

# Nuclear Safety and Regulation

## Highlights

- The CNRA established a working group on new reactors in response to the new projects under way or planned in several member countries. The working group will constitute an international forum for exchanging information and experience, and for ensuring improvements in nuclear safety through more effective and efficient regulation.
- In 2008, the CNRA and the CSNI organised several workshops, most notable were those on regulatory inspection practices; experiments and computational fluid dynamics (CFD) code application to nuclear reactor safety; lessons learnt from containment sump clogging; risk-informed, in-service inspection methodologies (RISMET); probabilistic seismic hazard assessment methodologies and applications; risk-informed piping integrity management; ageing management of thick-walled concrete structures; and justifying the suitability of nuclear licensee organisational structure, resources and competencies.

## 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, inspection practices and the regulation of new reactors.

### 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) has focused its activities on follow-up by each member country of lessons learnt from important events. At the last meeting, three events were selected and the working group members reviewed their actions in response to these events. They also provided information on additional regulatory practices and methodologies being applied in the assessment and use of operating experience in order to define and to assess corrective measures in response to operational events.

The working group completed two reports, one on Safety Analysis of Fire Operating Experience, and another on National Operating Experience Feedback Programmes. Both reports were approved by the CNRA for publication.

### Regulation of new reactors

A new Working Group on the Regulation of New Reactors (WGRNR) was established. The group has been mandated to address regulatory activities in the areas of siting, licensing and oversight of new commercial nuclear power reactors (Generation III+ and Generation IV).

Given that the sharing of information about the licensing process, construction experience and inspection practices will be helpful to all countries, a construction experience database is being developed. The aim is to collect inspection findings during the construction of new nuclear power plants as well as during major modifications of existing plants, and to share the lessons learnt.

An activity was also initiated on the regulation of site selection and preparation aimed at reviewing the various practices used by regulators in the regulation of nuclear power plant siting. A survey was issued covering different aspects of the regulation of nuclear sites, including seismicity issues, security issues, multi-unit questions and regulator practices on sites where mixed activities are taking place (e.g. operating units, new construction, decommissioning, etc.).

### 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.

An international workshop on inspection-related activities was held in June in Finland. Nuclear inspectors met with experts to discuss methods to improve inspection programmes and to address the training and qualification of inspectors, the integration of inspection findings and the inspection of new plants under construction. The proceedings were approved by the CNRA and are being finalised for



publication. The group also completed a report on inspection of fire protection programmes.

### 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) 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 2008 consisted of issuing a report on the main outcomes of the three workshops held from 2000 to 2007, and of establishing an operating plan for its activities in the coming years. Future reports from the WGPC will address: the transparency of regulatory activities, local public information, the use of public perception surveys and communication in emergency situations.

## 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 accidents and their management, ageing and structural integrity, fuel safety, contributors to risk and human factors. The committee also facilitates the establishment of international joint research projects when useful.

### Analysis and management of accidents

The activities of the Working Group on Analysis and Management of Accidents (WGAMA) have 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.

During 2008, 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 commercial nuclear power plant.

Activities in the area of CFD two-phase applications were completed in 2008. A pilot project to keep the CFD code assessment database up-to-date using a web-based portal started in 2008. The second workshop on validation and benchmarking of CFD codes for application to nuclear reactor safety was held in September, focusing on new experimental techniques and two-phase CFD applications.

Work continued on in-vessel behaviour of degraded cores; a report on predicting in-vessel accident progression (covering beyond-design-basis accident code capabilities) was completed. A state-of-the-art report on in-containment behaviour of aerosols was completed and is being published.

An activity on core exit temperature (CET) effectiveness in accident management was started. Discussions of the task group focused on a review of the design basis of CET application to accident management procedures in different countries and a review of relevant experimental results.

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

During 2008, the CSNI requested that an experts meeting be held to discuss the technical content of a new project on fuel overheating of spent fuel assemblies in storage ponds, subsequent to water loss. The discussion was very fruitful and led to the establishment of a new joint project to be carried out by the USNRC at the Sandia National Laboratory in the United States, with 12 countries participating.

### Ageing and structural integrity of reactor components

The main topics investigated in this area by the Working Group on Integrity of Components and Structures (IAGE) include the integrity of metal components, the integrity of concrete structures and the seismic behaviour of structures and components. 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). During 2008, the final meeting of the RISMET project took place during which the main results and conclusions of the study were discussed. A synthesis report on the ageing of nuclear power plant concrete containment structures was issued. Work was also carried out on finalising the report on

the second phase of the Probabilistic Structural Integrity of a PWR Reactor Pressure Vessel Benchmark (PROSIR).

