Nuclear Safety
Nuclear Regulation

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Collective Statement Concerning Nuclear Safety Research

Capabilities and Expertise in Support of Efficient and Effective Regulation of Nuclear Power Plants

NEA No. 5490

NUCLEAR ENERGY AGENCY
ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

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 (14th 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, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Luxembourg, Mexico, the Netherlands, Norway, Portugal, the Republic of Korea, the 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.

FOREWORD

The role of research sponsored by nuclear regulatory organisations is to provide those organisations with adequate information to assess reactor safety issues, review designs and perform their various other functions, independent from those seeking regulatory approval or promoting nuclear energy. Such research and independent expertise is fundamental to public confidence as well as to safety by enhancing the efficiency and effectiveness of regulatory programmes.

This collective statement represents an international consensus reached within the OECD/NEA Committee on the Safety of Nuclear Installations (CSNI) and the Committee on Nuclear Regulatory Activities (CNRA) on what constitutes adequate safety research capabilities and expertise in support of efficient and effective regulation of nuclear power plants. Although much of the following discussion is based upon experience with safety research in support of the regulation of light water reactors (LWRs) and pressurised heavy water reactors (PHWRs), the information and considerations developed can be applied to safety research programmes for other reactor technologies as well.

This statement is intended to assist NEA member countries in determining what safety research capability and expertise should be maintained in support of regulation and why. The intended readership is primarily nuclear safety research managers, regulatory organisations and research centres. Government authorities, nuclear power plant operators and the general public may also be interested.

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BACKGROUND AND PURPOSE

In June 2001 the NEA Committee on the Safety of Nuclear Installations (CSNI) and the NEA Committee on Nuclear Regulatory Authorities (CNRA) hosted a workshop on the role of research in a regulatory context. The purpose of the workshop was to bring together regulators, researchers and industry representatives to identify commonalities and differences in their perceptions on the role of research. A series of recommendations came out of the workshop, including one that stated: "Individual NEA member countries need to ensure that adequate research capability is maintained."

Areas of commonality and consensus included:

- Each country should try to establish an understanding of adequate research capability.
- There is a need to clearly articulate the value of nuclear safety research for the development (or revision) of regulation.
- It is essential to maintain an adequate infrastructure including people, facilities and analytical tools and it would also be beneficial for member countries to attain a better understanding and definition of what constitutes adequate research capability.

Similar concerns were expressed at an earlier (October 1999) CNRA workshop on assuring future nuclear safety competence, where it was stated that there is a continuing need for nuclear safety research capability to address residual concerns and any issues that may emerge in the future.

As a result of the above, the CSNI, in co-operation with the CNRA, undertook to be responsive to the recommendation from the June 2001 workshop by developing this statement, which articulates the value to efficient and effective regulation, as well as to safety, of maintaining safety research capability and expertise; it also provides information which can be of use to member countries in establishing and maintaining adequate safety research capability and expertise. In effect, this statement can serve as a guideline for consideration by NEA member countries that provides a perspective on what

safety research capability and expertise should be maintained in support of regulation and why.

The scope of safety research discussed in this statement is that related to power reactor design and operation. Although much of the following discussion is based upon experience with safety research in support of the regulation of light water reactors (LWRs) and pressurised heavy water reactors (PHWRs), the information and considerations developed can be applied to safety research programmes for other reactor technologies as well. The approach taken in developing this statement was to consider the various activities performed by a regulatory organisation (e.g. license new plants, assess the life extension of existing plants, respond to operational problems, etc.) and the research capabilities and expertise that can support the organisation in efficiently and effectively carrying out those regulatory activities. Where research capability and expertise is identified, such research capability and expertise may be maintained within a regulatory organisation, shared among organisations (co-operative research), or be available for timely access by the organisation.

The descriptions of the technical research capabilities and expertise in this statement are at a broad level since the details would be dependent upon the reactor designs, experience and technologies employed in each member country. The basis for the description of the research capabilities and expertise are the result of the collective experience of CSNI member countries. In addition, this statement has also been reviewed by the CNRA and reflects a joint CSNI/CNRA viewpoint on safety research capabilities and expertise.

THE VALUE OF SAFETY RESEARCH

The current safety record and success of nuclear power worldwide is built upon a foundation of research. Such research has been sponsored by governments and industry and has led to improved designs, safer and more reliable plant operation, improvements in operating plant efficiency and a future outlook that, in some countries, includes consideration of building additional nuclear power plants. A key element of this research has been the safety research sponsored by regulatory organisations. In part, it has been the safety research sponsored by regulatory organisations that has contributed to improved safety and has laid the foundation for activities such as risk-informed regulation, plant life extension, improved plant performance (e.g. power uprates) and new plant designs. In addition, operating experience continues to reveal areas that need additional attention. All of the above have or will require regulatory attention in the future.

The identification of research needs can result from needs within the regulatory organisation to support ongoing regulatory reviews and decisions it has to make, to confirm existing regulatory positions, to explore potential safety issues (e.g. resulting from operating experience) or to prepare the regulatory organisation for future challenges such as those resulting from initiatives by industry to change plant design or operation or pursue new activities. Such research has taken the form of developing analytical tools for use in regulatory reviews, performing experimental work to confirm or explore the safety associated with various issues of reactor design and operation (e.g. severe accidents) and developing the technical basis in support of national consensus codes and standards, regulatory practices and actions (e.g. regulation development).

