

# Nuclear Safety and Regulation

## 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.*

### 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 subjects of recent IRS topical studies have included electrical disturbances, maintenance issues, material degradation and the issue of how to close the operating experience feedback loop. A new study on refuelling events will soon be undertaken. Apart from these topics, there is continuing concern over the decrease in focus and resources for operating experience activities worldwide, despite stated priorities to the contrary, and the IRS community has taken initiatives to reverse the trend.

The CSNI Working Group on Operating Experience (WGOE), playing an active role in the IRS system, has continued its work to communicate lessons learnt from NPP operating experience to the nuclear safety community, notably in the form of annual technical notes about lessons learnt from recent events. In 2004, the group also continued to focus on recurring events by launching a study on corrective actions against loss of residual heat removal during outages. In addition, the group examined safety-significant events caused by modifications that were initially considered as minor; events caused by contractors; and national processes to analyse and disseminate operating experience. Furthermore, a joint CSNI/CNRA task force held a workshop in Granada, Spain on regulatory uses of safety performance indicators. Another workshop was held together with the Working Group on the Analysis and Management of Accidents (GAMA) on debris impact on sump strainer clogging in Albuquerque, New Mexico, USA.

### Analysis and management of accidents

Several CSNI activities in the area of safety assessment and research continue to relate to the analysis and management of accidents. Such work primarily concerns 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.

In the area of thermal-hydraulics, the main objective is to improve and expand the application of best-estimate codes in nuclear power plant safety and design evaluations, including

uncertainty analysis. This also involves the coupling of current thermal-hydraulic system codes with codes in the areas of 3-D neutronics, structure mechanics, computational fluid dynamics (CFD) codes, and the application of these codes to nuclear safety. Extensive reporting on the outcome of these activities took place in 2004, and action plans were implemented. A seminar on the transfer of knowledge generated in CSNI activities in the thermal-hydraulics area (THICKET seminar) was held in June 2004. The seminar was hosted by the French Institute for Radiological Protection and Nuclear Safety (IRSN).

Regarding in-vessel behaviour of degraded cores, after publication of the results of the International Standard Problem on the PHEBUS FPT-1 experiment (ISP-46), a new report has been completed on the progress made on the TMI-2 accident analyses. The report concludes that processes such as in-vessel natural circulation, heat transfer and oxidation during reflooding, melt progression, and behaviour of debris in the reactor lower plenum, need to be treated more accurately in computer codes.

The ISP-47 exercise, based on experiments performed in the TOSQAN, MISTRA and ThAI facilities, remains the main activity in relation to containment behaviour. The objective is to demonstrate the capability of lumped-parameter codes on containment thermal-hydraulics under accident conditions. The work involving the TOSQAN and MISTRA data was completed in 2004 and reporting is in progress. The analysis of the ThAI results is being carried out.

As regards fission product release, transport, deposition and retention, the CSNI approved publication of the ISP-41 (code comparison against CAIMAN and RTF tests). A state-of-the-art report on nuclear aerosols and a status report on iodine chemistry are being prepared.

The Co-ordinated Programme on Steam Explosion Resolution for Nuclear Applications (SERENA) took new steps in 2004 in the assessment of code prediction for selected steam explosion tests and for reactor cases. The latter involved the calculation of loadings on the vessel and/or cavity structure arising from fuel/coolant interaction. The report on these activities is due for completion in mid-2005. The report will contain recommendations as to which improvements need to be made as well as on the possible need for additional experimental work.

In conjunction with the WGOE, a workshop was held in Albuquerque, New Mexico (USA) aimed at reviewing the state of knowledge on the impact of sump clogging on emergency water coolant recirculation capability following a loss-of-coolant accident (LOCA).

- The CNRA and the CSNI, recognising the many common areas of interest, the close interrelationship between the work of the two committees and the need for close co-ordination and co-operation between them, decided to develop a joint CSNI/CNRA strategic plan for 2005-2009.
- The CSNI and the CNRA organised a number of workshops, most notable were the workshops on the regulatory uses of performance indicators, and building, measuring and improving public confidence; the conference on fatigue of reactor components; and the forum on technical support services and contractors.
- In 2004 two new projects, one on PWR thermal-hydraulics – the PKL Project – and one on fuel integrity – the SCIP Project – were started. A number of technical proposals for new NEA joint projects were set forth and discussed during the year.

## Integrated assessment of safety margins

Such factors 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 has been ongoing since 2002, aimed at developing a methodology for assessment of synergistic safety margin reductions. As a first step, a generalised safety margin concept is being elaborated by an ad hoc group of experts. Once agreed upon, a set of metrics will be defined for quantitative assessment of both the global safety margin and its partial components. The Action Plan is due to be completed by 2006.

## Ageing and structural integrity of reactors

The main topics investigated in this area include metal components, concrete structures, seismic behaviour of structures and components and the ageing of wire systems. Four workshops were held and seven reports issued.

