

Nuclear Safety and Regulation

Committee on Nuclear Regulatory Activities (CNRA)

The CNRA contributes to developing a consistent and effective regulatory response to current and future challenges. These challenges include operational experience feedback, increased public expectations concerning safety in the use of nuclear energy, industry initiatives to improve economics and inspection practices, the necessity to ensure safety over a plant's entire life cycle, and new reactors and technology.

Operating experience

The joint NEA/IAEA Incident Reporting System (IRS) is the only international system providing regulators and government bodies with information about lessons learnt from safety-significant events at nuclear power plants. The IRS co-ordinators exchange information about recent events during their annual meetings and jointly define topics of interest for further work.

The Working Group on Operating Experience (WGOE) completed its report on "The Use of International Operating Experience Feedback for Improving Nuclear Safety", providing several recommendations to improve the system to collect, assess and define corrective measures resulting from operational events.

The WGOE co-organised an International Workshop on Defence-in-Depth Aspects in Electrical Systems of Importance for Safety, held in September in Sweden. Senior regulators and researchers along with industry managers and technical-level experts discussed lessons learnt from the event that took place at the Forsmark nuclear power plant in 2006, as well as ways to improve system design and operation.

Other issues being studied by the working group include the safety analysis of fire operating events and the improvement of international networks for nuclear facility operating experience feedback.

The regulatory goal of assuring nuclear safety

The senior-level task group formed to address this subject completed its report which sought to answer the fundamental question, "How can the regulatory body judge whether its actions are actually assuring an acceptable level of safety at nuclear facilities?" The report noted that

there are many sources of information available to the regulator pertaining to safety at any given nuclear facility, such as inspection reports, operating experience reports, research results, periodic safety reviews, probabilistic safety analysis (PSA) results, insights from IAEA reviews and other similar information. The major challenge, and hence the primary focus of this report, is how can the regulatory body systematically collect the safety-relevant information and make an integrated safety assessment of that information to arrive at a sound judgement of the acceptability of a facility's level of safety.

The NEA also organised, in France in June, a Regulatory Forum on Assuring Nuclear Safety involving high-level participants from regulatory authorities, government agencies, nuclear industry leaders and other stakeholders. The forum addressed different perspectives for assuring nuclear safety and the principal challenges in arriving at an integrated assessment. Several subjects were discussed:

- maintaining safety focus on operating plants in a changing nuclear setting;
- operators' challenges in assuring nuclear safety in operating plants;
- essential safety topics for assuring nuclear safety;
- the integrated safety assessment;
- the regulatory challenges in communicating safety.

The findings from the forum were used by the senior-level task group to finalise its report on *The Regulatory Goal of Assuring Nuclear Safety*, which will be published early in 2008.

Regulatory inspection practices

As part of the activities of the Working Group on Inspection Practices (WGIP), inspectors from regulatory bodies meet periodically to exchange information and experience related to regulatory safety inspection processes and to carry out related studies. The WGIP mandate notes the important relationship between inspection practices and operating experience, and how regulatory inspections must be supplemented by reviews and by other regulatory controls to yield an integrated assessment of safety and to provide a basis for enforcement, an essential part of the regulatory oversight process.

An International Workshop on Inspection of Digital Instrumentation and Control (I&C) Systems Important to Safety was held in September in Germany. Nuclear inspectors met with experts to discuss methods to improve inspection programmes for these systems, which are being put into service in many power plants. Planning also began for the 9th international workshop, to be held in 2008 and to address the training and qualification of inspectors, the integration of inspection findings and the inspection of new plants under construction.

Highlights

- The main challenges identified by the Joint CSNI/CNRA Strategic Plan have been addressed in the committees' respective Operating Plans in order to assign priorities and to ensure efficiency within their programmes of work.
- In 2007 the CNRA and the CSNI organised several workshops, most notable were those on the Transparency of Nuclear Regulatory Activities; Regulatory Approaches to Licensee Safety Culture;

Fuel Cycle Safety: Past, Present and Future; Use of CFD Codes in Nuclear Reactor Safety; Defence-in-Depth Aspects in Electrical Systems of Importance for Safety; and the Role of Research in a Regulatory Context.

- Three new multilateral "Joint Projects" were started on containment thermal-hydraulics (THAI), on iodine chemistry (BIP) and on steam explosion (SERENA). See page 28 for further details on these and other joint projects under way.

Other issues being studied by the working group include regulatory inspection philosophy, inspection organisation and inspection of fire protection systems.

Nuclear regulators and public communication

Transparency is one of the keys to public acceptance of nuclear energy. Information officers from regulatory bodies meet once a year to exchange information and experience related to communication with the public and to carry out related studies. The mandate of the Working Group on Public Communication of Nuclear Regulatory Organisations (WGPC), as revised in 2005, includes

the preparation of reports addressing developments, tools, procedures and achievements in the area of nuclear regulatory communication with the public and stakeholders.

