

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. A variety of issues have been identified in international operating experience; recurring events figure prominently on the list. Many human and organisational factors including deficient operator knowledge, inadequate learning processes from prior events, problems with procedures, complacency in organisation and unclear definition of responsibility were also identified. Contractor work has also been involved in a number of events. Finally, maintaining adequate levels of exchange of international operating experience has been recognised as an important element in helping to improve nuclear safety. Corrective actions and research activities are ongoing or planned in all of the areas mentioned above.

The CSNI Working Group on Operating Experience (WGOE) has continued its work to bring lessons from NPP operating experience to the nuclear safety community. In 2003, the group issued the second international report on recurring events as well as a technical opinion paper on the same subject intended for a wide audience. The task force on safety impact of so-called minor and non-identified modifications organised a workshop on the safety of nuclear power plant (NPP) modifications jointly with the CSNI Special Expert Group on Human and Organisational Factors (SEGHOF). Furthermore, the activities of the task groups on safety performance indicators and strainer clogging are planning to hold international workshops in the near future; the task group that deals with computerised systems is looking to launch a joint NEA project in 2004.

Human and organisational factors are an important part of nuclear safety.



NEI, United States

Analysis and management of accidents

Most CSNI activities in the area of safety 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, in nuclear power plant safety and design evaluations, of best-estimate codes, 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. Action plans are being implemented in these areas.

Regarding in-vessel behaviour of degraded cores, the ISP-46 (international standard problem) exercise, based on a test at the PHEBUS facility, was completed during the year. The objective was to assess the capability of computer codes to reproduce an integral simulation of the physical processes taking place during a severe accident in a pressurised water reactor.

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 validate codes that calculate thermal-hydraulics inside a reactor containment under accident conditions.

As regards fission product release, transport, deposition and retention, the ISP-46 exercise, mentioned above, and a second follow-up exercise to ISP-41 on iodine behaviour, based on RTF and CAIMAN tests, were completed during the year.

Good progress continues to be made on the SERENA (Steam Explosion Resolution for Nuclear Applications) Co-ordinated Programme, investigating the field of steam explosions resulting from fuel/coolant interactions, with a view to determining by mid-2005 whether current knowledge is sufficient for risk management under reactor conditions, and whether additional, analytical, experimental work is needed.

Safety aspects of improved performance – Integrated assessment of safety margins

In recent years, largely as a result of economic pressures arising from the liberalisation of electricity markets, the nuclear industry has tried to maximise the

- The CSNI and the CNRA completed 30 reports. Particularly noteworthy were those on recurring events, fuel safety criteria and the inspection of research reactors.
- The CSNI and the CNRA organised 11 workshops, notably a workshop on redefining large-break, loss-of-coolant accidents and the Forum on Measuring, Assessing and Communicating Regulatory Effectiveness.
- In 2003 the MASCA Project completed its first phase and its members agreed to continue with MASCA 2. A number of initiatives were assessed in terms of their potential for becoming new NEA joint projects.

outputs of operating plants. This has resulted in changes to the main parameters of the reactor core. Such modifications require an in-depth safety analysis to evaluate the possible safety impact. More generally, the effect of cumulative, small design changes which are not individually tested can produce significant differences from the original design. A comprehensive, integrated assessment is needed in order to evaluate the impact of multiple, synergistic safety margin reductions (related to power uprates, longer operating cycles, fuel design, increased fuel burn-up, etc.), combined with plant ageing and plant life extension. An extensive Action Plan on Integrated Assessment of Safety Margins has been initiated.

Ageing and structural integrity of reactors

The main topics investigated in this area include metal components, concrete structures, seismic behaviour and the ageing of wire systems. One workshop was held and nine reports issued.

Work on concrete containments was completed and an international standard problem on containment capacity was begun based on NUPEC/NRC tests carried out at Sandia National Laboratories. Work on the use and performance of concrete structures in nuclear power plant fuel cycle facilities was initiated through co-operation with other organisations. A review of regulatory aspects and the technical basis for a possible redefinition of loss-of-coolant accidents (LOCA) was also carried out.

In the area of metallic components, several activities were initiated on non-destructive examination and risk-informed inspection, environmental effects on nickel-based alloys, thermal fatigue of reactor components and wire system ageing. A benchmark on the probabilistic approach for reactor pressure vessel integrity was launched.