Lifetime management remained a key topic for the Working Group on Integrity of Components and Structures (IAGE). Risk-informed in-service inspection methodologies were reviewed in a workshop that gathered key experts and identified several activities with both research and regulatory implications. Activities on fatigue and thermal fatigue were pursued with the organisation in October 2004 of the third International Conference on Fatigue of Reactor Components, in co-operation with the Electric Power Research Institute (EPRI) and the US Nuclear Regulatory Commission (NRC). Reactor pressure vessel integrity was addressed through a benchmark on probabilistic structural integrity methods.

An extensive and educative report on concrete containment integrity addressing instrumentation and monitoring, in-service inspection techniques, response of degraded structures, repair methods and condition assessment was completed. Work on the International Standard Problem on Containment Capacity (ISP-48) continued, and is aiming to provide consensus on containment calculation methods in early 2005. A workshop on the use and performance of concrete in nuclear power plant and fuel cycle facilities provided insights into structural and regulatory issues of interest to the CSNI and the CNRA, as well as the NEA Radioactive Waste Management Committee.

A review of large testing facilities for nuclear power plant seismic design in NEA member countries showed that a suffi-

cient number and array of large testing capabilities were available worldwide. Methods to calculate seismic input motions for nuclear power plants and related uncertainties continued to be explored through close co-operation with geologists and seismologists.

## 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) in ensuring the continued safety of nuclear installations in member countries. While PSA has matured greatly over the past years, further work is still required. WGRisk has been active in several areas, including developing a framework for information exchange on human reliability and software reliability. The working group collaborates with other CSNI working groups in the areas of operational experience, human factors and accident management, with other NEA standing technical committees on regulation and radiation protection, and closely co-ordinates its work with other international organisations.

Two workshops were held during the year. The first examined the state of the art in Level 2 PSA and Severe Accident Management, and the second addressed PSA for Non-reactor Nuclear Facilities. Technical opinion papers were finalised for publication on PSA-based event analysis; the development and use of risk monitors; and living PSA. Workshops on Fire PSA and Uncertainties are being planned. Work continues on the use of risk information in the regulatory process, and incorporating ageing effects into PSA applications.

## Fuel safety margins

In 2004, the NEA Special Expert Group on Fuel Safety Margins (SEGFSM) continued 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 Topical Meeting on LOCA Fuel Issues was organised in close co-operation with the US NRC at Argonne National Laboratory in May. It focused on the 17% cladding oxidation criterion and its applicability to high burn-up fuel and new cladding materials. The meeting showed that based on realistic, best-estimate safety analyses, safety margins are adequate in terms of existing acceptance criteria. Nonetheless, 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 pellet 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.

### Human and organisational factors

Activities of the Special Expert Group on Human and Organisational Factors (SEGHOF) included a report on systematic methods for safety management; a report on human factors in NPP modifications; investigation into the improvement of NPP maintenance safety by inclusion of human and organisational factors; and the organisation of a session on managing change at the NEA workshop on Safe, Efficient and Cost-effective Decommissioning. A new task was also started on human performance in advanced control rooms.

During the year, a technical opinion paper on managing and regulating organisational change was published. Among the conclusions of that publication were that organisational change has the potential to impact upon nuclear safety in an irreversible way; as such, both the licensee and the regulator need to adopt formal positions on the issue. The approach for managing organisational change should be comparable to the system for managing plant and equipment modifications, and should encourage self-assessment. Consequently, organisational change proposals need to be subject to suitable levels of regulatory scrutiny. Of course, the regulator also needs to be aware of the potential for its actions to restrict the licensee's freedom to manage its own organisation. Particular attention needs to be given to the steps that the licensee has to take to ensure that it retains effective control of its

operations, and that it maintains sufficient knowledge independently of the arrangement chosen.

### Fuel cycle safety

A new edition of the publication on *The Safety of the Nuclear Fuel Cycle* was finalised in 2004. Previous editions dated from 1981 and 1993. This new edition provides an updated analysis of the safety aspects of the nuclear fuel cycle. It addresses the safety and technical aspects of fuel cycle operations and supplies information on operating practices. The past decade has seen a number of changes in technical and policy areas, in nuclear power generation and in the associated fuel cycle. No significant event resulted from the operation and maintenance of industrial-scale facilities, although some significant events occurred in areas outside industrial-scale electricity generation. This shows that the fuel cycle industry has now reached full maturity, and that nuclear safety is adequately mastered.

### 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. The group is to revise an earlier CSNI report on the subject, and will address a number of technical disciplines and related facilities, aiming to define priorities for possible joint international initiatives or programmes in the future. The group met twice in 2004 and produced a preliminary report. Extensive consultations – including with industry – as well as report revisions are foreseen during 2005. The report is due for completion in mid-2006.

## 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 the shrinking nuclear infrastructure, increased public expectations concerning safety in the use of nuclear energy, industry initiatives to improve economics and safety performance in the production of nuclear power, the necessity to ensure safety over a plant's entire life cycle, and new reactors and technology.*

### Regulatory decision making

It has been recognised for some years that the nature of the relationship between the regulatory body and the operator can influence the operator's safety culture at a plant, either positively or negatively. An important factor affecting the relationship between the regulator and the operator is the nature of the regulator's decision-making process. It was in this light that the CNRA decided to examine the broad issue of regulatory decision making.

