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NUCLEAR ENERGY AGENCY
COMMITTEE ON THE SAFETY OF NUCLEAR INSTALLATIONS

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CONCLUSIONS DRAWN FROM RECENT (2001-2002) EVENTS IN NUCLEAR POWER PLANTS

TECHNICAL NOTE

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ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

Pursuant to Article 1 of the Convention signed in Paris on 14th December 1960, and which came into force on 30th September 1961, the Organisation for Economic Co-operation and Development (OECD) shall promote policies designed:

- to achieve the highest sustainable economic growth and employment and a rising standard of living in Member countries, while maintaining financial stability, and thus to contribute to the development of the world economy;
- to contribute to sound economic expansion in Member as well as non-member countries in the process of economic development; and
- to contribute to the expansion of world trade on a multilateral, non-discriminatory basis in accordance with international obligations.

The original Member countries of the OECD are Austria, Belgium, Canada, Denmark, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States. The following countries became Members subsequently through accession at the dates indicated hereafter: Japan (28th April 1964), Finland (28th January 1969), Australia (7th June 1971), New Zealand (29th May 1973), Mexico (18th May 1994), the Czech Republic (21st December 1995), Hungary (7th May 1996), Poland (22nd November 1996), Korea (12th December 1996) and the Slovak Republic (14 December 2000). The Commission of the European Communities takes part in the work of the OECD (Article 13 of the OECD Convention).

NUCLEAR ENERGY AGENCY

The OECD Nuclear Energy Agency (NEA) was established on 1st February 1958 under the name of the OEEC European Nuclear Energy Agency. It received its present designation on 20th April 1972, when Japan became its first non-European full Member. NEA membership today consists of 28 OECD Member countries: Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Luxembourg, Mexico, the Netherlands, Norway, Portugal, Republic of Korea, Slovak Republic, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States. The Commission of the European Communities also takes part in the work of the Agency.

The mission of the NEA is:

- to assist its Member countries in maintaining and further developing, through international co-operation, the scientific, technological and legal bases required for a safe, environmentally friendly and economical use of nuclear energy for peaceful purposes, as well as
- to provide authoritative assessments and to forge common understandings on key issues, as input to government decisions on nuclear energy policy and to broader OECD policy analyses in areas such as energy and sustainable development.

Specific areas of competence of the NEA include safety and regulation of nuclear activities, radioactive waste management, radiological protection, nuclear science, economic and technical analyses of the nuclear fuel cycle, nuclear law and liability, and public information. The NEA Data Bank provides nuclear data and computer program services for participating countries.

In these and related tasks, the NEA works in close collaboration with the International Atomic Energy Agency in Vienna, with which it has a Co-operation Agreement, as well as with other international organisations in the nuclear field.

COMMITTEE ON THE SAFETY OF NUCLEAR INSTALLATIONS

The Committee on the Safety of Nuclear Installations (CSNI) of the OECD Nuclear Energy Agency (NEA) is an international committee made up of senior scientists and engineers. It was set up in 1973 to develop, and co-ordinate the activities of the Nuclear Energy Agency concerning the technical aspects of the design, construction and operation of nuclear installations insofar as they affect the safety of such installations. The Committee's purpose is to foster international co-operation in nuclear safety among the OECD Member countries.

The CSNI constitutes a forum for the exchange of technical information and for collaboration between organisations, which can contribute, from their respective backgrounds in research, development, engineering or regulation, to these activities and to the definition of the programme of work. It also reviews the state of knowledge on selected topics on nuclear safety technology and safety assessment, including operating experience. It initiates and conducts programmes identified by these reviews and assessments in order to overcome discrepancies, develop improvements and reach international consensus on technical issues of common interest. It promotes the co-ordination of work in different Member countries including the establishment of co-operative research projects and assists in the feedback of the results to participating organisations. Full use is also made of traditional methods of co-operation, such as information exchanges, establishment of working groups, and organisation of conferences and specialist meetings.

The greater part of the CSNI's current programme is concerned with the technology of water reactors. The principal areas covered are operating experience and the human factor, reactor coolant system behaviour, various aspects of reactor component integrity, the phenomenology of radioactive releases in reactor accidents and their confinement, containment performance, risk assessment, and severe accidents. The Committee also studies the safety of the nuclear fuel cycle, conducts periodic surveys of the reactor safety research programmes and operates an international mechanism for exchanging reports on safety related nuclear power plant accidents.