In addition, a workshop was held in April in France on recent findings and developments in probabilistic seismic hazard assessment methodologies and applications. To discuss the final results of RISMET and the applications and uses of the Piping Failure Data Exchange (OPDE) database, a workshop was organised in conjunction with the EC Joint Research Centre (JRC) in June in Spain on risk-informed piping integrity management. A workshop was also organised in October in the Czech Republic to review the state of the art on ageing management of thick-walled concrete structures, including in-service inspection, maintenance and repair as well as instrumentation, methods and safety assessment in view of long-term plant operation.



View of a pipe failure.

## 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 status and experience with the technical basis and use of probabilistic risk criteria for nuclear power plants in member countries; preparing a low-power and shutdown PSA information base; and analysing and preparing recommendations on methods and information sources for quantitative evaluation of digital system reliability.

The activity related to human reliability analysis was completed. The group completed work on PSA of off-site external hazards other than earthquakes, where the focus was 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 may be important risk contributors, depending on the specifics of plant design and location.

Following a CSNI request, the group is also carrying out discussions on current experience with reliability modelling and qualifications of digital systems in the context of PSA applications. A technical meeting was held in Paris in October.

## 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.

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. The final draft of the report on LOCAs was approved by the CSNI.

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. It was decided to continue the benchmarking with two additional Halden LOCA tests, in co-operation with the Halden Reactor Project, to address in particular the effects from ballooning and related fuel blockage. The benchmarking results were provided at the WGFS meeting in September. Most presentations indicated that further refinements would be made in order to enhance the prediction accuracy of the various codes.

## 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. Two technical opinion papers were finalised and one workshop was held in 2008.

A technical opinion paper about human performance issues in the safety of nuclear power plant maintenance, to be published early in 2009, states that human errors during maintenance and periodic tests are significant contributors to plant events. The key steps in securing reliable and effective maintenance are the development of an effective planning process, and the formalisation of the communication processes, in particular when contractors are used.

Another technical opinion paper also due to be published early in 2009 identifies a set of research topics that will enhance the state of knowledge related to human and organisational factors. Eight research topics (among them the role of automation and personnel, organisational factors and safety culture) were defined. The paper recommends that the international community, including regulators, vendors, research institutes and other interested parties, pursue a collaborative and co-ordinated approach to addressing these important research areas.

A workshop on justifying the suitability of nuclear licensee organisational structure, resources and competencies was organised in co-operation with the Swedish Radiation Safety Authority and the EC Joint Research Centre's Institute for Energy in September in Sweden. The objective was to identify and to compare methods and approaches that can be used to demonstrate that licensees have suitable organisational



Comanche Peak NPP, United States

Safety management and the human factor.

structures, resources and competencies to manage safety throughout the facility's life cycle.

### 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 was operational at the end of 2008. Steps still need to be taken to update facility information and to finalise revised coding and updating of a number of older reports.

The group is also addressing the management of ageing fuel cycle facilities. The main objective is to review the potential impact of ageing on the safety, regulation and operability of reprocessing and fuel fabrication facilities.

### Integrated assessment of safety margins

Factors such as 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. The Task Group on Safety Margin Applications and Assessment (SM2A) began testing methodology finalised in 2007 by evaluating the change in safety margins which would result from implementing the newly proposed USNRC 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, as well as in support of setting safety limits for advanced reactor designs. A base case, with

a hypothetical 10% power uprate applied to a commercial NPP, was considered.

### Defence in depth of electrical systems and grid interaction

The July 2006 Forsmark-1 event identified a number of design deficiencies related to electrical power supply to systems and components important to safety in nuclear power plants. In follow-up, the Task Group on Defence in Depth of Electrical Systems and Grid Interaction (DIDELSYS) was established with its mandate developed in line with the findings of a workshop on lessons learnt from the event.

The general objectives of the task group were to evaluate the robustness of existing safety-related electrical systems in nuclear power plants; the basic principles used to develop a robust safety-related electrical system in terms of critical design features, redundancy, diversity, and the use of proven technologies; methodologies used to demonstrate the robustness of safety-related electrical systems considering the definition of input transients, analytical approaches, defence-in-depth issues, simulation techniques, the use of computer codes, and the definition of safety margins; and the various modes of interaction between nuclear power plants and the electrical grid, and the command and control interface between operators of the electrical grid and nuclear power plants.

The task group is currently drafting the final technical report that will provide information on the state of the art regarding the robustness of safety-related electrical systems (SRES), taking into account their interaction with other electrical equipment, the use of new technologies and the problems encountered when the modernisation of existing plants is undertaken. It will also provide guidelines for improving communication and co-ordination among the grid operator, the nuclear safety authorities and the licensees.

### Research facilities for existing and advanced reactors

Following several years of work on the subject, a CSNI Collective Statement on Support Facilities for Existing and Advanced Reactors was published. 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 the industry, and on preparing for the next generation of reactors. Based on that, the CSNI established a task group to assess research needs in the medium term. The objectives, scope and schedule have been defined for the Task Group on Advanced Reactor Experimental Facilities (TAREF), which will focus on gas reactors and sodium fast reactors in a first phase.

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