The report on this subject presents some basic principles and criteria that a regulatory body should consider in making decisions and describes the elements of an integrated framework for

making regulatory decisions. It is not a handbook or guide on how to make regulatory decisions. Each country's laws, customs and administrative processes are unique, and the range of circumstances potentially facing a regulatory body is so great that a handbook approach is simply not practical.

The report recalls that the fundamental objective of all nuclear safety regulatory bodies is to ensure that nuclear utilities operate their plants in an acceptably safe manner at all times. In order to meet this objective, the regulatory body should strive to ensure that its regulatory decisions are technically sound, consistent from case to case, and timely. In addition, the regulator must be aware that its decisions and the circumstances surrounding those

decisions can affect how its stakeholders, such as government policy makers, the industry it regulates, and the public, view it as an effective and credible regulator. In order to maintain the confidence of those stakeholders, the regulator should make sure that its decisions are transparent, have a clear basis in law and regulations, and are seen by impartial observers to be fair to all parties.

Although the report stresses the importance of the regulatory body having a structured decision-making process, one must remember that it cannot substitute for the experience and judgement of the senior managers in a regulatory body gained over many years in facing diverse situations and making regulatory decisions. Likewise, the decision-making framework should not be so rigid that it does not allow room for individual judgement and discretion on the part of inspectors and managers in making regulatory decisions. In approving the report, which will be published early in 2005, the CNRA noted that it will provide excellent training to new persons entering the nuclear field, whether in a regulatory body or a licensee organisation.

### Nuclear regulators and the public

Transparency is one of the keys to the public acceptance of nuclear energy uses. The workshop on Building, Measuring and Improving Public Confidence in the Nuclear Regulator, held on 18-20 May 2004 in Ottawa, Canada, was organised under CNRA auspices in collaboration with the Canadian Nuclear Safety Commission (CNSC). The objective of the workshop was to provide nuclear regulatory bodies with the opportunity to share information, practices and experience, and to discuss developments, progress and techniques in the area of nuclear regulatory communication with the public.

The workshop showed that cultural differences between countries prevented similar means for communication being effective in all countries. It was also clear that in some countries, the regulators can achieve public confidence more easily than in others. An important factor is general public trust in the government and its representatives. A number of common principles for successful nuclear regulation were nevertheless identified, such as high priority being given to building and maintaining public confidence, and the need to keep an adequate distance from the licensees when communicating with the general public. The NEA Working Group on Public Communication will use the findings from this meeting to continue to assist its members on related matters of regulatory transparency.

### Regulatory inspection practices

Inspectors from regulatory bodies meet periodically to exchange information and experience related to regulatory safety inspections processes, discuss commendable inspection practices and carry out related studies. A report was issued on regulatory inspection practices used to bring about compliance. A seventh international workshop was organised in this area, providing inspectors with an opportunity to discuss inspection activities related to risk-informed inspections, inspections of plants at or near end-of-life, and inspections of licensee organisation performance.

In addition, several issues are currently being studied by the working group, including inspection of site selection, pre-

construction and construction; inspection efforts; and updating the report on regulatory inspection philosophy, inspection organisation and inspection practices. Plans were started for the eighth international workshop, which will take place in 2006 and cover the following issues: how regulatory inspections can promote, or not promote, good safety culture; inspection of interactions between the licensee and its contractors; and future challenges for inspectors (new techniques, developing competence, etc.).

### Safety of technical support services and contractors

The licensee's ability to maintain control over the nuclear safety aspects of technical support services and contracted work represents a safety concern that cuts across the spectrum of contracting activities. This ability was identified as a topic for which an international exchange of views and experience could bring useful insights to operators and regulators. The regulatory community considered it worthwhile to identify commendable means used by the operators to maintain such control, as well as the type of regulatory oversight (e.g. inspections, assessment, etc.) that allows the regulator to gain assurance of the adequacy of such controls. Recognising the importance of these concerns, the CNRA decided to hold an international forum on this subject in June 2004. Heads of nuclear regulatory authorities were brought together with executives from the nuclear industry to exchange perspectives and experience.

Participants examined three key areas of interest: the overall environment, the licensees' responsibilities and the regulators' responsibilities. Regarding the environment, it became clear that while fewer key suppliers of nuclear components exist, many small expert contractors are available and sufficient competition continues. It is also clear that the use of contractors will continue – what is important is to recognise what work they do and how. Participants reaffirmed that the licensee is always responsible for safety, and as such core activities such as control and supervision of operation, or quality assurance, cannot be contracted out. Further, in order to fulfil their responsibilities, licensees must be "smart buyers" and "intelligent customers". This requires good control, supervision and oversight of contractors' work. On the other side, the regulator needs to provide clear explanations of what is required to the highest management levels of the licensee or its parent organisation, and to closely follow the contractors' actions to ensure safety.

The forum's final panel derived a number of conclusions including: licensees need to develop strategies for dealing with diversified contractors who are becoming more global; regulators need to develop their practices for verifying adequate arrangements between licensees and contractors; and finally, there is a need to develop, with international guidance, a concrete description of what is meant by the statement "the licensee has full responsibility for the safety of the plant".

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