Activities are continuing in the area of seismic engineering, notably on seismic codes and standards, seismic inputs, and testing facilities to be maintained for the future.

Risk assessment

The main mission of the Working Group on Risk Assessment (WGRisk) continues to be to advance the

understanding and utilisation of probabilistic safety assessment (PSA) in ensuring the continued safety of nuclear installations in member countries. While PSA methodology has matured greatly over the past years, further work is required. WGRisk has been active in several areas, including human reliability, low power and shutdown risk. In order to maintain a current perspective, the working group collaborates and assists other working groups within the CSNI, such as those on operating experience and organisational factors, as well as ensuring close co-ordination with other international organisations.

A technical opinion paper was approved for publication on human reliability analysis in PSA. WGRisk is beginning work on several new tasks, including the use of risk information in the regulatory process, the use of Level 2 PSA information for emergency planning, the development of methodology for the use of OECD databases, and probabilistic safety analysis for non-reactor nuclear facilities.

Fuel safety margins

Among the most important issues to the international nuclear industry is high burn-up fuel performance both during normal operations and under accident conditions, such as loss-of-coolant accidents (LOCA) and reactivity-initiated accidents (RIA). The NEA Special Expert Group on Fuel Safety Margins is seeking, in particular, to systematically assess 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 survey of ongoing fuel safety research programmes in NEA member countries was completed and published in 2003. It demonstrates a tremendous effort, in both time and money, to improve understanding of materials and component behaviour in a wide range of postulated scenarios. The majority of ongoing activities are addressing such issues as the 17% cladding oxidation criterion in the light of new alloys and new geometries, and energy deposition levels leading to fuel failure by rapid reactivity insertion. In addition, the high burn-up structure at the pellet rim is under intense separate-effects study as this is anticipated to be the root cause of the increased fuel clad loading.



P. Stroppa, CEA, France

Remote manipulation at the Phebus research reactor for the programme on severe accidents (PWR core melt).



Plant improvements being implemented at the Bohunice nuclear power plant in the Slovak Republic.

Human and organisational factors

The Special Expert Group on Human and Organisational Factors (SEGHOF) continued its activities in this area, producing in particular a technical opinion paper about regulatory management of organisational change. The programme of work also included drafting a state-of-the-art report on scientific methods for safety management; a report on events involving MTO (man, technology, organisation) aspects and techniques to study them; preparatory work in the area of maintenance; and continuation of the task on human factors in NPP modifications.

In terms of design modifications, a workshop was organised in Paris jointly with the WGOE in October 2003 with wide participation by utilities, regulators and research bodies. Recent events show that minor modifications may be of high safety significance but sometimes remain unnoticed, e.g. when manufacturers introduce small changes considered as improvements solely in electrical and instrumentation systems. The conclusions of the workshop stated that operability and maintainability issues need to be taken into account early enough in the modification processes, and that careful scrutiny needs to be exercised independently of the size of the modifications.

Safety research capabilities and expertise in support of regulation

The role of research sponsored by nuclear regulatory organisations is to provide those organisations with adequate capability and expertise to assess reactor safety issues, review designs and perform their various other functions, independent from those seeking regulatory approval or promoting nuclear energy. Such capability and expertise is fundamental to

public confidence and contributes to safety by enhancing the efficiency and effectiveness of regulatory programmes. A collective statement on capabilities and expertise in support of efficient and effective regulation of nuclear power plants was approved at the end of the year for publication in 2004. The statement provides information which can be of use to member countries in establishing and maintaining adequate safety research capability and expertise, and is intended to assist NEA member countries in the task of judging and defining what safety research capability and expertise should be maintained in support of regulation.

Good practice and closure criteria for safety research

The method for setting nuclear safety research priorities and the criteria for ranking programmes and projects, including for closure, vary from one country to another. A successful research project requires clearly defined research programme backgrounds, objectives, deliverables and schedules, and progress must be monitored regularly. Setting a well-defined programme basis and monitoring programme performance, including closure considerations, are examples of good practice in conducting research.

In 2003 the CSNI developed a collective statement addressing good practices in conducting nuclear safety research and focusing on closure considerations. The statement also addresses the potential detrimental effects of programme closure, such as potential losses of technical capability, expertise and facilities, etc. This statement is intended to assist NEA member countries and the CSNI in the task of defining, monitoring and judging whether certain safety research programmes should be closed.

