

# 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, addressing in particular operational experience feedback, inspection practices, the regulation of new reactors and increased public expectations concerning safety in the use of nuclear energy.

### Highlights

- The CNRA and the CSNI have maintained their focus on the safety of existing plants, although activities have also been launched on new reactors and advanced designs. Other key topics addressed during the year included the efficiency and effectiveness of regulators and technical support organisations as well as the availability of adequate nuclear skills and technical infrastructure.
- In 2009, the CNRA and the CSNI organised several workshops and conferences, most notable were those on the Implementation of Severe Accident Management Measures; In-Vessel Coolability; Simulator Studies for Human Reliability Analysis; Reactivity Insertion Accidents; and Ageing Management of Fuel Cycle Facilities.

### 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 (NPPs). 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. The group continues to examine regulatory activities based on the 2006 Forsmark event and is currently assessing the report of the Task Group on Defence in Depth of Electrical Systems and Grid Interaction (DIDELSYS). At the group's last meeting, two events were selected and members reviewed their actions in response to these events. The WGOE is also working on establishing trends from international events. The WGOE continues to exchange information on 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 WGOE issued two reports. The first examines the current status of national operating experience feedback

programmes, comparing programmes for the screening, investigation and analysis of events. It also addresses corrective actions, trending and the dissemination of information as routine aspects of the operating experience programmes. The second report focuses on operating experience feedback related to fire events and fire protection programmes. The report is intended to provide practical information for inspection programmes and to facilitate improvements in national operating experience feedback.

### Regulation of new reactors

The Working Group on the Regulation of New Reactors (WGRNR) is reviewing regulatory activities concerning siting, licensing and oversight of new commercial nuclear power reactors. Given that sharing information about the licensing process, construction experience and inspection practices will be helpful to all countries, a construction experience programme is being developed. The objective of the programme is to identify the major deficiencies associated with the design and construction of NPPs, to assess the adequacy of, and to supplement if necessary, current regulatory activities to detect and correct such events, notably before the plant becomes operational, and finally to disseminate information to ensure appropriate regulatory attention is given to lessons learnt from past events.

A report 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 is under preparation. The report is based on a survey covering different aspects of the regulation of nuclear sites, including seismicity, security and multi-unit issues as well as regulator practices on sites where mixed activities are taking place (for example, units being constructed, operated and/or decommissioned).

An activity was also initiated with the aim of producing a report on recent regulatory experiences describing licensing structures, the resources and skills needed to perform reviews, assessments and construction oversight, the types of training needed for these activities, and the various licensing processes in member countries. A member country survey will be conducted to produce the report which is intended to enhance international understanding of reactor licensing processes.

### Regulatory inspection practices

In 2009, the Working Group on Inspection Practices (WGIP) focused its efforts on the inspection of the licensee's corrective action programme and human and organisational

factors in safety culture. The inspection of safety culture remains a topic of keen interest and discussion in the group. The latter also finalised the programme for the tenth international workshop on inspection practices to be held in May 2010 in the Netherlands.

### **Nuclear regulators and public communication**

The main activity of the Working Group on Public Communication of Nuclear Regulatory Organisations (WGPC) consisted of discussing the transparency of regulatory activities, local public information, the use of public perception surveys and crisis communication. Deliberations on transparency are considering the nuclear safety information to be given to the public regarding the safety level of nuclear installations, regulatory decisions and general issues of concern to the public. Discussions on local public information deal more specifically with the information to be provided to persons living in the vicinity of a nuclear facility, including what to do in case of an incident or

emergency. Group members also debated the use of public perception surveys by nuclear regulatory organisations (NRO) to correct and improve the image given by the regulators to the public as an independent body in charge of protecting the population. Crisis communication concerns NRO communication in the case of events which have a particular media impact. Surveys on the above subjects were conducted amongst regulators whose answers are being analysed and compiled into WGPC guidance reports.

### **Senior-level expert group**

A senior-level expert group was formed to produce a regulatory guidance booklet on the regulator's role in assessing the licensee's oversight of vendor and other contracted services. The objective of this booklet is to examine contemporary regulatory challenges in ensuring nuclear safety in an environment in which licensees are increasing their use of contractors and subcontractors. The group's first meeting was held in November 2009; work will continue through 2010.

## **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 and fuel cycle 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. Work has also been undertaken on new and advanced reactors.

During 2009, 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. The report on Uncertainty and Sensitivity Analysis of a Large-break Loss-of-Coolant Accident (LOCA) in the Zion Nuclear Power Plant was issued.

