Challenges Faced by Technical and Scientific Support Organizations in Enhancing Nuclear Safety

Proceedings of an International Conference
Aix-en-Provence, 23–27 April 2007

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CHALLENGES FACED BY TECHNICAL AND SCIENTIFIC SUPPORT ORGANIZATIONS IN ENHANCING NUCLEAR SAFETY

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FOREWORD

Over the past two decades, the IAEA has conducted a series of major conferences that have addressed topical issues and strategies critical to nuclear safety for consideration by the world's nuclear regulators. More recently, the IAEA organized the International Conference on Effective Nuclear Regulatory Systems — Facing Safety and Security Challenges, held in Moscow in 2006. The Moscow conference was the first of its kind, because it brought together senior regulators of nuclear safety, radiation safety and security from around the world to discuss how to improve regulatory effectiveness with the objective of improving the protection of the public and the users of nuclear and radioactive material.

The International Conference on Challenges Faced by Technical and Scientific Support Organizations in Enhancing Nuclear Safety was held in Aix-en-Provence, France, from 23 to 27 April 2007. This conference, again, was the first of its kind, because it was the first to address technical and scientific support organizations (TSOs), the role they play in supporting either the national regulatory bodies or the industry in making optimum safety decisions and the challenges they face in providing this support. This conference provided a forum for the TSOs to discuss these and other issues with the organizations to which they provide this support — that is, the regulators and the operators/industry — as well as with other stakeholders such as research organizations and public authorities.

This conference can also be considered to have a link to the Moscow conference. The Moscow conference concluded that effective regulation of nuclear safety is vital for the safe use of nuclear energy and associated technologies, both now and in the future, and is an essential prerequisite for establishing an effective Global Nuclear Safety Regime. The Moscow conference also highlighted the importance of continued and improved international cooperation in the area of nuclear safety. These conclusions apply equally to TSOs, since their expertise is an integral part of supporting the regulatory decision making process over the entire life cycle of facilities and activities for the continuous improvement of safety.

On the basis of the presentations and discussions, the conference developed conclusions as well as recommendations for consideration by TSOs, regulatory authorities, national governments, relevant international and regional organizations, the nuclear industry and other stakeholders. This publication constitutes a record of the conference and includes: a summary, the opening speeches, the invited papers, and the conclusions and summary of the conference by the President. The attached CD-ROM contains the unedited

contributed papers and the presentations that were submitted with some of the invited papers.

The IAEA gratefully acknowledges the support and generous hospitality provided by the Government of France in organizing this conference.

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CLOSING SESSION

SUMMARY

The ideas for this conference were first discussed at a brainstorming session in Vienna with the heads of three leading organizations in this area, namely, J. Repussard of the Institut de radioprotection et de sûreté nucléaire (IRSN), France, L. Hahn of the Gesellschaft für Anlagen- und Reaktorsicherheit (GRS), Germany, and H. Nariai of the Japan Nuclear Energy Safety Organization (JNES). The discussions highlighted the need of technical and scientific support organizations (TSOs) for a dedicated conference to discuss the challenges they face in providing effective and proactive support to the organizations that rely on them for their expert services.

The objectives of the conference were to provide TSOs from different countries and other organizations and experts the opportunity to discuss and develop a common understanding of the responsibilities, needs and opportunities of TSOs; to explore appropriate approaches for addressing current and expected challenges in nuclear and radiation safety; and to discuss the roles, functions and value of TSOs.

This was the first international conference dedicated to TSOs. The President of the Conference was Li Ganjie, Vice Minister of the State Environmental Protection Administration (SEPA) of China, and Administrator of the National Nuclear Safety Administration (NNSA) of China. A total of 170 participants from 45 countries and 4 international organizations, and 2 observers participated in the conference.

The conference programme consisted of an opening session, four topical sessions and a concluding panel on Strengthening Technical and Scientific Support: Recommendations for the Future. The topical sessions were devoted to: roles, functions and value of TSOs; challenges faced by TSOs and TSO effectiveness; international cooperation, networking and the application of IAEA safety standards; and perspectives on the evolving needs for technical and scientific support.

In the opening session, there were three keynote addresses to set the scene for the conference and identify major challenges faced by TSOs and relevant stakeholders. The first keynote address, by P.B. Lyons, Commissioner of the United States Nuclear Regulatory Commission (NRC), presented the regulatory perspective on managing TSOs at the NRC. He pointed out that diverse challenges require diverse approaches and described the broad range of TSO support utilized by the NRC. He also highlighted the great value of collaboration between international bodies and TSOs and the need for regulatory bodies to determine their TSO support requirements. The second keynote address was by B. Thomauske, Managing Director of Vattenfall

Europe Nuclear Energy GmbH, Germany, on the perspectives of the operator/industry, in which he identified a number of factors affecting the roles of TSOs. These include: the expected nuclear power renaissance, the merger of some TSOs with energy producing companies and differences in standards and regulatory arrangements in different countries. The third keynote address, by M. Sené, Vice President of the Association Nationale des Commissions Locales d'Information (ANCLI), France, presented a local government perspective on ANCLI-CLI: Mediators of Access to Information and Expertise — A Tool at the Service of the Public. She described the history and activities of ANCLI and the Local Information Commissions (Commissions Locales d'Information, or CLIs), and emphasized the importance of a mechanism for permitting the expression of public views on major nuclear issues, including safety of reactors, waste management, radiation protection, transportation and protection of the environment.

The first topical session, on the roles, functions and value of TSOs, provided an overview of the role of TSOs in enhancing nuclear and radiation safety, and identified the main roles and functions of TSOs in supporting a regulatory body and/or the operator/industry. The second topical session, on the challenges faced by TSOs and TSO effectiveness, highlighted the increasing importance of the role of TSOs in global nuclear development and the need to identify current and future challenges and the means for addressing them. The conference identified several key challenges faced by TSOs related to globalization, regulatory aspects and management issues. These challenges seemed to fall into two categories, namely, those that are current or new challenges and those that have been present for a long time. The third topical session, on international cooperation, networking and application of IAEA safety standards, focused on continuous improvement of the technical and scientific capabilities and expertise of TSOs and the contribution of TSOs to the enhancement of the Global Nuclear Safety Regime. It emphasized the need for international cooperation and for performing research on safety related issues to maintain and enhance the technical capabilities and expertise of TSOs. The fourth topical session, on perspectives on the evolving needs for technical and scientific support, focused on the need for TSOs to keep pace with changes in nuclear technology, so that they can continue to provide optimum support for enhancing nuclear and radiation safety.

The concluding panel, Strengthening Technical and Scientific Support: Recommendations for the Future, addressed the following questions: What is the main contribution of TSOs in enhancing nuclear safety? What is the main challenge faced by TSOs? What should be done in the short and medium term to enhance TSOs?

The discussions clearly indicated that TSOs are seeking clarification with respect to their identity and their role and activities, and that they are requesting common guidance coordinated by the IAEA. The panel identified the following specific issues that require such guidance: the concept and definition of a TSO; clarification of terminology regarding TSOs; objectives and roles of TSOs and related needs for qualification and technical competencies; differences among types of TSO; human and financial resources; relationships of TSOs to regulatory bodies, industry, the public and other relevant stakeholders; legal, technical, organizational and management aspects of TSOs; independence, values and accountability of TSOs; activities of TSOs in the transnational context; and priority areas and modalities for international cooperation among TSOs.

The conference concluded that TSOs are playing, and will continue to play, an important role in the use of nuclear energy and associated technologies in a safe, reliable, secure and technically sound manner, and thus are an essential component of the efforts to achieve global energy security and sustainable development. The importance of the need of TSOs for a strong knowledge base and technical competencies, including adequate resources, was affirmed, and it was agreed that TSOs should be able to provide independent technical and scientific advice without pressure from external bodies. In addition, effective regional and international cooperation among TSOs was considered important in ensuring and continuously improving their ability to provide the services necessary for ensuring nuclear safety. It was further agreed that the TSOs should meet on a regular basis to discuss common challenges and to exchange and share experience.

The conference identified a number of recommendations to be considered by TSOs, regulatory authorities, national governments, relevant international and regional organizations, the nuclear industry and other relevant stakeholders. These are related in particular to: networking between TSOs and other relevant bodies to more effectively cooperate and share knowledge, experience and advice; cooperation among TSOs in developing common research work on nuclear and radiation safety using, where feasible, the existing frameworks, in particular those provided by the IAEA and the OECD/NEA; the role of international organizations in clarifying questions raised in Member States with respect to the roles and activities of TSOs in enhancing nuclear safety, and in the consideration of the relevant issues and approaches; the role of international organizations in facilitating peer review and self assessment approaches for TSOs; adoption of management systems, especially qualification procedures, by TSOs to maintain credibility and competence; and the provision by TSOs of continuing support to the IAEA in conducting activities related to nuclear installations and radiation safety, security and protection of the environment.

The need for a follow-up conference, in about three years, was emphasized by several participants, with the objective of reviewing the progress made and identifying fresh challenges and solutions.

OPENING SESSION

OPENING ADDRESS

H. Revol
Senator for Côte d'Or and
Chairman, Parliamentary Office for Evaluation of Scientific and
Technological Options (OPECST),
Paris, France

On behalf of France, I would first of all like to thank the IAEA for selecting our country to host the first international conference on technical and scientific support organization (TSO) priorities to enhance nuclear safety in the future. I would also like to welcome all the delegates to this conference, which justly deserves to be called an international conference, as some sixty countries are represented here. I would like to thank the organizers of the conference and, first and foremost, the Institut de radioprotection et de sûreté nucléaire (IRSN), which has brought to a successful conclusion this extremely important initiative for the much needed strengthening of links among all the global actors in the nuclear sector, the cornerstones of which are the nuclear safety authorities and their TSOs.

As a Senator reporting to the Senate on several laws on energy, on the organization of nuclear safety and on the sustainable management of radioactive waste, and as Chairman of the Parliamentary Office for Evaluation of Scientific and Technological Options (OPECST), your conference seems to me to be particularly timely, since nuclear energy is having to face numerous challenges, most of which involve safety.

First, I would like to inform you about the progress France has made over the past two years in the field of nuclear energy. In France, 2005 and 2006 were major years for the nuclear industry. A number of basic laws concerning the future of the nuclear sector and its organization were passed in 2005 and 2006.

Second, based both on my experience as a nuclear engineer, the profession that I have followed at the Commissariat à l'énergie atomique (CEA) for almost 25 years, and on the work of the OPECST, I would like to underscore the following issues, which, from my point of view, will be the main technical expertise issues for the safety authorities in the coming years: radioactive waste management, the ageing of operating reactors; the replacement of existing reactors and the development of new reactors, and the construction and operation of reactors in new nuclear countries.

RECENT LAWS CONCERNING FRANCE'S NUCLEAR SECTOR

In France, three basic laws concerning the future of the nuclear sector have recently been passed: the programme law of 13 July 2005 establishing the energy policy guidelines, the law of 13 June 2006 on nuclear transparency and security, and the programme law of 28 June 2006 on sustainable management of radioactive material and waste.

The programme law of 13 July 2005 establishing the energy policy guidelines

Through the programme law of 13 July 2005, France has established its energy policy guidelines, which comprise four main objectives: the management of energy demand, diversification of supply sources, research in the energy field and the development of means of energy transport and storage.

As you certainly know, nuclear electricity accounts for 78% of France's electricity generation and provides 42% of national primary energy consumption. It was therefore of the utmost importance that the law set for the State the objective of keeping the nuclear option open up to 2020 by having a new generation nuclear reactor in operation by around 2015, thereby enabling the option of replacing of current generation reactors. This reactor will be the AREVA European pressurized water reactor (EPR), built at Flamanville by EDF, authorized by the Government on 10 April 2007.

The law of 13 June 2006 on nuclear transparency and security

The second basic law for the nuclear sector, the law of 13 June 2006 on nuclear transparency and security, has provided the much needed legislative framework for nuclear security and transparency, while at the same time reforming governance in the sector.

In the field of radiation protection, the law of 9 August 2004 on public health established the three principles of optimization, justification and limitation for radiation protection, while in 2002, the services responsible for radiation protection were amalgamated with those responsible for nuclear safety within the nuclear safety authority, and in 2001, expertise in radiation protection was fused with expertise in nuclear safety.

Prior to this law, however, nuclear activities in the field of nuclear safety were for the most part regulated on the basis of a 1963 decree and good management and operating practices. As regards the basic nuclear facilities, the principle of operator responsibility established by the 1963 decree has been progressively defined in more detail, strengthened and supplemented. The law of 13 June 2006 has finally provided the appropriate legislative framework for nuclear security and transparency, at the same time improving safeguards.

Finally, the law of 13 June 2006 has established the nuclear safety authority within the State as an independent administrative authority, whose main role will be to provide advice, at a technical level, on the safety and radiation protection regulations and to ensure compliance with them by the nuclear operators.

Thus, by providing the civil nuclear sphere with a legislative framework that is as rigorous as its management from the technical point of view, the law strengthens confidence in nuclear energy, which alongside its economic importance has distinct advantages in efforts to deal with climate change.

The programme law of 28 June 2006 on sustainable management of radioactive material and waste

The third basic law for the future of the nuclear sector in France, the programme law of 28 June 2006 on the sustainable management of radioactive material and waste, establishes an overall long term framework for both the research that is still needed in these areas and the practical implementation of operational facilities.

Within the general framework of the French option for waste treatment/recycling, the law prescribes the creation of storage facilities — temporary solutions — by 2015; the construction of a reversible, deep geological layer repository — final solution for long lived high or medium level waste — for 2020–2025; and the commissioning of an industrial separation and transmutation service by 2040.

In addition to reaffirming the importance of research, especially into the separation and transmutation of long lived high level waste, the law stipulates the ways of attaining an optimum result for radioactive waste management.

A general framework, entitled the national programme for the management of radioactive material and waste (PNG-MDR), is given for the 'back end' of the fuel cycle and for all radioactive waste. Legal security is ensured through clear definitions of the various radioactive substances and treatment operations authorized for foreign fuels. Various types of information level for radioactive waste management are given at the local level for the underground repository research laboratory and at the national level with the new National Evaluation Commission. The missions of the National Radioactive Waste Management Agency (ANDRA) have been expanded, including the possibility of responsibility for storage. Finally, a clear system for financing the research and the construction of storage and disposal centres has been put in place with the creation of two dedicated funds in ANDRA's accounts and the securing of dedicated assets from the radioactive waste producers.

Thus, 2005 and 2006 were major legislative years for the nuclear sector in our country. The stage has been clearly set. There is a solid legal framework for nuclear activities. The relevant authorities establish the nation's nuclear framework and options. The Government has the responsibility and the means to deal with emergencies. The nuclear safety authority is independent of the ministers. The State remains the sole guarantor of nuclear security.

Within this clearer and updated framework, the technical support provided by the nuclear safety authority, the IRSN, created in 2001, is gradually finding its feet. There is no doubt that, like all the global institutions providing expertise, its assistance will be much sought after in the years and decades to come in view of the anticipated nuclear power developments in the world.

FOUR CRUCIAL ISSUES FOR TECHNICAL EXPERTISE IN NUCLEAR SAFETY

Since 1989 the OPECST has been monitoring nuclear activities closely, not only the organization of safety and radiation protection supervision, but also at the industrial level — power plant operation and design of new reactors — and concerning radioactive waste management.

In making reference to French Parliamentary work, I would like to underline what we view as the main challenges ahead regarding nuclear safety expertise. Limiting myself just to the main ones, I will cite four challenges: radioactive waste management, the ageing of reactors now in service, preparation for the new generation of reactors and, finally, expansion of the civil nuclear sector in countries now opting for this energy form.

In all cases, international cooperation is an imperative. The IAEA has laid the groundwork with INSAG (International Nuclear Safety Advisory Group) for this purpose. Your conference, I am pleased to say, will help us go further.

Radioactive waste management

As I have already indicated the progress made by France in the sphere of radioactive waste management, I will be brief on this matter. In my view, international cooperation must undergo rapid strengthening in this sphere. It goes without saying that radioactive waste management modalities are to a great extent dependent upon the industrial choices made — direct disposal of spent fuel or waste treatment and recycling — and on the specific geological and national sociological circumstances.

There is, however, a body of methods and know-how that our countries are interested in sharing widely. The CEA's commitment to international cooperation is long-standing and well known. I would simply like to underline that, under the law of 28 June 2006, ANDRA has been given the mandate to disseminate its know-how abroad and will therefore be prepared to share, as widely as possible, the methods and techniques that it has developed.

The challenge of ageing nuclear power plants

On average, the world's nuclear power plants are still young. The weighted average age of the 436 reactors currently in operation is 24 years. However, 114 reactors — that is, 20% of global installed nuclear capacity — are 30 or more years old.

In the case of France, it is known that the design lifetime of the second generation reactors currently in service is 40 years. The third ten-year safety review of our oldest reactors, due to take place at the end of the decade, will therefore be extremely significant, as its lessons and the cost–benefit ratio of the work to be done will determine whether their operation will be extended or brought to an end. The problem of ageing nuclear reactor components is an absolutely crucial safety issue.

The IAEA is already addressing these issues. INSAG report No. 14, which deals with the safe management of the operating lifetimes of nuclear reactors, presents a set of organizational principles and rules. INSAG report No. 19 deals with maintaining the integrity of nuclear installations throughout their operating life. One might wonder whether, on the basis of these not insignificant grounds, the TSOs could not go further and strengthen their cooperation on a practical level, while of course respecting the imperatives of intellectual property and industrial confidentiality.

In any case, while the material aspects of the nuclear reactor ageing problem are crucial to safety, there is another issue that will have to be addressed by the TSOs, namely, ensuring the continuity of competencies and training, which needs to be done to replace the large numbers of retiring nuclear engineers, researchers and power plant operators.

In this non-material field, probably even more so than in the field of technical knowledge of nuclear power plant materials and components, international cooperation can only be of benefit to all Member States. The IAEA can obviously play a major role in ensuring effective dissemination of information and the transfer of good methods and practices for training in nuclear techniques.

The challenge of replacing nuclear power plants

The third challenge to which TSOs will have to pay particular attention in the coming years is the replacement of nuclear power plants, a necessity that looms on the horizon.

The full or partial dismantling of the current facilities will be a requirement, where expertise in nuclear safety will have a vital role to play. Since this affects everyone, there is no doubt that international cooperation will be of great use in the development of better methods and knowledge transfer.

Another key area for expertise in nuclear safety in the coming years is the fourth generation reactors, which should enter into commercial service around 2040. These include supercritical water cooled reactors, high temperature reactors, fast reactors and molten salt reactors. These reactors will be very different from the bulk of the second generation reactors currently in service.

Based on different principles and aimed at passive safety, their safety cannot be inferior to that of the existing reactors, and passive safety will need to be assessed in detail by the TSOs. This will involve, in particular, a large number of material and system tests, and the development of numerical models and verification of their relevance, which are essential large scale tasks that the TSOs should tackle without delay so that demonstration models will be ready by 2020. INSAG addressed this matter in its report No. 16 on maintaining research in the field of nuclear safety.

A considerable challenge that must not be overlooked is to ensure, in the context of the budgetary difficulties that most nuclear countries are facing, rigorous and effective research in this field. A difficult but essential objective is finding a mechanism for smooth networking among TSOs, research organizations and industries, not only at the national level, but also at the international level, as the safety issues are so difficult and critical and the investments are so large. The prospective safety of fourth generation reactors is undoubtedly one of the most exciting elements of TSOs' responsibilities.

The challenge of civil nuclear expansion in non-nuclear countries

The final area that will be of immense importance in the coming years is, from my point of view, reflection on international cooperation to establish TSOs in countries opting for nuclear power. INSAG addressed this issue indirectly in its report No. 17 on independence in decision making for safety authorities.

I hope that your conference will call for a strong commitment by governments and all nuclear actors to collaboration and cooperation among the various countries that stand to benefit from pooling certain nuclear safety research and development costs. This essential cooperation could, in particular, take the form of joint investments in research reactors, which are essential for developing reliable safety assessment codes and for keeping pace with technological developments as they occur. It will be beneficial to everyone to share with the new nuclear countries in-depth knowledge of safety, which the international community should be acquiring constantly.

CONCLUSION

Nuclear power contributes only 6% of the world's primary energy consumption and 16% of global electricity generation. However, nuclear power plants and the associated fuel cycle are responsible for only 3% of global CO_2 emissions,[1] and natural uranium reserves are sufficient for 170 years of consumption at the current level using second and third generation reactors, and several millennia using fourth generation reactors.

It is progress in nuclear safety that will put an end to this untenable paradox in the long term for humanity as a whole. I believe that expertise in nuclear safety is and will continue to be of vital importance for the future of the planet in terms of energy.

This international conference organized by the IAEA with the support of the IRSN on the priorities of TSOs in the coming years is extremely important for the world's energy future. I hope that you all have excellent discussions and that there is much creativity in defining the new paths ahead and in proposing strong recommendations to our governments.

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[1] Global annual CO_2 emissions are estimated at 25 billion tonnes. Emissions from nuclear power plants (construction) and the fuel cycle are estimated by the Energy Information Administration of the U.S. Department of Energy at 30 g/kW·h produced. Global electricity generation is approximately 15 000 TW·h. Nuclear power makes up 16% of global electricity generation.

OPENING ADDRESS

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International Atomic Energy Agency,
Vienna

On behalf of the International Atomic Energy Agency, I would like to welcome you to Aix-en-Provence and to the International Conference on the Challenges Faced by Technical and Scientific Support Organizations in Enhancing Nuclear Safety. I would like to thank the Government of France and especially the Institut de radioprotection et de sûreté nucléaire (IRSN) for hosting the conference.

As you are all aware, the IAEA has organized many international conferences to address nuclear regulators, operators/industry and users of nuclear applications, and continues to do so. However, this is the first international conference to address technical and scientific support organizations (TSOs). The ideas for this conference were first discussed at a brainstorming session in Vienna with the heads of three leading organizations in this area, namely, J. Repussard of IRSN in France, L. Hahn of the Gesellschaft für Anlagen- und Reaktorsicherheit (GRS) in Germany, and H. Nariai of the Japan Nuclear Energy Safety Organization (JNES). Technical and scientific support organizations needed a dedicated conference to discuss the challenges they face in providing effective and proactive support to the organizations that rely on them for their expert services.

At this juncture, I would like to briefly look back on an important and related conference, the IAEA Conference on Effective Nuclear Regulatory Systems — Facing Safety and Security Challenges, held in Moscow in 2006. The Moscow conference concluded that the delivery of effective nuclear safety regulation is vital for the safe use of nuclear energy and associated technologies, both now and in the future, and is an essential prerequisite for establishing an effective Global Nuclear Safety Regime. The Moscow conference also highlighted the importance of continued and improved international cooperation in the area of nuclear safety. These conclusions apply equally to TSOs, since their expertise is an integral part of supporting the regulatory decision making process over the entire life cycle of facilities and activities for the continuous improvement of safety.

The scope of this conference encompasses the entire spectrum of nuclear safety, that is, nuclear installation, radiation, waste and transport safety, as well as emergency preparedness and response. In addition, as can be seen from the programme, this conference will address not only those TSOs providing expert services to the regulators, but also those supporting the operator/industry and those involved in safety research. These globalized roles of TSOs and the associated questions related to their independence will, I am certain, lead to some interesting discussions that are very relevant in the framework of the current and future development of the Global Nuclear Safety Regime.

CURRENT SITUATION AND DEVELOPMENTS

This conference is taking place against the backdrop of a changing world and globalization, especially in the areas of safety, technology, information, and public and media concerns. This situation presents both opportunities and challenges. We are currently going through a period of so-called nuclear renaissance, with new builds being considered both in countries with experience in operating nuclear power plants and in countries new to the use of nuclear power with very limited experience. In this context, the options of both new technologies and new designs are being debated. There is also a rapid expansion of the use of radiation technology, more so than in the case of nuclear facilities, especially in the medical and industrial areas. This is why I prefer to use the phrase ‘vita nova’ rather than ‘renaissance’, which requires fresh insights, overcoming old mindsets and promoting modest but careful consideration.

In view of these developments, I continue to be concerned about the widening gap between the rapidly increasing number of ambitious nuclear development plans and the absence in many places of corresponding plans for nuclear safety arrangements. I am also concerned about the status of aged facilities and supporting infrastructures in some Member States. Existing infrastructures need to be carefully re-evaluated and enhanced in the light of the large potential, both positive and negative, for new builds as well as ageing facilities and organizations.

At the beginning of March 2007, the Nuclear Safety Review 2006 was presented to the IAEA Board of Governors. The overall theme of the Review continues to be the increasingly global nature of the issues and challenges relating to nuclear safety. Since the tragic Chernobyl accident in 1986, a strong consensus has emerged in the nuclear safety area that we are all literally ‘in the same boat’. This accident evidenced that an accident anywhere is an accident everywhere. Therefore, the nuclear community has to make all efforts in concert to continue to improve nuclear safety worldwide and to avoid another serious accident.

The acceleration of change has led to a large accumulation of experience and knowledge, and the opportunity for improvements. However, this experience and knowledge is being neither adequately shared nor fully utilized. Considering the limited resources of the world nuclear community, the experience and knowledge needs to be better shared as a global common asset. I firmly believe that experience and knowledge are significantly increased rather than decreased through wider sharing and utilization.

STRENGTHENING TECHNICAL AND SCIENTIFIC SUPPORT

This conference is all about technical and scientific support and how best to strengthen the capacity, mechanism and process of this support. One of the essential prerequisites for this is the pooling of knowledge and research resources. This must be the starting point to achieve a critical mass to lead to a chain reaction for tangible improvements and clear mutual benefits. Mechanisms need to be set in place to promote mutual learning and feedback. Proper consideration should be given to developing a well organized and user friendly knowledge base with the associated arrangements for easy access to information and active interaction between the participants.

Effective technical and scientific support, whether it is for the regulator or the operator/industry or through safety research, also implies building confidence and respect not only for TSOs but also for the supported organizations and the relevant stakeholders. The measures to build and constantly maintain confidence, especially among the communities of experts and among the public, need to be taken extremely seriously and should be part of the mission statement.

NETWORKING

A prerequisite for better recognition of the TSOs and their services is that the TSOs themselves strive to keep their knowledge current and in tune with the latest developments. This brings me to the topic of networking and knowledge sharing. Networking is essential for sharing and learning, as well as for creating new knowledge and for innovative improvements. Networking should not be just among the TSOs but should be extended to include other research and academic institutions.

Today, there is a common perception that a strong and sustainable Global Nuclear Safety Regime rests in the legally binding and non-binding international instruments, the IAEA safety standards and their application, national safety infrastructures, and arrangements for vigorous sharing of knowledge and experience. The concept of a Global Nuclear Safety Regime also recognizes that, just as the safety risks inherent in nuclear activities extend beyond facility fences and national borders, nuclear safety strategies must firmly incorporate international cooperation for standard setting, their application and feedback, and information networking. We must learn from each other, and we must continually stimulate each other towards greater effectiveness to maintain a high level of safety.

The IAEA has facilitated the development of a variety of knowledge networks, among which two could serve as good examples both for regional networking and for the further development of a Global Nuclear Safety Network. These are the Asian Nuclear Safety Network (ANSN) and the Ibero-American Radiation Safety Network. Such networks are established to promote pooling, analysing and sharing nuclear safety knowledge and experiences at the national, regional and international levels.

In terms of international cooperation, I was pleased to receive a letter earlier this year from the GRS, the IRSN and the Association Vinçotte Nucléaire (AVN) of Belgium informing me that they have decided to form a dedicated network called the European TSO Network. They further informed me that:

> “The aim of this network is to promote and develop European scientific and technical cooperation between the TSOs in the field of nuclear safety. This will be achieved by systematically exchanging, in particular, R&D (Research and Development) results and experience in connection with the operation of nuclear facilities and safety assessments by promoting a harmonisation of nuclear safety assessment practices in Europe, and by encouraging initiatives to define and implement European research programmes”.

The GRS, IRSN and AVN have thus intensified the cooperation among the three TSOs, with a view to also opening this cooperation to other TSOs in Europe. I find these to be very encouraging developments that enhance the Global Nuclear Safety Regime. I was also pleased to be informed about the Western European Nuclear Regulators’ Association (WENRA) initiative to improve the sharing of operational experience and R&D results in Europe through the Petten Centre. What is now needed is an effective overall configuration of international nuclear safety knowledge networks. I welcome international cooperation in nuclear safety research to better meet the enormous challenges in the nuclear safety field today, and this could counter-balance, and possibly reverse, the declining trend of safety R&D investments.