In implementing its programme, the CSNI establishes co-operative mechanisms with NEA's Committee on Nuclear Regulatory Activities (CNRA), responsible for the activities of the Agency concerning the regulation, licensing and inspection of nuclear installations with regard to safety. It also co-operates with NEA's Committee on Radiation Protection and Public Health and NEA's Radioactive Waste Management Committee on matters of common interest.

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CONCLUSIONS DRAWN FROM RECENT (2001-2002) EVENTS IN NUCLEAR POWER PLANTS

Technical note

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This document has been written in order to meet the spirit of the WGOE mandate and a request by the CSNI chairman in June 2002 to transmit recommendations to CSNI and CNRA related to recent events. The idea is to make this note an annual practice. The identified safety issues are generic and national bodies obviously need to use their own consideration about how to take them into account in their action programmes.

Introduction

The Incident Reporting System (IRS), jointly operated by the IAEA and NEA, has contributed to the promotion of the feedback of lessons learned from operating experience of nuclear power plants (NPPs). The IRS has enabled the agencies to start operating experience based studies and other types of joint activities. Recognizing the importance of sharing the lessons learned worldwide, the annual joint IAEA/NEA meetings dedicated to the exchange of information on recent events have been held since 1983. The last meeting was held in Paris in May 2002.

This Paper presents the views of the Working Group on Operating Experience (WGOE) of the Committee on the Safety of Nuclear Installations (CSNI) concerning the significant events presented in the meeting. WGOE discusses recent events based on its mandate approved by CSNI.

Recent Significant Events

One of the most recent safety significant events is the Davis Besse-1 (USA) event in March 2002 that involved boric acid corrosion of the reactor pressure vessel (RPV) head (IRS-7510, 7511). Boric acid corrosion is a known phenomenon. There are several precursor events in the IRS including the Turkey Point-1 (USA) event in March 1987 (IRS-722). This report (IRS-722) says, “After removal of the boron crystals, extensive corrosion of various components on the reactor pressure vessel (RPV) head was discovered.” Therefore boric acid corrosion is a recurring event. As well, it is worth pointing out several “missed detection opportunities.” For example in the Davis Besse-1 case, the containment air cooler was clogged in 1999, and the containment radiation monitor filters had been changed more frequently than before since 1999. An important lesson is that a questioning and safety oriented attitude is necessary to detect early warning signs.

Pipe rupture took place in Hamaoka-1 (Japan) due to hydrogen detonation in November 2001. A rather similar event occurred in Brunsbuettel (Germany) in December 2001, five weeks after the Hamaoka-1 event. In BWRs, the main steam contains a very small amount of non-condensable gases produced by radiolysis such as hydrogen and oxygen. The event was initiated by the accumulation of non-condensable gases in a dead-end pipe connected to the main steam line. This was caused by steam condensation due to ambient heat loss. In the IRS database, we can find many events caused by deflagration/detonation of radiolysis hydrogen in several countries (IRS-668, 756, 840 and 1437).

In Hamaoka-1, the pipe layout was modified in 1993 to 1994 to improve the leak-tightness of the valve located just downstream of the ruptured portion. If the adverse effects of the modification had been analysed more carefully, the accumulation of the radiolysis gases could have been noticed. As well, this event may involve an issue of loss of technical expertise and/or loss of knowledge. In an early stage of the development of BWR designs, more than 40 years ago, the treatment of radiolysis gasses had been a major technical issue. The issue was then resolved and people had concentrated more upon other phenomena. This may partially explain why it was not noticed at the modification.

The Philippsburg-2 (Germany) event in August 2001 demonstrated weaknesses in safety management. In this event, the plant has been started up without testing the boron concentrations in the borated water storage tanks. After detecting that the boron concentrations were below the specified value, the plant personnel did not shutdown the plant but rather took measures to increase the concentrations. In addition, it was revealed afterwards that the plant had been started up with too low levels in all the borated water storage tanks.

The fact that the homogenisation of borated water in the large tanks required a rather complex and time-consuming operation may have contributed to the event. However, we need to keep in mind that difficulties in operation accompanied by unclear procedures may contribute to the degradation of safety culture, especially under time pressure and demand for higher production efficiency. Similar weaknesses in safety management were also identified in the JCO criticality accident in Japan in September 1999.

