaller number of examples.

The actual modelling exercise began at the end of 2001 and will continue for a period of six months. More than 20 teams supported by national waste management organisations are participating. It is expected that more than 50 cases will be presented and analysed during the second part of 2002.

The Thermochemical Database (TDB) Project

The aim of the Thermochemical Database (TDB) Project is to critically review and to recommend chemical thermodynamic data needed in the safety assessment of radioactive waste repositories. The review leading to recommended data for neptunium and plutonium was completed and published by Elsevier North Holland in 2001. Five separate expert teams are presently working on the evaluation of the following data:

- updates of the existing reviews for inorganic species of U, Am, Tc, Np and Pu;
- simple organic compounds of U, Am, Tc, Np, Pu, Se, Ni and Zr;
- inorganic compounds of Se;
- inorganic compounds of Ni;
- inorganic compounds of Zr.

Among these five review efforts, it is expected that the updating of U, Am, Tc, Np and Pu data will be completed and sent for publication in 2002. The reviews of the inorganic compounds of Zr and the simple organic compounds will be sent for peer-review in 2002 and published in early 2003. The two remaining reviews will be published later in 2003.

A workshop entitled "The Use of Thermodynamic Databases in Performance Assessment" was organised in Barcelona, Spain in May 2001. The objective of this workshop was to provide a forum where the producers (TDB review teams) and the users (performance assessment modellers) could discuss the thermodynamic data requirements and applications for radioactive waste management performance assessment. The proceedings will be published by the NEA in spring 2002.

Decommissioning

The RWMC Co-operative Programme for the Exchange of Scientific and Technical Information Concerning Nuclear Installation Decommissioning Projects (CPD) expanded its membership to 40 projects during 2001. At the end of the year, participants extended the Programme's mandate until 2005 and agreed on an approach for self-financing Programme co-ordination.

To assist in the development of high-level policy and regulations for decommissioning, the CPD provided decommissioning cost input to a sub-group of the Nuclear Development Committee (NDC), and technical, managerial and strategic experience in decommissioning to a sub-group of the Radioactive Waste Management Committee (RWMC). The CPD also pursued work on summarising experience from the first 15 years of the Programme, as well as developing other summary documents of experience, from the decommissioner's viewpoint, addressing policy and strategy, materials management, cost and safety.

SCK•CEN, Belgium

Decontamination of large and heavy components by abrasive blasting.