Another important aspect that needs to be considered is the closer link between the TSOs and the academic and other expert communities in finding viable solutions to safety problems.

GLOBAL NUCLEAR SAFETY REGIME

Germany, as the current chair of the G-8 and as the country currently holding the presidency of the European Union, has floated an initiative towards further developing and strengthening a Global Nuclear Safety Network. This would build upon the vision of the Global Nuclear Safety Regime.

Global regimes are based on a wide range of national and international actors working to achieve shared goals while preserving and complementing the sovereignty, authority and ultimate responsibilities of States. However, it should be noted that the primary responsibility for safety rests with the operator/industry and the users of nuclear technology. The relevant actors also include non-governmental and intergovernmental organizations, communities of experts and civil society. The IAEA has been supporting the development and enhancement of a Global Nuclear Safety Regime based on four principal elements: (i) the widespread subscription to legally binding and non-binding international instruments such as the conventions and the codes of conduct; (ii) a comprehensive suite of nuclear safety standards that embodies good practices as a reference point for the high level of safety required for all nuclear activities; (iii) a suite of international safety reviews and services based on the safety standards; (iv) the need to ensure strong national infrastructures and a global community of experts. National infrastructures include appropriate legal and institutional aspects, particularly the nuclear regulatory body, research and educational institutions, and industrial capability. Self sustaining safety networks of expert knowledge and experience connecting these four elements are essential to continuous safety improvement and mutual learning. The IAEA serves as the principal actor for the second and third elements, and strongly supports network connections among all four elements. In this context, advantage is being taken of the newly published Fundamental Safety Principles to ensure an integrated safety approach.

Technical and scientific support organizations should assume a more active role in this set-up. They are part of the governmental and operator/industry infrastructure and also serve as an important part of the global community of (nuclear) experts. Technical and scientific support organizations could more actively participate in the establishment and revision of safety standards, especially the Safety Guides, and in the application of safety standards. With their knowledge and expertise, experts from TSOs could make a valuable contribution to international safety reviews and services, as well as to the national efforts related to the conventions and codes of conduct. In the case of the conventions, the support would primarily be towards preparing and reviewing the national reports. This entire area has perhaps not yet benefited from the perspective of the TSOs, as participation in these activities has been more or less limited to the players directly involved, that is, the regulators, the operator/industry and the users of nuclear applications. I would like to encourage governments, as well as TSOs, to explore the possibilities for TSOs to play a larger role in enhancing the effectiveness of the Global Nuclear Safety Regime.

SUMMARY AND CONCLUSION

In summary, I would like to leave you with several thoughts that could shape the outcome of your deliberations this week: (a) networking among TSOs to share safety related information, knowledge and resources, thus ensuring effective support for the regulators and improving safety; (b) identifying and addressing the safety research needs, and possibly the associated education and training; (c) ensuring adequate competence and independence of the TSOs in providing technical and scientific expertise/ advice; (d) building and maintaining confidence among the communities of experts and the public; (e) increasing the role of TSOs in the establishment and revision of the IAEA safety standards and their application, and in the national efforts related to the implementation of conventions and codes of conduct; (f) supporting the creation and enhancement of the safety infrastructures in those countries with limited nuclear experience that are embarking on the use of nuclear power.

Your programme committee has worked hard to come up with a useful agenda, for which I would like to thank them. I also thank Li Ganjie, Vice Minister of the State Environmental Protection Administration (SEPA) of China, and the Administrator of the National Nuclear Safety Administration (NNSA) of China, for agreeing to be the President of the Conference.

I wish you all a successful conference.

OPENING ADDRESS

TSOs: A BRIGHT IDEA TO HELP MEET NUCLEAR SAFETY CHALLENGES IN A FAST CHANGING INTERNATIONAL ENVIRONMENT

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I would like to contribute some initial ideas on the goals we are trying to achieve through this conference. In my view, the question is not so much what the international community can do for technical and scientific support organizations (TSOs), but what TSOs can do for the international community. What can TSOs do to enhance nuclear safety in a fast changing environment?

There is a lot of talk about ‘nuclear renaissance’ at the moment — I note the new expression ‘vita nova’. In many countries however, the ‘new build’ decision has not yet been made; it is still in the making. Such new developments, if they occur, will follow two different historical phases of nuclear energy development.

The 1970s saw the first major deployment of operational reactors for producing electricity and, at the same time, the initial codification of nuclear safety, which was done mostly in the United States of America (USA) — and we are grateful to our US colleagues for this investment in safety through scientific tools and analysis methods. This deployment was made possible in a number of countries mainly because the USA allowed other countries to use their safety approaches with the permanent support of the IAEA, which was one of its missions. Then came the near accident at Three Mile Island and the accident at Chernobyl. This led to a freeze in public confidence in nuclear power and, consequently, a freeze in new investment. Nevertheless, at the same time — and this is often forgotten — there was a surge in research on safety because it became clear that the initial codification had not gone into sufficient depth to take into account, for example:

— Human factors;
— Organizational factors;
— Some accident scenarios and phenomena for which safety margins had been estimated, but clearly not in an adequate manner.

In that period, there was also a lot of work performed in the field of international legislation, with the Convention on Nuclear Safety, and a number of nuclear power countries started to develop stronger national legislative bases for nuclear safety and radiation protection.

Today, we may be approaching (2010s) a new build era, with new Generation II and III reactors and even the start of the operational configuration of Generation IV reactors. However, in a kind of reversal of the situation after Chernobyl, when there was a lot of research on safety but a freeze in private investment in new nuclear power stations, we are seeing comparatively less emphasis given to safety and radiation protection research for the future, to accompany future reactors. But safety cannot be static. Without safety progress, there may difficulties ahead.

So what are the main conditions that have to be met in order to have a sustainable nuclear future? First, it is up to the industry to demonstrate the economic performance of nuclear power, thereby providing competitive and reliable conditions for electricity generation. There are other possibilities for carbon free electricity, so nuclear may well have a role to play, but it must demonstrate its actual competitiveness. Second, sustainability also means that the industry has to look at the optimized use of national resources. There is not an endless supply of uranium, and prices may vary substantially. Therefore, the optimal use of the energy initially contained in uranium and the resulting choice of nuclear fission technologies will be key for the future. These elements are mainly in the hands of the industry.

However, there are four other conditions that concern not only the nuclear industry but also governments:

— The first two relate to the very high levels of nuclear safety and nuclear security that will be expected. This is a key demand from the public, and it was also a key demand during a debate in Parliament in France last year. This is clearly an objective that has to be written into legislation and technically achieved afterwards.
— In other respects, radiation protection must continue to be maintained at the highest level for workers, the general population and the environment. It is not coincidental that the International Commission on Radiological Protection (ICRP) has recently issued a new set of recommendations that follow the line of trying to maintain clear, applicable and simplified rules for maintaining high levels of radiation protection.
— Then there is the issue of high activity, long lived radioactive waste. Senator Revol mentioned that waste management was a key issue in nuclear energy production. It is a key factor in the public perception of the usefulness of nuclear energy produced in a sustainable way, and this

develops into two issues: that the optimal technology should produce as little toxic waste as possible, and that final waste having no more potential for use should be eliminated in a manner acceptable to the society. This is not an easy matter, because it means looking at long term risk issues for future generations, and this is not a subject that is easily grasped by the public or even by parliaments. There was a lot of work done recently in France, with very interesting results, but the debate was not easy to perform, and it is fortunate that we have some key Members of Parliament who are very knowledgeable about the technical issues, so that the political debate could be conducted taking into account the technical issues as well.

These conditions for success will raise four interrelated challenges that cannot be treated separately:

— First, one needs the technology. We cannot advance with future nuclear reactors without available, trustworthy and economically viable technology. This is the business of public and private R&D operators.
— Second, we cannot develop technology without ‘people’ and ‘money’. A country may develop concepts with limited resources, but when it comes to constructing reactors, the engineering capacity that has been rapidly disappearing over the past twenty years needs to be resurrected. With the construction of the European pressurized water reactor (EPR) in Finland, we see that it is not easy for the industry to become efficient all at once. Skills have disappeared since the 1980s, and a lot of effort, people and money are needed for training.
— The third and fourth challenges are again partly in public and partly in private hands:
  - There will be no significant future for nuclear power without sufficient public acceptance. Public acceptance is not reached just by giving information to the public; it is actually about creating a climate in which the general public understands enough about the issues and a majority supports the policies. The public is becoming better informed through the Internet, associations and the like, and they will need facts if they are to believe that safety will be ensured worldwide. As Mr. Taniguchi said, nuclear safety and security is not a national issue, it is an international issue.
  - Finally, there will be no nuclear new build if there is no efficient licensing process. The licensing process has to meet some conditions, too: it has to be predictable and transparent for capital to be freely invested in nuclear rather than other forms of energy. But the licensing

process should be not only transparent but also effective in achieving long term safety in a way that does not require that the wheel be reinvented each time a new reactor is built in another country, but rather in a way such that safety increases with regulatory experience and associated research.

These are four key challenges that will have to be met in the coming years. To meet these four challenges, the use of TSOs may prove to be a flexible and sustainable concept that could provide support on some points to the public, authorities and the industry, at both the national and international levels. The TSOs can, in effect, be a bridge between safety authorities and operators and licensees, from the concept development stage to the licensing process itself. Technical and scientific support organizations maintain the experts and scientific resources that allow the pre-licensing dialogue to take place between the TSOs in an open environment. This was done, for example, for the EPR development.

When the idea of the EPR came about between France and Germany, there were two complementary approaches. One was an industrial approach, where the companies, Siemens and what later became AREVA, were invited to work together to produce a new concept. At the same time and in parallel, the German and French Governments asked their TSOs (the Gesellschaft für Anlagen- und Reaktorsicherheit (GRS) and, at that time the Institut de protection et de sûreté nucléaire (IPSN), respectively) to work together to jointly develop the safety and radiation protection requirements for the new reactor. The combination of these two approaches led to clear-cut innovations in both the industry and the licensing process. The French licensing process has taken on board many ideas that were of German origin. We, in the IRSN, see the added value of cross-cutting bilateral cooperation on many themes, which has created a very rich environment in which the safety of future reactors has progressed from the previous generation. I do not believe this could have been achieved without the parallel work of both the industry and the TSOs. This took place during the pre-licensing phase. Now, during the proper licensing process, GRS is still involved in the French licensing process through its cooperation with the French organizations.

Technical and scientific support organizations are also a bridge between research and operating experience feedback. Operating experience feedback is like having a rear-view mirror in front of the driving seat. While you need the results of operating experience, you mainly have to look forward, and not just by extrapolating from the rear-view mirror for short term anticipation. You look forward in time to the next twenty years; you look forward to new scientific approaches and codes, to making use of the latest scientific discoveries, computing capacities and so on. Technical and scientific support organizations have the ability to bridge the research community, which is very wide, and match that with operating experience feedback and the concrete issues at hand concerning the licensing process.

There is also the issue of a dialogue on technical questions between the authorities of different countries. It is sometimes practical for authorities to develop a dialogue via TSOs. At times it is a way of avoiding administrative issues — and technical dialogue tends to raise less political issues. A technical approach through TSOs has, on some occasions, proved to be efficient. For example, when the East European countries started their process of joining the European Union (EU), or when it was deemed necessary to build closer links between the EU and Ukraine and Russia, there was a development that allowed PSM and GRS — French and German TSOs in cooperation with others, particularly the Association Vinçotte Nucléaire (AVN) in Belgium — to develop a joint approach, whereby a TSO service was provided by the EU to the Governments and safety authorities of the East European countries and Ukraine and Russia in order to enhance nuclear safety in those countries. There was a political objective that was fulfilled through a technical cooperation process involving West European TSOs.

Technical and scientific support organizations are also a place where it is possible to open a neutral technical dialogue between the authorities, licensees and stakeholders, including the media. This is one of the ways public confidence can be built up. In France, the Commissions Locales d'Information (CLIs) that exist near each nuclear facility have been encouraged by the recent legislation. The CLIs discuss technical issues, and they not only listen to the operator and safety authority, but they also raise questions of their own. To be able to raise the right questions, they need access to some technical support as well. The IRSN's mission is also to provide some technical support to the CLIs. In a wider sense, we contribute to public information, mainly through the media and our web sites.

Having mentioned the IRSN, I will just say a few words about the institute, which, I am proud to say, could be one of the examples of a modern TSO in support of, mainly, the public authorities. As Mr. Revol said, the IRSN was created by the law of 2001, and today we have a status that guarantees our independence of judgement. The IRSN reports to the Government. The nuclear safety authority is an independent administrative body, and its ties with the IRSN are not reporting ties but ties of a contractual nature — they ask for the technical support they need, and we provide expertise in response. We maintain total independence of judgement, which means there is no undue pressure concerning what we should say in our assessment reports. It is clear that our role also is to alert them to different issues: we may raise questions of our own and draw their attention to potential difficulties, if we feel there is a need.

In this system, the TSO is in a permanent dialogue with the industry for the preparation of the assessment: the assessment of safety files is not done the purely on paper, there are a lot of exchanges of technical information with the industry.

Through our research departments, we also maintain close links with AREVA, CEA and EDF on R&D issues related to safety and radiation protection. This concerns both existing facilities and future projects, such as Generation IV concepts. Such scientific programmes do not form part of any formal licensing process; they just prepare for the future, and this often proves extremely useful.

The IRSN has a very wide field of competencies that allows us to have a broad vision of safety, security and radiation protection issues. Indeed, in my view, one of the key values of a TSO is to be able to have a comprehensive view of the issues at hand, rather than a narrow expert view.

We also try to maintain the right balance between operational duties in support of authorities and research. This allows us to plan for the future and provide the best available assessment technology.

Finally, we are deeply involved in European cooperation. Mr. Taniguchi made a reference to the European TSO Network, which was formally launched last year and which is open for wider membership across Europe and internationally. I am very happy that Mr. Taniguchi very quickly picked up the idea of a TSO conference, which we discussed last year, and I hope this is the beginning of a new road. There is a lot of bilateral cooperation in which the safety authorities are also usually involved.

Naturally, there are other types of TSO, and different kinds of organization exist in different countries. So, when you look at it as a whole, the TSO concept is still not very consolidated, and we therefore need to develop some doctrine and some key values for the development of TSOs — independence of judgement, for example. The IRSN was created following the concepts initially developed by the US National Academy of Sciences, which said that when you deal with risks in a public policy process, the evaluation of the risk should be a function separate from the decision making on risk management. This was a key finding by the US National Academy of Sciences, and it was implemented in France in a number of reforms that were mainly focused on public health issues, but it was also used in the field of nuclear safety.

Can such a concept be made apparent internationally? It is not a question of organization, it is a question of functionalities. Is a TSO only a support function for resources the authority or the industry does not have? Or is it a function in its own right, to promote efficiency, effectiveness and public confidence? These are two different approaches:

— One is pure support — you lack something that you can find outside, so you subcontract.
— The other — which is much more ambitious — takes care of a function that is recognized as a significant parameter for achieving a high level of nuclear safety.

We are dealing today with very different situations worldwide. Some countries have established TSOs, with different types of organization. Some TSOs are embedded in the framework of the authority, and in that framework the functions of TSOs are sometimes quite apparent, while at other times they are not so clear. There are other countries where there are no TSOs, and some countries considering new build today do not have much experience and so are looking to have a TSO abroad and avoid creating their own TSOs. Is this a wise solution? Should networking be encouraged between TSOs? This conference should try and answer such questions.

Another point is that it is sometimes difficult, today, to know whether you provide a good service or not. There is no reference for performance assessment of the TSO function. The TSO function is not clearly defined, but even if it were, there is no reference model to evaluate whether we perform well or not. So we probably need something similar to the Integrated Regulatory Review Service (IRRS) or peer assessment or self-evaluation — some form of agreed tools to benchmark the performance of TSO services.

Finally, there is very little written about the key requirements for good technical expertise support. This has to be worked on further, and I believe this should become an agenda item for international organizations. This conference will not solve everything by the end of this week, but it will hopefully open up some avenues and gather some consensus about key elements for further discussion. The concepts of TSOs in support of authorities should be further clarified. I think this is a more complex question than the role of TSOs in supporting the industry, because it concerns the questions of involvement in the licensing process, independent judgement and public confidence. There are no such issues concerning TSO support to the industry. You have to set an improved basis for cooperation between TSOs — I think guidelines would be very useful — and also for sharing development of high level scientific and technical expertise resources. And of course, there is the issue of organizations that perform tasks for both authorities and the industry.

Cooperation should be a keyword to avoid redundancy of efforts. Money is scarce. Mr. Revol mentioned that public budgets in many countries are tight and getting tighter, yet there is a need to support nuclear safety through technical investment. However, we should not repeat the errors of the past, and perhaps there should be an international objective to develop, in a timely manner, the safety codes of the future. Usually the result of international cooperation is better than that of any single country's effort, if it is a proper active cooperation. We should pool research facilities and consider a road map for renewing key infrastructures for nuclear safety research. The OECD Nuclear Energy Agency (OECD/NEA) has a committee dealing with these issues, but it does not have a sufficiently visible agenda for the needs of the future development of nuclear safety tools. We need codes that take advantage of the latest development technologies in probabilistic safety assessment analysis and computing sciences. We need interrelated knowledge management tools, because we need to replace the generation of people who are going to retire over the next ten years. We need more training courses. For all these goals, we should share development costs. Why should we leave each country to face its own problems? There are most probably a lot of areas where networking and cooperation could be very efficient, but we need a leading line, and we are looking to the IAEA and also to the OECD/NEA to support that.

This is a significant agenda. I hope it will be very challenging to all the participants in this conference and that, at the end of the day, we will have some valuable recommendations in front of us, thanks to the involvement of all of you here in this room.

OPENING ADDRESS BY CONFERENCE PRESIDENT

Li Ganjie
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Administrator, National Nuclear Safety Administration,
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It is a great honour for me to give an opening address as the President of this International Conference on the Challenges Faced by Technical and Scientific Support Organizations in Enhancing Nuclear Safety.

First of all, on behalf of the programme committee, I would like to express my warmest welcome to all of you to the beautiful city of Aix-en-Provence, France, to attend this important conference.

Under the current global circumstances of steady and rapid economic growth combined with the need for environmental protection, the nuclear energy industry is encountering a renaissance. Accordingly, nuclear and radiation safety need to be increasingly promoted as high priorities. The governments of many countries attach great importance to nuclear safety and have carried out a great deal of work in such areas as improving the legal system for its regulation, promoting capacity building in its surveillance, establishing a healthy management system and developing a nuclear safety culture. Effective nuclear safety regulatory systems have been set up around the world after several decades.

In order to enhance nuclear safety, it is necessary to establish technical and scientific support organizations (TSOs) in the field of nuclear safety. Such organizations, whether pertaining to the nuclear regulatory body or to the utilities, are gaining increased importance by providing the technical and scientific basis for safety decisions and activities. At present, TSOs are playing a crucial role in technical backup for nuclear regulatory bodies and utilities in all areas of nuclear and radiation safety.

This conference is the first international conference to address TSOs, with a focus on developing a global vision of the role of TSOs and recommendations for the future. It provides a platform for further promoting and strengthening international cooperation on nuclear and radiation safety to enhance the Global Nuclear Safety Regime.

Actually, we are now faced with both challenges and opportunities. More improvements will be required in our work henceforth, and there are arduous tasks ahead and a long way to go. The venue of this conference here in France has provided wonderful opportunities for us to learn from their successful ideas and experience to enhance our nuclear and radiation safety management levels, as well as to explore appropriate approaches and means to face current and expected challenges in nuclear and radiation safety.

We strongly believe that nuclear and radiation safety in the world will witness a continuous enhancement through our efforts and with the support of TSOs in each country. I am sure that the extensive discussions and in-depth exchanges during the conference will bring valuable benefits for the future and emphasize the role of TSOs in enhancing nuclear and radiation safety at the national, regional and international levels.

Finally, on behalf of the programme committee, I would like to express my deep appreciation to all of you who have made great efforts for the preparation of this conference. I would also like to thank both the Government of France and the IAEA for their strong support of this conference and our colleagues from the Institut de radioprotection et de sûreté nucléaire and the local government of Aix-en-Provence for hosting this conference and providing the excellent arrangements.

I wish you all a successful and fruitful conference and an enjoyable stay here in Aix-en-Provence.

OPENING KEYNOTE ADDRESS

MANAGING TECHNICAL SUPPORT ORGANIZATIONS AT THE US NUCLEAR REGULATORY COMMISSION

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INTRODUCTION AND OVERVIEW

It is a great honour to speak to you here in beautiful Aix-en-Provence on behalf of the United States Nuclear Regulatory Commission (NRC). This is not the first time I have been to this wonderful city, and I am pleased to return. Both my colleague, Mark Cunningham, Director of the Division of Fuel, Engineering and Radiological Research, and I look forward to sharing our perspectives on the role that technical support organizations (TSOs) will have in helping the NRC meet its future challenges.

Today, I would like to share with you my views about the benefits that the NRC derives from its diverse TSOs, a perspective shaped in part by my own research career. That career included more than 34 years at the Los Alamos National Laboratory prior to my becoming a Commissioner. During my laboratory career, I had many opportunities to interact and work with colleagues around the world, including a memorable five-month assignment with the French Commissariat à l'énergie atomique (CEA) at Bruyères-le-Châtel, in addition to many years of collaborative research conducted under the auspices of the North Atlantic Treaty Organization.

THE BENEFITS OF TSO DIVERSITY

I am a strong supporter of NRC regulatory research and a strong supporter of international research collaboration. I am guided by my career experience and by my strong belief that we must be led by facts and data, not just theory and speculation, to move forward into a future that safely achieves the benefits of technology. One of the best expressions of this idea comes from the writer Robert Heinlein, who asks:

"What are the facts? Again and again and again — what are the facts… and to how many decimal places? You pilot always into an unknown future; facts are your single clue. Get the facts!"

In my first speech as an NRC Commissioner, I reflected on one example from Los Alamos relating to my research group's pioneering work on some aspects of laser fusion. There was immense optimism then that modestly sized lasers would provide enough energy to ignite fuel and enable efficient energy production. Early calculations suggested that reaching the energy break-even point would require only about a kilojoule of laser energy. Some assumed that laser fusion would soon be producing power.

Now, 30 years later, not much is heard about laser fusion supplying power in the near future. The anticipation of success with 1 kJ lasers has been replaced with construction of the multi-billion dollar National Ignition Facility to provide almost 2 000 000 J, where ignition and energy gain might be demonstrated. The increase in required power, by almost 2000 times, traces back to many careful experiments, some done by my group at Los Alamos, that simply did not support that early optimism.

Calculations and modelling have a critical role in any technically complex endeavour, certainly including the work of the NRC. However, I have learned that computational models are as good or as bad as the physics and engineering underpinning them. Models used for regulatory decisions require careful validation, and that requires careful research.

Today, at the NRC, we face many diverse challenges and require correspondingly diverse approaches to meet them. We rely on TSOs not only for many of our research needs, but also to augment our own staff in completing regulatory licensing reviews and inspections. We are also planning to use TSOs to assist us with regulatory reviews of expected new reactor applications.

Our Office of Nuclear Regulatory Research is the principal coordinating organization that contracts with external TSOs for our research needs, coordinates and guides such research, and collects and instils the knowledge gained from this research into a retrievable corporate memory of documents, literature and procedures. These TSOs not only include the national laboratories with which I am personally most familiar, but also universities, private commercial contractors, consensus standards committees, national research centres such as the NRC sponsored centre to support a potential high level waste geologic repository, and international research centres and programmes. In addition, each of our three principal programme offices, for reactors, materials and security, also manages certain contracts for external TSO assistance in licensing, inspection and other support functions.

The NRC's regulatory mission was created when it was separated from the promotional research and development mission of the United States Department of Energy (DOE), and it is therefore not surprising that much of the NRC's research is performed by national laboratories that also perform research for the DOE. The NRC continues to take advantage of the wide diversity of expertise and capability in national laboratories such as Argonne, Brookhaven, Idaho, Los Alamos, Livermore, Oak Ridge, Pacific Northwest and Sandia.

Such diversity remains highly valuable to the NRC, in some cases allowing us to choose from a variety of sources or approaches or test capabilities to best fulfil our regulatory research needs. One good example is the support we need for reviewing advanced computer based safety systems and instrumentation and control. We have obtained this support from a variety of TSOs over many years, including the National Research Council of the National Academies of Science and Engineering and the international research centre at Halden. The extremely competitive job market for these skills requires that we continue to maintain a diverse pool of sources of such expertise. However, this increases the challenge of sharing and retaining information among the various TSOs. Improving this situation in the long term may require that the NRC explore new approaches that centralize such expertise, perhaps in collaboration with other industries and Government agencies. Such an approach might also better attract and retain the expertise we need.

Another useful approach for the NRC has been to access similar capabilities among different TSOs. Doing so can help to address certain issues in a more timely manner. One recent example is the utilization of three separate national laboratories to conduct a spectrum of tests to determine the effects of water chemistry on potential clogging of emergency sump filter screens at pressurized water reactors (PWRs).

Concerning funding, in recent fiscal years the NRC's total budget has been roughly \$700 million. Of that sum, about \$160 million has been budgeted for contract support in the reactor and material programmes together, about a third of which has been budgeted through our Office of Nuclear Regulatory Research. It should be noted here that the NRC recovers 90% of its budget from fees assessed to our licensees.

Let me further itemize our various regulatory and research needs and how the NRC meets them through TSOs. First and foremost is our need to maintain the safety of our operating reactor plants. Most of these plants will request renewal of their licences to operate beyond the original 40 years, and our research approach must continue to seek a better understanding of the issues concerning ageing of materials that we have seen or that we can predict.

The nuclear industry is addressing these issues, and the NRC continues to review the results of industry sponsored research and to contract with our national laboratories to verify such results, when necessary.

Other potential challenges to safety margins must also be addressed, such as the effects of water chemistry on PWR emergency recirculation that could precipitate solids and, in addition to clogging sump screens, could interfere with mechanical components or heat transfer. Other operating reactor issues include vibration and associated increased mechanical stress that can occur in certain components owing to increases in reactor power ratings. As the affected licensees and industry have worked to resolve these issues, the NRC has contracted with private engineering firms to perform independent simulations and calculations to provide the level of assurance we need to ensure that the resolutions are adequate.

Over the past 15 years, the NRC has certified four new reactor designs: the General Electric ABWR, Combustion Engineering System 80+, and the Westinghouse AP600 and AP1000. We are currently reviewing the General Electric ESBWR and are planning to begin a review of the AREVA European pressurized water reactor later this year. The adequacy of new safety features in these new designs must rest on facts, not theory. For example, we employed university researchers to provide the test data we needed to certify the passive safety system design of the Westinghouse AP600 and AP1000, and future university research capability remains a valuable tool in our research toolkit. In addition, more than 25 years of research into severe accidents by different TSOs from many countries have contributed greatly to developing severe accident design features.

The somewhat uncertain number of new reactor plant applications expected over the next few years has made it necessary for the NRC to plan for contracting with a diverse set of TSOs to supplement our review capability if the demand for such reviews exceeds our in-house capability. For this purpose, we have identified TSOs that can be categorized into two main groups: those with very specialized skills or expertise that the NRC staff does not possess and for which adding full-time staff would not be cost-effective, and those with more general engineering expertise that are needed to augment the staff.

Our national laboratories are coordinating closely to serve this need, allowing for an efficient process for the NRC to obtain needed resources from these laboratories. In addition, we have looked to other Federal agencies with specific expertise, such as the US Army Corps of Engineers and the US Geological Survey for their environmental and geological/seismic expertise. Finally, we have identified a pool of approximately 1200 persons from small commercial businesses and consulting firms that have potentially no or limited conflicts of interest arising from prior work with licensees.

Looking even further into the future, the NRC is planning for the possible licensing of the Next Generation Nuclear Plant and Global Nuclear Energy Partnership (GNEP) facilities. The technical bases developed for these technologies will be valuable not only to the DOE, as the principal advocate for pursuing them, but also to the NRC, as the principal safety reviewer for their licensing. Of course, the NRC must remain independent at all times. However, while bearing this in mind, there may still be advantages to sharing the costs and benefits of related research activities between the NRC and the DOE.

On the security front, we must use the best available insights regarding threats such as aircraft crashes, using computer simulations that are extraordinarily challenging to benchmark against actual data. However, we have worked in this area with our national laboratories, which are equipped to handle the classified and sensitive information involved and have extensive and highly relevant test facilities.

