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 2002 programme of work in the fuel and materials area addressed the preparation of an important loss-of-coolant experiment aimed at clarifying such phenomena as fuel relocation after ballooning. The programme continued to focus on high burn-up fuel properties. The scope of work encompasses studies on PWR cladding corrosion, where many different alloys are directly compared. The work on high burn-up properties of mixed-oxide and gadolinium fuels, in addition to uranium-oxide fuel, continued in 2002, and it was enlarged to comprehend inert matrix fuels. Investigations of embrittlement and cracking behaviour of reactor internals material have provided valuable data on how the cracking progresses in 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, and 2002 was the last year of the 2000-2002 mandate. Discussions among the Halden Project participants on the continuation of the Halden Project were successful. The framework programme for the new three-year period 2003-2005 was completed and submitted to the Halden Board of Management, which approved it at its December 2002 meeting. The new legal Agreement for 2003-2005 is being circulated to members for signature.

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. It also held several workshops and a large technical meeting ("Enlarged HPG") where recent results of Halden research were presented.

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 re-fabricated to suitable length. The project began in 2000 and will run for eight years. 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. Thus far, the Cabri Agreement has been signed by 14 organisations in 12 countries, including regulators, industry and research organisations; the project's bilateral agreements are being finalised.

Two meetings of the Technical Advisory Group (TAG) took place in 2002. Progress was made to gather all relevant information, define the test conditions and make the necessary preparations for the first two tests, which were carried out in October-November. They involved fuel with very high burn-up (~ 70 MWd/kg) and having two types of modern cladding materials. No fuel failure was registered in the first test, whereas the outcome of the second is still being investigated.

Two meetings of the project Steering Committee were also held in 2002 during which discussions on the different phases of the project took place, especially in relation to the plan for installing the water loop and to test conditions that had been 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 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 investigations on the effect of the chemical composition of the molten corium on stratification continued in 2002. These comprised experiments in which carbon and boron were added to the melt. Experiments with liquid steel present in the corium were also carried out. Investigations on partitioning of different chemical elements – including fission products – were completed in 2002. Materials property data continued to be produced in the programme. Since the current MASCA Project is approaching conclusion, discussions are taking place among participants on a possible continuation of the project for another three-year period, in consideration of the experimental needs that still exist as well as the quality of the experimental work performed so far.

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 results of this exercise as well the overall outcome of the Lower Head Failure Project and participants analyses were reviewed at a seminar that was held in June 2002.

The MCCI Project

The Melt Coolability and Concrete Interaction (MCCI) Project is managed by the USNRC and carried out at the Argonne National Laboratory (USA). It was started early in 2002 with participation from 13 countries and will continue for four years. It addresses ex-vessel phenomena, which occur in the hypothetical case that the molten core is not retained inside the reactor vessel, and is spread in the reactor cavity where it can interact with the concrete structure.

The MCCI Project is to provide experimental data relevant for the severe accident mentioned above 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.

The first experiments have focused on water ingress mechanisms, as these are thought to be the most effective ones for cooling the melt. Three of these types of tests were carried out in 2002. At the same time, progress was made in defining the follow-up programme, in particular the design of the long-term, two-dimensional, melt-concrete interaction test.

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 PKL tests, which were run in the first phase of the SETH Project, were completed in 2002. They included one mid-loop operation test (with an open primary circuit) and LOCA tests. From these, one can derive that boron dilution can occur under some conditions. For this reason, the possibility of continuing the PKL tests under a separate arrangement – but still as an OECD/NEA project – is being considered. The planning of the PANDA tests was discussed in great detail during the two SETH meetings that were convened in 2002. In particular, the test matrix was reviewed in depth and modified to include condensation phenomena. Details of the test set-up and the instrumentation in particular were also discussed.

The Bubbler Condenser Project

Following a CSNI recommendation in June 2001, the NEA proceeded with the constitution of a project to resolve remaining issues on bubbler-condenser performance under accident conditions. The project started in December 2001 and was successfully completed in December 2002.

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 provided answers to the remaining issues by means of in-depth analyses of previous experimental results and three new experiments carried out at the Electrogorsk Research Center (EREC) in Russia. Regulatory bodies and utilities from the Czech Republic, Hungary and the Slovak Republic, as well as experts from France, Germany and the USA participated in the project and supported the experimental work with pre- and post-test analyses. The European Union also participated in

Bubbler condensers at the Bohunice nuclear power plant, Slovak Republic.

the project. Czech, Hungarian and Slovak utilities provided the financing for the test programme.

Three project meetings were held in 2002. The first two focused on the analyses of earlier tests and the preparation of the new experiments. The third meeting was used to review the experimental results and associated pre- and post-test analyses, as well as to plan the preparation of the final report of the project. The latter will be published during the first half of 2003.

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 entered into force in 2002.

Japan and the Republic of Korea joined the project in 2002. The other participating countries are Canada, Finland, France, Germany, Spain, Sweden, Switzerland, the United Kingdom and the United States.

The ICDE Project is envisaged to include all possible events of interest, comprising complete, partial and incipient CCF 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.

The Fire Project

The Fire Project started in 2002 and will run for three years. Its main purpose is to encourage multilateral co-operation in the collection and analysis of data relating to fire events in nuclear environments. The objectives are to:

- Define the format for, and collect fire event experience (by international exchange) in, a quality-assured and consistent database.
- Collect and analyse fire events data over the long term so as to better understand such events, their causes and their prevention.
- Generate qualitative insights into the root causes of fire events that can then be used to derive approaches or mechanisms for their prevention or for mitigating their consequences.
- Establish a mechanism for the efficient feedback of experience gained in connection with fire events, including the development of defences against their occurrence, such as indicators for risk-based inspections; and to record event attributes to enable quantification of fire frequencies and risk analysis.