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 interface between the public and the regulator, the effectiveness of the regulatory process, the introduction of competition in the electricity market, the maintenance of a high level of safety competence and the development of advanced reactors.

Regulatory effectiveness

Under the aegis of the NEA, heads of nuclear regulatory authorities met in June with high-level government officials and executives from the nuclear

industry to exchange perspectives on measuring, assessing and communicating regulatory effectiveness. The main conclusion of the forum was that regulatory performance indicators are both good and useful in improving a regulator's effectiveness and

efficiency, but there are a number of areas that deserve careful attention. For example, incorrect analysis of these indicators could lead to inaccurate decision making, and misinterpretation could lead to misunderstandings by the stakeholders.

The underlying starting point for this forum was a set of performance indicators recently developed to measure regulators' performance in five key areas: competence; promotion of safety; continuous improvement; internal processes; and stakeholder confidence. The results of a one-year pilot project undertaken by nine NEA member countries provided the basis for the discussions. A main objective of the forum discussions was to seek verification and validation of the selected measures. Participants debated the appropriateness of the indicators chosen, whether others could be applied and what were the most essential measures of a regulator's effectiveness and efficiency. The final publication was approved by the CNRA at the end of 2003 and is scheduled to be issued early in 2004.

Nuclear regulators and the public

Efficiency in decision making by government authorities is increasingly dependent upon public trust. Public communication is one of the keys to the future of nuclear power. In 2003, an NEA working group on public communication of nuclear regulatory organisations discussed such topics as public communication in relation to the April 2003 Paks-2 incident in Hungary; the public impact of the April 2003 HSK (Swiss nuclear safety authority) report on aircraft attacks of nuclear power plants; lessons learnt from the Swiss vote in May 2003 in favour of nuclear power; Swedish public opinion of nuclear power; and follow-up to inspection findings on core internals in Japan. Preparations were also undertaken to organise a workshop on "Building, Measuring and Improving Public Confidence in the Nuclear Regulator", to be held in Ottawa, Canada in May 2004.

Regulatory inspection practices

Inspectors from regulatory bodies meet periodically to exchange information and experience related to regulatory safety inspections, discuss commendable inspection practices and carry out studies. Reports were issued on nuclear regulatory inspection of contracted work and on inspection practices of nuclear research reactors. A seventh international workshop is being planned for 2004 and will cover inspection activities related to risk-informed inspections, inspection of plants at or near end-of-life and inspection of licensee organisation performance.

The working group in this area is currently studying several inspection issues including: inspection of site selection, construction and commissioning; inspection of licensees' capability to assure the nuclear safety aspects of contractors' work; and regulatory inspection practices used to bring about compliance. It is also preparing a compendium of commendable inspection practices.

Licensees' capabilities to ensure nuclear safety

A common concern to both regulators and industry is the ongoing gradual loss of experienced and competent personnel in nuclear technology and the resulting weakening of nuclear field organisations. In some cases NPP vendors have merged with other companies and are no longer offering their earlier designs, while the technical strength of some others has decreased from the time they were actively designing and constructing NPPs. Consequently, some nuclear operating organisations have difficulty finding sufficient external support needed for the maintenance and operation of their facilities. Additionally, suppliers of specific nuclear equipment are disappearing from the market and as a result, the in-depth knowledge on the design features of their equipment is being lost. Similarly, nuclear research institutes and other expert organisations have reduced their nuclear staff and budget.

The gap is partly filled by consultants and specialised companies that offer contracted services to the operators. The expert knowledge of these contractors is often focused on a limited area, and does not include a comprehensive understanding of the NPP safety concept. Furthermore, contractors may not have had much involvement or experience on the specific plant sites where they are working. Therefore they require due guidance and supervision by the operating organisation.

The licensee's ability to maintain control over the nuclear safety aspects of the 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. It would be worthwhile to identify commendable means used by the operators to maintain control over nuclear safety aspects of contracted work and to identify the type of regulatory oversight (e.g. inspections, assessment, etc.) that allows the regulator to have assurance on the adequacy of such controls.



KKB/NOK, Switzerland

Inspection of a residual heat removal pump at the Beznau nuclear power plant in Switzerland.



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