In preparation for the review of an application for a high level waste repository at Yucca Mountain, we created a dedicated research centre, the Center for Nuclear Waste Regulatory Analyses (CNWRA), to focus on the related unique research challenges. We are also looking at the CNWRA as having the expertise needed for our regulatory needs outside the waste area, in our materials and even reactor programmes. In the special case of the Yucca Mountain application, the DOE is the applicant and will have extensively utilized its laboratories in preparing the application. Therefore, an extremely important advantage of the CNWRA is that it will provide us with the necessary technical support without any concern over a conflict of interest that might otherwise arise had we instead used DOE laboratories.

AVOIDING CONFLICTS OF INTEREST

In awarding contracts, the NRC is required by law to avoid contracting with sources that have conflicts of interest owing to their work with the nuclear industry or specific licensees. Avoiding such conflicts of interest is extremely important in maintaining the confidence of the public. Our contracting procedures require that contractor proposals affirm in writing the absence of any conflict of interest, and NRC specialists in contracts and technical monitoring are required to carefully examine and check the basis of this assertion. In addition, contract language specifically requires that the contractor immediately inform the NRC should a conflict of interest arise or become apparent during the implementation of the contract. In such situations, the NRC may have civil remedies against a contractor for non-compliance with these terms, and in certain cases, criminal sanctions can even be imposed. The overall goal of avoiding conflicts of interest is always present in our contracting activities.

This challenge has recently become greater as the DOE has chosen to use large engineering firms to manage or co-manage its national laboratories. Many such large firms are also extensively involved in the nuclear industry, and this involvement is likely to increase with any new reactor construction. In fact, any renaissance of nuclear plant construction in the United States of America will also attract many small and medium sized commercial engineering and consulting firms, which could limit the NRC's ability to use them for supplemental support in licensing and inspection of these new plants.

CONCLUSION

As I noted earlier, I am a strong believer in international collaborations that address nuclear science and technology. I also strongly support collaborations among international regulatory bodies and value the expertise of their associated TSOs. Each regulatory body has its own unique needs for TSO support related to the technologies it regulates and the manner in which it is organized. I believe there can be many benefits from collaborative arrangements between countries with shared interests and needs. Such benefits can be found from specific technical collaborations as well as more general regulatory collaborations. It can also be very beneficial in international conferences such as this one to share our experiences in effectively utilizing TSOs.

Finally, if I let my thoughts drift northward for a moment to Cadarache, the future home of the International Thermonuclear Experimental Reactor (ITER) project, I see one of the most impressive and complex examples of an international commitment to research collaboration. I believe that such commitments are necessary to solve the most significant problems that face our global human society today.

Again, I am very pleased to be invited to join you, and I hope you have a very productive exchange while you are here. I look forward to further discussions with you on this very important topic.

OPENING KEYNOTE ADDRESS

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First of all, I would like to thank the IAEA for the invitation to this conference. I am very pleased to have the opportunity to talk about the view of the operators and the industry on challenges faced by technical and scientific support organizations (TSOs) in enhancing nuclear safety and the relevance of TSOs in providing technical and scientific services to the operators and the industry.

Let me say a few words about my background. Before working for an energy producing company, I worked for more than 20 years in the field of final disposal of radioactive waste and then as an operator of a final repository. Afterwards, I was also responsible for licensing interim storage facilities. During this time period, I worked in the German Federal Office for Radiation Protection, part of the German Ministry of the Environment, Nature Conservation and Reactor Safety. This office is responsible for the final disposal of radioactive waste, in addition to being a licensing authority for interim storage facilities and transport of radioactive material. Since 2003, I have been working for the energy producing company Vattenfall as the Managing Director for the nuclear part of the company in Germany. We operate two nuclear power plants and hold shares in two others. Due to my professional background, I have experience in cooperation with TSOs working for the regulator and the authorities, as well as for the operators of nuclear power plants.

CHARACTERIZING THE PRESENT SITUATION

At present, we are expecting a breakthrough in investment in new nuclear power plants — the so-called renaissance of nuclear power. At the same time, we see an ongoing globalization, with mergers of manufacturers, TSOs and electricity producing companies. Many are now international operator companies. However, we have different requirements in different countries. Consequently, a European pressurized water reactor (EPR) in Finland will not be the same as that in France or the United States of America (USA). The IAEA is promoting the harmonization of safety standards, but there is still room for improvement. We are seeing an increasing acceptance of nuclear power in a global perspective, despite stagnation in some countries. However, in all countries, solving the final disposal problem is an issue.

All the countries using nuclear power are Member States of the IAEA. The West European regulators have established the Western European Nuclear Regulators' Association (WENRA), and the operators in all countries use the World Association of Nuclear Operators (WANO) as an international platform for sharing experience. Therefore, it is logical to think of a common platform for TSOs as well.

THE MAIN DIFFERENCES BETWEEN TSOs FOR REGULATORS AND TSOs FOR OPERATORS

The operator's responsibility is to show that a power plant and its operation meet the safety requirements. To establish proof of compliance with safety requirements, the operator might involve the manufacturer, the engineering companies or universities as TSOs. As a prerequisite for permission to operate a nuclear power plant, the operator has to be competent and prove its specialized knowledge; thus it has to have expertise concerning the various issues related to plant operation and safety.

A TSO is usually utilized when additional human resources are needed or more detailed questions have to be answered. Quite often, a TSO will be involved when specialized knowledge or an independent view is needed or useful.

In contrast to the requirements to be met by operators, there is neither a definition nor the need for formal proof of the regulator's competence. The consequence is that the competencies of the authorities vary widely from country to country. In some countries, the competencies are internalized in the authorities. In other countries, the authorities might not even be able to judge the results in accordance with the requirements. Here, the TSOs play a major role and take on a great responsibility.

We must also take into account that TSOs are required to be financially sustainable, profit oriented companies. The large German TSO TÜV, for example, will have 18 000 employees after completion of the ongoing merger process. This TSO — working for the authorities — announced that the percentage return on sales would increase in the near future. Consequently, from the operator's perspective, the authorities have to take into account this profit orientation of TSOs, which means that the authorities should have the necessary expertise to end investigations when safety issues and requirements are not the driving forces. As key indicators, we can use the costs for the use of

TSOs per plant per year or the number of letters sent to a plant per year. Here we see an increase of more than a factor of 2 since the year 2000.

The requirement is that the authorities should have sufficient expertise to supervise the TSOs. Moreover, we have to take into account the fact that, although TSOs have a broad range of competencies, they might not be equally skilled in certain subject areas. In such cases, the regulators should place a requirement on the TSOs to include the expertise of other relevant TSOs, even though this might reduce their profit margin.

Let us now look at the situation of TSOs working for the utilities. At the moment, more and more new plants are expected to be built. Consequently, the different TSOs involved in these projects might also experience resource problems. Therefore, the utilities will have to examine whether they should extend their core competence and recruit more personnel in order to be less dependent on TSOs.

On the other hand, the renaissance of nuclear energy is leading to positive development of the market. The times when people were afraid that the availability of expertise would decrease are behind us. Working for the development of new nuclear power plants is favourable for the acquisition of knowledge. It will also result in even greater progress in knowledge about safety related issues and solutions.

THE KNOWLEDGE BASE REQUIRED FOR TSOs

The knowledge base of TSOs has to be differentiated between TSOs working for the government, the licensing and supervising authorities, and the operators of nuclear power plants. The closer the TSOs are to the operation of the plant, the more specific and detailed their skills have to be. On the other hand, the nearer they are to the regulator, the more generic their expertise has to be.

A common prerequisite for TSOs on the regulator’s side is that they must be organizationally independent from the client. For example, a regulator or a plant owner should not be part of the TSO’s board. Otherwise, the TSO could not be regarded as being organizationally independent.

Another prerequisite is that the TSO has to be economically independent of the client. The more dependent a TSO is on job orders from the regulator, the more likely it is to be judged as being less independent. To be economically independent, the TSO has to have several clients, and none of the clients should play a dominant role.

ENSURING ADEQUATE EXPERTISE BY TSOs IN AN INCREASINGLY COMPETITIVE ENVIRONMENT

The TSOs working for the operators are normally engaged by different power plants in different countries. This is why they can bring in a broad perspective and a wide range of experience. They are also engaged in a variety of R&D programmes as well as in new projects. Thus they are at the forefront of technical and scientific development. This might also be the case for TSOs working in countries where nuclear power is considered an important option for the future. In countries where the phaseout of nuclear power leads to self-restricted participation in national or international R&D programmes, there is a risk of being disconnected from the international developments and scientific progress.

With regard to the competitiveness of the TSOs, those working for the operators are engaged on the basis of their expertise. However, the supervising authorities tend to have a limited choice of TSOs. This might result from the intention to have one TSO responsible for covering all the different technical and safety aspects. We do have TSOs with such a broad range of competencies. On the other hand, this approach would make it almost impossible to bring in competition. Given the specific knowledge of the TSO concerning the plant and know-why, the supervising authority is hardly able to exchange the TSO for another one and is, therefore, dependent on it.

If competition is considered advantageous, the contract packages have to be reduced, as a first step, before starting the bidding process. This may be deemed as a requirement, as otherwise the TSOs would have an unduly large influence on their clients. A second problem associated with employing a single TSO to advise a supervising authority lacking the expertise to cover all different aspects on its own is that it might lead to a learning-by-doing situation, which would be unacceptable.

The situation with regard to TSOs working for the national regulator might be considered even more dangerous, as there is an ongoing debate on the benefit of having one TSO per country. Such a concept would be in contradiction with the need to introduce competition. If the concept of a single TSO per country is accepted, the economic and organizational independence of such a TSO has to be ensured as a prerequisite.

ORGANIZATION OF A TSO NETWORK

As mentioned before, selecting a single TSO to advise the national regulator might require an assurance of the independence of this TSO from the regulator. However, should this TSO be responsible for forming the international information exchange network of TSOs? What could the challenges for the international TSO network be, and who should take part?

The challenges for the international network might be:

— Exchange of information in the field of safety;
— Identification of necessary further developments in analyses and R&D;
— Development of a common view on best nuclear safety practices.

In this network, all the TSOs, whether they work for regulators or operators, have to be involved. Such a network might be organized on an international level where the different TSOs are represented. Having an international network only for those TSOs working for national regulators would ignore the essential expertise of TSOs working for the authorities or operators. I would like to propose an international platform that can be used by all the different TSOs. The organization should be set up by the TSOs themselves. This international TSO organization could in turn communicate with the IAEA, WENRA and WANO.

SAFETY STANDARDS AND THE ROLE OF THE TSO PLATFORM

Currently, different countries have different safety standards. This is also the case within Europe, where WENRA is harmonizing the safety standards. The IAEA safety standards are the basis for WENRA reference levels. A commitment exists to improve and harmonize national regulatory systems by the year 2010.

The European nuclear licence holders, through the European Atomic Forum (FORATOM), created a platform addressing new national and international regulatory activities. With regard to safety standards, the European Nuclear Installations Safety Standards (ENISS) initiative was established. One aim is to establish a common licensee’s view between the different countries with respect to the WENRA proposals. Another goal is to support an exchange of information about the interaction of licence holders with their national regulators, in order to achieve a harmonized set of new regulations. In this context, a parallel platform of TSOs could provide additional expertise and could play an important role in bringing in the perspective of TSOs.

CONCLUSION

From the operator's view, establishing an international TSO platform could provide additional input and further improve nuclear safety. All TSOs, whether they support the regulators, operators or industry, should have the opportunity to be part of this platform.

The TSOs should have a role in harmonizing safety standards, exchanging experience, improving the operating experience feedback process, evaluating the events, identifying further R&D requirements, developing a common view on best nuclear safety practices and giving objective advice to regulators and operators.

As a first step, this platform could be established at a regional level in Europe. It should then be involved in an information exchange with the relevant international organizations.

This presentation discussed the operator's perspective on the establishment of an international TSO platform. I would like to thank the IAEA for this initiative.

OPENING KEYNOTE ADDRESS

ANCLI-CLI: MEDIATORS OF ACCESS TO INFORMATION AND EXPERTISE — A TOOL AT THE SERVICE OF THE PUBLIC

M. Sené
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The Local Information Commissions (Commissions Locales d'Information, or CLIs) came into being in 1977 with the Local Supervisory Commission at the Fessenheim nuclear power plant. There had been a struggle, and Solange Fernex made a decisive contribution to the establishment of this body.

In 1981, under pressure from the Deputy Mayor of Cherbourg, the Standing Special Commission on Information at the La Hague establishment was created. The same year, a circular from the then Prime Minister, Pierre Mauroy, invited all sites to set up CLIs. Twenty-five years have passed, and CLIs exist at nuclear sites and even at chemical plant sites under another name.

To exchange information and experience, an association of the presidents of CLIs was initially created. In 2005, in order to form the federation of CLIs, the Association Nationale des Commissions Locales d'Information (ANCLI) changed its statutes, giving itself an administrative board consisting of CLI delegates.

At its meeting in February 2005, the administrative board set itself three major objectives:

- To make the voice of the CLIs heard on all subjects that may concern them (law on transparency, law on waste management, protection of the environment and of persons);
- To represent all the CLIs (or similar bodies) set up at nuclear facilities while being representative of all the groups that make them up (elected bodies, associations, unions, commercial chambers, experts, etc.);
- To offer the CLIs technical and human resources to better accomplish their mandate: expert resources through the Scientific Committee of ANCLI and other measures such as setting up a web site to serve as a portal for distributing information from ANCLI to the CLIs and among the CLIs themselves.

Regarding the first objective, ANCLI and the CLIs have published two compilations:

- White Book I, "Local governance of nuclear activities", presents the aspirations of the CLIs and ANCLI with regard to their statutes, mandates and involvement in decision making processes.
- White Book II, "Radioactive material and waste — territories", whose principal aims are:
  - To contribute to the objectivity, quality and pluralism of the information made available to the public — this is why the CLIs and ANCLI are asking for information held in the inventories of the National Radioactive Waste Management Agency (ANDRA) and the national and departmental plans for the management of radioactive material and waste. They want to be able to address the actors of the 2006 law on all issues relating to radioactive material and waste that affect their territory;
  - To get established by law (and implemented by the public authorities) a national pluralist standing commission to monitor the management of radioactive material and waste, consisting of representatives of civil society (administrators, elected representatives, operators, CLI members, experts, etc.);
  - To facilitate, jointly with ANCLI, access by CLIs to expertise through agreements with public experts, regulators and operators.

White Book II has been widely disseminated in French society. It has been sent to members of the French Parliament and to the various public institutions concerned in France, as well as to members of the European Parliament, the EU Committee of the Regions and the European Commission.

Regarding the second objective, these two White Books have, on the one hand, enabled the CLIs to participate in the elaboration of the various proposals of the White Books, and have, on the other, enabled ANCLI to set up working groups on the statute of the CLIs and on their financing with a view to strengthening their active role in the dialogue with the authorities.

They have also led to ANCLI's establishing two standing groups:

- The standing group on waste to monitor ANDRA's files and the law on waste: tritium activity, enhanced natural radioactivity, state of the sites in each CLI;
- The standing group on the European pressurized water reactor (EPR): this enables ANCLI and the Flamanville CLI to monitor the EPR during

its construction under a tripartite agreement with Électricité de France (EDF).

Regarding the third objective, the ANCLI web site (www.ancli.fr) contains all the relevant information. This web site is open to the different CLIs. The activities of the CLIs and ANCLI are outlined there, and conferences and seminars are announced through it so that the CLIs can send their representatives. There is also a newsletter, DECLIC, published periodically.

It should be noted that the Law on transparency and security in the field of nuclear security was published in the Official Gazette on 14 June 2006. This Law devotes its Heading III to public information in the field of nuclear security and Chapter II of this Heading III to the CLIs.

The decree relating to the CLIs is expected to be discussed with the CLIs and the Nuclear Safety Authority (ASN) in 2008. In addition, ANCLI has received the national calendar established by the Directorate General for Nuclear Safety and Radiation Protection (known as the ASN as of November 2006) on the nuclear emergency exercises in 2006 and the exercises forecast for 2007.

For several months, ANCLI and its European counterparts have been considering the idea of creating a European association of CLIs. On 4 October 2006, in Dunkirk, a statement of intent was approved for the creation of EUROCLI.

After various meetings and discussions between European partners, the following unanimous conclusion was reached:

> "We all want to promote broader involvement of participatory democracy in the governance of nuclear activities; to make the voice, questions, expectations and contributions of the local commissions heard at the national and European levels; to demonstrate the capacity of the CLIs to increase the quality of decision making processes by their follow-up and monitoring activity; and finally to propagate the good practices developed over the past 20 years in the European Community, without detracting from the role of existing national organizations."

France, Romania, Spain and the United Kingdom have officially recognized the establishment of EUROCLI and have taken the discussion further. Others are to join them in the coming months. Given the extensive experience of the CLIs in France, and the Federal capacity of ANCLI, the members of EUROCLI have decided to entrust the presidency of the

European association to Jean-Claude Delalonde for two years. It has been agreed that the presidency will rotate every two years.

In conclusion, ANCLI, in modifying its statutes, has clearly expressed its wish to be allowed to speak for the CLIs and the various groups that constitute them. While this gives it full legitimacy to call itself the federation of CLIs, its task is difficult, as each of the groups naturally has its own views on the drafts being prepared or on Government decisions. It is important for each of the groups and each member making up ANCLI to preserve its individual right of expression and opinion, but let us not make the possible divergence of views a handicap. On the contrary, let us make them an asset.

This plurality of viewpoints will be ANCLI's strength, and its mandate will be to identify convergent views and make them heard in the proper quarters, as was done through the two White Books.

In 25 years, we have come a long way, but the road is cluttered with hurdles. Good luck to the CLIs and to ANCLI, as well as EUROCLI in arriving at quality civilian governance! I would like to add that it has been possible to come this far because the Institut de radioprotection et de sûreté nucléaire (IRSN), the ASN and the various partners (operators, administrations, associations, etc.) have taken notice of the queries from the CLI and ANCLI.

Among our counterparts, I would like to acknowledge the support given to us by the ASN and IRSN, and particularly the activities of Annie Sugier of IRSN, who has tried tenaciously to create and maintain groups with pluralist expertise. However, she has not succeeded in giving them the permanence that is essential in view of their subjects: safety, waste, environmental protection and protection of the health of all workers and the public.

It is necessary that these groups come into existence, however, for — like the national pluralist standing commission demanded by ANCLI for waste management — they will enable the public to express its views and grasp such nuclear issues as reactor safety, waste management, radiation protection, environmental impact and transport.

ROLES, FUNCTIONS AND VALUE OF TECHNICAL AND SCIENTIFIC SUPPORT ORGANIZATIONS

(Topical Session 1)

Chairpersons

M. ISHIKAWA
Japan

LEAD-IN PRESENTATION: ROLES, FUNCTIONS AND VALUE OF TSOs

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Abstract

The notion of a technical and scientific support organization (TSO) is very broad, ranging from specialists with very specific areas of expertise to university laboratories, each with its own field of competence, nuclear research centres, often with large experimental facilities, and organizations having experts covering most domains of nuclear and radiological safety, which can give regular, global assessments of the safety of installations. As a support to the national regulatory authority (NRA), TSOs provide technical and scientific bases for the NRA's decisions. They provide safety assessments and in some countries also inspect installations on behalf of the NRA. They can in this way give early warning of declining performance and degradation before these become safety problems. They can also assist the NRA in writing regulations, taking into account the implementation aspects. In case of accidents, TSOs can try to predict their evolution and advise on possible countermeasures. Technical and scientific support organizations can play similar roles as a support to the industry, including assessing draft regulations. They can also make proposals on how to solve the problems they unearth, as the licensee is responsible for the safe operation of its facilities and must select the appropriate solutions. A major task for TSOs is to keep abreast of technological developments, emerging concerns and new designs. Thus there is a need to participate in R&D projects, often at the international level. Tasks that can help in the maintenance and transfer of knowledge include operating experience feedback and periodic safety reviews, both of which are quite useful for improving the safety of existing installations. When TSOs provide the scientific basis for decisions, they can explain and give credibility to such decisions, taking care to stay independent of political or economic interests.

1. DIFFERENT TYPES OF TSO

In the context of this conference, a TSO is a technical and scientific support organization that provides support concerning nuclear and radiation safety issues to the national regulatory authority (NRA) or to the nuclear industry. The scope of its activities is very broad, and the situation in a given country depends strongly on the historical development of nuclear activities in that country.

After the Second World War, atomic energy commissions were created in many industrialized countries, with the aim of developing peaceful applications of nuclear energy. Nuclear research centres were established, where a number of research reactors were built. At the end of the 1950s, after the two Geneva Conferences, the production of nuclear electricity on an industrial scale became a reality, as demonstrated for example by the Shippingport plant in the United States of America (USA), and electric utilities began to order nuclear power plants.

The need for licensing and safety assessments of such plants led to the creation of NRAs, which often also became responsible for the licensing of the installations belonging to the atomic energy commissions, which up to that time had performed these tasks for their own installations. In this way, licensing activities became completely separated from the technological development and promotion of nuclear energy. Depending on the country, the responsibilities of the NRA can include both nuclear and radiation safety, or the two can be separated, with two coexisting regulatory authorities.

To perform its tasks, the NRA can do everything itself, with in-house technical and scientific support. However, it is becoming difficult to have specialists in every field of nuclear technology to cover an ever increasing number of topics, including human and organizational aspects. Hence many NRAs opt for outside technical and scientific support.

One way of doing so is for the NRA to use specialists for each precisely defined topic (e.g. corrosion, digital instrumentation and control (I&C), evolution of concrete structures over time, fracture mechanics). These specialists may be university laboratories, dedicated departments of a nuclear research centre or of a national laboratory (as in the USA), or even consultants on issues concerning human factors or organizational matters, etc. The NRA must accurately define what needs to be investigated, its significance with respect to safety and potential interactions or interfaces with other topics. The NRA must then assess each contribution, manage the interfaces, synthesize all requested contributions to produce a global and consistent assessment, form its conclusions and take the appropriate decisions.

Another way is to delegate the whole safety evaluation to a single organization, which has a safety dedicated approach and a regulatory vision, and provides an integrated and global safety assessment. Such organizations have existed for a long time in Europe, where they call themselves technical *safety* organizations to emphasize that safety is their main objective.

Recently, three such organizations (from Belgium, France and Germany) have decided to increase their cooperation by exchanging R&D results and their experiences in operational aspects and safety practices in Europe. They have proposed a ‘European TSO Network’ open to other similar organizations within Europe.

This is in line with the nuclear safety assistance programme that was started in 1990 to assist East European countries. The programme is sponsored mainly by the European Union, which has created collaborative links between the various parties. In this way, TSOs provide training to third parties at the national and international levels. As organizations independent of the NRAs and the industry, they can also provide technical information to stakeholders and the public.

2. TSOs AND THE NRA

National regulatory agencies are responsible for licensing nuclear installations, for issuing regulations and for supervising licensed facilities during their operation, with corresponding decision making and enforcement if needed. In the licensing process, a TSO can provide support to an NRA at all stages of the process. At the pre-conceptual phase, the design objectives must be defined for internal and external events and for the various plant operational conditions. The consequences of such events are analysed by deterministic or probabilistic approaches.

The design choices are assessed at the successive stages of the project via the safety analysis report in its different forms (from the preliminary to the final report), making clear what constitutes the design basis, which events should be considered as ‘beyond design basis accidents’ and what constitutes the residual risk. Through its analysis of the results of the commissioning tests, the TSO can check if the design objectives have been met and report its conclusions to the NRA.

Depending on the country, inspection activities during operation are performed by the NRA itself or are delegated to the TSO that did the safety assessment. When the TSO is in charge of inspection, it will of course immediately inform the NRA if licence conditions have been violated, so that the NRA can impose enforcement measures or take legal action. In addition, the TSO can assess the way the installation is operated, identify modifications that should be included in the licensing basis and proactively examine any early signals of declining performance or degradation mechanisms before they become safety problems. In this way, it can also warn the operator and ask for corrective measures. As requested by the NRA, the TSO reports periodically about the level of safety in the controlled installation, synthesizing what it has ascertained.

In many countries, periodic safety reviews are required. For the initial safety assessment, the TSO can provide the NRA with an evaluation of the actions proposed by the licensee and advise it concerning any additional measures required to maintain or improve the safety of the installation and update the licensing basis.

Operational experience of the plant, and of similar plants worldwide, should also be investigated by the TSO, so that the NRA can ask the licensee to identify preventive measures, avoid recurring events, and verify that lessons have been learned and modifications made have met their objectives.

In the case of accidents, the TSO can advise the NRA about the possible accident scenarios and emergency measures that might be necessary. Some TSOs have indeed developed computer codes to predict the radiological consequences of design basis accidents or more severe accidents.

When a plant ceases its operations, the TSO can assess the decommissioning plan and monitor its implementation.

For all these assessment activities made in support of the NRA, while the TSO should clearly define what the problems are, it should refrain from proposing solutions to the licensees, who bear the complete responsibility for the safety of the licensed installations. In this way, the TSO maintains its freedom to assess the licensee's proposals.

A last field of activity for the TSO in support of the NRA is assistance in developing regulations. As TSOs are well aware of the practices on the shop floor, they are in a position to anticipate possible difficulties in the interpretation of regulations and influence the wording so as to avoid future implementation problems.

In all the fields mentioned above, the NRA will be able to outsource the assessments to the TSO and integrate the results into its decision making and enforcement processes.

3. TSOs AND THE NUCLEAR INDUSTRY

The TSO activities in support of the nuclear industry cover some of the same areas as those in support of NRAs. However, the emphasis is not only on the problems to be tackled, but also on proposals for solving them.

As its contribution to the licensing process, the TSO can carry out the safety assessment of the project, identify the problem areas and indicate the best solutions. It can also help to prepare the commissioning tests, participate in them and evaluate the results.

During operation, the TSO can identify/review modifications to facilitate plant operation, increase plant availability through a reduction of the outage time, prepare the periodic safety reviews, examine measures to extend the life of the installation and assess lessons learned from feedback of operational experience, both national and international.

The TSO can even make inspections of the installation during operation, if the operator desires some kind of external audit.

It should be noted that electric utilities have often created research institutions to obtain scientific and technical support in solving their specific problems, such as the Electric Power Research Institute (EPRI) in the USA, which is also open to foreign utilities.

When the NRA intends to develop new regulations, the TSO can review the draft regulations and provide comments, reflecting the viewpoints of the industry so as to facilitate full compliance with the requirements.

In the case of accidents, the TSO can try to develop different evolution scenarios, evaluate their possible radiological consequences and recommend appropriate countermeasures to the licensee.

4. TECHNICAL AND SCIENTIFIC KNOWLEDGE OF THE TSO

As the main task of the TSO is to provide technical and scientific support in the decision making process of the NRA or of the industry, its knowledge must be maintained at the highest level in all the fields of its expertise.

For TSOs that deal with very specific subjects — for example, university laboratories or dedicated departments of nuclear research centres — keeping abreast of the latest studies, discoveries and technological developments is an inherent part of their mission. Nowadays, collaboration between researchers has developed, for example in the R&D Framework Programme of the European Union.

For TSOs that perform global safety assessments for NRAs or for the industry (the technical safety organizations), the development and maintenance of the technical and scientific knowledge base and paying attention to emerging concerns are much more difficult, as the scope is much larger. For this reason, it is necessary to prioritize topics according to their safety significance. An efficient way to obtain and keep this knowledge is to participate in international research programmes (e.g. those sponsored by the IAEA, the OECD Nuclear Energy Agency (OECD/NEA) and the European Commission (EC)), where each participant makes its expertise available to all, while the costs are shared among all participants. Bilateral and multilateral collaborations are also possible, for example for the development of computer codes and their validation on experimental results. The Committee on the Safety of Nuclear Installations (CSNI) of the OECD/NEA has been very active in the launching of international research programmes in quite a number of domains, including fuel behaviour under design basis accident conditions, severe accidents, thermal hydraulic experiments and computer codes benchmarking, fire propagation and reliability bases.

Periodic safety reviews are intended to maintain or improve the safety of operating installations. They are also a way to maintain the knowledge about the installation, or to transfer it to younger people. An interval of ten years appears to be adequate for this purpose. Operating experience feedback and in-depth reviews of the applicability of lessons learned are also occasions to revisit the knowledge concerning an installation.

5. TSO RELATIONSHIPS WITH OTHER STAKEHOLDERS

Technical and scientific support organizations provide the scientific basis for decisions made by either the NRA or the industry. To maintain their credibility with respect to the other stakeholders and the public, the TSOs must observe a number of ethical codes. They must focus on the technical problems and their impact on safety, and express technical judgements independent of external interests, both political and economic. Among the qualities to be promoted are honesty, impartiality, proactiveness and initiative, consistency and proportionality in the safety approach, and respect to all stakeholders.

