

# Nuclear Safety and Regulation

## Highlights

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- The CSNI and the CNRA have prepared and approved their respective Operating Plans, which develop the main challenges identified by the Joint CSNI/CNRA Strategic Plan into specific activities within the programme of work of the committees. The Operating Plans will provide a very useful tool to assign priorities and to ensure efficiency and adequate supervision of the committees' activities.
- Both committees organised several workshops, most notable were those on Improving Nuclear Safety Through Operational Experience Feedback; Regulatory Inspection Practices; Seismic Probabilistic Safety Assessment of Nuclear Facilities; and Benchmarking of CFD Codes for Application to Nuclear Reactor Safety.
- Knowledge management has become a growing concern in many countries, and both safety committees agreed to participate in an NEA pilot project on boron dilution, which will provide the key elements for the establishment of an NEA policy on data preservation and information access.
- In 2006 two new multilateral "Joint Projects" were started on fire safety assessment (PRISME) and on ageing issues (SCAP). See page 28 for further details on these and other joint projects under way. One project was completed (MASCA-2).

## 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.

In 2006, a report was published on *Regulatory Challenges in Using Nuclear Operating Experience*. The report focuses on how regulatory bodies can ensure that operating experience is used effectively to promote the safety of nuclear power plants.

The Working Group on Operating Experience organised a major conference on operating experience feedback in May. Senior regulators and researchers along with managers and technical-level experts discussed ways to improve nuclear safety through operating experience feedback and developed a number of recommendations.

Several issues are currently being studied by the working group, including the safety analysis of fire operating events, loss of heat sink events and international networks for nuclear facility operating experience feedback.

## The regulatory goal of ensuring nuclear safety

A senior-level task group was set up to address the fundamental question, "How can the regulator judge whether its actions are actually ensuring an acceptable level of safety at nuclear facilities?" The group's findings will be published.

Preparations also began for an NEA forum which will be held in June 2007 and involve top-level participants from regulatory authorities and government agencies, nuclear industry leaders and other stakeholders. The forum will examine how regulatory bodies can systematically collect and analyse all of the safety-related information available to arrive at an integrated judgement on the acceptability of the level of safety of the nuclear facilities that they regulate. The forum will seek regulatory body perspectives, industry perspectives, governmental perspectives and other stakeholder perspectives on this question.

### 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 internal report was completed on inspection efforts. The basis for this work was to study more in-depth how much effort member countries expend on nuclear regulatory inspections. Sharing this information could help the regulatory bodies in NEA member countries to better understand the effort required to support the different

inspection approaches and to consider opportunities for improving the effectiveness of their regulatory strategies.

The 8<sup>th</sup> International Workshop on Nuclear Regulatory Inspection Activities was held in May and hosted by the Canadian Nuclear Safety Commission. Topics addressed included how regulatory inspections can promote, or not promote, good safety culture, interactions between the licensee and its contractors, and future challenges for inspectors.

Other issues being studied by the working group include regulatory inspection philosophy, inspection organisation and inspection practices, inspection of fire protection systems and digital instrumentation and control (I&C) inspections.

## Nuclear regulators and the public

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. Two such reports were issued in 2006 which address the challenges associated with public communication during abnormal situations and with the publicity given to regulatory decisions.

The group's main activity in 2006 was the preparation of a workshop on the Transparency of Regulatory Activities, to be held in Japan in May 2007. This workshop will bring together communicators and technical staff of the nuclear regulatory organisations and senior regulators. The workshop includes five topical sessions: Understanding transparency; Stakeholders' expectations regarding transparency; Conditions for ensuring the transparency of regulatory activities; Changing 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

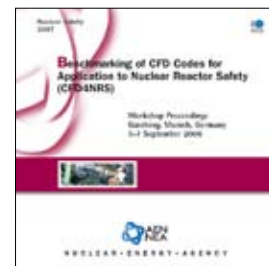
Current CSNI activities on the analysis and management of accidents primarily concern the thermal-hydraulics of the reactor coolant system and related safety and auxiliary systems; in-vessel behaviour of degraded cores and in-vessel protection; containment behaviour and containment protection; and fission product release, transport, deposition and retention. According to CSNI recommendations, additional efforts will need to be made in other areas, notably in the fire safety area.