It is recognised that the practices of regulatory organisations vary from country to country and that the degree to which regulatory-sponsored research is conducted and utilised in the regulatory process also varies. However, in general, the role of research sponsored by regulatory organisations is to provide those organisations with the 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

independent capability and expertise provides the regulatory organisation with a deeper understanding of the activities it regulates. This deeper understanding can result in insights that contribute to the quality, timeliness and thoroughness of the regulatory review, confidence in the information provided by the industry, or identification of safety issues that may have gone undetected.

Such research is not intended to duplicate what is industry's responsibility, but rather to provide a check on its completeness and quality in an independent fashion. This capability and expertise by the regulator is fundamental to public confidence as well as contributing to safety by enhancing the efficiency and effectiveness of regulatory programmes. Finally, in some countries emphasis is placed upon continuously improving safety by improving knowledge, assessment methods, procedures, etc. Research plays a vital role in such improvements by providing the technical bases and experimental data to validate the analyses and proposed changes.

Active research programmes also provide an opportunity to attract new people into the field of nuclear safety. They provide training on the fundamentals of reactor safety issues as well as experience in evaluating and resolving actual problems. Such experience can lead to individuals continuing to support or joining regulatory organisations. The NEA conducted a study on the decline in nuclear education opportunities and interest and in its 2000 publication on *Nuclear Education and Training: Cause for Concern?* it is stated that: "...one way to help stimulate interest in the nuclear field is to provide opportunities for students to participate in research projects." Before that, at the NEA 1999 workshop in Budapest on "Assuring Nuclear Safety Competence into the 21st Century" it was noted that research attracts the most able university faculty members and students and contributes strongly to the maintenance of competencies. This conclusion was endorsed in the 2001 CNRA report on *Assuring Future Nuclear Safety Competencies – Specific Actions*, which stressed the need to retain essential research capability. Others have also recognised the value of safety research to regulation. For example, the International Nuclear Safety Advisory Group (INSAG) recently published a note (INSAG Note Number 4) titled "Maintaining Knowledge, Training and Infrastructure for Research and Development in Nuclear Safety" which emphasised the importance of maintaining capabilities for nuclear research and education. The CSNI and the CNRA endorse the conclusions and recommendations contained in this Note. In addition, INSAG in its INSAG-12 report titled "Basic Safety Principles for Nuclear Power Plants (75-INSAG-3, Rev. 1)" includes safety research among its basic safety principles and states that "research and development activities are needed to maintain knowledge and competence within organisations that support or regulate nuclear power plant activities." The CSNI and the CNRA also endorse this principle.

There is a general consensus that safety research in support of a regulatory organisation can improve the efficiency and effectiveness of that organisation. The NEA, in its 2001 publication on *Improving Nuclear Regulatory Effectiveness*, has defined regulatory effectiveness as doing the right work, and regulatory efficiency as doing the work right. Consistent with those definitions, safety research sponsored by regulatory organisations can directly support the regulatory effectiveness and efficiency in the following ways:

Effectiveness

- Helping to identify the items of most importance to safety, thus allowing resources to be focused on the most significant concerns.
- Anticipating future regulatory actions or issues, thus preparing the organisation for the future.

Efficiency

- Helping to improve the quality of regulation by providing tools and information that allow a more in-depth understanding of safety issues as well as more timely regulatory decisions.
- Helping to identify problems before they become significant safety or regulatory concerns.

SAFETY RESEARCH CAPABILITIES AND EXPERTISE

This section discusses factors that are important for determining what safety research capabilities and expertise a regulatory organisation should maintain, develop or be able to access. The factors are related to which activities the regulatory organisation must perform and, since the role and activities of regulatory organisations may be different, not all of the factors would apply to each organisation. It would be up to each member country to consider the factors discussed in this section and to make a determination of the safety research capabilities and expertise needed. It should be emphasised that although the factors described in this section are guidelines only, to assist NEA member Countries, they nevertheless represent the experience and judgement of CSNI and CNRA members regarding what should be maintained.

Assessing the activities a regulatory organisation performs is the first step in determining what regulatory research should be maintained to support efficient and effective regulation. The regulatory activities related to nuclear power plant design and operation can be categorised as follows:

- oversight of currently operating reactors (e.g. evaluating operational problems, performing periodic safety reviews, etc.);
- assessing proposed modifications to currently operating plants (e.g. higher burnup fuel, power uprates, I&C upgrades);
- life extension of currently operating plants;
- licensing new reactors (of current or new technology).