If a TSO provides support to both an NRA and an operator, that fact should be made known to all parties and the TSO should be required to demonstrate that there are no conflicts of interest.

In this way, TSOs can gain public confidence and explain the technical bases on which decisions have been made. They should try to make the scientific information accessible to the non-specialist, while avoiding any oversimplification that might introduce misunderstandings and misconceptions.

INDEPENDENT TECHNICAL AND SCIENTIFIC ADVICE FOR REGULATORY DECISION MAKING

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Abstract

Technical and scientific support organizations (TSOs) dedicated to supporting national regulatory authorities need comprehensive know-how and know-why concerning nuclear science and technology, and all the technical aspects of a given nuclear installation. This comprehensive knowledge can only be obtained if a TSO is involved in the nuclear licensing and supervision process, and if R&D activities are continuously sponsored to maintain the institutional knowledge base and to contribute to the development of nuclear safety. The R&D activities need not be directly connected to current regulatory requirements, but could serve for developing the state of the art in view of long term regulatory considerations. The TSOs need their independent knowledge to be able to provide technically correct insights and reactions to various regulatory requests and to define their research topics. The Convention on Nuclear Safety and other international agreements, as well as national acts and ordinances, set out the responsibilities of licensing and supervisory authorities. Some requirements of the Convention on Nuclear Safety are used here as examples for the various regulatory aspects that underline the variety of technical support provided to regulatory authorities by TSOs. The areas of support include siting assessments, design assessments, evaluations of operating experience and the development of different aspects of emergency preparedness. The issues of decommissioning and waste disposal are also taken into account. Technical and scientific support organizations support the regulatory authorities in the decision making process by providing technical advice in all these areas. Doing so requires the cooperation of experts from various technical and scientific disciplines, including neutron physics, thermo-hydraulics, material science, civil engineering, process engineering, human and organizational factors, health physics and many more. The requests of regulatory authorities concerning day to day business may limit the focus of the TSOs to the assessment of licensee reports. The daily supervisory business tends to leave too little room to enhance the installation's safety. The TSOs must, therefore, have sufficient personnel and financial resources to perform safety related research that is not driven by current regulatory needs. The knowledge gained from this research ensures that the expertise requested by the regulator is based only on the most up to date science and technology, and is independent of current regulatory and political influence. Thus the independence of a TSO is a prerequisite for its long term support of regulatory decision making. Cooperation with international bodies such as the IAEA

and the OECD Nuclear Energy Agency, as well as with other TSOs, is necessary to maintain a technically advanced level of knowledge and to serve as a source of new ideas.

1. INTRODUCTION

The safe operation of nuclear power plants and the prevention of accidents, particularly those with radiological consequences, are the most important objectives of those countries that make use of nuclear energy. To achieve and maintain a high level of nuclear safety in each of these countries, a sound national technical and scientific infrastructure is necessary, including a number of highly experienced experts, who build up a knowledge pool for all relevant technical and research fields in nuclear safety.

The regulatory bodies must fulfil some basic functions such as developing and enacting a set of appropriate and sound regulations, verifying compliance with such regulations and, in the event of a departure from licensing conditions, imposing the appropriate corrective measures. The performance of these functions must be entrusted to a regulatory body with sufficient independence to ensure that regulatory decisions can be made and enforced without pressure from interests that may conflict with safety. To ensure independence, there must be an effective separation of the functions of the regulatory body from those of any other body or organization concerned with the promotion or utilization of nuclear energy. Moreover, to act as an independent regulator under these conditions, the authority must have access to the necessary competence and expertise in nuclear safety according to the state of the art, independent of the licensees and other stakeholders.

The provision of the necessary competence to the regulatory body differs from country to country. In some, sufficient competence is available within the regulatory body itself, and further technical support is provided by other independent organizations. This is referred to as an integrated TSO model. Another approach is the external TSO model, where the TSO is specifically assigned to assist the regulatory body. In this model, both the TSO and the regulatory body require independent in-depth knowledge and high levels of competence in the relevant areas of nuclear operation and related research activities to provide technically correct insights and reactions to various regulatory requests and to define their research topics.

2. REQUIREMENTS FOR AN EFFECTIVE REGULATORY DECISION MAKING SYSTEM

The history of the use of nuclear energy and the potential for radiological accidents make it clear that the peaceful use of nuclear energy must be regulated on a sound technical basis and that continuous supervision is necessary, as laid down in the nuclear acts worldwide.

The Preamble to the Convention on Nuclear Safety (CNS) [1] states that the Contracting Parties are:

> "i. Aware of the importance to the international community of ensuring that the use of nuclear energy is safe, well regulated and environmentally sound;
> ii. Reaffirming the necessity of continuing to promote a high level of nuclear safety worldwide;
> iii. Reaffirming that responsibility for nuclear safety rests with the State having jurisdiction over a nuclear installation ..."

Moreover, according to Article 8 of the CNS: "Each Contracting Party shall establish or designate a regulatory body entrusted with the implementation of the legislative and regulatory framework referred to in Article 7, and provided with adequate authority, competence and financial and human resources to fulfil its assigned responsibilities."

Article 8 also states that: "Each Contracting Party shall take the appropriate steps to ensure an effective separation between the functions of the regulatory body and those of any other body or organization concerned with the promotion or utilization of nuclear energy."

On the basis of these internationally agreed general requirements, regulatory decision making takes place within a national regulatory framework related to the use of nuclear energy and the licensing and supervision of the operation of nuclear power plants, as well as waste disposal. In addition to the licensing of design and construction of the plants, the assessment and verification of nuclear safety are among the most important tasks of the regulator.

To meet these internationally agreed requirements, comprehensive expertise in all fields of nuclear safety has to be built up on a national level at least twice, once on the side of the regulator and its supporting organizations and again on the side of the licensee. Analyses of the causes of the accidents at Three Mile Island and Chernobyl have underlined that a sound national technical–scientific infrastructure is necessary to ensure nuclear safety. Moreover, communication on ongoing activities, insights and recent developments among all involved organizations must be well organized within a national network to bring every party to the same high level of nuclear safety.

Additional efforts are necessary to maintain and improve the level of know-how and know-why concerning nuclear safety and regulatory issues. These efforts include knowledge management, which is particularly important in the light of the fact that the generation that licensed and built today's operating nuclear power plants will be retiring, and with them will go their knowledge. In addition to knowledge management, education and training of a younger generation in nuclear energy is necessary. This is of course important not only for countries that are experiencing a renaissance of nuclear energy, but also for countries with phase-out policies, as during the phase-out period it is still necessary to operate the nuclear power plants safely and to organize safe storage of the waste.

Arising from these national efforts, international exchanges have been performed since the beginning of the peaceful use of nuclear energy. The globalization of the past century has affected not only the manufacturers and utilities, but also the regulators and experts of related organizations. Organizations like the OECD Nuclear Energy Agency (OECD/NEA), the Western European Nuclear Regulators' Association (WENRA) and the European Nuclear Installations Safety Standards (ENISS) group provide a platform for the exchange of expert opinions. The IAEA, as an organization that fosters the exchange and convergence of expert opinions as well as the establishment of internationally accepted safety standards, also plays an important role in international networking.

The well known graphic in Fig. 1 shows the link between national and regional activities concerning regulation, operation, and research and education, and the establishment of international legal instruments. The graphic emphasizes the central role of the global knowledge network and the global community of experts, of which TSOs are becoming an important part. This Global Nuclear Safety Regime is one of the real advances in nuclear safety of the past decade. The IAEA safety reviews, as well as the safety standards, have a strong influence at the national level. Nevertheless, the accident at Chernobyl has shown us that nuclear safety is not just a national problem.

3. POSSIBILITIES AND CONDITIONS OF EXTERNAL SUPPORT FOR THE REGULATOR

In Article 1 of the CNS, the Contracting Parties have laid out the entire frame of the tasks that should be supported by the national TSOs. It states:

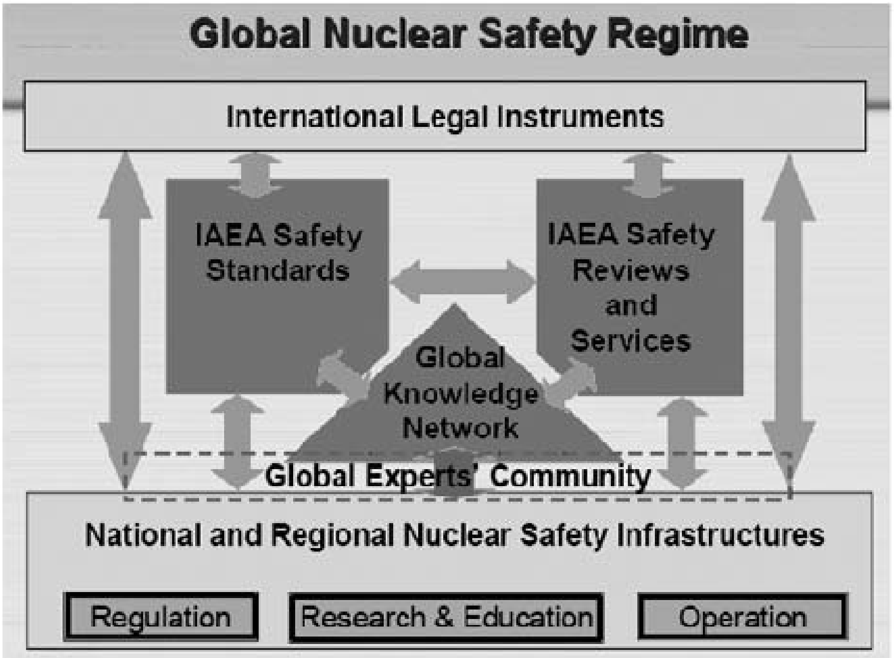

FIG. 1. The Global Safety Regime.

"The objectives of this Convention are:

i. to achieve and maintain a high level of nuclear safety worldwide through the enhancement of national measures and international co-operation including, where appropriate, safety-related technical co-operation;
ii. to establish and maintain effective defences in nuclear installations against potential radiological hazards in order to protect individuals, society and the environment from harmful effects of ionizing radiation from such installations;
iii. to prevent accidents with radiological consequences and to mitigate such consequences should they occur" (Ref. [1]).

From these very general objectives, the requirements for regulatory support are derived in the subsequent Articles of the CNS. Article 7, for example, includes the need to establish applicable national safety requirements and regulations, a system of licensing and a system of regulatory inspection and assessment of nuclear installations to ascertain compliance with applicable regulations and the terms of licences.

For the TSO, which is embedded in this system, the following working areas can be derived:

— *Rules and regulations:* TSOs support the regulator in the development of technical guidelines, in contributions to acts and ordinances concerning technical questions, and in developing and improving rules and regulations. To serve the regulator in this field, the TSO must have a comprehensive knowledge of nuclear safety and its regulatory basis.
— *Licensing:* The support in licensing questions includes the licensing of both new nuclear installations and major backfits. An independent analysis of important safety issues is necessary, as is sound technical analysis of the licensee's assessments.
— *Operating experience feedback (OEF):* The OEF is a fundamental source for the continuous improvement of nuclear safety, and thus an important field of competence for TSOs.
— *Inspection:* The confirmation of the licensing status of the plant is the main objective of inspection. The support of the TSO also includes determining how detailed and frequent the inspections will be, as well as reviewing safety assessments like the periodic safety review.
— *R&D*: The possibility of having competencies in the field of R&D is an important prerequisite for the independence of a TSO. A distinction can be made between basic R&D and regulatory oriented R&D. Basic R&D can be used to increase knowledge concerning important phenomena and to be aware of the state of the art of safety related research. Regulatory oriented R&D concerns activities in the field of current regulatory safety issues and includes the verification of the licensee's calculations. For both applications, a sound scientific basis and various numerical codes or code systems are needed.

Although the elements of technical and scientific support are the same worldwide, TSOs may be very different in different countries. Concerning the structure of the regulation in Germany, for instance, the fact that Germany is a federal republic has led to special solutions in the regulatory supervision of the nuclear power plants and has also had implications for the TSOs. The execution of Federal laws lies within the responsibility of the Federal states, or Länder. In the case of the use of nuclear energy, where it is particularly important that laws be executed in a uniform manner across the Federation, the order for the Länder is that they execute the laws acting as agents of the Federation (federal executive administration). This means that in executing the Atomic Energy Act and its associated ordinances, the Länder are under the supervision of the Federation with regard to the lawfulness and expediency of their actions, and are subject to the directives issued by the Federal Government.

The nuclear licensing and supervisory authorities are state ministries of those Länder in which the nuclear installations are located. The Federal supervisory authority is the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU). With regard to the TSOs, the situation is similar to that of the authorities. For day to day supervision, the Länder use the technical inspection agencies, known worldwide as the TÜV, as their TSO, and the BMU uses mainly the Gesellschaft für Anlagen- und Reaktorsicherheit (GRS) as its TSO.

This difference leads to task sharing with more generic activities at the GRS and mainly plant specific activities at the TÜV. The expertise of the GRS is mainly in basic R&D, in providing OEF concerning more generic aspects and in supporting the BMU in technical questions in the development of rules and regulations and other generic safety related questions. The activities include international networking with other TSOs and representing German positions at international fora. The TÜV organizations are mainly involved in plant specific activities such as inspection, regulatory R&D and OEF. The TÜV and GRS cooperate via the TÜV-Leitstelle Kerntechnik and the TÜV nuclear technology coordinating group to coordinate generic and methodological questions on nuclear safety. The TÜV organizations participate in international networking as far as is appropriate. Such participation mainly takes place if plant specific knowledge is necessary in international discussions.

Whatever may be their organizational form, TSOs have to fulfil some common requirements to be independent. In the foreword to INSAG-17 [2], which deals with independence in regulatory decision making, it is mentioned that: “It is widely recognized that independence of the regulatory body is needed to ensure that regulatory decisions can be made and enforcement actions taken without unwarranted interaction and attempts to influence regulatory decision making in a way that is detrimental to safety.”

INSAG-17 also refers to the role of TSOs, for example, stating that: “It is important that principles and tools similar to those discussed above for ensuring independence in regulatory decision making should also be applied to ensure the independence and quality of the scientific and technical advice provided by such regulatory support functions, with due adjustment for the special features of their scientific and technical work.”

Hence, similar to the requirements concerning the regulatory bodies, there are also requirements for the independence of TSOs. The technical advice of the TSO must be independent of any external influences as far as possible. This means that:

- TSOs must have an overall view of safety. This implies that the TSOs follow a long term strategy to develop methods and codes related to nuclear safety. Concentration solely on day to day regulatory business could hinder this continuous and necessary development process. Furthermore, this process builds up and maintains the knowledge of the TSO. Knowledge is necessary for independence. Independent knowledge is the only way to support the regulatory body in the long term.
- TSOs must develop their own assessment and evaluation processes. These processes ensure that a TSO need not follow the justifications of the operators, but can evaluate the safety implications of design measures or procedures based on its own expertise. TSOs must be independent of industrial developments and research.
- TSOs must be able to push the development of nuclear safety by defining their own research needs and their own research results, and by using the results and experiences of other organizations, including operators. The operational data acquired by the operators should be, to a large extent, open for the research needs of TSOs and vice versa. An important example is the use of data in preliminary safety assessments. Without TSOs, the development of this important tool, from the regulatory side as well as from the licensee side, would not have advanced so far. Probabilistic safety assessments (PSAs) can now be performed in the design stage of new reactors, without specific operational data, through verified application of the operation experiences and progressive mathematical methods. TSOs must be involved in the exchange of safety related insights.
- TSOs must cooperate with other TSOs, research centres, universities and specialized expert organizations. This collaboration is necessary, especially in those areas of competence that are not fully covered by the TSO. These areas may not be within the nuclear core areas of competence but may have an oblique influence on safety. TSOs must cooperate with other TSOs to complement their areas of competence.
- International cooperation between different TSOs and with international organizations such as the IAEA and OECD/NEA is indispensable for ensuring that the TSO competence is at the state of the art of science and technology. Continuous international benchmarking and the exchange of experiences and views are important measures for maintaining and developing competencies. This implies participation in the related working groups and meetings of the international organizations, as well as

bilateral or multilateral cooperation. International cooperation is indispensable for maintaining competence.

Independence is crucial where a TSO cooperates with the licensee. On the one hand, such cooperation is important for the TSO, as it enables it to remain up to date with respect to technical solutions and to obtain sound experience concerning operating issues and safety related questions. On the other hand, the TSO serves as a counterpart to the licensee in reviewing and assessing technical solutions. Therefore, a code of ethics is necessary when a TSO provides services to a domestic or foreign licensee. Full transparency is necessary with respect to the licensee's nuclear safety authority to demonstrate that conflicts of interest are avoided.

4. RECENT TSO DEVELOPMENTS

The above mentioned requirements describe the ideal TSO. Real TSOs may not be competent in all nuclear related areas, but they should cultivate a network of expert organizations with broad access to results of R&D and other safety related insights.

The main challenges of the future may derive from the internationalization of markets. Already, operators and vendors are no longer focused solely on their traditional national market. Even regulators work together to harmonize their approaches for existing reactor regulation and regarding the assessment of new reactor designs.

TSOs must be ready to face these challenges. A coordinated approach with respect to regulatory needs and industrial developments is necessary. Therefore, the Institut de radioprotection et de sûreté nucléaire (IRSN), GRS and the Association Vinçotte Nucléaire (AVN) have formed the European TSO Network with the following objectives:

- To form a suitable forum for exchange of the results of analyses and R&D in the field of nuclear safety, to share experiences, and to exchange technical and scientific opinions;
- To contribute to fostering the convergence of technical nuclear safety practices in Europe;
- To further the definition and implementation of nuclear safety research programmes;
- To promote the formation of a European scientific and technical network in the nuclear safety field.

This network is considered as a first step, that is, as a networking core for TSOs in Europe. The network membership is open to organizations from the European Union and Switzerland that perform safety assessments in support of their national nuclear safety authorities or those in that role, with a global regulatory vision, on a regular basis and with a broad scope. Membership is by joint acceptance by the current members. The expansion is a part of the programme of the network.

From the international point of view, there is a need to ensure the availability of a strong national infrastructure in addition to a global community of experts. In Germany, we have established a strong national network. Research centres, universities and the GRS have formed the Nuclear Competence Cooperation (Kompetenzverbund Kerntechnik) to harmonize nuclear research activities. In times of restricted financial resources this cooperation was necessary to ensure completeness — that is, to ensure coverage of all significant areas — and to avoid duplication of efforts.

As a complement to the national infrastructures, a self-sustaining safety network of expert knowledge and experience is essential to promote continuous safety improvements and mutual learning. The current Global Nuclear Safety Regime functions at an effective level, but its impact on improving safety could be further enhanced.

5. CONCLUSION

To support the regulatory body in an appropriate way and in accordance with the state of the art, it is necessary for TSOs to be independent of any external influence. Since the regulatory bodies have multiple responsibilities in regulating nuclear safety, it is the task of the TSO to provide its expertise on a solely technical and scientific basis in all technical and scientific fields of nuclear safety. Therefore, staff members who are well trained in their respective technical and scientific areas are necessary to maintain the international state of the art.

Such comprehensive support can only be fulfilled by the TSO if:

— A programme is available to develop and maintain the expertise on nuclear safety;
— Research activities are ongoing to gather independent knowledge on safety issues;
— International cooperation is undertaken to complement and maintain its areas of competence.

To preserve its support in the long term, the TSO must retain its independence from the regulator and licensee.

The main challenges of the future may arise from the internationalization of markets. Technical and scientific support organizations must be ready to face these challenges. A coordinated approach with respect to regulatory needs and industrial developments is necessary. Therefore, the development of regional networks of TSOs is necessary, which could then serve as a model for an integrated global network.

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RELEVANCE OF TSOs IN PROVIDING TECHNICAL AND SCIENTIFIC SERVICES TO OPERATORS/INDUSTRY

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Abstract

The role of a TSO is to provide operators and the industry with the technical and scientific expertise to enable them to obtain a good understanding of and to achieve safe operation, to attain the highest possible operating and maintenance performance, and to provide the highest quality of electric supply services to the public. The technical know-how and knowledge provided by the TSO to the operators/industry should be comprehensive and encompass all the operator's activities, such as feasibility studies; site preparation; preparation of bid invitations; obtaining governmental licences for construction and operation of the plants, including preparation of the PSAR (preliminary safety analysis report), ER and FSAR (final safety analysis report); preparation of purchase specifications for main equipment and BOP (balance of plant) equipment; preparation of construction specifications; and preparation of installation, startup and operation guidelines/procedures. The TSOs supporting operators should provide overall technological value and experience for managing radioactive waste and decommissioning plants with the highest safety and confidence levels. They should also perform the basic role of organizing all activities beneficial to stakeholders in an optimized way during the construction and operation phases of nuclear power plants. In this context, TSOs providing support to operators are technical doctors, messengers and developers for upgrading nuclear safety and for efficient adoption of new and advanced technologies. The experiences of TSOs supporting operators in the Republic of Korea are discussed and related topical issues are touched upon in the paper.

1. INTRODUCTION

Technical and scientific support organizations (TSOs) provide operators with technical and scientific services at all phases of the nuclear power plant life cycle, from building the plant within the budget to safely operating and maintaining the plant over its lifetime. The safety and economics of an installation are greatly affected by the quality of such TSOs, combined with the operator's skill and experience. With the help of TSOs, the operator manages site preparation, procurement, construction, installation, testing and operation/maintenance. The TSOs undertake the design and engineering aspects of nuclear power plants, manufacture and supply plant equipment and material, construct structures, install plant equipment, and support operators in obtaining licences.

Technical and scientific support organizations that support operators in nuclear power projects are typically architect engineering (A/E) companies, nuclear steam supply system (NSSS) vendors, turbine/generator (T/G) vendors, balance of plant (BOP) equipment suppliers, constructors, research organizations and universities. To ensure the safety of the plant, the work of each TSO should meet the quality, safety and performance requirements of the customer and/or the regulatory body. Unlike TSOs providing support for regulators, TSOs providing support for operators need to perform a full spectrum of safety and performance analyses. There should be a balance between safety improvements and the costs incurred in enhancing the safety. Research organizations and universities support the nuclear industry by developing new ideas and concepts, and computer tools that may lead to the enhancement of nuclear safety and performance.

Among these TSOs, the A/E companies usually play a leading and central role. Depending on the type of project, the role of the A/E company and the scope of its activities can vary significantly. For new plants, the A/E company is responsible for design and engineering aspects, the issuance of procurement and construction specifications, the development of installation, testing and operation guidelines, and the provision of technical support during the process of obtaining construction permits and operating licences from the government. For operating plants, the A/E company provides technical services to maintain and repair the installation, to upgrade and improve safety and performance, to uprate the power output and to extend the lifetime of the plant. The A/E company links the operator, the NSSS supplier, the T/G supplier, the BOP equipment manufacturer and the main contractor. It also provides technical support to the operator in obtaining licences from the regulatory authorities. The various activities of TSOs, especially those of A/E companies, are discussed in this paper.

Support for operators by TSOs is categorized into two fields: (i) new plants or plants under construction and (ii) operating plants. The main focus of the discussion in this paper is on TSO support for operating plants, but some discussion of support for new plants is also included.

2. ROLES OF TSOs FOR OPERATORS/INDUSTRY

2.1. TSO activities

Services provided by TSOs for operating plants involve various technical and managerial processes ranging from conducting feasibility studies to providing plant design system analyses and safety evaluations, suggesting methods to improve plant performance, selecting equipment, providing final detailed designs for plants, and supporting the operator in construction, schedule and cost management during the construction phase. When construction of a nuclear plant passes the commercial operation date milestone, it becomes an operating unit, typically licensed for 40 years of operation. The operator of the unit will require proper maintenance of the systems, components and structures of the plant in order to safely operate the unit. There will also be maintenance and modifications required by the regulatory authority, unexpected component or equipment failures and the operator's desire to improve plant performance.

In particular, during the operation and post-operation phases, the TSO helps the operator to improve equipment/system reliability and plant availability and safety, to reduce or control operation and management (O&M) costs and outage duration, to utilize specialized resources, and to standardize processes and procedures to improve work efficiency.

2.2. Life cycle management

Life cycle management (LCM) is the integration of ageing/obsolescence management and economic planning to optimize the operation, maintenance and service life of plant systems, structures and components (SSCs), to maintain an acceptable level of performance and safety, and to maximize return on investment over the lifetime of the plant without sacrificing safety.

Life cycle management is a process by which the nuclear plant operator optimizes the operating life of components and systems. Technical and scientific support organizations support the development and implementation of system/component specific LCM plans. Thus, TSOs support operators in developing long term plans for maintenance, replacement, refurbishment and redesign of major plant components/systems that will improve the overall plant reliability and plant value (see Fig. 1).

In this context, the key elements of LCM are equipment reliability, maintenance allocation, ageing management and economic optimization. Support provided by TSOs for LCM integrates operation, maintenance, engineering, regulatory, environmental and business activities to manage

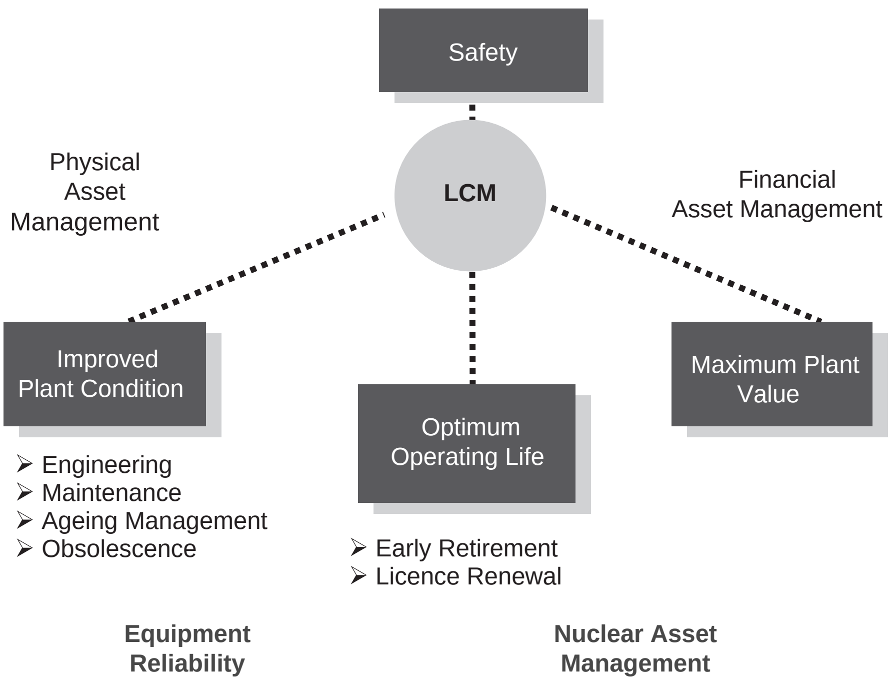

FIG. 1. Life cycle management programme.

ageing and obsolescence assessments, to optimize operating life (including early retirement and licence renewal) and to provide short and long term planning.

Services provided by TSOs during the operation phase are founded on extensive nuclear expertise, including:

— LCM plans;
— Licence renewal;
— Equipment qualification (EQ), ageing and obsolescence assessments;
— Preventive maintenance (PM), predictive maintenance (PdM) and condition monitoring programme development;
— Root cause analysis;
— Equipment/system condition assessment;
— Maintenance rule programme assessment and implementation.

Technical and scientific support organizations also provide the operator with in-service inspection/testing (ISI/IST) services, including the development of basis documents, ISI/IST programme updates and the development of repair/replacement programmes.

In doing so, the TSO supports the operator in the preparation of O&M procedures including:

— Operation procedures;
— Maintenance procedures;
— Predictive/preventive maintenance programme procedures;
— Safety programme/fire protection procedures;
— System line-up procedures;
— Alarm response procedures;
— Operational surveillance procedures;
— Work flow process procedures.

The TSO also supports the preparation of ISI/IST surveillance procedures including:

— ASME Section XI and OM code reconciliation procedures;
— Independent third party technical overview procedures;
— Independent programme assessment procedures;
— Technical specification and FSAR update procedures;
— Risk informed initiatives in ISI/IST programme procedures;
— Staff augmentation and training procedures.

Technical and scientific support organizations also perform root cause analyses for equipment, that is, the TSOs review and evaluate equipment history and characteristics, conduct interviews of appropriate personnel, identify plausible causes for all failure modes and the root causes, perform failure trend analysis, document the evaluations and results, and develop monitoring and feedback techniques for determining whether the corrective actions taken are suitable.