The main objective regarding thermal-hydraulics of the reactor coolant system and related safety and auxiliary systems is to improve and expand the application of best-estimate codes, including uncertainty analysis, in nuclear power plant safety and design evaluations. During 2006, progress was made on the quantification and application of best-estimate methods including uncertainty and sensitivity (BEMUSE). The study addresses thermal-hydraulic, best-estimate calculations from an integral test

facility with a nuclear core (Phases 2 and 3) and is planned to continue for a nuclear power plant (Phases 4 and 5) in 2007-2008.

Activities in the area of computerised fluid dynamics (CFD) code utilisation include best practice guidelines, completed in 2006, and multi-phase applications, most of which will be completed in 2007. For CFD codes nodalisation is still a challenge and there is a lack of good experimental data suitable for two-phase code validation.

A workshop on Benchmarking of CFD Codes for Application to Nuclear Reactor Safety was held in September. Clear recommendations were made at the workshop relating to best-practice guidelines, experimental data and measurement uncertainties, and interaction with experimenters involved in producing data. The workshop proceedings will be released on CD-ROM and the NEA website in the beginning of 2007. Also soon to be released are the recommendations from the workshop on evaluation of uncertainties in relation to probabilistic safety assessment (PSA).



Work continued on in-vessel behaviour of degraded cores, notably the report on predicting in-vessel accident progression, covering beyond-design-basis accident code capabilities, the state-of-the-art report on in-containment behaviour of aerosols, the International Standard Problem (ISP) 47 on predictability of containment atmosphere, and the containment code validation matrix. The status report on iodine chemistry was completed.

## Ageing and structural integrity of reactor components

The main topics investigated in this area include metal components, concrete structures, and the seismic behaviour of structures and components. Maintenance, in-service inspection and 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 radiation exposure to inspection personnel.

Current activities in this area include a benchmark on risk-informed, in-service inspections methodologies (RISMET), a synthesis report concerning the ageing of nuclear power plant concrete containment structures, and a joint IAEA/NEA survey on nuclear facilities that have experienced an earthquake. During 2006, work was also carried out on the Probabilistic Structural Integrity of a PWR Reactor Pressure Vessel Benchmark (PROSIR). The reports on Differences in approach between nuclear and conventional seismic standards with regard to hazard definition and on the Survey of primary water stress corrosion cracking (PWSCC) in Ni-based alloys were approved for release.

A workshop on Structural Reliability Evaluation and Mechanical Probabilistic Approaches of NPP Components was organised in September in France. Workshop recommendations pruned the continuing use of mechanical probabilistic approaches since they give more information than deterministic evaluations and constitute an essential tool for highlighting effects of uncertainties surrounding the deterministic criteria for structural integrity of safety-class components.

An expert meeting was held to discuss the Spanish proposal to set up a co-operative research project on ex-plant materials from the José Cabrera nuclear power plant. The project aims 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; organising an international experts' meeting in the area of seismic PSA; work on using risk information in the regulatory process; and writing a technical opinion paper on recent developments in level-2 PSA.

A specialist meeting was organised on the Seismic Probabilistic Safety Assessment of Nuclear Facilities in

November in the Republic of Korea. The meeting resulted in a new set of findings and recommendations to guide future national and international work on effective ways of using seismic PSA. The group also started to work on PSA of off-site external hazards other than earthquakes, where the focus is on off-site external events, including (external) 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.

## 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. A concise review of existing data resulting from reactivity-induced accident (RIA) and loss-of-coolant accident (LOCA) experiments was carried out. The group also assessed how these data affect fuel safety criteria at increasing burn-up.

In 2006, the WGFS continued to review the adequacy of existing codes for the simulation of high burn-up fuel behaviour under accident conditions. A benchmark for the Halden irradiated LOCA test was organised in co-operation with the OECD Halden Reactor Project. The benchmark showed that further effort is needed to better model and validate high burn-up phenomena as related to internal pressure; transient fission gas release; collapse of the fuel column after ballooning of the cladding; oxidation and related hydriding; ballooning and related fuel blockage. The experimental database on actual irradiated fuel claddings requires additional data. Ongoing national and international fuel safety research programmes are expected to fill the existing gaps.