The group's main activity in 2007 was the organisation of a workshop on the Transparency of Regulatory Activities, which was held in Japan in May. This workshop attracted communicators and technical staff of the nuclear regulatory organisations together with a number of top regulators. The workshop addressed the understanding of transparency; stakeholders' expectations regarding transparency; the conditions for ensuring the transparency of regulatory activities; changes in regulatory practices for ensuring transparency; and methods for evaluating transparency.

Committee on the Safety of Nuclear Installations (CSNI)

The CSNI contributes to maintaining a high level of safety performance and safety competence by identifying emerging safety issues through the analysis of operating experience and research results, contributing to their resolution and, when needed, establishing international research projects.

Analysis and management of accidents

Regarding the analysis and management of accidents, work in this area has primarily focused on the thermal-hydraulics of the reactor coolant system; in-vessel behaviour of degraded cores; containment behaviour and protection; computational fluid dynamics (CFD); and fission product release, transport, deposition and retention. According to CSNI recommendations, in the future additional efforts will be made in other areas, notably as related to new and advanced reactors.

The main objective regarding thermal-hydraulics of the reactor coolant system and related safety and auxiliary systems is to improve and to expand the application of

best-estimate codes in nuclear power plant safety and design evaluations, including uncertainty evaluations. During 2007, further progress was made on the uncertainty and sensitivity evaluation of best-estimate methods (BEMUSE). Following an assessment based on calculations from an integral test, work continued on an analysis of a commercially operating nuclear power plant. This work will be completed during 2008.

Activities in the area of CFD code utilisation include best practice guidelines, completed in 2006, a CFD code assessment and validation database for single-phase applications in the area of nuclear reactor safety, completed in 2007, and multi-phase applications, which will be completed in 2008. A pilot project to keep the CFD code assessment database up-to-date using a web-based portal will start in 2008. Preparations have also begun to hold a second workshop on validation and benchmarking of CFD codes for application to nuclear reactor safety. This workshop, to be held in September 2008, will focus on multi-phase applications.

The International Standard Problem (ISP) No. 47 on predictability of containment atmosphere was completed in 2007. Work continues on in-vessel behaviour of degraded cores, including the preparation of a report on predicting in-vessel accident progression (covering beyond-design-basis accident code capabilities), a state-of-the-art

report on in-containment behaviour of aerosols and the containment code validation matrix.

Regarding the transfer of knowledge to young engineers and scientists, the organisation of two courses is under way: one on severe accidents, to be held in co-operation with the Severe Accident Research Network (SARNET) in Hungary in April 2008, and one in the area of thermal-hydraulics, to be held in Italy in May 2008.

Ageing and structural integrity of reactor components

The main topics investigated in this area include the integrity of metal components, the integrity of concrete structures and the seismic behaviour of structures and components. Maintenance, in-service inspections and the testing of structures, systems and components important to safety need to be of such a standard and frequency as to ensure that levels of reliability and effectiveness remain in accordance with the design assumptions. The concept of risk-informed, in-service inspection (RI-ISI) has been successfully implemented in several NEA countries and is now, along with non-destructive testing qualification, providing improved in-service inspection, reducing both plant risks and inspection personnel's exposure to radiation.

Current activities in this area include a benchmark on risk-informed, in-service inspection methodologies (RISMET), a synthesis report concerning the ageing of nuclear power plant concrete containment structures, and a joint IAEA/NEA survey of nuclear facilities that have experienced an earthquake. During 2007, work was also carried out on finalising the second phase of the Probabilistic Structural Integrity of a PWR Reactor Pressure Vessel Benchmark (PROSIR), and preparing PROSIR phase 3 on probability of crack arrest.

During 2007, preparations began for a workshop on recent findings and developments in Probabilistic Seismic Hazard Assessment Methodologies and Applications, to be held in April 2008 in France. Preparatory work was also undertaken in 2007 to organise an NEA/JRC Workshop on Risk-informed Piping Integrity Management, aimed at discussing the final results of RISMET and the applications and uses of the OPDE database (see page 33 for further details on the OPDE Project). This workshop will take place in June 2008 in Spain.

Similarly, progress was made in organising a workshop on ageing management of thick-walled concrete structures, which will address in-service inspection, maintenance and repair as well as instrumentation, methods and safety assessment in view of long-term plant operation. The workshop will be held in October 2008 in the Czech Republic.

A second expert meeting was held in 2007 to pursue discussions on the establishment of a co-operative research project on ex-plant materials from the José Cabrera nuclear power plant. The project is intended to focus on assessing properties of extended operation and in-plant irradiated materials from the José Cabrera reactor vessel core internals.

Risk assessment

The main mission of the Working Group on Risk Assessment (WGRISK) is to advance the understanding and utilisation of probabilistic safety assessment (PSA) as a tool to support decision making in member countries on matters related to nuclear safety. While PSA has matured greatly over the past decades, further work is still required to refine methods and to apply PSA methodology to new areas.

Current tasks include establishing a framework for human reliability data exchange; analysing the uses and developments of PSA in member countries; preparing a technical note on the use of risk information in the regulatory process; and writing a technical opinion paper on level-2 PSA and severe accident management.