Many aspects of these activities are done in response to initiatives from the industry, and such initiatives may be supported by research funded by the industry. In fact, the degree to which industry is responsible for the research may vary from country to country depending upon the regulatory system employed in the country. Accordingly, it is important for regulatory organisations to keep abreast of industry initiatives and research activities. In addition, it is important for regulatory organisations to be able to assess the industry-funded research done in support of industry initiatives so as to be able

to judge its adequacy (scope, quality and relevance) with respect to the safety issues. This is not intended to imply that a regulatory organisation must duplicate industry-performed research, but rather it should be in a position to judge the adequacy of that research and to explore any additional areas relevant to the safety decision. Each of the above activities requires the regulatory organisation to have certain capabilities and expertise. The Annex to this report summarises CSNI and CNRA views on the research capabilities and expertise that support a regulatory organisation carrying out its duties in an efficient and effective manner.

The research capabilities and areas of expertise included in the Annex follow closely those identified in the SESAR – Capabilities and Facilities (SESAR/CAF) report and the SESAR – Facilities and Programmes (SESAR/FAP) report. However, unlike SESAR/FAP, which was directed at research needed to address specific open issues related to currently operating LWRs and PHWRs, the expertise needs are more general in nature so as to address the broader aspect of research capabilities and expertise that support an efficient and effective regulatory organisation.

In general, to have a viable research capability and expertise requires a stable programme with challenging and useful work as well as sufficient staff and resources to ensure a long-term commitment by staff and to permit constructive interaction among the staff. It is recognised that not all member countries have the resources to support research in all areas and, therefore, co-operation among countries and through organisations such as the NEA are an effective way to compensate and ensure access to the needed capabilities and expertise. In addition, some capability and expertise needs may be obtained from other industries (e.g. some aspects of digital I&C) and, when this is the case, there may be less of a need for the regulatory organisation to maintain the capability and expertise, provided the safety implications can be determined.

Annex

SUMMARY OF REGULATORY AREAS SUPPORTED BY RESEARCH CAPABILITY AND EXPERTISE

Regulatory area	Abilities supported by research	Research capability and expertise	Regulatory function*
Risk assessment	• To develop or acquire analytical tools for independent assessment of plant design, safety, performance and operating events • To understand the physical modelling and its limitations • To maintain and upgrade these analytical tools	Modelling of plant, and human reliability and performance	1, 2, 3, 4
Materials/structures (steel and concrete)	• To anticipate and assess problems associated with materials such as steel, cables and structures • To assess and analyse damage and respond to operating events	• Metallurgy, chemistry, strength of materials • Performing tests on radioactive materials	1, 2, 3, 4
Human and organisational performance	• To assess root causes of human performance problems • To assess characteristics of organisational performance and degradation related to safety	Organisational management and human reliability	1, 2, 4

* Regulatory functions:
1. Oversight of operating reactors.
2. Modifications of operating reactors.
3. Plant life extension.
4. Licensing new reactors.

Regulatory area	Abilities supported by research	Research capability and expertise	Regulatory function*
Mechanical/electrical systems	To assess operational problems associated with systems and components	Operation and maintenance of mechanical and electrical equipment	1, 2, 3, 4
Evaluation of operating experience	To detect anomalies, trends, patterns, causes and safety significance of plant conditions, parameters and events	Broad knowledge of system engineering, I&C, mechanical, electrical, metallurgical, fuel, thermal-hydraulic and reactor physics	1, 2, 3
Fuels	• To assess the safety of proposed fuel changes, including safety limits • Assess operational problems associated with fuel • Assess fuel cycle facility safety	Criticality, reactor physics, materials	1, 2, 4
Accident analysis	• To develop or acquire analytical tools for independent assessment of accident behaviour • To understand the physical modelling and its limitations • To maintain and upgrade analytical tools • To perform or have access to confirmatory experimental data	Thermal-hydraulic, physics modelling, code writing, analytical and conduct of experiments	2, 4

* Regulatory functions:
1. Oversight of operating reactors.
2. Modifications of operating reactors.
3. Plant life extension.
4. Licensing new reactors.

Regulatory area	Abilities supported by research	Research capability and expertise	Regulatory function*
Plant control and monitoring	To assess I&C hardware and software for reliability in various operational and environmental conditions	Instrumentation, software (including software quality) and hardware	2, 3, 4
Severe accident management	• To develop or acquire analytical tools for independent assessment of accident behaviour • To understand the physical modelling and its limitations • To maintain and upgrade the analytical tools • To perform or have access to confirmatory experimental data • To assess the consequences of accidents	Modelling, code writing, conduct of experiments analytical capability and broad knowledge of severe accident phenomena	1, 2, 4
External hazards (flooding, fire, earthquake, tornado, airplanes, wind, etc.)	To understand and model the phenomena	Seismology, meteo-rology, chemistry and structural engineering	1, 2, 3, 4

* Regulatory functions:
1. Oversight of operating reactors.
2. Modifications of operating reactors.
3. Plant life extension.
4. Licensing new reactors.

Regulatory area	Abilities supported by research	Research capability and expertise	Regulatory function*
Emergency preparedness	To assess onsite and offsite hazards to workers, public, society (e.g. transportation, industry, etc.) and the environment	• Broad knowledge of the nature and timing of radio-active releases and their dispersion and affect on humans and the environ-ment • Mathematical and physical modelling	1, 4

* Regulatory functions:
1. Oversight of operating reactors.
2. Modifications of operating reactors.
3. Plant life extension.
4. Licensing new reactors.

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