A CFD blind benchmark on flow mixing in a T-junction experiment was launched and is expected to be completed by the end of 2010. In addition, preparations are underway for the Workshop on Experimental Validation and Application of CFD and CMFD Codes to Nuclear Reactor Safety, to be held in September 2010.

In order to assess safety analysis code capabilities, two international standard problems (ISP) were launched on thermal-hydraulics of the reactor coolant system (ISP-50 on the Korean ATLAS facility) and on hydrogen combustion (ISP-49 based on the French ENACCEF and German THAI facilities).

Work continued on in-vessel behaviour of degraded cores and a state-of-the-art report on in-containment behaviour of aerosols was issued. An activity on core exit temperature (CET) effectiveness in accident management is being completed.

Two workshops were organised. The first one on Implementation of Severe Accident Management Measures was held jointly with the WGRISK and addressed severe accident management (SAM) measures for operating NPPs and new plant designs, as well as the integration of SAM measures into probabilistic risk assessment. The second workshop was dedicated to in-vessel melt pool retention and coolability.

### **Ageing and structural integrity of reactor components**

The main topics addressed by the Working Group on Integrity and Ageing of Components and Structures (IAGE) concern the integrity of metal components and concrete structures, and the seismic behaviour of structures and components.

Current activities in the area of risk-informed, in-service inspection (RI-ISI) include drafting the final report on the results of the benchmark on risk-informed, in-service inspection methodologies (RISMET). 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).

Several proceedings were issued. They concerned the workshop on recent findings and developments in probabilistic seismic hazard assessment methodologies and applications, the workshop organised in co-operation with the EC Joint Research Centre (JRC) on risk-informed piping integrity management, and the workshop to review the state of the art on ageing management of thick-walled concrete structures.

The IAGE initiated an activity aimed at improving the robustness of assessment methodologies for structures impacted by missiles. The purpose is to develop guidance that outlines effective methods of evaluating the integrity of structures in such circumstances.

The group also started an activity to compare the different approaches followed in member countries regarding the performance or non-performance of hydro-proof tests and the rationale behind each approach. The activity should determine whether further technical knowledge is needed to support either option, and if so what research should be undertaken.

Component fatigue is a key issue for the safety of nuclear power plants. During the last IAGE annual meetings, member countries have reported leaks and deep cracks where fatigue appeared to be the active degradation mechanism. The group has initiated an activity to assess fatigue data transferability practices in member countries.

Earthquakes recorded in the vicinity of NPPs may have higher than expected peaks and the plant's buildings need to be accurately assessed in terms of seismic response. In 2009, the IAGE initiated an activity to improve the understanding of soil structure interaction on the seismic behaviour of plant buildings, which affects the dynamic response of the internal components and structures.

Finally, the group initiated a task on high energy arcing fault events to provide the basis for deterministic correlations serving to predict damage and to establish a set of input data and boundary conditions for more detailed modelling which can be agreed upon by the international community.

## Risk assessment

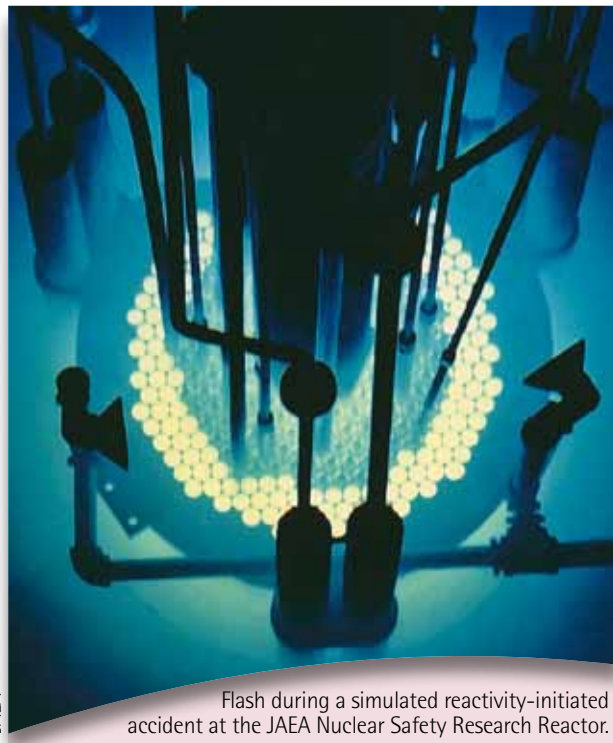
The main mission of the Working Group on Risk Assessment (WGRISK) is to advance the understanding and utilisation of probabilistic safety assessment (PSA) as a tool to support nuclear safety decision making in member countries. Tasks completed in 2009 include an analysis of the status and experience with the technical basis and use of probabilistic risk criteria for NPPs in member countries; the establishment of a low-power and shutdown PSA information base; and recommendations on methods and information sources for quantitative evaluation of digital system reliability. All corresponding reports were issued.