A meeting was organised in Paris to review the status of LOCA analyses and tests as well as plans for future activities. The meeting addressed the current development of burn-up dependent LOCA criteria and aimed to identify areas where data might be needed.

The Review of High Burn-up and LOCA Database and Criteria was issued as a CSNI report. The Technical Note on LOCA Fuel Cladding Test Methodology was completed.

## Human and organisational factors

The Working Group on Human and Organisational Factors (WGHO) constitutes a unique international forum for addressing safety management, human and organisational factors, and human performance in nuclear facilities. Current activities include writing technical opinion papers about human performance in the safety of NPP maintenance and about the role of human factors in NPP modifications. An activity on maintaining oversight of licensee safety culture and the technical bases for philosophies, methods and approaches was started in 2006 to accommodate a request from the CNRA, including the organisation of a workshop in 2007. A workshop on future control room designs and human performance issues and work practices was organised in Norway in May.

## 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 new web-based FINAS is scheduled to go into operation early in 2007.

Planning continued on an international workshop to be held in October 2007 which will address 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 will also address potential future issues based on preliminary results of the survey on fuel cycle safety issues such as fire, 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 methodology derived can be used to quantify the change in margins due to combinations of plant modifications occurring together. It could also be used as support for setting safety limits for advanced reactor designs. The Action Plan and the Final Guidance document are expected to be completed early in 2007.

## Research facilities for existing and advanced reactors

Following a CSNI recommendation, a group of senior research managers was constituted with the aim of providing the necessary input and elaborating elements of strategy for maintaining key safety research facilities and possibly expanding their use. Its main task was to revise an earlier CSNI report on the subject, and to address a number of technical disciplines and related facilities, aiming to define priorities for possible joint international initiatives or programmes in the future. Extensive consultations and report revisions took place during 2005 and 2006, including consultation with industry. The final report was completed and approved in June.

The report concludes that the CSNI should adopt a strategy for preserving a research facility infrastructure for the long term (past 2008), based on maintaining unique, versatile and hard-to-replace facilities. These facilities are identified in the Executive Summary of the report. Factors to be considered for initiatives include:

facility operating and replacement cost; ability to define a useful programme; industry participation; and host-country commitment. In the thermal-hydraulics area, the report recommends in the short term to support a co-operative research programme at the PANDA facility. It should be noted that CSNI actions stemming from an earlier report played a major role in the preservation of the PANDA facility over the past five years. Regarding severe accidents, facilities supporting the resolution of pre-core melt conditions, combustible gas control and coolability of overheated cores are in danger in the short term. The report recommends that action be taken to preserve the MISTRA facility in light of its 3-D containment simulation and instrumentation capabilities. The CSNI will be following up the report by defining the Committee's responsibilities in the long-term strategy and the implementation of the long-term recommendations.

## Industry participation in CSNI activities

Both the NEA Strategic Plan and the Joint CNRA/CSNI Strategic Plan recognise the importance of co-operation with industry, including in the area of nuclear safety. Following a CSNI debate on the subject, it was concluded that the benefits of co-operation include a better understanding of the technical issues, a pooling of expertise and improved programme design in terms of access to information and greater confidence that the focus of research will be realistic and practical. The debate also found that, while maintaining and encouraging adequate co-operation with industry:

- The regulator should maintain independence and, at all times, be able to demonstrate its independence.
- There is a long tradition of industry participation in joint research projects in several countries, especially in projects devised to address operational issues. For generic, long-term issues, public funding is perhaps more appropriate.
- There should be a gradual approach to industry participation, where co-operation first occurs in joint projects and in working group activities. Industry involvement in working groups would also facilitate industry participation in new joint projects as they are first discussed in the pertinent working group.
- CSNI work on high burn-up fuel is a good example of industry involvement with positive results. In a research framework where both plant safety and efficiency are addressed, industry participation will occur naturally.

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