2.3. Maintenance optimization

Technical and scientific support organizations can also serve as the technical adviser for maintenance optimization (MO). Operators want to achieve cost savings and enhance equipment reliability through the implementation of a MO programme. An effective power plant maintenance programme utilizes a well orchestrated blend of PM and PdM technologies, which includes non-intrusive diagnostic testing, proactive maintenance (PAM) and corrective maintenance (CM) techniques to improve equipment reliability in a cost-effective manner.

The TSO must have the know-how to integrate industrial, regulatory and technical requirements into the MO programme. The objectives of maintenance optimization are to improve equipment/system reliability through a cost-effective programme, to establish the PM/PdM task and frequency basis in a database that will facilitate a ‘living’ MO programme, to perform systematic evaluation of the tasks and frequencies of PM/PdM activities, to create an integrated equipment health report and to develop a cost–benefit analysis model.

2.3.1. Valve programme

An effective valve programme is key to the efficient operation of a plant. A TSO’s in-depth knowledge support for nuclear systems and components enables operators to achieve cost-effective maintenance performance. Technical and scientific support organizations work closely with plant operators to provide them with on-site supports for valve performance to ensure safe and reliable operation. Valve support service includes:

— Valve programme assessment, development and implementation;
— PM/PdM programme development;
— Maintenance procedure development;
— Configuration control;
— Calculations and preparation of valve setup data sheets;
— Root cause analysis and failure trend analysis;
— Outage support and staff augmentation;
— Diagnostic testing, data analysis and troubleshooting;
— Valve software programme development;
— Technical training.

2.3.2. Operation and maintenance procedures

Accurate and concise O&M procedures are necessary for efficient, safe and reliable O&M of the systems and equipment. Technical and scientific support organizations develop operation, maintenance, modification and test procedures for operators to support efficient and high quality work on the part of operator.

The O&M procedures benefit operators by:

— Minimizing human error by being simple and easy to use;
— Ensuring consistency in the performance of work;

— Reducing maintenance and rework;
— Capturing knowledge and lessons learned;
— Achieving economies of scale by standardization;
— Providing consistent quality in maintenance work.

2.3.3. Equipment condition assessment

An equipment condition assessment is required for early detection of equipment problems that can affect plant availability and system/component reliability. For the equipment condition assessment, the TSO performs a plant walk-down to visually inspect the physical conditions. The TSO also:

— Interviews plant personnel;
— Reviews O&M histories, root cause reports and inspection reports;
— Evaluates equipment/system performance trends and condition monitoring data;
— Reviews vendor documentation;
— Generates integrated equipment/system integrity reports;
— Defines alternatives, analyses benefits and provides recommendations.

2.3.4. Maintenance rule

Technical and scientific support organizations must have extensive expertise in the assessment and implementation of maintenance rule programmes and in the training of staff. Services provided by TSOs for the maintenance rule include programme assessments, staff augmentation for data retrieval, display and analysis, software development to balance reliability and unavailability through predictive/preventive maintenance and MO, development of the periodic report and performance of risk assessments prior to the removal of equipment from service.

3. TSO EFFORTS IN THE REPUBLIC OF KOREA

As a Korean engineering TSO, the Korea Power Engineering Company, Inc. (KOPEC) plays a leading role in the Republic of Korea and is positioned at the centre of many nuclear power technology areas. The main role of KOPEC is to design new nuclear power plants and to provide operators with technical support for operating plants. KOPEC, a company with Government investment, has achieved technical self-reliance in nuclear power plant design and engineering. KOPEC supports operators by providing:

— Power plant (nuclear and thermal) design and engineering services;
— Power plant O&M services;
— Power plant lifetime extension and restart services;
— Power plant safety and performance improvement services.

KOPEC has the ability to design both the NSSS and the BOP. Thus, KOPEC is truly the only integrated A/E company in the world that engineers both nuclear and conventional islands of a nuclear power plant. With the technologies and experience obtained from the design, engineering and construction of nuclear power plants, KOPEC has developed two different standardized nuclear plant models: the 1000 MW(e) class OPR1000 (Optimized Power Reactor 1000) and the 1400 MW(e) class APR1400 (Advanced Power Reactor 1400). They represent the culmination of the Republic of Korea's effort to achieve self-reliance in nuclear technology.

KOPEC has adopted an evolutionary design improvement strategy for OPR1000 and APR1400 to enable the operator to gradually enhance plant safety and performance.

3.1. TSO efforts for plants under construction

There are six nuclear units under construction in the Republic of Korea: Shin-Kori 1 and 2 (2 × 1000 MW(e) OPR1000), Shin-Wolsung 1 and 2 (2 × 1000 MW(e) OPR1000) and Shin-Kori 3 and 4 (2 × 1450 MW(e) APR1400).

KOPEC is responsible for the full scope of engineering aspects for the six units including:

— The feasibility study;
— The site study;
— Environmental impact analyses, including preparation of an environmental report (ER);
— The conceptual design;
— The basic design;
— The detailed design;
— Support for construction management;
— Support for purchase of components;
— Support for start-up;
— Support for commercial operation;

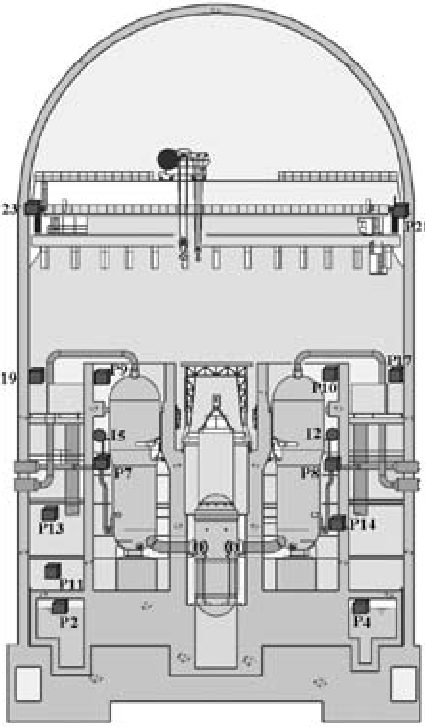

FIG. 2. The APR1400 HMS locations.

— Preparation of the construction permit and operating licence documents, the preliminary safety analysis report and the final safety analysis report;
— Analysis and documentation of severe accident related issues.

The TSO's efforts have enabled the Korean operator Korea Hydro and Nuclear Power Co., Ltd. (KHNP) to achieve its safety goal of a core damage frequency of 10^{-4}/reactor per year for the OPR1000 and 10^{-5}/reactor per year for the APR1400, which is one of the lowest in the world. For achieving the safety goal for the APR1400, KOPEC completed the design and obtained the design certification from the Korean regulatory authority by adopting severe accident mitigation features, to be installed in Shin-Kori 3 and 4, such as:

— A hydrogen mitigation system (HMS) capable of igniting any hydrogen gas produced during severe accidents (see Fig. 2);
— A design for protection against high pressure melt ejection and direct containment heating;

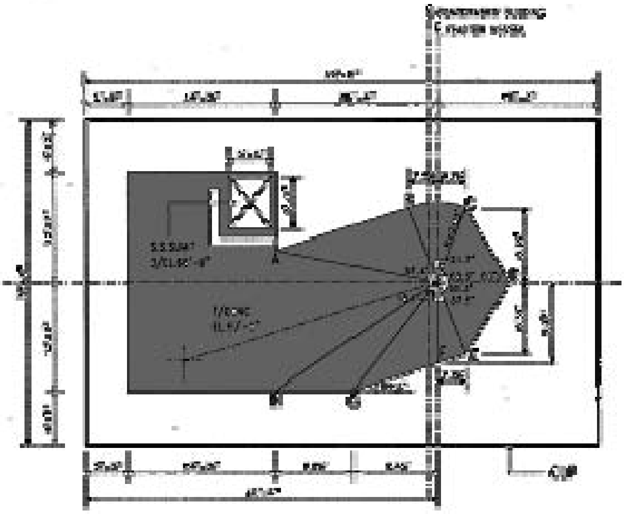

FIG. 3. APR1400 reactor cavity bottom floor.

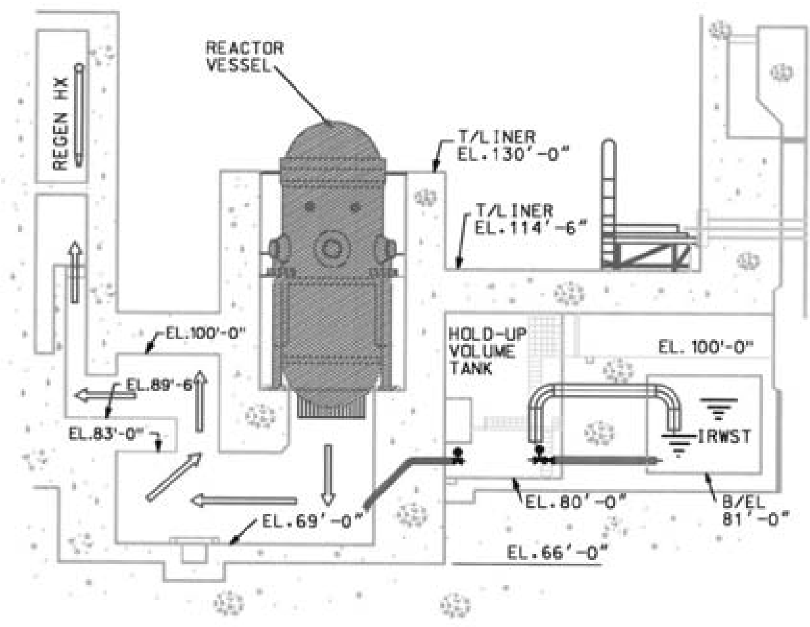

FIG. 4. APR1400 reactor cavity.

— A reactor cavity structure designed to mitigate steam explosion due to a reactor pressure vessel breach;
— A reactor cavity design for protection against molten core and concrete interaction (see Figs 3, 4).

Additional efforts aimed at ensuring equipment survivability after severe accidents were made in designing the APR1400 reactor. In doing so, KOPEC has provided the KHNP with the world's highest level of safety.

3.2. TSO efforts for operating plants

3.2.1. Plant lifetime evaluation

Currently, there is no limit set for the licensed life of nuclear power plants in the Republic of Korea. Technical and scientific support organizations help utilities to conduct the periodic safety review (PSR) that is required every ten years for operating nuclear power plants and to submit PSR reports for regulatory review and approval.

3.2.2. Periodic safety reviews

Periodic safety reviews are performed with the 11 safety factors recommended by the IAEA. These include the actual condition of SSCs, EQ, ageing, deterministic safety analysis, PSAs, hazard analysis, safety performance, use of research findings and the experiences of other plants, organization and administration, procedures, human factors, emergency planning and radiological impact on the environment. The PSR report consists of five chapters including site characteristics, ageing assessment of SSCs, radiation safety evaluation, safety assessment and administration, including staff training and emergency planning.

A major aim of the PSR is to analyse the ageing mechanisms and the effects on SSCs. Figure 5 shows the evaluation process in a PSR.

An enhanced PSR activity adopted by the Republic of Korea includes identifying the SSCs within the scope of continued operation, ageing management programmes (AMPs), time limited ageing analyses (TLAAs) and the use of the operation experiences and findings from other plants.

The AMP results demonstrate that the SSCs can be adequately managed with respect to ageing effects with the current and enhanced plant programmes.

The SSCs subjected to ageing management, selected by a scoping and screening process, were in three major areas: mechanical, structural and

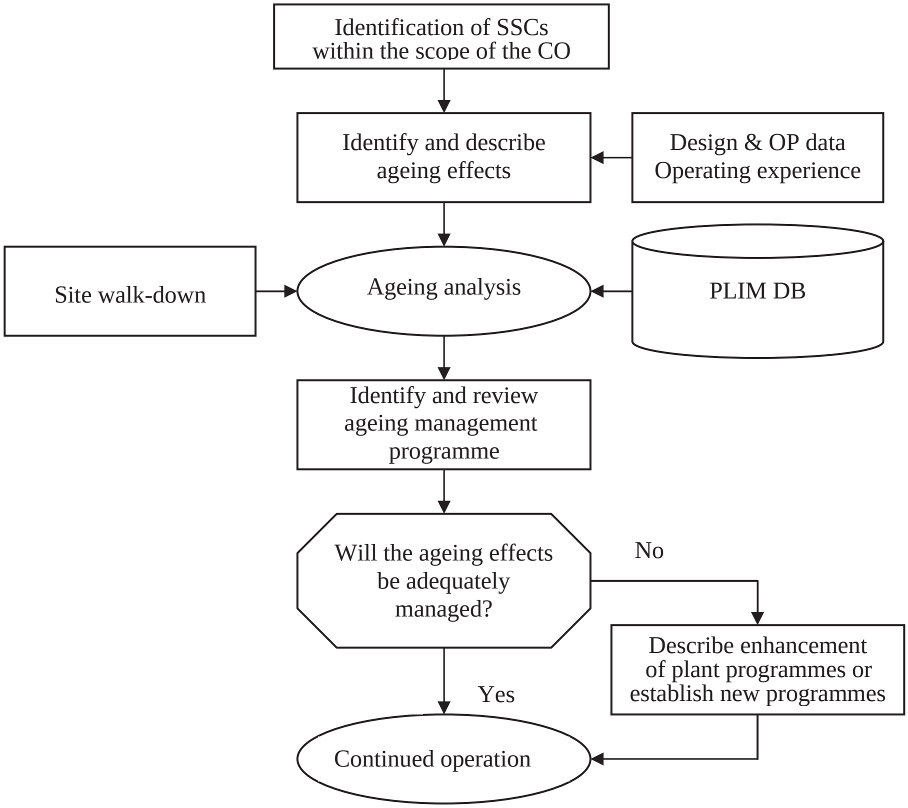

FIG. 5. Ageing evaluation process in a PSR.

electrical. The AMPs are generally of four types: prevention, mitigation, condition monitoring and performance monitoring. The Korea Institute for Nuclear Safety (KINS) Review Guidelines describe the following elements, which must be considered in an appropriate evaluation:

- — The scope of the programme/activity;
- — Preventive actions;
- — Parameters to be monitored, inspected and/or tested;
- — Detection of the ageing effect;
- — Monitoring and trend analysis;
- — Acceptance criteria;
- — Confirmation process;
- — Corrective action;
- — Administrative controls;
- — Operation experience.

These elements should be evaluated taking into consideration research findings and the operating experience of other plants. A major part of the evaluation programme is the review of the current surveillance/maintenance procedures and the actual maintenance practices to confirm that certain ageing effects can be adequately managed.

3.2.3. Time limited ageing analyses

Time limited ageing analyses are performed to ensure that the integrity of the SSCs will be maintained throughout the plant life extension. For a TLAA, an independent analysis is performed to confirm that the acceptance criteria are met. It should be demonstrated that the TLAAs ensure one of the following acceptance criteria during the plant life extension:

(A) The analyses remain valid for the period of continued operation.
(B) The analyses are projected to the end of the period of continued operation.
(C) The effects of ageing on the intended function(s) are adequately managed for the period of continued operation.

Table 1 shows the TLAA categories and analysis descriptions.

3.2.4. Use of operating experience and research findings

In the Republic of Korea, the operating experience and research findings of domestic and foreign plants were reviewed, and eight issues were selected for plant life extension (see Table 2). Related enhancements have been performed to satisfy the acceptance criteria.

4. ACTIONS AND TASKS TO BE PERFORMED

4.1. Safety enhancement by TSOs

It is rational that TSOs should make efforts to enhance safety:

(1) Technical and scientific support organizations are technically responsible for supporting the setting up of nuclear safety policies of international organizations and national authorities, and for making every effort to implement risk reductions related to utilization of nuclear power during the entire lifetime

TABLE 1. TLAA CATEGORIES AND ANALYSIS DESCRIPTIONS

TLAA category	Analysis description	Disposition
Reactor vessel neutron embrittlement	Upper shelf energy PTS P–T curve	B
Metal fatigue	ASME Sec. III, Class 1 ANSI B31.1 ASME NC-3200 vessel Fatigue monitoring system	A or B or C
EQ of the electrical equipment	EQ evaluation	B
Containment liner plate and penetration fatigue	Containment liner plate and penetration fatigue	A
Flux thimble tubes wear	Thickness measurement	B
Reactor coolant system main loop piping LBB	NUREG-1061, SRP 3.6.3	B
Crane load cycle limit	Fatigue	A
Reactor coolant pump flywheel	Flaw evaluation	B
Spent fuel pool liner	Fatigue	A
Component/piping subsurface indication	Flaw evaluation	B
Thermal embrittlement of CASS	LBB requirement and flaw evaluation	B

of nuclear power plants, including site selection, design, construction and manufacturing of components, operation and decommissioning.

(2) They are technically responsible for supporting operators in managing plant safety.

(3) They are technically responsible for providing guidelines for familiarization with the nuclear safety culture.

(4) They are responsible for providing the stakeholder and public with the technical bases and solutions for setting up the safety criteria.

(5) They should serve as a bridge between research organizations and operators.

4.1.1. TSO strategies for enhancing safety

Strategies of TSOs for enhancing nuclear safety include, but are not limited to, the following:

TABLE 2. ISSUES FOR PLANT LIFE EXTENSION AND EVALUATION RESULTS

Issue No.	Description	Reference code	Evaluation result
1	Fire protection	MOST bulletins 2005-31 10CFR50.48	Satisfies the requirements
2	Seismic qualification of equipment	MOST bulletins 2005-31	Under review
3	Pressurized thermal shock of reactor pressure vessel	10CFR50.61 Reg. Guide 1.154, etc.	Satisfies the requirements
4	Anticipated transient without reactor scram	10CFR50.62	Under review
5	Maintenance programme for active components	10CFR50.65 NUMARC 93-01	Satisfies the requirements
6	Piping thermal stratification	NRC bulletin 88-08, 88-11	Satisfies the requirements
7	Safety analysis for combustible gas	IAEA Safety Guide NS-G-1.10	Satisfies the requirements
8	Station blackout	10CFR50.63	Satisfies the requirements

— Adoption of ‘intrinsic safety’ concepts;
— Adoption of defence in depth concepts;
— Optimized adoption of engineered safety features considering redundancy, diversity and independence;
— Use of proven technologies;
— Consideration of severe accident mitigation.

4.1.2. TSO design improvement process for enhancing safety

Technical and scientific support organizations could adopt the process for design improvement for safety enhancement shown in Fig. 6.

4.1.3. Cooperation among stakeholders for enhancing safety

All stakeholders should cooperate with one another to enhance safety according to the scheme shown in Fig. 7.

The special roles and tasks imposed on engineering TSOs include:

— Achievement of improved safety for new reactors;
— Safety assessments based on integrated system performance;
— Resolution of licensing issues related to nuclear safety;
— R&D for confirmation of technical bases;

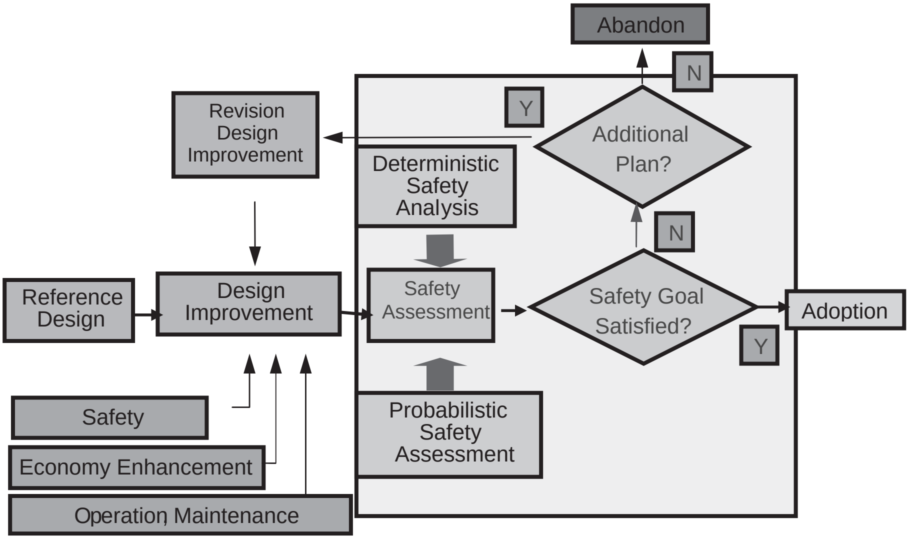

FIG. 6. Process for design improvement for enhancing safety.

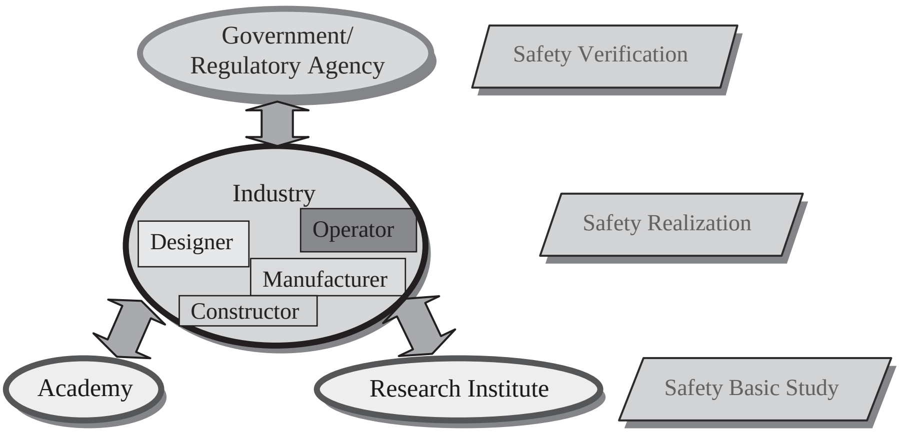

FIG. 7. Cooperation between stakeholders for enhancing safety.

— Harmonization of safety and economic considerations;
— Identification of potential safety issues.

4.2. Issues and studies for enhancing safety

Results of R&D for enhancing safety could be utilized through the process proposed in Fig. 8.

The main topical issues to be studied are:

— Resolving safety issues through optimized analysis methodologies;
— Developing computer programs for nuclear safety analyses and utilization of experiments;
— Improving nuclear safety analysis methodologies;
— Expanding international and/or joint safety analysis studies;
— Improving economic performance of nuclear power operation:
  - Eliminating excessive design criteria;
  - Eliminating excessive rules and regulations;
  - Adopting a risk informed approach;
— Enhancing plant performance for upgrading safety:
  - Reducing excessive operational margins;
  - Eliminating excessive technical specification requirements;
  - Reducing reactor shutdowns;

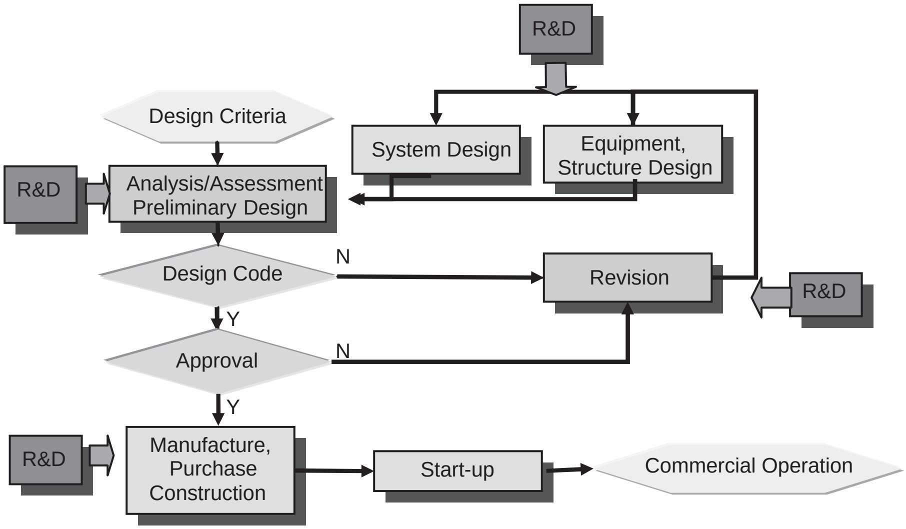

FIG. 8. Process of using the results of R&D for enhancing safety.

— Resolving issues on operating plants:
  - Safety study for licence renewal;
  - Safety study for power uprating;
  - Safety study for PSR/ageing;

— Establishing regulatory requirements including risk informed regulation and severe accident management;

— Preventing accidents:
  - Study of safety enhancements for accident prevention;
  - Study for reducing human error;
  - Study for protection against component failure;
  - Study for hazard analyses.

5. CONCLUSION

Global warming due to careless use of fossil fuels should be avoided through the use of other energy options that do not contribute to global warming and environmental pollution. Nuclear power could be one of the solutions to meet the energy needs, subject to the condition that new generation nuclear power plants are cleaner and ensure a much higher safety level compared with that of the current generation of nuclear power plants.

The roles and responsibilities of TSOs are becoming broader and deeper to fulfil the need to act as a bridge between the stakeholders.

The possible transition to a hydrogen economy in the 21st century could be one of the drivers for the growth of nuclear power, as the economies of scale offered by very high temperature nuclear reactors enable the large scale production of hydrogen economically and in a sustainable manner. The TSOs have an important role to play in this field as well.

KOPEC as a TSO for operator/industry is ready to put in the best efforts to enhance nuclear safety and to cooperate with other organizations, worldwide, to improve the quality of life.

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DEVELOPMENT AND MAINTENANCE OF THE TECHNICAL AND SCIENTIFIC KNOWLEDGE BASE NECESSARY FOR TSOs

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Abstract

The development and maintenance of the technical and scientific knowledge base crucial for the nuclear field, and the management of knowledge and the response to society's expectations are key issues for this sector. In this context and regarding the challenges faced by technical and scientific support organizations (TSOs), two main points must be addressed: the role of TSOs with respect to the national regulatory body and the knowledge base necessary to enable TSOs to provide high quality support to the operators/industry regarding existing facilities and those under construction or planned for the future. The Institut de radioprotection et de sûreté nucléaire (IRSN) is a public sector expert body in charge of the technical assessment and research related to nuclear and radiological risks. Its main functions are to support the French public authorities in the field of safety, security and radiation protection, and to perform research either alone or with other TSOs, or in collaboration with the nuclear industry. The example of the IRSN shows that the research performed by TSOs is important for many reasons, as it makes it easier to focus research on assessment needs and to utilize the results appropriately, and it enhances the scientific credibility of TSOs. It also appears that a distinction should be made between technical *safety* organizations supporting the regulatory authorities, which do not promote nuclear applications, and other TSOs, which do. The objective of the assessment process is to advise authorities on practical decisions within a well defined time scale. To achieve this aim, the TSOs should be familiar with the installations and their operation, and with a large number of specialized technical and scientific subjects. The TSOs should also have well established methodologies and concepts to integrate the various aspects of the assessment. For existing facilities, there is a need to extend the knowledge base in areas such as reduction of uncertainties, new fuels, ageing, minimization of dose to the public (chronic exposure), and human and organizational factors. Regarding future facilities, the French Government's decisions to develop improved concepts (e.g. sodium cooled fast reactors (SFR) and possibly gas cooled fast reactors (GFR) for power plants) make it possible for the IRSN to efficiently play its TSO role and to start to define the knowledge base and research needed to cope with this challenge.

1. SUSTAINABLE DEVELOPMENT AND MAINTENANCE OF THE TECHNICAL AND SCIENTIFIC KNOWLEDGE BASE

Nuclear energy could play a larger role for future generations, provided that all requirements for its positive contribution to sustainable development are met, particularly in terms of societal expectations and nuclear safety. A high level of nuclear safety is a priority for countries using nuclear energy. In this context, it is essential that technical and scientific support organizations (TSOs), which provide the technical and scientific basis for decisions and activities regarding nuclear and radiation safety, play an important role and have the necessary resources and knowledge base to face this challenge.

In this context, the development and maintenance of this knowledge base within TSOs and the response to society's expectations are certainly key issues for the nuclear field.

This paper addresses two specific aspects of this key issue:

— What is the role of TSOs in the national safety organizations?
— What technical and scientific knowledge base is necessary to enable TSOs to provide high quality support for existing facilities and those under construction or planned for the future?

2. ROLE OF TSOs IN THE NATIONAL SAFETY ORGANIZATION: THE FRENCH EXAMPLE

The position of the Institute de radioprotection et de sûreté nucléaire (IRSN) in the French safety and security organization became clear after the 2002 reform of nuclear and radiological risk management in France. This reform appeared to provide an explicit answer to current societal expectations regarding nuclear safety and contributed to ensure that industrial and economic processes are sufficiently safe and acceptable.