In the Flamanville-2 (France) event in January 2002, a human error during a routine maintenance activity led to a loss of off site power to one train accompanied by many less-successful human actions. Potential interactions between non-safety and safety system may require more work, which also were the lessons learned from the station blackout (SBO) at the Maanshan (Taiwan) in March 2001 and its precursor event in San Onofre (USA) in February 2001.

A steam generator tube rupture (SGTR) took place in Ulchin-4 (Korea) in April 2002. This is a new plant that commenced its commercial operation just three years ago (December 1999). SGTR also is a typical recurring event - more than 10 may be found in IRS, mostly in the USA (IRS-819, et al.), two in Belgium (Doel-2, 1979, IRS-1434 – Tihange-3, 1996, IRS-1620) and one in Japan (Mihama-2, 1991, IRS-1172). It is important to note that in this event also an opportunity might have been missed to interpret the eddy current inspection results.

A power oscillation event, known as the BWR instability phenomenon, occurred at Philippsburg-1 (Germany) in December 2001. Although measures have been taken in many countries after the LaSalle-2 event in the USA in March 1988 (IRS-877), the phenomenon is still recurring (IRS-7330, 7384). This event is especially important because it occurred during a new operation mode for high burn-up fuels. It is well known that the use of high performance fuels, including high burn-up and MOX fuels, would reduce the stability margin, and this event gave further evidence about the phenomenon.

Identified Safety Issues

One of the common aspects to the events mentioned above seems to be the recurrence of events with known phenomena. NPPs have already accumulated so much operating experience data that it becomes rare to encounter events caused by completely new phenomena. Recurrence of events exhibits weaknesses in designs, organisations and in operating experience feedback loops. The operating experience feedback loop may be inefficient due to an insufficient root cause analysis, lack of feedback from foreign NPPs or possibly even loss of corporate knowledge.

CSNI/WGOE task force on recurring events is currently preparing a report about defenses against recurring events. It is advisable also to make sure that national organisations dealing with operating experience have understood the importance of analysing potential for recurrence on time. Further efforts should be made to close the feedback loop more effectively in the operating organizations, regulatory bodies, research institutes and other supporting organizations.

The other common aspect identified in the events may be called “missed opportunities”. It exhibits weaknesses in detection capabilities. These weaknesses may have to do with quality control / quality assurance process in maintenance and testing activities or lack of expertise. In some cases also qualification & re-qualification processes before and after modifications need revisiting. In order to maintain a detection capability, we need not only to foster a questioning attitude and blame-free culture, but also to maintain technical capabilities, expertise and design knowledge. It may be worth studying if there are commonalities among the “missed opportunities” events. WGOE is investigating possibilities to organise a task about the topic in future.

As well, we, the international nuclear safety community, need to monitor events associated with management of organizational changes and hardware modifications, loss-of-technical expertise and competence and loss-of-corporate knowledge including design knowledge. Some of them may be closely related to the competitive environment in the electricity market due to deregulation.

Issues related to modifications have recently become important. In many cases, human and organisational factors played an important role. This means it is necessary to focus on the management of both organisational changes and hardware modifications. Both the WGOE and SEGHOF have already started activities to study the topic in their task forces. A generic lesson is that no modifications may be regarded as purely technical and without related needs for training, competence and organisation.

WGOE has extensively discussed the influence of competitive environment in the electricity market due to deregulation on events. It seems to be very difficult to detect evidence pointing at deregulation directly. One of the reasons for that is that the effects of deregulation are not instantaneous. A continued focus by the Licensees to reduce the costs and to improve efficiency will undoubtedly have safety implications in the long term. Direct effects of the deregulation may be seen in some recent events involving the electrical grid.

Therefore, it is meaningful to continue discussion about the deregulation issues in relation to factors such as priority given to production efficiency rather than to safety, minimum actions taken to meet regulatory requirements, expansion of use of contractors, outsourcing, change of ownership, and so forth. Regulatory effectiveness should be discussed at the same time with those issues as well as possible actions from the regulatory point of view to follow-up the potential problems and to prevent a degradation in safety culture.