The group has begun work on PSA of off-site external hazards other than earthquakes, where the focus is on off-site external events, including floods. PSA in several member countries indicates that external off-site events such as extreme weather conditions or high temperatures are important risk contributors. In addition, work has begun on the status of, and experience with, the technical basis and use of probabilistic risk criteria.

Based on a CSNI request, the group also initiated discussions on current experience with reliability modelling and qualifications of digital systems in the context of PSA applications. A meeting was held on this subject in October. The group launched an activity aimed at creating an information base and preparing a state-of-the-art report on risk analysis methods for addressing low-power and shut-down practices.

Fuel safety

The Working Group on Fuel Safety (WGFS) addresses the systematic assessment of the technical basis for current safety criteria and their applicability to high burn-up, as well as to the new fuel designs and materials being introduced in nuclear power plants. The main focus of the group remains on reviewing data from reactivity-induced accident (RIA) and loss-of-coolant accident (LOCA) experiments, and assessing how these data affect fuel safety criteria, in particular at increasing burn-up, notably because these two design basis accidents and the establishment of their safety limits continue to be the centre of regulatory attention.

The WGFS is continuing its work to update the 1986 CSNI state-of-the-art report on RIA and LOCA, although this time the two issues will be separated into two reports. Final drafts of these reports were prepared in 2007 and will be submitted to the CSNI for approval in 2008.

The adequacy of existing fuel performance codes for the simulation of high burn-up fuel behaviour under accident conditions was assessed by benchmarking against an irradiated LOCA test performed at the Halden reactor. The benchmark was successfully completed in 2006 and showed that further effort was needed to better model and validate high burn-up phenomena. It was therefore decided to continue the benchmarking with two additional Halden LOCA tests, in co-operation with the Halden



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Inspecting a new fuel shipment at the Brunswick nuclear power plant.

Reactor Project (see page 28), to address in particular the effects from ballooning and related fuel blockage. Ongoing national and international fuel safety research programmes are expected to provide additional experimental data on irradiated fuel claddings for further code assessment and improvement.

Human and organisational factors

The Working Group on Human and Organisational Factors (WGHOF) constitutes a unique international forum for addressing safety management, human and organisational factors, and human performance in nuclear facilities. A technical opinion paper about human factors in nuclear power plant modifications was finalised in 2007, with publication foreseen early in 2008. Other activities include writing technical opinion papers about human performance issues in the safety of nuclear power plant maintenance, and about the role of human factors in advanced control room developments. A workshop on Maintaining Oversight of Licensee Safety Culture – Methods and Approaches was organised in co-operation with the CNRA, the IAEA and WANO in May in the United Kingdom.

Fuel cycle safety

The Working Group on Fuel Cycle Safety (WGFCS) brings together regulatory and industry specialists to address a broad range of interests, including safety assessments, nuclear criticality safety, probabilistic safety assessment, safety management, decommissioning and site remediation, fire protection and human factors.

The joint NEA/IAEA Fuel Incident Notification and Analysis System (FINAS) is the only international system providing regulators and government bodies with information about lessons learnt from safety-significant events at fuel cycle facilities. The introduction of the new, web-based FINAS has suffered some delays, but is expected to be operational in 2008.

A successful international workshop was held in October, addressing the questions of how to ensure the safety of current and new fuel cycle facilities, legacy waste concerns (including facilities and waste), the reprocessing of nuclear fuel and the recycling of waste. The workshop also addressed potential future issues based on preliminary results of the survey conducted on fuel cycle safety issues such as fires, human factors and ageing in relation to fuel cycle safety.

Integrated assessment of safety margins

Factors such as ongoing power uprates, longer operating cycles, new fuel designs and increased fuel burn-up, combined with plant ageing and plant life extension require a comprehensive, integrated assessment in order to evaluate their potential cumulative safety impact. An extensive Action Plan on Integrated Assessment of Safety Margins (SMAP) began in 2004, aiming to develop a methodology for the assessment of synergistic safety margin reductions. The Action Plan's Final Report, presenting the methodology with two examples of application, was approved by the CSNI in June 2007. At that time, the CSNI agreed to test the methodology, beginning in 2008, by evaluating the change in safety margins which would result from implementing the newly proposed US NRC rules on performing LOCA analyses. Overall, it is intended that the methodology will be able to be used to quantify the change in margins due to combinations of plant modifications occurring together, as well as in support of setting safety limits for advanced reactor designs.

Research facilities for existing and advanced reactors

Following several years of work on the subject, in December the CSNI adopted a Collective Statement on the Support Facilities for Existing and Advanced Reactors. The statement places particular emphasis on CSNI experience in acting as an efficient co-ordinator of international reactor safety research projects involving both regulators and industry, and on preparing for the next generation of reactors.

A joint CSNI/CNRA workshop was held in France in December on the Role of Research in a Regulatory Context (RRRC-2). The workshop concluded that the CSNI should define a long-term strategy and approach for joint efforts aiming at developing infrastructure for advanced reactors (Generation IV). In particular, it was agreed that the CSNI should identify the key safety and risk issues and the data needs for specific Generation IV design concepts, or the infrastructure needs for producing the required data, and the role of the regulator, industry and R&D institutions in the development of such infrastructure.

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