As a result of this reform, the regulatory authority and the scientific and technical assessment body were separated. The responsibility of the research to be performed for the purpose of safety and radioprotection assessment was given to the technical assessment body, while other research missions remained within the scope of France's Commissariat à l'énergie atomique (CEA) and the industry. These changes were aimed at clarifying responsibilities, optimizing the efficiency of the overall risk management organization at the national level, and building public confidence in this organization.

This led to the creation of the IRSN as an autonomous public expert body in charge of the technical assessment and research related to nuclear and radiological risks. Its main functions are to support the French public authorities in the field of safety, security and radiation protection, and to perform research either alone or with other TSOs, or in collaboration with the nuclear industry. The IRSN also carries out a number of public duties, including contributing to training and education in the field of exposure of populations and of the environment to ionizing radiations. The IRSN has a yearly budget of around €290 million and over 1600 employees. It was in effect created through the merger of the CEA's Institute for Protection and Nuclear Safety (IPSN) and the Office for Protection against Ionizing Radiations (OPRI).

It is now clear that in France there are two main technical support organizations for nuclear matters:

— The IRSN, which is the public expert body in research and specialized assessments into nuclear and radiological risks. This technical safety organization, supporting the French public authorities in the fields of nuclear safety, nuclear security and radiation protection, does not promote nuclear applications.
— The CEA, which is a national organization in charge of technical assessment and research related to nuclear and radiological applications. This TSO, supporting the French Government (energy policy) and the industry, contributes to the promotion of the nuclear applications.

Concerning the technical safety organization, it should be noted that one unique feature of the French organization regarding nuclear risks is that there is only one support organization – the IRSN – for all the safety authorities. In this respect, the IRSN can submit advice to the safety authority for civil applications (Nuclear Safety Authority (ASN)), the safety authority for defence applications, the security authority, the civil security administration (emergency preparedness), the workers health administration, the food agency and the drugs agency. Institutional memory and consistency are essential elements for ensuring the permanency of the IRSN safety assessment system. They allow the performance of adequate assessments that are closely linked to the reality of the current state of the installations and activities studied, including civil installations, defence installations, sources, industrial applications, medical applications, the workers and food and the environment.

3. TSOs AND RESEARCH

The IAEA INSAG-12 report [1] reported the following conclusions:

— "…research and development activities are needed to maintain knowledge and competence within organizations that support or regulate nuclear power plant activities";
— "Nuclear research and development is an essential element of nuclear plant safety and its continued support is very important…. [C]o-operative research on an international scale to reach a common understanding on major safety issues is an important way to avoid duplication of efforts and to reduce costs."

These conclusions highlight the importance of nuclear research for improving the knowledge base, and consequently the need to maintain, to the maximum extent possible, significant research efforts in order to reduce gaps in available knowledge. Under these circumstances, the IRSN is responsible for the research needed for the quality of its assessment. This 'regulatory' research is generally performed by the IRSN itself or by external institutions/other TSOs with financial support from the IRSN. Cooperation with industrial bodies, nationally or internationally, also provides the potential to expand the field of research programmes and the knowledge base, while respecting the independence of the IRSN and the responsibility of the operator. The resources committed to upstream R&D efforts within a body like the IRSN represent around 50% of the total budget. The example of the IRSN shows that research performed by TSOs is important for many reasons, since it contributes to several important achievements including:

— An adequate focus of research on assessment needs;
— Better appropriation of results and their more direct use in assessments;
— Enhancement of the scientific credibility of TSOs and a strengthening of their position with respect to the industry and the public;
— A better understanding of the research processes generally and of ways to manage external research;
— The possibility to hire young, high level scientists and to offer them a career within the TSOs.

4. KNOWLEDGE BASE NECESSARY FOR HIGH QUALITY SUPPORT

The quality and level of safety depend to some degree on the expertise efficiency, which is function of the quality of the safety assessment provided by the TSO.

4.1. Existing facilities and facilities under construction

One of the main objectives of review and assessment of existing facilities or facilities under construction is to determine whether the operator's submissions demonstrate that a nuclear activity complies with safety objectives and requirements. In this context, the assessment process aims at advising authorities on practical decisions within a well defined time scale.

The assessment methodology is based on two successive processes: an analytical process and an integration process. The analytical process focuses on the different aspects of the evaluation of the risks and of the demonstration of safety. To this end, this process very often implies the need for several specialists having complementary knowledge, including knowledge of the installations (their design, modifications and operation) as well as a large amount of technical and scientific knowledge (thermohydraulics, mechanics, metallurgy, fire, neutronics, criticality, fuel, radiation protection, human factors and the environment).

The integration process requires both the collaboration of all the specialists in nuclear safety and radiation protection that are involved in the technical assessment and effective coordination structures to highlight the essential safety issues, which are 'integrated' in the final advice.

4.1.1. Conditions for the completion of this analytical process

Regarding the quality of assessment, several conditions can be considered in the completion of the analytical process:

— The TSO must be in a close contact with the installations and aware of the national and international operational experience feedback. The safety assessment is based on in-depth technical exchanges with the operator teams responsible for designing and operating the plants.

— The TSO should be aware of the latest technical and scientific results. It must ensure, on the one hand, that it accesses new scientific knowledge for improving the safety of existing facilities, and, on the other hand, that its expertise capabilities keep pace with technological progress and the developments introduced by nuclear designers and operators. Ensuring a strong connection with R&D is, in this context, a key element.

- The TSO must have efficient documentation and databases (installations, sites, events, previous assessments, technical data) with efficient knowledge management systems. It must also have suitable scientific tools, which must be capable of probing proposed technologies beyond their design limits, in order to allow the TSO to perform its critical assessment from an independent point of view, and to propose an analysis of safety margins to support the decision making process of the regulatory authorities.

4.1.2. Assessment integration

To ensure the quality of the assessment, the process of integrating the various aspects of the assessment into final advice should take into account the following principles:

- To foster the incorporation of the Safety Fundamentals, as defined by the IAEA;
- To have working procedures and a strong common culture that allows discussions between experts with different backgrounds and specialities, proper weighting of the different aspects and resolution of conflicts between different points of view;
- To rely on sound technical bases for the integration process.

The major tools for this purpose include:

- The defence in depth concept;
- Operational experience feedback;
- Probabilistic safety assessments (PSAs);
- Radiation protection principles.

4.1.3. Need to expand the present knowledge base

Technical and scientific support organizations are acting in an environment that continues to evolve owing to at least the liberalization of the electricity market, the development of innovative concepts by operators, internationalization and society's need for more transparency and an understanding of the decisions taken. More particularly, when operators make use of new technologies, TSOs must be in a position to evaluate these new elements, and thus they require the appropriate information, knowledge and competence.

In this context, with respect to existing facilities or facilities under construction, there is a need to expand the knowledge base and to perform research activities in the following areas:

— Reduction of uncertainties (e.g. concerning the issues of sump clogging or source term);
— Ageing (e.g. for the cables and materials used in nuclear power plant technology);
— Questions resulting from industry initiatives (e.g. the introduction of new fuels, fuel assessments for normal and postulated accident conditions and investigations in the high and very high burn-up range);
— Human and organizational factors (e.g. human reliability research or human–machine issues regarding the role of the operator and its interactions with advanced automated controls, assessment of an organization from the safety viewpoint);
— New requirements when TSOs must check that operators have found solutions to comply with them (e.g. in the field of severe accidents for Generation III reactors);
— Public expectations (e.g. the effect of chronic exposure).

International cooperation between TSOs, which would contribute to the sharing of knowledge and resources, is of the utmost importance for the enhancement of safety. A good example of this is the close and long-standing cooperation between the IRSN and its German counterpart, the Gesellschaft für Anlagen- und Reaktorsicherheit (GRS), in the field of nuclear installation safety. Initiatives taken by the OECD Nuclear Energy Agency during the past three decades have greatly encouraged cooperation in several research programmes (e.g. the Halden project) and the exchange of scientific information among participating organizations.

4.2. Future facilities

Regarding future facilities, the first challenge for TSOs is to prepare themselves to perform the necessary safety assessments even before the concepts have been clearly defined. A general approach consisting of following up on orientations and concepts discussed at the national and international levels, and gathering existing knowledge concerning design experience, operational experience and R&D can be developed to cope with this issue. This should be followed by participation in the efforts to define the safety and security of future installations as well as assessment methods (e.g. INPRO, MDEP). Nevertheless, before the installation type has been determined, it will remain difficult to efficiently prepare expertise (huge domain, limited resources).

France prepares to build a Generation IV nuclear reactor

French President Jacques Chirac reaffirmed the country's goal of building a Generation IV nuclear reactor by 2020. The aim of the Generation IV reactor will be to meet France's medium term energy needs, taking into account the following requirements:

— To reduce the amount of waste;
— To save uranium;
— To improve safety and security;
— To reduce proliferation risks.

The new reactor is expected to lead to significant improvements in economics, safety, reliability and sustainability.

In December 2006, the French Government decided to proceed with a Generation IV sodium cooled fast reactor (SFR) prototype. The decision date for this prototype construction, and for the definition of the design options, is 2012. This prototype is planned to start operation in 2020. The project will be led by the CEA.

A gas cooled fast reactor (GFR) design might be developed in parallel as a second option. The decision date for the possible construction of an experimental reactor is 2012. This experimental reactor is planned to start operation in 2020.

It should be noted that the nuclear industry may possibly develop high or very high temperature gas cooled reactors (HTR or VHTR).

The decision of the French Government to develop precise concepts (e.g. an SFR and possibly a GFR) for power plants make it possible for the IRSN to begin to define the knowledge base and research that will be needed to cope with this challenge. Research into materials, fuel, operation, in-service inspection and maintenance, as well as facilities for reprocessing spent fuel from the proposed reactor, are among the aspects to be explored in the initial stages of the project.

Depending on the concept that is adopted, the necessary knowledge base should be developed in a number of areas, including:

— Core neutronics (SFR and GFR);
— In-service inspection of material structures (SFR);
— Management of loss of coolant accident (GFR);

— Accidental behaviour of high temperature fuel (GFR and possibly SFR);
— Risk of propagation of local fusion in the core (SFR and possibly GFR);
— Radioactive transfers within the circuits in the case of an accident (GFR).

Similarly, new research programmes will have to be launched in the area of waste repository (tightness of seals). Regarding the International Thermonuclear Experimental Reactor (ITER) project concerning an international experimental fusion reactor, one example of knowledge base development that will be needed concerns structural damage due to plasma disruption.

5. CONCLUSION

Regarding the definition of TSO, it appears that a clear distinction should be made between technical *safety* organizations supporting the regulatory authorities, which do not promote nuclear applications, and other TSOs, which do.

The knowledge base needed to enable technical safety organizations to provide high quality support for existing facilities and for those under construction or planned for the future is a key element of safety. For existing facilities and facilities under construction, this necessary knowledge base encompasses data from installations, high level technical subjects, working methods and concepts needed to integrate the different aspects of the assessments. Further development of this knowledge base through adequate research programmes is a vital issue that remains necessary for ensuring a high level of safety. International cooperation is of primary importance in this respect. Regarding future facilities, the choice of the concepts makes it possible to begin to define the knowledge base developments that will be necessary. According to the decisions taken by the French Government (definition of the design options in 2012 for construction of a prototype in 2020), the schedule might be tight, especially if large experimental facilities prove to be necessary.

REFERENCE

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ROLE OF THE TSO IN PUBLIC INFORMATION/ DEBATE OPENNESS, TRANSPARENCY

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Abstract

Licensing of a nuclear facility in Finland involves three phases: the Government resolution, construction licence and operating licence phases. Implementation of the resolution requires Parliamentary approval. At each step, Finland's regulatory body, the Radiation and Nuclear Safety Authority (STUK), is requested to give its opinion on the acceptability of the nuclear facility from a nuclear safety point of view. In making its evaluation, the regulator needs assistance from its technical and scientific support organizations (TSOs). In such a role, it is not the duty of the TSO to participate in public debate regarding the safety of the nuclear reactor concept. Likewise, if the TSO supports the power company or the plant vendor in the licensing process, it should not have an active public role. The TSO should only 'tell the facts' if asked by the customer. Often, the TSOs are publicly owned, and in small countries with limited resources, the same TSO may need to work for both sectors. In such a case, the need to maintain independence and impartiality in a plausible way is indeed challenging and the role in public debate is restricted. There are, however, other opportunities where the TSO could gain credibility as an impartial source of information. For example, if the TSO is an institute that conducts research in various energy sectors and is well established at least nationally, its views are noticed. It could publish background information for the layperson, where different phenomena, opportunities, threats and future views are presented in a balanced manner. The views should be balanced in the sense that they should not be interpreted as advocating nuclear energy as the only solution. In order to demonstrate transparency, the organization should be able to show how possible conflicts of interest are resolved. This paper discusses these opportunities based mainly on the experience of cooperation between the Technical Research Centre of Finland (VTT) and STUK.

1. INTRODUCTION

For many reasons, construction and operation of nuclear power plants have always been of special interest to the media and the public. Nuclear power projects are not only large and long lasting investments with high economic expectations, but also are often associated with the risk of accidents with potentially severe human or environmental consequences. The possible connection to proliferation of nuclear weapons frequently arises, as do issues associated with the whole fuel cycle and disposal of radioactive waste.

Because of the specific features of nuclear energy, it has always been subject to regulatory control in all countries. The sophisticated technologies and the strict acceptance criteria necessarily imply that the regulatory body needs a substantial amount of technological expertise, either in-house or acquired through contracting other organizations or companies with relevant competence. In some countries, the State may have specified such a technical support role for one or more technical and scientific support organizations (TSOs) that may be solely at the disposal of the regulator. Similarly, the local utilities or vendors may have contracted other corresponding organizations or companies to support their needs in the design, construction, licensing and operation of nuclear installations.

For obvious reasons, the TSO should refrain from public debate in its basic task of supporting either the regulator or the licensee in the licensing process. The only role in this respect, if asked by the client, should be to present the facts or conclusions drawn during the process. In such a case, the main responsibility of informing the public belongs to the contractor.

Public debate is very important regarding the use of nuclear power, especially if there is the intention to start constructing new nuclear power plants, to increase the capacity of existing plants or to decommission facilities or dispose of nuclear material. Such a debate is needed nationally or within the local community when the site selection of a facility is discussed. Natural participants in such a discussion are the Parliament, the Government, local decision making bodies, various interest groups, the media and the public at large. Under what conditions and how could a TSO (or the regulatory body itself) participate in the public debate? This paper attempts to answer this question from the Finnish viewpoint based on the recent experience of new capacity construction. In order to understand the local circumstances, the Finnish regulatory process is first described, including the contributions of the national nuclear safety authority, the Radiation and Nuclear Safety Authority (STUK), and its support organizations.

2. REGULATOR AND TSO TASKS IN THE LICENSING PROCESS IN FINLAND

Licensing of a nuclear power plant in Finland is subdivided into three different phases: the Government resolution, construction licence and operating licence phases.

The construction of a nuclear facility requires, first, a Government resolution (or decision in principle). The Government resolution must be submitted for consideration to the Parliament, which may approve or reject it.

The next step in the licensing process is obtaining the construction licence and then the operating licence. The utility is required to apply to the Government for both the construction and operating licence for a nuclear facility.

When a utility applies for either the construction or the operating licence, the documents listed in the Nuclear Energy Decree, and other reports considered necessary by STUK under the decree, are to be submitted to STUK for its approval. STUK issues a statement about the construction licence application and the operating licence application only after having approved essential parts of each of these documents by a separate decision. The statement is supplemented with a safety assessment, which is based on reviewers' reports on different topics. A general description of the licensing process and the stakeholders involved is presented in Fig. 1.

The TSO's role in the licensing process is to support STUK in its licensing efforts. A common practice during licensing is that STUK orders from a TSO independent safety analyses or asks for expert opinion regarding some technical issues. The selection of issues for which TSOs are used is made by STUK, which also draws the final conclusions about the results. The reports produced by TSOs on specified subject areas are included as background information in the statement on safety prepared by STUK prior to the issuance of the construction or operating licence by the Government (Council of State). Most of the documents (excluding some sensitive security documents) related to licensing as well as statements on safety prepared by STUK are made available to the public. Communication between the general public and other stakeholders takes place officially via the Ministry of Trade and Industry and the Council of State (see Fig. 1).

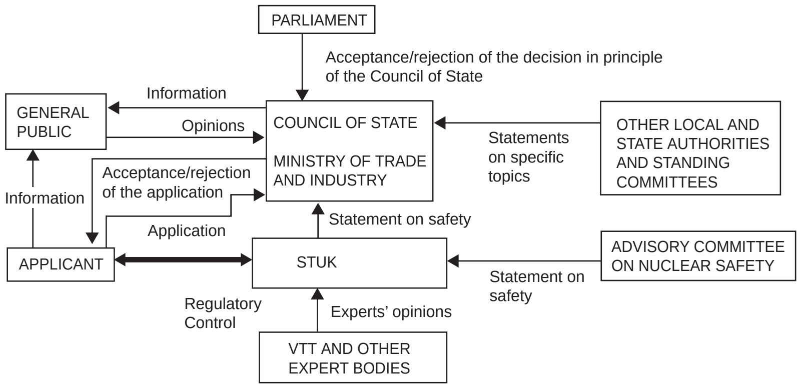

FIG. 1. Stakeholders involved in licensing and their roles.

3. TECHNICAL SUPPORT FOR NEW NUCLEAR POWER PLANT PROJECTS

In the European pressurized water reactor (EPR) review carried out for Olkiluoto 3, STUK used a number of domestic and international TSOs. The criteria for the selection of a TSO were that the organization had to:

— Be competent to carry out EPR specific analysis;
— Be independent of the licensee;
— Have codes independent of the licensee's codes;
— Have adequately validated codes for EPR.

The main organization used as a TSO by STUK was the Technical Research Centre of Finland (VTT). Other organizations used during the licensing of Olkiluoto 3 were:

— Lappeenranta University of Technology (Finland);
— Tampere University of Technology (Finland);
— Institute for Safety and Reliability (ISaR, Germany);
— Gesellschaft für Anlagen- und Reaktorsicherheit (GRS, Germany).

During the licensing of Olkiluoto 3, the following independent studies were conducted by the TSOs:

— Transient analyses (most limiting cases from different types of transient);
— Design basis accident analyses:

  - Small break loss of coolant accident (LOCA);
  - Steam generator tube rupture;
  - Large break LOCA;
  - Anticipated transient without scram (ATWS);
- Severe accident analyses:
  - Station blackout;
  - Large break LOCA;
  - Erosion of sacrificial concrete in the dry cavity;
  - Stability of the cavity structural concrete;
- Fire safety;
- Primary circuit design: integrity analyses, review of manufacturing technology;
- Containment design:
  - Structural analysis reviews of containment;
  - Construction technology (statements on corrosion protection);
  - Airplane crash (APC) impact, vibration;
- Review of design phase probabilistic safety assessment (PSA);
- Primary circuit water chemistry;
- Review of digital instrumentation and control (I&C) issues.

4. ROLES OF TSOs IN PUBLIC INFORMATION

The licensing process calls for strict impartiality and adherence to the technical requirements of the regulator and legislation. A lot of proprietary information needs to be analysed in the process. In this task, the TSO has a minimal public role.

On the other hand, before the licensing process — when, for example, the decision in principle is taken on whether or not to construct the nuclear power plant — the public debate is naturally intensive. The various stakeholders and interest groups bring up opinions and facts supporting their arguments. In the debate, it is crucial that the scientific facts and impartial, unbiased information be available to the participants. This raises the question of which party has the required authority and knowledge to produce the information. In principle, the TSO supporting the regulator, or the regulatory body itself, if it has the required technical competence, could be one such party. In the debate, their most natural role could be to produce the background information and all the facts, but preferably not to argue in favour of or against any specific solution or concept.

It is crucial for a TSO to maintain impartiality and independence in a plausible way so that its basic task of supporting the regulator is not questioned. This is even more important if the TSO, as an organization, has to work both for the regulator and for the licensee, as is the case of VTT. This translates into a requirement that no one should work for both parties in the same subject area so as to avoid reviewing one's own results. Different persons and different methods of analysis are used by the two sides. If the client is technically competent enough, boundary conditions for the analyses are selected by the client.

In Finland, VTT was frequently interviewed by Parliamentary committees when the decision in principle to construct the fifth reactor in Finland was discussed in Parliament in Spring 2002. The hearings concerned not only the nuclear power generation process but also the overall energy policy of the country, including the availability of other energy sources. Also, the media often interviewed VTT experts. The authority of VTT in this respect is based on VTT's extensive experience in conducting research on various sectors of energy technology and the energy market, of which nuclear is only one component. Balanced viewpoints could be expected from the VTT side, and this was actually confirmed through opinion polls conducted after the decision in principle, according to which VTT was regarded by the public and all stakeholders as the most reliable source of information.

Both VTT and STUK have also adopted a more active role as reliable sources of information by producing textbooks on energy production and consumption as a whole and on radiation and nuclear safety. Such material is useful for the layperson and students when phenomena and technologies need to be put into perspective.

One important tool for a TSO to gain competence is to undertake research in the relevant fields, even though the results do not directly reach a large audience. Indirectly, however, scientific merits strengthen public credibility.

5. CONCLUSION

The Finnish experience demonstrates that the public information role of a TSO in the licensing process of a nuclear power installation is very restricted in order to maintain credibility and to protect proprietary information. The main areas of the technical content of the licensing process are highlighted. The public role of a TSO (or the regulator) is mainly associated with supplying general background information to the decision makers and to the larger audience. High technical competence and demonstrated impartiality are important requirements for a TSO for achieving a successful outcome in the field of public information. Credibility is slow and difficult to achieve, but easy to lose.

CHALLENGES FACED BY TSOs AND TSO EFFECTIVENESS

(Topical Session 2)

Chairpersons

I. SOUFI
Morocco

A. OMOTO
IAEA

LEAD-IN PRESENTATION: CHALLENGES FACED BY TECHNICAL AND SCIENTIFIC SUPPORT ORGANIZATIONS

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Abstract

Technical and scientific support organizations (TSOs) are increasing in their importance to both the nuclear safety regulatory bodies and the nuclear industry. In the changing technological, economic and social environment surrounding TSOs, the scope of their role has also been changing. In particular, TSOs providing support to the safety regulatory bodies are facing a number of technical challenges to ensuring the safety of nuclear installations over the plant life cycle; at the same time, they are facing managerial challenges such as maintaining technical competence and improving performance. The paper gives an overview of the current challenges faced by TSOs and the future challenges that could be expected, as well as some approaches to or remedies for these identified problems, focusing on safety regulation of nuclear installations. TSOs providing support to nuclear regulators must have strategic plans to cope with these challenges effectively and efficiently, and to provide adequate technical assistance to the regulators for their regulatory decision making and administrative measures.

1. INTRODUCTION

Technical and scientific support organizations (TSOs) are becoming increasingly important in providing technical and scientific support to both the nuclear safety regulatory bodies and the nuclear industry. In particular, with their technical expertise and objectivity, they are expected to play key roles in supporting effective and efficient safety regulation. Some TSOs contribute to the nuclear safety regulation by being directly involved in the safety review and inspection of nuclear installations, and some contribute by providing technical information for regulatory decision making. In the changing technological, economic and social environment, TSOs are now facing a number of challenges that they, together with the regulatory bodies, must address for more effective nuclear safety regulation. This paper gives an overview of the current and future challenges faced by TSOs, with the intention of stimulating discussion on how to cope with those challenges.

2. ENVIRONMENTAL FACTORS

Major environmental factors that must be considered when discussing the roles and strategies of TSOs are summarized in Table 1, along with the challenges we are facing and some examples of related activities. They are often interconnected and sometimes conflict with each other.

Although the nuclear industry is now showing signs of revitalization, we continue to be influenced by the ‘nuclear recession’ that began after the Chernobyl accident. Typical examples of this kind of influence are shortages of young experts, decreased financing for safety research, the possibility of loss of background knowledge and degradation of staff morale. The commercial environment has changed drastically in the past decade, partially as a result of deregulated electricity markets. Increased economic pressure on electric power companies led to extensive management reforms, including reorganization, restructuring and all kinds of cost reduction measures (e.g. reduction of operation and maintenance expenses, reduction of staffing levels, increases of work contracted to external companies. On the one hand, such an economic environment has brought business difficulties to electric companies and safety concerns to regulatory bodies and the public. On the other hand, however, it has encouraged various improvement efforts in both nuclear power plant management and regulatory activities. Examples of such efforts are recent improvements of capacity factors, the reduction of occupational radiation exposure, industry initiatives to further improve economics, improvements in the safety performance of nuclear power plants and new approaches to improve regulatory effectiveness.

Internationalization/globalization is also a big trend in both the nuclear industry and in nuclear safety regulation. In addition to nuclear material transportation, emergency response planning also sometimes requires consideration of transboundary issues. Nuclear business markets are being globalized, and the worldwide nuclear industry reorganization is ongoing, both of which are bringing about new challenges to nuclear safety regulators. Nuclear safety is becoming more and more a global issue, and establishing a nuclear safety regime in a global context is a current trend. International conventions and international safety standards are becoming increasingly important.

In addition to existing technical issues such as plant ageing and back end issues, some new issues are emerging in connection with, for instance, new reactor concept/design and design basis threats. Technical and scientific support organizations have to deal with such issues applying their technical expertise. Furthermore, nuclear security is gaining increased attention, and the need for close integration of safety and security (synergies between safety and security) is becoming a big issue.

TABLE 1. OVERVIEW OF ENVIRONMENTAL FACTORS, CHALLENGES AND RELATED ACTIONS

Environmental factor	Challenge	Related action
Remaining influence of 'nuclear recession' after the Chernobyl accident	• Enhancement of nuclear technology (especially nuclear safety) infrastructures weakened by decreased number of plant/component/service suppliers • Maintenance of nuclear safety competence (organizational knowledge and personnel expertise) • Revitalization of nuclear R&D (recovery of downsized R&D facilities and activities) to maintain basic technical capability and skills • Human resource development to cope with the ageing of skilled and experienced experts and shortage of young engineers to enter into the nuclear field • Public concerns about nuclear safety (including back end issues)	• Government and international R&D initiatives • Effective use of experienced engineers • Technical succession between generations for retaining basic technical skills, background knowledge, know-how (including documentation of implicit knowledge) • Revitalization of nuclear education in universities by increasing attractiveness of nuclear industry • Enhancement of training programmes in organizations • Cooperation among organizations to maintain technical competence • Domestic and international knowledge sharing • International human resource development cooperation (education and training) • Promotion of public understanding of nuclear safety
Increase of economic pressures on electric power companies	• Ensuring nuclear safety under the pressures of cost reduction for construction and operation (compatibility between safety and electric power generation costs) • Enhancement of safety conscious management and safety culture in operating organizations • Effective safety regulation with minimized cost burdens to nuclear operators	• Verification and introduction of state of the art technologies for cost reduction • Pooling and sharing of skilled technicians/workers • Improvement of capacity factors (plant life extension, high burn-up and long cycle operation, preventive maintenance, etc.)

TABLE 1. OVERVIEW OF ENVIRONMENTAL FACTORS, CHALLENGES AND RELATED ACTIONS (cont.)

Environmental factor	Challenge	Related action
Increase of economic pressures on electric power companies		• Streamlining of safety regulation by introducing new regulatory approaches (e.g. risk informed, performance based regulation), rationalized safety review procedures, etc. • Improvement of inspection of licensee's safety management and safety culture • Application of international safety standards, multinational design evaluation, international qualification of manufacturers, etc.
Increased importance of nuclear security	• Consideration of close interlink between safety and security, and compromise on conflict between security and transparency • Regulatory consideration of design basis threats	• International efforts for sharing information and for seeking synergies between safety and security
Internationalization/ globalization of nuclear industry and safety regulation	• Qualification of products manufactured by multinational manufacturers or purchased from different countries • Domestic licence for export nuclear power plant • International harmonization of nuclear safety regulation (response to trends towards the Global Nuclear Safety Regime: increased importance of conventions and international safety standards) • Response to increased need for global sharing of nuclear information, experience and knowledge	• Application of international safety standards, multinational design evaluation, international qualification of manufacturers, etc. • Harmonization of regulatory systems such as movements in Western European Nuclear Regulators' Association (WENRA) framework

TABLE 1. OVERVIEW OF ENVIRONMENTAL FACTORS, CHALLENGES AND RELATED ACTIONS (cont.)