At present, the project participants are the Czech Republic, Finland, France, Germany, Japan, Sweden and Switzerland. Several more are expected to join in the near future.

The OPDE Project

The OECD Piping Failure Data Exchange (OPDE) Project started in 2002 and will run for three years. Its goals are to:

- Collect and analyse piping failure event data to promote a better understanding of underlying causes, impact on operations and safety, and prevention.
- Generate qualitative insights into the root causes of piping failure events.
- Establish a mechanism for efficient feedback of experience gained in connection with piping failure phenomena, including the development of defence against their occurrence.
- Collect information on piping reliability attributes and factors of influence to facilitate estimation of piping failure frequencies.

The OPDE Project is envisaged to include all possible events of interest with regard to piping failures. It will cover piping components of the main safety systems (e.g. ASME Code Classes 1, 2 and 3). It will also cover non-safety piping systems that, if leaking, could lead to common-cause initiating events such as internal flooding of vital plant areas. As an example, raw water systems such as non-essential service water could be a significant flood source given a pipe break. Specific items may be added or deleted upon the unanimous decision of the Project Review Group. Steam generator tubes are excluded from the OPDE project scope.

The current project participants are Belgium, Canada, the Czech Republic, Finland, France, Germany, Japan, the Republic of Korea, Spain, Sweden, Switzerland and the United States.

RADIATION PROTECTION

ISOE: The Information System on Occupational Exposure

The Information System on Occupational Exposure (ISOE) is a joint NEA/IAEA programme that was launched in the early 1990s. ISOE has

since become a unique worldwide programme to discuss, promote and co-ordinate international co-operative undertakings for the radiological protection of workers at nuclear power plants; a forum for discussing occupational exposure management issues; as well as the repository for the world's largest database on occupational exposure from nuclear power plants. ISOE is the only programme in the field of occupational exposure which enjoys active participation of radiation protection experts from both utilities and national regulatory authorities. This programme supplies data to the European Commission and to UNSCEAR.

At the end of 2002, data in the ISOE programme had grown to include 407 operating commercial nuclear reactors and 54 commercial nuclear reactors in cold-shutdown or some stage of decommissioning, representing 72 utilities from 29 countries. Regulatory authorities from 25 countries participate in the ISOE programme. During 2002, the software used to manage and analyse the information in the ISOE database was finalised and issued. An international "Workshop on Occupational Exposure in Nuclear Power Plants" was held in Slovenia to exchange operational dose reduction experience. The first "International Conference on Occupational Radiation Protection: Protecting Workers Against Exposure to Ionizing Radiation", which was held in Switzerland and sponsored by several international organisations including the NEA, discussed issues in occupational radiation protection, and explicitly recognised the ISOE system to be "...a very useful mechanism for disseminating information, examples of good practice and lessons learned."

RADIOACTIVE WASTE MANAGEMENT

The 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 safety assessments of geological repositories. The project has taken the form of a "benchmarking" exercise for the different modelling approaches being pursued by the participating organisations. 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 is made possible and thus recommendations on their use.

With the help of five international experts, reference data sets were analysed in respect of their suitability for the benchmarking exercise. 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 for a period of six months. Twenty teams, supported by national waste management organisations, submitted 49 test cases. A project workshop was organised in Spain, at the end of October 2002, to analyse the results and discuss unresolved issues. The project is now in its final phase. A report on the results of the exercise and lessons learnt will be available for participants in spring 2003. It will be submitted to an international peer review before publication, which is intended for the end of 2003.

The Thermochemical Database (TDB) Project

The NEA is developing a database of recommended chemical thermodynamic data for the safety assessment of nuclear waste repositories. The work is performed by the Data Bank, under the scientific guidance of the Integration Group for the Safety Case (IGSC) of the NEA Radioactive Waste Management Committee (RWMC).

The present programme is based on reviews of the following data:

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

The first two reviews are ready for peer review, as well as the report on the inorganic species of Se. The reports on the inorganic species of Ni and Zr will be finalised in 2003.

Considering the good advancement of the present phase of the project, the TDB Management Board decided in November 2002 to launch a new four-year phase. This new phase will cover the maintenance of the existing database, as well as the review of inorganic species and compounds of Fe, Nb, Sn and Th. In addition, the project will aim to improve communication and interface with the user community.

The Co-operative Programme on Decommissioning

The Co-operative Programme for the Exchange of Scientific and Technical Information Concerning Nuclear Installation Decommissioning Projects (CPD) has been a joint research project operating under Article 5 of the NEA Statute since its inception in 1985. Half way through its fourth 5-year Agreement, the CPD is focusing its efforts on the exchange of decommissioning experience among its participating projects. This exchange continues to include biannual meetings of the Technical Advisory Group (TAG), during which the site of one of the participating projects is visited, and good and bad examples of decommissioning experience are openly exchanged for the benefit of all. The new membership of four organisations during 2002 attests to the continued interest in this programme.

During 2002, the practical experience of the CPD was brought to the service of the NEA through participation of CPD experts in two key groups. The RWMC Working Party on Decommissioning and Dismantling (WPDD), with several members from the CPD, produced during 2002 a significant document on the status, approaches and challenges of the decommissioning and dismantling of nuclear facilities, as well as an update of its decommissioning fact sheets on national decommissioning programmes. The NDC Expert Group on Decommissioning Strategies and Costs, again with several members who were also members of the CPD, produced a draft report on this subject. The practical experience of the CPD has thus served to help the NEA expert groups involved in regulatory and policy aspects of decommissioning to develop products that are solidly grounded in real-world experience.