An international workshop was organised to discuss human reliability analysis (HRA) data collection in simulators, to plan simulator studies for HRA and to improve HRA methods using data. A survey is being conducted and a workshop will be held in April 2010 on PSA for advanced reactors. Finally, an activity was launched on PSA knowledge transfer at national and international levels in order to support the dissemination of lessons learnt and best

practices, and to identify follow-up activities for knowledge preservation.

## Fuel safety

The Working Group on Fuel Safety (WGFS) is concerned with 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-initiated accident (RIA) and loss-of-coolant accident (LOCA) experiments, and assessing how these data affect fuel safety criteria, in particular at high burn-up.



JAERI

Flash during a simulated reactivity-initiated accident at the JAERI Nuclear Safety Research Reactor.

The WGFS succeeded in updating and expanding upon the 1986 CSNI state-of-the-art report on pressurised water reactor (PWR) fuel behaviour in design-basis accident (DBA) conditions, which was limited to a PWR loss-of-coolant accident (LOCA). Since the initial report, considerable efforts have been made worldwide on modelling PWR and boiling water reactor (BWR) fuel behaviour in accident conditions, in particular for high burn-up fuel. The update is being issued as two reports: the first covering nuclear fuel behaviour under LOCA conditions was issued in spring 2009, the second covering reactivity-initiated accidents (RIAs) will be issued early in 2010.

The adequacy of existing fuel performance codes for the simulation of high burn-up fuel behaviour under accident conditions was assessed by benchmarking against irradiated LOCA tests performed at the Halden reactor. The exercise consisted of two benchmarks, with pre- and post-test calculations having been carried out.

Two new tasks were initiated on the safety significance of the Halden IFA-650 LOCA test results and to LOCA cri-

teria basis and test methodology. Final objectives of both tasks are to provide recommendations to the international community.

Progress in the testing and modelling of nuclear fuel behaviour during RIAs was discussed at a workshop organised in France in September. Participants concluded that further development of analytical codes is needed and that the transposition of separate effect mechanical tests carried out in laboratories to the reactor case remains an open question.

## 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 specialists meeting on Identifying and Overcoming Barriers to Effective Consideration of Human and Organisational Factors (HOF) in Event Analysis and Root Cause Analysis was held in France in September. The objectives were to identify barriers to correctly identify, analyse and implement lessons learnt from HOF causes of events.

A technical opinion paper published in 2009 identified a set of research topics that would enhance the state of knowledge related to human and organisational factors in the operation of new nuclear plant technology. Eight research topics, among which the role of automation and personnel, organisational factors and safety culture, were defined. The paper recommended that the international community, including regulators, vendors, research institutes and other interested parties, pursue a collaborative and coordinated approach to addressing these important research areas. In follow-up, a workshop will be held on this topic in March 2010.

## 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. During the last WGFCs meeting, members supported the development of a FINAS web training module and encouraged all members to contribute reports regularly to the system.

The WGFCs also organised a workshop in October whose main objective was 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 extensions require a comprehensive, integrated assessment in order to evaluate their potential cumulative safety impact. The Task Group on Safety Margin Applications and Assessment (SM2A) is validating the methodology agreed in 2007 by evaluating the change in safety margins which would result from implementing the newly proposed rules on performing LOCA analyses. Ultimately, 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. The activity is nearing completion with a report to be issued in 2010.

## 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 NPPs. In follow-up, the Task Group on Defence in Depth of Electrical Systems and Grid Interaction (DIDELSYS) was established.

In May 2009, the DIDELSYS task group organised a workshop to present and discuss lessons learnt. It issued its final technical report which provides 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 modernising existing NPPs. It will also provide guidelines for improving communication and coordination among grid operators, nuclear safety authorities and licensees.

## Research facilities for existing and advanced reactors

Following a *CSNI Collective Statement on Support Facilities for Existing and Advanced Reactors*, a Task Group on Advanced Reactor Experimental Facilities (TAREF) was established with a mandate to examine gas-cooled reactors and sodium fast reactors in a first phase. In 2009, the activity on gas-cooled reactors was completed and the corresponding report entitled *Experimental Facilities for Gas-cooled Reactor Safety Studies* was published. The report identifies relevant safety issues and facilities to address them, and provides recommendations on strategies for facilities and international programmes in support of safety assessment. The activity on sodium fast reactors is ongoing.



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