Environmental factor	Challenge	Related action
Internationalization/ globalization of nuclear industry and safety regulation	• Transboundary consideration in nuclear materials transportation and emergency planning	• Information and knowledge networking among regulators/TSOs (Asian Nuclear Safety Network (ANSN)), knowledge sharing among Ibero-American radiological and nuclear safety regulators, Nucleus (IAEA), World Association of Nuclear Operators, etc. • International discussions on common regulatory issues (competence, effectiveness and efficiency, etc.) at IAEA and OECD/NEA
Unresolved and emerging technical issues	• Plant ageing (plant life management, licence renewal, life extension, countermeasures, etc.) • Management and disposal of radioactive waste and spent fuel, and decommissioning of old nuclear facilities • New reactor concepts and designs, application of new technologies and technical findings • Regulatory consideration of design basis threats • Reduction of trouble occurrence • Use of risk information, performance indicators, etc. • Unexpected phenomena	• Improvement of ageing management system and application of new ageing countermeasures • Research on ageing phenomena • International cooperation for technical evaluation, joint research programmes, etc. • Effective operational experience feedback methods (including international knowledge sharing)

TABLE 1. OVERVIEW OF ENVIRONMENTAL FACTORS, CHALLENGES AND RELATED ACTIONS (cont.)

Environmental factor	Challenge	Related action
Revitalization of nuclear power generation	• Response to global and domestic restructuring of nuclear industry • Licensing of new reactor concepts/designs/ technology • Enhancement of work force in both industry and regulators • Assistance for establishing and enhancing nuclear safety infrastructures in developing countries with the intention of future introduction of nuclear power generation • International qualification of manufacturers and products	• Knowledge sharing (ANSN, knowledge sharing among Ibero-American radiological and nuclear safety regulators, etc.) • Application of IAEA safety standards • Multinational design evaluation programme • International human resource development cooperation (education and training) • Multilateral and bilateral cooperation/assistance for enhancing nuclear safety infrastructures in developing countries • International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO) activities
Requirement for more effective and efficient nuclear safety regulation in the changing environment	• Response to unresolved and emerging technical issues • Improvement of regulatory oversight of organizational and human performance (licensees' safety management, safety culture, quality management, control of contractors, etc.) • Improvement of regulatory effectiveness and efficiency with new regulatory approaches (improvement of licensing procedures, inspection and oversight) and evaluation of performance of regulators and TSOs	• Development and application of more effective regulatory approaches and tools (risk informed regulations (RIR), process oriented regulatory inspection, performance indicators, etc.) • International sharing of regulatory experience and knowledge: – Operational experience feedback; – Regulatory experience feedback; – Regulatory oversight and inspection methods/ tools; – Regulatory research /study programmes; – Human resource development programmes; – Public communication.

TABLE 1. OVERVIEW OF ENVIRONMENTAL FACTORS, CHALLENGES AND RELATED ACTIONS (cont.)

Environmental factor	Challenge	Related action
Requirement for more effective and efficient nuclear safety regulation in the changing environment	• Enhancement and maintenance of technical competence of regulatory bodies and TSOs (including measures for staff ageing, recruiting, training and technical succession issues) • Regional cooperation for emergency response • Regulatory consideration of security issues • Enhancement of credibility, transparency and accountability • Information sharing and cooperation with academic societies, industry and other stakeholders • Effective public communication	• Development of experience/knowledge sharing mechanisms: – Improvement and/or active use of existing mechanisms (IAEA Incident Reporting System (IRS), etc.); – Global and regional knowledge networks. • Development of tools for self-assessment of regulators and TSOs • External reviews of regulatory bodies (IAEA Integrated Regulatory Review Service (IRRS), etc.) • Qualification and application of private/academic sector technical codes and standards

In connection with global warming as well as energy security, there are indications of the possible revitalization of the nuclear industry — the so called nuclear renaissance — to build new nuclear power plants and to introduce new reactor designs. In addition, there is an increasing number of countries that have future plans to introduce or have an interest in nuclear power generation.

All of the above mentioned environmental factors and related challenges are more or less applicable to nuclear safety regulation. At the same time, they are creating new environmental factors for and impose new challenges to both regulatory bodies and their TSOs as summarized in Table 1.

3. REGULATORY CHALLENGES

Technical and scientific support organizations are expected to provide objective scientific and technical expertise and professional judgement based on the latest knowledge available to them. In the case of TSOs supporting regulatory bodies, they must be ready to provide proper technical solutions or approaches to existing and emerging regulatory issues.

The most important role of TSOs supporting regulatory bodies is to provide effective measures for ensuring the safety of nuclear installations over the plant life cycle (design, construction, commissioning, operation, maintenance, modifications, transportation, waste management and disposal, emergency preparedness and response, and decommissioning). The following are examples of the technical challenges that TSOs supporting regulatory bodies must deal with within the scope of their missions:

- Regulatory approaches/solutions to current technical issues, for instance, identified design deficiencies, ageing and degradation of components and structures, power uprate, extended operation cycle, low power and shutdown risks, management and disposal of radioactive waste and spent fuel, and decommissioning of old nuclear facilities;
- Feedback of operational experience, including feedback of lessons learned from event investigation and cause analysis, identification of generic safety issues, trends and potential problems, and precursor studies;
- Response to emerging technical issues such as the use of risk information, security enhancement from the technical viewpoint (physical protection, design basis threats, etc.), new reactor concepts/designs and a multinational design evaluation programme;

- Updating of safety codes and standards based on the regulatory experience feedback and the latest scientific and technical knowledge (including consideration of international safety standards);
- Development of effective and efficient regulatory approaches and methods for non-technical issues including evaluation/inspection of licensees' safety management systems, safety culture, quality management systems, staff training, control of contractors, and potential safety impact of other managerial, organizational and human factors;
- Preparation (accumulation of technical knowledge) for coping with future issues including hidden vulnerability of current designs, unknown events or technical problems beyond current engineering experience and potential regulatory issues where no governing criteria exist;
- Public communication to obtain the general public's trust in nuclear safety and safety regulation.

Technical and scientific support organizations should function as think tanks to deal with the above challenges in-depth and from a broad perspective in order to provide the regulatory bodies with adequate technical assistance for effective nuclear regulation and, at the same time, to give the nuclear industry assurance that it is reasonably regulated. They must cultivate the society's confidence in nuclear safety as well.

4. CHALLENGES IN THE MANAGEMENT OF TSOs

Technical and scientific support organizations supporting regulatory bodies need to have sufficient scientific and technical competence to cope with the above mentioned regulatory challenges. Sometimes TSOs are requested to provide technical judgement even on issues requiring currently unavailable data or information. They need to be ready to carry out their missions and to answer to the expectations of the stakeholders by accumulating knowledge and experience, developing and maintaining the necessary tools, keeping up with new technologies, ensuring human and financial resources, and having suitable management systems to maximize the use of such assets.

The first thing TSOs have to consider in their management strategies is how to sustain an adequate level of scientific and technical expertise and the competence necessary to accomplish their missions. In developed countries, on the one hand, it is still not so easy to recruit capable young engineers wishing to enter into the nuclear industry; on the other hand, scientists and engineers with high level skills, knowledge and experience in nuclear science and technologies are ageing and retiring. Practical skills, know-how and background knowledge, especially implicit knowledge, are being lost with their retirement. Some effective measures for technical succession (technology transfer between generations) — for instance, documentation of implicit knowledge, staff rotation and technical transfer through daily jobs — have to be considered in the management systems. In parallel to maintaining the technical competence of individual staff members, we need to have measures to maximize the organizational competence as a whole with the available levels of staff and financial resources. Considering such factors, we have to have a strategic human resources development programme.

With limited human resources, it would be an easy option to carry out some of our jobs by outsourcing them to external organizations, if any capable organizations exist. However, we should be careful in outsourcing jobs, since it could bring a hollowing out or loss of our technical competence.

In the past, R&D activities played a significant role in nurturing both personal and organizational technical competence in nuclear safety. However, for more than a decade, financing for nuclear safety research has been decreasing and a number of research facilities have been decommissioned or are no longer in use in many parts of the world. Once a facility is dismantled, it is almost impossible to rebuild a similar facility when the need arises. Although simulation technology using high performance computers has made remarkable progress, a minimum level of research facilities should be maintained to develop new technologies, to study and cope with technical issues beyond current knowledge and engineering experience, and especially to maintain basic technical expertise.

International cooperation could be an effective measure to enhance the technical competence of regulatory bodies and TSOs, through exchanging safety related information and knowledge, establishing a common understanding of current and future safety issues, and developing practical approaches to such issues. International databases (e.g. the IAEA/NEA Incident Reporting System) and global/regional nuclear knowledge networks (e.g. the Asian Nuclear Safety Network) can play important roles. Personnel exchange could also be helpful in improving the technical competence of both parties. International joint R&D programmes such as those of the OECD Nuclear Energy Agency (OECD/NEA) serve as tools for maintaining a certain level of research activities as well as research facilities that are the basis of technical expertise. Technical and scientific support organizations should incorporate international cooperation into their business strategies to maximize their technical competence within their available resources.

Safety regulation is required to have independence, transparency, accountability and public credibility, as well as effectiveness and efficiency. This is applicable also to TSOs supporting regulatory bodies. Independence from organizations and activities subject to regulation could place restrictions on the TSOs' scopes of technical activities, funding, outsourcing, staff recruitment, etc. At the same time, TSOs have to take into account the opinions and needs of stakeholders, including licensees, without compromising independence. Transparency is fundamental to gaining public confidence, but transparency and confidentiality have to be properly balanced when dealing with security matters.

Technical and scientific support organizations have to make the adequacy of their staff, work processes and products visible to the public. For that purpose, TSOs have to analyse their own performance in the context of the missions and roles expected of them. Measuring the effectiveness and efficiency of their own activities is not so easy, but, if properly evaluated, it would significantly enhance transparency, accountability and the public credibility of the TSOs. Assessment by third parties such as outside consultants or knowledgeable people, as well as international appraisal or peer review, could be useful for the performance evaluation and improvement of management systems.

5. CONCLUSION

Situations differ from country to country, however, the technical and managerial challenges described above and those summarized in Table 1 are more or less common to all TSOs. Some of the challenges are interlinked with one another and, in some cases, include conflicting elements. As expert organizations, TSOs are expected to provide both immediate and long term solutions to those challenges, and they have to establish practical approaches to meet the challenges within the scope of their missions and within the resources available to them. Some of the items listed in the column "Related action" in Table 1 are examples of approaches to (or remedies for) the challenges, and some are components of bigger challenges.

In developing strategies and programmes to cope with these technical and managerial challenges, we have to consider all aspects to be discussed at this conference. The conference is expected to be a good opportunity for exchanging views and experience in addressing the technical and managerial challenges that TSOs are facing and for facilitating further discussion on establishing common understanding and developing practical approaches to those challenges.

LEGAL STATUS, CREDIBILITY, VISIBILITY AND CONFIDENCE IN TECHNICAL AND SCIENTIFIC SUPPORT ORGANIZATIONS

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Abstract

The current international legal framework for nuclear energy and safety reflects a lack of precision regarding technical and scientific support organizations (TSOs). Indeed, relevant international legal instruments and guidance documents do not contain an agreed definition of TSOs or provide significant information on the status and proper roles of such organizations. Given the fact that TSOs can be expected to play an important role in future global nuclear development, particularly in States with modest technical and scientific resources, clarifying the status and proper roles of TSOs should be a priority. The related issues of enhancing the credibility, visibility and confidence in TSOs can involve consideration of a wide range of issues. In the paper, the following seven elements for enhancing TSO credibility are explored: competence/expertise, independence, transparency/openness, integrity, efficiency, responsiveness/initiative and accountability. The paper concludes by offering five approaches for clarifying the legal framework for TSOs and enhancing their credibility. These include interpretation of existing legal instruments, adoption of a code of conduct for TSOs, revision of existing IAEA guidance documents, development of a new IAEA guidance document on TSOs and addressing TSOs in the findings and reports of relevant international fora.

1. INTRODUCTION

Assessing the effectiveness of any organization can obviously involve many factors. For technical and scientific support organizations (TSOs), the spectrum of relevant factors can be particularly broad, including inter alia: technical, human and financial resources; management competencies; legal and regulatory environment; nature of assigned tasks; access to relevant information; and relationships with clients, stakeholders and the public. This paper will not attempt to survey even a fraction of these dimensions, but will concentrate only on two: legal and credibility aspects. These two areas pose issues that have not received focused attention by either the international nuclear community or interested parties in many countries. The paper will seek to determine whether current legal instruments and guidance documents provide a clear and adequate framework for the important activities of TSOs. Where a lack of clarity or adequacy seems apparent, options for improvement are identified.

2. DEFINITION, LEGAL STATUS AND ROLES OF TSOs

2.1. Definition of TSOs

The international nuclear community has not articulated a generally accepted definition of a 'technical support organization', 'technical safety organization' or 'technical and scientific support organization'. The IAEA Safety Glossary [1] does not contain a definition of a TSO in any of these formulations. Some IAEA guidance documents use the term "dedicated support organization" [2], but do not define the term. Therefore, it is not precisely clear which organizations engaged in activities related to nuclear energy should be considered as TSOs or what characteristics distinguish them from other bodies.

This lack of clarity contrasts with the treatment of other institutions involved in nuclear related activities. The IAEA Safety Glossary categorizes organizations involved in nuclear energy development as either 'regulatory bodies' or 'operators' or 'licensees'. For a 'regulatory body', the key element is that it possesses legal authority to "conduct the regulatory process" or "exercise regulatory control". For an 'operator', 'operating organization' or 'licensee', the key defining attribute is that it has been "authorized" or is "applying for authorization" to conduct activities relating to nuclear energy or ionizing radiation.

The relevant international conventions and codes of conduct in the nuclear safety field are also silent on the status or role of TSOs. All of them contain definitions of "regulatory body" [3]. They also refer to licensees or operators using various undefined terms such as "licence holder" [4], "operating organization" [5] or "authorized person" or "person with an authorization" [6]. For some years the European Community maintained a Technical Safety Organizations Group (TSOG), most of whose members are national nuclear regulatory bodies. It is unclear whether the organizational arrangements for the TSOG included a definition of a TSO, and if so, whether it covers non-regulatory bodies [7]. The TSOG has not been active for some time and a new body, the European TSO Network, has been recently established to enhance regional cooperation. Other regional or sub-regional cooperative activities involving TSOs have been conducted, for example, in Northeast Asia between Japan, Korea and China.

Although TSOs lack an agreed definition under international nuclear law, they may be defined under the domestic law of States in which they are organized or conduct business. However, a brief survey suggests that national laws do not use the TSO term, but use other formulations such as:

— Incorporated administrative agency (JNES, Japan) [8];
— Publicly owned establishment (IRSN, France) [9];
— Non-profit company (GRS, Germany) [10];
— Private non-profit organization (AVN, Belgium) [11];
— Federally funded research and development center (CNWRA, USA) [12].

Given that TSOs currently play an important role in nuclear safety from both a regulatory and operational perspective — a role that is likely to expand in the future — developing an agreed definition of these organizations would seem to be a priority. As a starting point for discussion, the following definition is offered:

> 'Technical and scientific support organization' means an organization established to provide independent technical or scientific advice or assistance to a regulatory body or operating organization concerning matters affecting the safety of facilities, activities or practices involving nuclear energy or ionizing radiation.

2.2. Legal status of TSOs

The problem of assigning an agreed definition to TSOs introduces a second major issue; namely, what legal status do these organizations have under international or domestic law? The analysis offered above indicates that the legal status of a TSO under international practice appears to be determined primarily by the organization for which it performs technical work. In this regard, it is important to distinguish TSOs from 'contractors' that provide services to licensees or operators in the design, manufacture, construction, installation, maintenance or safety analysis of facilities or other activities. For purposes of nuclear law, a contractor possesses the same status as the licensee or operator that has engaged its services [13].

However, it would be incorrect to characterize a TSO simply as an 'operator' because it is conducting analysis for an operator or as a 'regulatory body' because it is performing work for a regulator. Depending on national law, a TSO may support both regulatory and operator organizations, giving it a 'mixed' or 'hybrid' character. This can lead to issues about the proper role and functioning of a TSO in particular circumstances. These issues have received some attention in the policy debate over so-called ‘hybrid organizations’ — organizations possessing legal characteristics of both government and private sector entities [14]. However, these discussions have been conducted within the framework of national laws or specific regional arrangements. Thus, opportunities are available for further development of international norms concerning the status of TSOs, a subject that will be addressed in Section 4 of this paper.

2.3. Roles of TSOs

Moving from issues of definition and status, a more concrete question involves the role(s) that should be properly exercised by TSOs in the area of nuclear safety. The various broadly multilateral nuclear safety instruments and guidance documents have given only indirect attention to TSOs. These instruments have affirmed the need for regulatory bodies and operators alike to ensure that they have access to adequate scientific and regulatory capabilities, with support organizations mentioned as one mechanism for ensuring such adequacy. They also affirm the importance of independence or separation of functions between bodies exercising regulatory versus operational roles. Beyond these few basic concepts, little specific guidance is offered.

With regard to regulatory control, it may be useful to recall that the relevant international instruments identify the following basic functions:

— Standard setting;
— Authorization or licensing;
— Inspection and monitoring;
— Enforcement;
— Public information;
— Regulatory research.

Technical and scientific support organizations can play a role in all these functions, each of which poses somewhat different issues regarding the credibility of the regulatory process. Some of these issues are discussed in the following section.

3. MEANS FOR ESTABLISHING TSO CREDIBILITY

3.1. Definition of credibility

Credibility is not a technical term. A recognized English language dictionary defines it as “the quality or power of inspiring belief” [15]. Missing from this definition is the recognition that what may inspire "belief" in one audience may fail to do so in another. For example, highly technical information related to risk analysis that would be persuasive to scientifically trained engineers may be unpersuasive to the general public. For purposes of this analysis, it will be assumed that TSOs will want to establish credibility with the broadest range of audiences, including regulatory bodies, operators, stakeholders, interest groups, the media, legislators, government officials and the general public.

3.2. Elements of credibility

What elements[1] can contribute to enhancing credibility with a range of different audiences? Although many aspects could be discussed, it is submitted that the following seven elements are particularly relevant for establishing and maintaining a TSO's credibility. Although discussed separately, these seven elements are closely related and overlapping. In addition, of course, some of these factors will have greater significance for some audiences than for others. However, taken together, they represent a strong framework for "inspiring belief" in a State's nuclear programme for most participants.

3.2.1. Competence/expertise

Perhaps the most important factor in establishing a TSO's credibility with virtually all audiences is its technical or scientific competence to perform its assigned tasks. Some TSOs will have demonstrated such competence by receiving some form of certification or licensing by relevant national bodies, whether governmental or private. For TSOs performing services specifically related to the scientific characteristics of nuclear energy or ionizing radiation, it may be desirable for the nuclear regulatory body to certify that the TSO or its employees possess the necessary expertise. Credibility can be enhanced by adopting the requirements for such certification in regulations, including a formal process for reviewing and granting certifications.

Wherever practicable, another means of establishing technical competence is to participate actively in cooperative arrangements with other TSOs, both domestically and internationally. Broadened opportunities for international cooperation, including meetings like the current conference, could make an important contribution to fostering TSO competence.

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[1] Although the term 'elements' is used in this paper, other terms such as 'principles', 'values', 'factors' or 'approaches' could as easily have been adopted.

3.2.2. Independence

The concept of independence has been thoroughly considered by the international nuclear community in a variety of fora and publications [16]. Notwithstanding this consideration, the practical aspects of achieving independence for various organizations and functions continue to be a matter of active debate. For regulatory bodies, at least six aspects have been considered important, including: political, legislative, financial, competence, public informational and international [17]. Application of the independence principle regarding TSOs shares most of these aspects, but with a somewhat different emphasis. For example, as discussed previously, a TSO must possess the requisite competence and resources to perform its assigned tasks in an effective, efficient and independent manner. However, a TSO providing technical advice to a regulatory body cannot have absolute independence from regulatory policy or even some technical determinations properly adopted by the regulator within the scope of its authority. A TSO must operate within the boundaries established through regulatory control, a factor that limits — to some extent — its complete freedom of action.

The most important consideration for independence is that the TSO must exercise its professional competence and judgement in a manner that is not improperly influenced by extraneous considerations. In particular, arrangements are needed to ensure that the TSO is "effectively independent of the operator" [18]. The variety of practical arrangements to implement such "effective" independence lies beyond the scope of a limited paper. However, a few points can be mentioned. Separate management and direction of employees engaged in work for operators and regulators is obviously a key consideration. Another important aid to independence would be measures to ensure that analysis performed for an operator is conducted by different personnel at a TSO than that conducted for the regulatory body. Internal and external review of analysis by separate experts is also a good practice.

3.2.3. Transparency/openness

The issue of how to handle information about TSOs and the work they perform could easily occupy a separate paper. As an initial matter, information concerning the general structure, composition and activities of a particular TSO should be broadly available and well publicized. Credibility with any audience is bound to suffer if the audience believes that unidentified parties are taking important safety related decisions without public knowledge or scrutiny by authorized government bodies.

The transparency issue becomes more complicated concerning the availability of specific technical information developed by a TSO. Normal rules adopted by the regulatory body for the protection of proprietary, classified, confidential or pre-decisional information should also apply to the work of a TSO. The more interesting issue is whether a TSO should be allowed to release certain types of information to the public or particular stakeholders without authorization by the regulatory body. This question highlights a certain tension between the concepts of 'independence' and 'transparency'. Difficult cases can be imagined. If a TSO conducting work for a regulatory body identifies what it believes to be a significant safety issue, but the regulatory body disagrees, should the TSO express its opinion to others, including the public? Would the answer be different if the TSO were working for an operating organization? How would this relate to the operator's primary responsibility for safety?

In general, a principle of maximum openness regarding technical analysis should be implemented by all bodies involved in ensuring nuclear safety. Exceptions must obviously be made for security related information. However, it is particularly important that TSOs, regardless of the organization for which they have conducted work, provide complete and accurate information to the regulatory body. In particularly difficult cases, regulators and operators need to consult on whether and how to release technical information in a way that contributes to public understanding of safety issues, but that does not cause unnecessary confusion or concern.

3.2.4. Integrity

In common with all other organizations involved in nuclear development, the credibility of a TSO can be enhanced by a perception by relevant audiences that it conducts its work with high levels of honesty and fairness. This element goes beyond demonstrating technical competence. It focuses on an ethical dimension; namely, that the organization and its individual employees conduct business in a trustworthy manner, without partiality or favouritism based on extraneous considerations. Means for demonstrating integrity include standards for employee conduct, conflict of interest rules and procedures to prevent bias or discrimination. Integrity also has an economic dimension. Since much of the work of TSOs involves contracting on individual projects, arrangements must be in place to ensure that work is not influenced by improper payments or offers to obtain unwarranted favours.

3.2.5. Efficiency

Although efficiency is valued by all audiences, the greatest emphasis on this aspect is probably given by the user of a TSO's services. Efficiency can comprise many factors, but economic and scheduling aspects are typically most important. Indeed the most important reason for establishing a particular TSO can frequently turn on resource issues. For example, it may be too costly for a regulatory body or operating organization to maintain a staff of specially trained experts to perform tasks that are only needed on a periodic basis. Regulatory bodies may also be subject to government wide personnel limitations. Therefore, the creation of a separate organization that can be funded from sources outside the user organization's regular budget may be attractive or even essential. However, to maintain credibility with the user, a TSO must be able to perform required tasks in a manner that reduces costs while meeting programme needs. Timeliness is also a key element of efficiency. If a TSO regularly fails to complete scheduled work on time, credibility suffers. The efficiency element requires both TSOs and user organizations to conduct thorough cost–benefit analyses to determine what organizational arrangements and task assignments are most useful in implementing safety responsibilities.

Another aspect of efficiency involves the consistency and predictability of TSO performance. Credibility suffers if some projects are performed by a TSO promptly and to high professional standards, while others reflect delay and lack of competence. Internal management arrangements are necessary to maintain a uniform level of performance across a range of projects. A key in this regard is identification of project managers who not only possess essential technical capabilities, but also have the personal and organizational skills necessary to motivate employees and bring projects to expected fruition on schedule. This may require substantial investments by the TSO in management training and oversight.

3.2.6. Responsiveness/initiative

Technical and scientific support organizations can enhance credibility by fostering a "proactive" attitude toward the needs and interests of their client organizations. Anticipating issues and problems, rather than passively awaiting an assignment, can help confirm that a TSO can be relied upon to assist a regulatory body or operating organization in meeting its responsibilities. In particular, the early identification of safety related issues that may not have been anticipated by the client organization can avoid unnecessary costs and disruption. However, care must be taken in the anticipatory identification of projects needing work to avoid an impression that a TSO is merely seeking business to enhance its ‘bottom line’.

3.2.7. Accountability

The essence of this element is that a TSO assumes responsibility for the work it performs. In cases where the client organization finds a TSO’s work to be unsatisfactory, the TSO must be prepared to take corrective action or provide adequate compensation. Accountability can involve measures of quality control, with establishment of internal administrative arrangements for periodic review of performance. Prompt and stringent compliance with relevant regulations and rules promulgated by the regulatory body or other relevant government agencies also contributes to credibility. Accountability can also be aided by subjecting a TSO’s work to external review by an independent body. Such an outside review could be separate from reviews conducted by the client organization.

4. OPTIONS FOR CLARIFYING THE STATUS AND ROLES OF TSOs

Although TSOs may have a clear legal status and role under the domestic laws of States in which they are organized and conduct business, they have not received meaningful attention under current international law and practice. This lack of attention is significant, particularly in the light of the fact that TSOs are likely to be called upon to play an increasingly important role in the development of nuclear energy, especially in States entering the nuclear power field [19]. Many of these States not only lack the technical and scientific resources that TSOs can provide, but they also lack well developed legislative and regulatory frameworks for the control of nuclear energy. As a result, both legal and policy issues concerning the role of foreign TSOs can arise, potentially complicating efforts to enhance technology transfer in a manner that ensures the highest levels of safety and security.

What options are available for clarifying the status and role of TSOs under international law and practice? Without offering recommendations on which options would be most useful, interested governments, TSOs, the IAEA and stakeholders might wish to consider some of the following approaches.

4.1. Interpretation of existing legal instruments

As discussed previously, the key international nuclear instruments are ambiguous concerning the status and role of TSOs. The Convention on Nuclear

Safety (CNS) and the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management address regulatory bodies and operating organizations. It is probably not practicable to amend these instruments to take account of the specific status and role of TSOs. However, this does not exclude consideration of the role of TSOs from the process of reviewing and implementing these important instruments.

In most cases, TSOs are deemed to possess the characteristics of regulatory bodies, sometimes being merely subsidiaries of those organizations. Thus, an interpretation of the CNS and Joint Convention could be adopted at one of the periodic meetings of the parties to the effect that TSOs that are primarily regulatory in nature should be considered to be covered by the relevant articles of the Convention. Technical and scientific support organizations that primarily provide services for operators or licensees could be considered to be covered by relevant articles covering operating organizations. Issues that are more difficult would arise with truly hybrid organizations having both regulatory and operational characteristics.

Unlike the conventions, formal periodic meetings of the parties are not currently available to review the IAEA Codes of Conduct on the Safety of Research Reactors and the Safety and Security of Radioactive Sources. However, nothing bars States applying those documents from consulting on ways to clarify their applicability to TSOs.

The 'interpretation' approach would not give TSOs a formal status under the relevant instruments, but would help clarify applicable norms and practices. This could be of considerable value to new entrants in the nuclear power and waste management fields in assessing how to utilize the services of TSOs.

4.2. Code of conduct for TSOs

If TSOs are considered sufficiently important to the future of nuclear development and safety, some type of international legal instrument might be desirable to define the status and roles of these organizations. A non-binding 'soft law' code of conduct, like those covering research reactors and radioactive sources, would be one option. Elaborating such a code would pose issues similar to those arising from a 'hard law' instrument. In fact, depending on how an instrument or document is implemented by relevant authorities, there may be little practical difference between 'hard law' and 'soft law' instruments.

Possible elements for a code of conduct on TSOs include the following:

— Definitions;
— Status and roles of TSOs:
  - Standards development;

    - Authorization/licensing;
    - Monitoring and inspection;
    - Enforcement;
    - Research;
    - Public information;
- Technical competencies;
- Human and financial resources;
- Relationships with regulatory bodies;
- Relationships with licensees or operating organizations;
- Accountability and liability;
- TSOs in the transnational setting.

4.3. Revision of existing IAEA guidance documents

As has been previously noted, a number of guidance documents in the IAEA Safety Standards Series make very brief mention of support organizations. These references do not use a consistent terminology for TSOs, nor do they treat the issues surrounding TSOs in a consistent or systematic fashion. One approach to clarifying the status and roles of TSOs would be to review existing guidance documents and supplement them, where appropriate, with information specifically addressing organizations providing scientific and technical support to both regulators and operators. Documents of particular interest in this regard include:

- GS-R-1 on legal and governmental infrastructure [20];
- GS-G-1.1 on organization and staffing of the regulatory body [21];
- GS-G-1.2 on review and assessment by the regulatory body [22];
- GS-G-1.3 on regulatory inspection and enforcement [23];
- IAEA Safety Glossary [24].

In fact, efforts are already under way at the IAEA to revise the key framework document GS-R-1. It would be very useful to address the specific roles and functions or TSOs in the revised GS-R-1.

4.4. New IAEA guidance document on TSOs

If it is decided not to pursue the development of a code of conduct or revision of existing IAEA guidance documents, it could still be useful to consider developing a new IAEA publication to provide guidance to regulators, operating organizations and other stakeholders concerning issues arising from the activities of TSOs. Such a document could be produced either as a safety guide in the IAEA Safety Standards Series or as a technical document (TECDOC). Possible contents of such a document would be similar to those suggested for a code of conduct in Section 4.2 above.

4.5. Findings and reports of relevant international fora

An approach having even less formality than those previously mentioned would be to use the various available international fora where nuclear safety issues are discussed as a means of clarifying the status and roles of TSOs. Indeed, the summary and conclusions of the present conference could begin this process. Other international or regional meetings (e.g. those conducted by the IAEA, the European Community's TSOG, WENRA, INRA and the International Nuclear Law Association) could take up various aspects of how to ensure that TSOs contribute effectively and efficiently to nuclear development and nuclear safety.

5. CONCLUSION

The basic conclusion of this paper is that TSOs have received inadequate attention from the international nuclear community, particularly in terms of their legal status and credibility. The likelihood that TSOs will play an increasingly important role in global nuclear development and safety suggests that greater attention should be given to these important organizations. This conference has provided a very useful impetus for a more focused dialogue on the roles TSOs can play in supporting both regulatory bodies and operating organizations.

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MANAGEMENT OF TECHNICAL AND SCIENTIFIC COMPETENCE AND HUMAN RESOURCES

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Abstract

The Canadian nuclear industry has recently begun to expand and is facing challenges in developing and maintaining expertise in the nuclear sector. A report commissioned by the CANDU Owners Group confirmed that organizations that provide R&D support to the nuclear industry were operating at or near minimum capabilities. It revealed low entry rates into the nuclear industry and an ageing workforce. In response, industry adopted a three part strategy: (i) development of a strategic plan for maintaining the strength of R&D organizations, (ii) development of CANDU specific technical centres of excellence and (iii) development of strategies for the attraction, training and retention of new graduates. The University Network of Excellence in Nuclear Engineering (UNENE) was established as an alliance of Canadian universities, nuclear power utilities, and research and regulatory agencies for the support and development of nuclear education, as well as R&D capability in Canadian universities. The University of Ontario Institute of Technology (UOIT), Canada's newest university, includes the School of Energy Engineering and Nuclear Sciences (SEENS), which offers undergraduate degrees in nuclear engineering, radiation science and related areas. The Canadian nuclear industry and universities established the CANTEACH programme to develop a comprehensive set of education and training documents, with university participation. The Canadian Nuclear Association prepared three initiatives: (i) developing a strategic and long term view of the nuclear industry on which individual companies can anchor and build recruitment strategies; (ii) pursuing career and industry branding initiatives to attract young students; (iii) providing benchmarking initiatives to improve workforce planning, talent management, succession planning capabilities and knowledge management. Through these initiatives, the Canadian nuclear industry believes that it has a realistic and achievable plan to ensure the continuing technical and scientific expertise that is necessary for a safe, reliable nuclear industry.

1. INTRODUCTION

Like many countries that rely on nuclear energy, the Canadian nuclear industry was not seen as a growing field for most of the past two decades. That situation has just recently changed, leaving us with considerable challenges in developing and maintaining expertise in the nuclear sector to meet what we now believe will be a period of sustained growth over the next few decades.

My assumption is that this gathering is particularly interested in learning about how we identified and defined the problems, and the key steps that we undertook to begin to resolve them. Over the course of my remarks, I will attempt to outline for you the action steps taken by the Canadian nuclear sector to support the management of technical and scientific competence and human resources. There is no doubt that the Canadian nuclear sector is dedicated to implementing strategies for human resource development. Indeed, the Convention on Nuclear Safety, to which Canada is a leading signatory, obliges each Contracting Party to "take the appropriate steps to ensure that sufficient numbers of qualified staff with appropriate education, training and retraining are available for all safety-related activities in or for each nuclear installation, throughout its life."

As we proceed with the refurbishment of our reactors and guide requests for new build through the regulatory process, it is clear that the Canadian nuclear sector will continue to need a strong, well informed independent regulator and that the industry will need innovative and leading edge technical expertise. We need to develop the human resources to run a nuclear industry that will serve Canadians well into the second half of this century. I will outline how the Canadian nuclear sector is pulling together in the right direction and will share with you the core activities the industry has under way and is contemplating to attract more people to a growing sector of the Canadian economy.

2. TECHNICAL AND SCIENTIFIC SUPPORT FOR THE NUCLEAR SECTOR

The Canadian nuclear sector is well established and has safely operated nuclear reactors for over forty years. In that time, technical and scientific support was drawn from a domestic and foreign workforce that was both well trained and plentiful. This allowed the sector to develop without too many constraints on talent and workforce availability. In fact, we were quite successful at attracting and retaining bright students to our universities and promising them long employment careers with higher than average salaries, a very good pension and well defined benefits at the end of their service.

This changed somewhat in the early 1990s, when the Canadian nuclear sector experienced a period of reversing fortunes. We entered a no growth period after the completion of the Darlington project in 1993. In 1997, we experienced the lay-up of seven reactors. Skilled trades as well as technical and scientific expertise left the industry. The industry had reached a plateau, but the public perceived the levelling off as something else.

For Canadians, it was a sign of declining interest and confidence in the nuclear industry. The media reinforced the perception with many negative stories about nuclear power around the world. The result was predictable. Schools, universities and institutions that produced much of the technical and scientific expertise needed by the industry faced declining enrolment and fewer graduates were produced.

While not an immediate crisis, the situation did point to a potentially acute future problem in the ability to support power plant operation in terms of resolving safety related and economic issues.

At this point, the nuclear industry did a not so remarkable thing. A plan was developed and responsible action was taken to implement solutions. The industry dealt with it as a capability issue.

As we know in the nuclear regulatory world, capability maintenance implies that the licensee is qualified to carry on the activity that is authorized by the licence. This is specified in paragraph 24(4) (a) of the Nuclear Safety Control Act and is therefore of vital importance to reactor operators.

Capability maintenance as understood by the Canadian nuclear regulator includes the following:

— R&D programme funding;
— Status of facilities used in R&D programmes;
— Managing human resources within an organization (recruitment, succession planning, knowledge retention, maintaining expertise in core areas);
— Provision of trained personnel through university undergraduate and graduate programmes.

3. CANADIAN INITIATIVES TO MAINTAIN TECHNICAL AND SCIENTIFIC CAPABILITIES

As a first step, in 1999 the CANDU Owners Group (COG) commissioned a report to evaluate the status of R&D capabilities within Canada. In particular, the report addressed human resources and the state of R&D facilities. The report confirmed that, in a number of areas, organizations that provide R&D support to the nuclear industry were operating at or near minimum capabilities. It revealed low entry rates into the nuclear industry and an ageing workforce. In addition, the study indicated that a number of facilities were at risk of closing in the short and medium terms.

This first step taken by the industry to address capability was followed by a three part strategy, or more appropriately a game plan:

- Canadian nuclear utilities and Atomic Energy of Canada Limited (AECL), through the COG, developed a strategic plan for maintaining the strength of R&D organizations that support the nuclear industry. This plan included identification of the technical skills and facilities required to maintain and develop industry knowledge in key technical areas.
- Once the technical skills were identified, the industry developed CANDU specific technical centres of excellence. In order to maintain expertise in the long term, utilities propose to collaborate with the R&D organizations to ensure that appropriate succession planning is in place.
- Enrolment in nuclear related programmes and the entry rate into the industry needed to be increased. Fundamental to long term capability maintenance is the attraction, training and retention of new graduates by the Canadian nuclear industry. In addition, the scope of nuclear engineering education within Canada needed expanding.

Nuclear regulatory bodies have the responsibility for providing oversight and assurance of safety. The regulator needs to be able to confirm that the licensees have adequate scientific and technical support to maintain safe operations and to address potential unexpected issues. The regulator also needs independent scientific and technical information to support its review and assessment of safety submissions from licensees. Thus, in Canada, the Canadian Nuclear Safety Commission (CNSC) closely followed the evolution of national R&D capacity and intervened on occasion — for example, by carrying out its own reviews and by requiring periodic status reports from the industry.

The Canadian nuclear sector also faces a challenge with our current demographics. The Canadian nuclear sector is in a growth period where we are refurbishing reactors and guiding projects to build more reactors that need to be processed by the regulator. We must make sure that there is a steady stream of new replacement workers of all kinds joining the sector. The demographic challenge we face is caused by the retirement of the 'baby boomers'.

In the post-war period, Canada experienced a rapid population expansion from both a dramatic increase in the birth rate and immigration, as people from all over the world came to Canada to contribute to building a new country. Canada is now anticipating that these children of the post-war era will retire in great numbers in the next five years. What this phenomenon represents for the Canadian nuclear sector and the regulator is clear: we could face up to a 50% reduction in our workforce over the next five to ten years.

Current estimates for retirement in the Canadian electricity sector — including generation, transmission and distribution — indicate that 17 066 trades, engineering and managerial staff are expected to retire within the next seven years. Estimates provided by employers indicate that over 17% of the existing workforce will be eligible for retirement in the next five years and almost 37% of the workforce will be eligible for retirement by 2014. Further, the majority of staff reported that they are unlikely to work past the date of eligibility for retirement. Nuclear staff is older than the general population in the power sector.

The expansion phase of the industry of the 1970s and 1980s led to a stocktaking study in 1993, just before we reached the plateau mentioned earlier. It reported that the nuclear industry employed 30 000 Canadians in more than 150 companies across six provinces, and 90% of these positions were full time. Of these 30 000 jobs, 3 200 were engineers and scientists. Despite a recession at the time, at least 10 000 more jobs in other related sectors indirectly depended on the nuclear industry. A similar exercise based on 2001 data conducted in 2003 revealed a nuclear industry with 21 000 direct jobs and 10 000 indirect jobs.

To address the issue of maintaining long term human resource capability, in 2002 the Canadian nuclear utilities established the University Network of Excellence in Nuclear Engineering (UNENE) as an alliance of Canadian universities, nuclear power utilities, and research and regulatory agencies for the support and development of nuclear education, as well as R&D capability in Canadian universities.

The main objective of the UNENE is to contribute a sustainable supply of qualified nuclear engineers and scientists to meet the current and future needs of the Canadian nuclear industry and the regulator. This is done through university education and university based training, as well as by encouraging young people to choose careers in the nuclear industry. The UNENE not only funds research chairs in nuclear engineering at Canadian universities to support the Canadian nuclear industry, but also promotes internships and provides valuable financial aid and scholarships to attract and retain students in areas critical to the industry.

The University of Ontario Institute of Technology (UOIT), Canada's newest publicly funded university, was created in June 2002, with its first students joining in September 2003. The UOIT includes the School of Energy Engineering and Nuclear Sciences (SEENS), which offers undergraduate degrees in nuclear engineering, radiation science and related areas. The programme focus is on reactor kinetics, reactor design, plant design and simulation, radiation detection and measurement, radiation protection, radiation biophysics and dosimetry, environmental effects of radiation, production and utilization of radioisotopes, radiation chemistry and material analysis with radiation techniques.

Since its doors opened to its first 900 students in 2003, UOIT has grown. It currently has 4 300 students; more than 30 undergraduate offerings; two masters programmes, and six more planned for September of this year; more than 100 core faculty members, all of whom have PhDs; and faculties in engineering, science and health sciences. Canada's first cohort of nuclear engineers will graduate in June.

In addition, AECL, Ontario Power Generation (OPG), COG, Bruce Power, McMaster University, École Polytechnique and the Canadian Nuclear Society established the CANTEACH programme. CANTEACH was initiated by the Canadian nuclear industry and educational institutions in an effort to meet the succession planning requirements within their organizations. The aim of CANTEACH is to develop a comprehensive set of education and training documents, with university participation.

As we look ahead and collectively assess the size and depth of the investment we need to make in our human resources planning and recruiting efforts, it is recognized that individual companies making up the Canadian nuclear sector have recruitment and retention strategies under way. Most, if not all, companies have initiated mentoring programmes to pair new staff with experienced staff members to transfer knowledge.

In addition, the Canadian Nuclear Association, on behalf of its members, is preparing three initiatives to assist in the recruitment of new human resources:

— Developing a strategic and long term view of the nuclear industry on which individual companies can anchor and build recruitment strategies;
— Pursuing career and industry branding initiatives to attract young students to study the sciences, mathematics and engineering leading to a career in the nuclear industry;
— Providing a platform for nuclear industry benchmarking initiatives to improve workforce planning, talent management, succession planning capabilities and knowledge management.

4. CONCLUSION

In conclusion, the Canadian nuclear industry has recognized the challenges for both the regulator and the nuclear industry in ensuring the availability of technical and scientific support organizations on which we rely for expertise to ensure continuing safe operation of nuclear plants and facilities.

We have initiated realistic and achievable steps over the past decade, and the individual companies and the industry have undertaken aggressive promotion and recruitment initiatives to ensure that we continue to have the technical and scientific expertise necessary for a safe, reliable nuclear industry well into the latter half of this century.

QUALIFICATION OF TSOs — SOME IDEAS FOR DISCUSSION

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Abstract

The growing use of technical and scientific support organizations (TSOs) in the nuclear sector demands the establishment of qualification mechanisms. The TSOs provide technical services such as testing, monitoring, inspections, reference materials and R&D, among other technical activities, for both the regulators and operators. The qualification mechanism is similar to the accreditation process used in conformity assessment and metrology activities. A brief presentation on the use of accreditation and metrology systems by regulatory authorities in other sectors is made, and some considerations are given regarding the usefulness of that experience in setting up qualification mechanisms in the nuclear sector. Ideas are proposed for the discussion of the options available for implementing qualification mechanisms and the use of accreditation and metrology systems combined with designation mechanisms for that purpose.

1. INTRODUCTION

Technical and scientific support organizations (TSOs), public or private (in this case, usually non-profit organizations), provide technological services and solutions for regulators or operators. The services include tests, inspections, calibration, production of reference materials, examination and assessment of personnel, studies, monitoring and risk assessment. A great part of these activities is in the fields of metrology and conformity assessment. The importance of TSOs to the regulators and operators is increasing, especially in the context of the expected renaissance of the nuclear industry and the scarcity of resources available, particularly specialized expertise.

Technical and scientific support organizations are important in every area of the nuclear industry, from mining of uranium through all fuel cycle activities, construction, commissioning, operation and maintenance, life management and decommissioning of nuclear power plants, to other uses of nuclear technologies such as those in medicine and industry. They provide scientific and technological support services and develop new solutions, including those related to safety, security and environmental issues. They also contribute to the development of standards, the provision of technological information and the conduct of research related to the issues that are of interest to regulators and operators of nuclear facilities. Therefore, they can be viewed as a very important element of the technological infrastructure of the nuclear industry. They can be very specialized in certain areas of knowledge to a level that is not easily achieved by a regulator or operator. Thus, it is possible to consider a network of TSOs, very specialized and focused, providing knowledge and services. This network will help TSOs to maintain their competence through their interactions with one another and the sharing of knowledge and experience. In some activities, TSOs would also compete with each other. It is important that they avoid conflicts of interest and act in an open and transparent manner, since credibility is the foundation of their business. As their activities are essentially scientific and technological in nature, regulators or operators could outsource technical matters to TSOs.

One of the main issues concerning the role of TSOs is the choice of an appropriate mechanism to ensure that they meet certain levels of performance regarding the quality and reliability of the services they provide. Qualification of the TSOs could be a useful tool for this purpose.

As mentioned, one of the key aspects related to the work of a TSO is credibility in the eyes of the regulators, operators and all other stakeholders, including the general public. However, credibility is not an objective parameter that can be easily measured. It comprises several characteristics and dimensions, such as transparency, independence, objectivity, impartiality and technical competence. Nevertheless, it is possible to objectively assess some of the elements that contribute to the credibility of an organization, particularly technical competence, independence and procedural transparency. In this context, the process of qualification could be used to assess and evaluate those objective characteristics of an organization necessary for ensuring the quality and reliability of the services, thus giving confidence to the parties using their services.

2. SOME QUESTIONS CONCERNING QUALIFICATION

Perhaps the first question is who should conduct the qualification: Should it be undertaken by the regulator? By scientific communities such as national/regional associations of scientists and technologists? Or can another entity be designated do that work?

There is no single answer. In each case, the appropriate solution will depend on the culture of the country and the organizations concerned.

However, it should be said that qualification is also a technical activity, with its own requirements of specific knowledge and techniques. Therefore, any solution should consider the need to build competence in that field. This question will be discussed in more depth later in this paper.

The second question is how to establish the criteria against which the qualification is performed. Usually, these criteria are specified in standards or regulations. Those standards or regulations usually include requirements related to the organization, processes and procedures, personnel and infrastructure available.

It is necessary to establish a proper qualification process for this purpose, which should be transparent. It should be conducted by personnel having the appropriate skills and training and following clear rules and procedures in accordance with the good practices for that activity.

Usually, qualification is based on technical and administrative requirements. There is already a well established practice for those activities and requirements. Typically, qualification is based on audits, but in some cases there is a need to perform other activities, such as comparisons of test results against benchmarks.

3. SOME EXPERIENCES OF OTHER INDUSTRIAL SECTORS

It may be useful to look at what has been done in other sectors. In the industrial sector, for example, a lot of work has been done concerning the qualification of organizations. In fact, during the past century, it has become usual to test and certify consumer products in the market. This was done by the producers to control their processes and for quality control purposes, by consumers to verify that the products were as expected and by regulatory authorities to control what was being delivered to the market and to protect the consumers. The manufacturing companies had their own laboratories, but there were also a few independent laboratories. Similarly, there were a few independent technical organizations evaluating processes and products and acting as certification bodies. Typically, there was one certification body per country and product. In many countries, there was just one certification body for many sectors. Its technical competence was presumed by everyone in that particular market or country, and it was usually formally recognized by the government.

In the case of laboratories, to enable the comparison of results it was necessary to put in place metrological infrastructures to deal with aspects such as assurance of repeatability of results, primary standards and production of reference materials. There was also the need to establish criteria to qualify those laboratories so that they would be accepted by the relevant parties. This was done by means of setting standards for the processes used, for their quality management and for the requirements and procedures to assess the technical competence of laboratories. Programmes were also established for comparison of laboratories as well as standards to design and manage those programmes. Peer evaluation mechanisms were also used in some cases. In the end, the establishment of accreditation programmes for laboratories, for both testing and calibration, was an approach to solve the problem of assessing the competence of laboratories. The aim of these programmes was to establish a mechanism to formally certify the technical competence of the laboratories, thus promoting confidence in the results and avoiding multiple evaluations. Therefore, all the interested parties could use them and rely on their results to make decisions. Accreditation is a third party attestation that an organization fulfils specified requirements and is competent to carry out specific tasks.

Of course, similar questions also apply to certification or inspection services. In general terms, the issue of establishing the acceptability of the results of such technological services and certification of organizations that provide reliable and quality services was addressed through the establishment of mechanisms to formally recognize their technical competence. This was done by setting up accreditation systems, which, of course, are qualification mechanisms specifically developed to assess technical organizations providing services.

Typically, there is an accreditation body for each sector in each country. This accreditation body is an independent organization; in many cases it is a private organization, and sometimes it is a public organization or one with the participation of both the State and the private sector. Usually, this accreditation body is formally recognized by the State. It should be totally independent of the organizations being accredited and should not provide services or expert advice on facilitating accreditation or the services that are provided by the accredited organizations. Some developing countries are in the process of implementing their national accreditation systems.

Regulatory authorities in several industrial sectors use the services of the national accreditation bodies. They use the mechanism of designation — governmental authorization of a conformity assessment body or accreditation body to perform specified conformity assessment activities in accordance with national legislation or regulations. The regulator sets a requirement that the technical support services organizations must be accredited. The regulator can establish appropriate rules for the designation process. Using this mechanism, the regulator maintains its authority, which is not transferred or delegated, and uses the technical competence of the accreditation body. Thus the regulator need not set up specific structures for the qualification of organizations and can

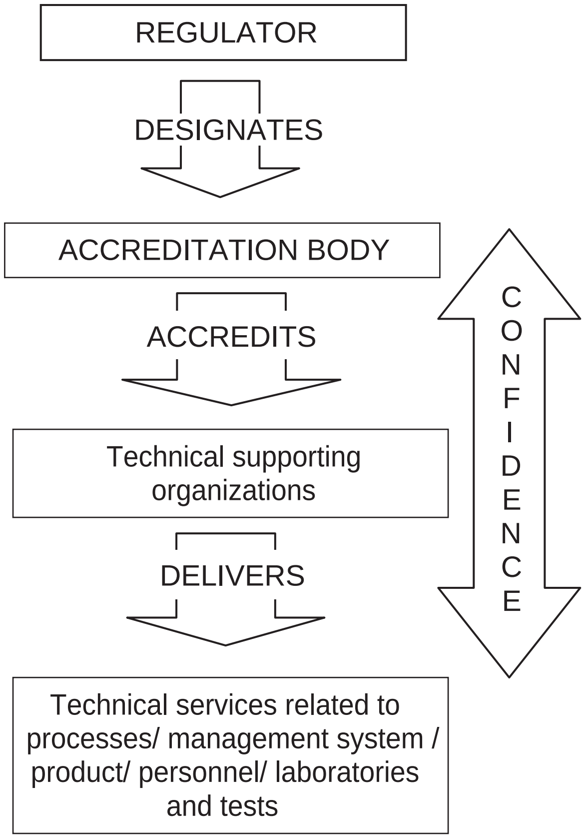

FIG. 1. Use of accreditation services by a regulatory authority (adapted from [1]).

maintain its focus on the regulatory activity and continue using a highly technical and specialized body to qualify the organizations that provide the technical services it needs. Fig. 1 illustrates the use of accreditation services by a regulatory authority. Many countries use this approach, which is the result of an evolution of the regulatory regimes.

Figure 2 shows different regulatory regimes using, to different extents, the services of a national accreditation body and national metrology system. In regulatory regime X, the regulatory authority uses the resources of those systems. It also has its own specific structure, with its own authorization procedures and technical regulations, which are to some extent based on technical standards. The regulatory authority also uses services delivered by accredited organizations within the national systems for the provision of inspection services and other conformity assessment activities. In regulatory

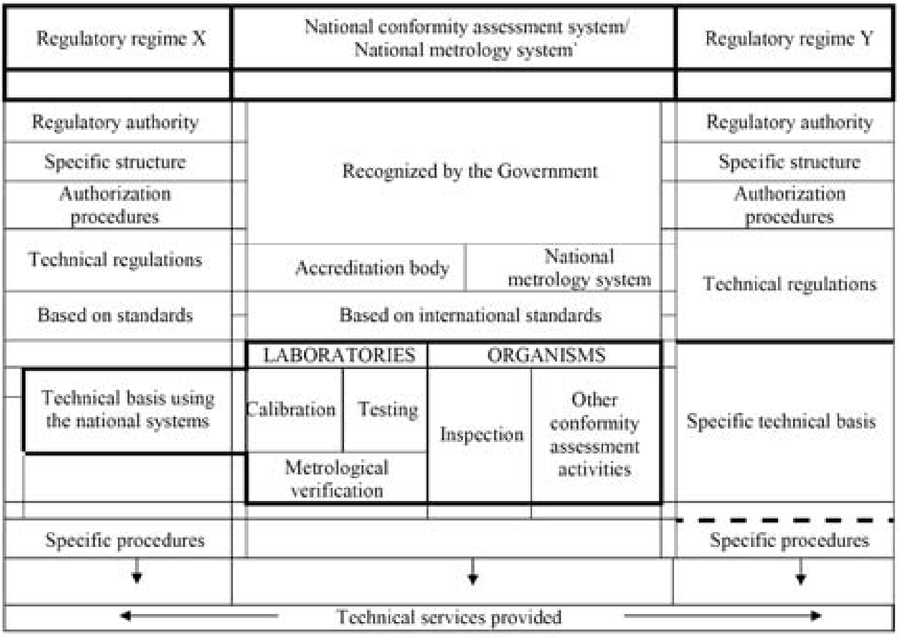

FIG. 2. Regulatory regimes and the national conformity assessment system and national metrology system (adapted from [2]).

regime Y, there is no such arrangement, and the regulatory authority has to perform all the technical functions. In some cases, the regulatory authority has its own laboratory, inspection services and metrological infrastructure. This is also the case in some countries for activities in the nuclear sector.

Many regulatory regimes are moving toward the situation shown in Fig. 3. This trend can be seen in different sectors such as health, labour, agriculture and aerospace. This type of solution avoids duplication of structures and optimizes the use of the available resources, with more focus on the core activities of the regulators and a more rational use of specialized service providers. It also enables maximal use of international references and the promotion of multilateral recognition. In less developed countries in particular, this solution maximizes the use of scarce technical resources. Figure 4 shows the articulation of the elements for qualification in conformity assessment activities.

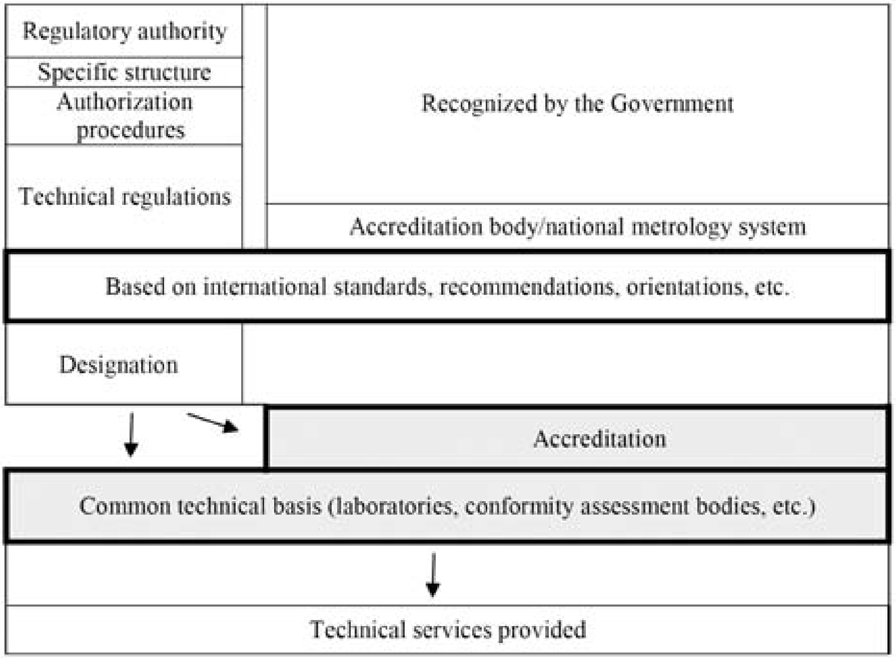

FIG. 3. Regulatory regime using a common technical basis provided by national systems (adapted from [2]).

4. QUALIFICATION OF TSOs

Technical and scientific support organizations perform a wide range of activities, from metrology and conformity assessment through personnel training and qualification, participation in standards setting, emergency preparedness and response, and R&D. Qualification in such a wide variety of fields requires specific capabilities involving specialized personnel, infrastructure, resources and techniques.

As mentioned, there are some options for the qualification of TSOs. One of the options is for the regulator to be in charge of performing the qualification. For this purpose, it should establish an appropriate specialized structure. In this option, the regulator will have firm control over the qualification mechanism; on the other hand, however, it will consume a significant share of resources and attention.

A second option is to use some kind of peer evaluation or formal recognition by academia. This alternative could have some limitations, as this kind of process is not a part of the main activities of universities and R&D.

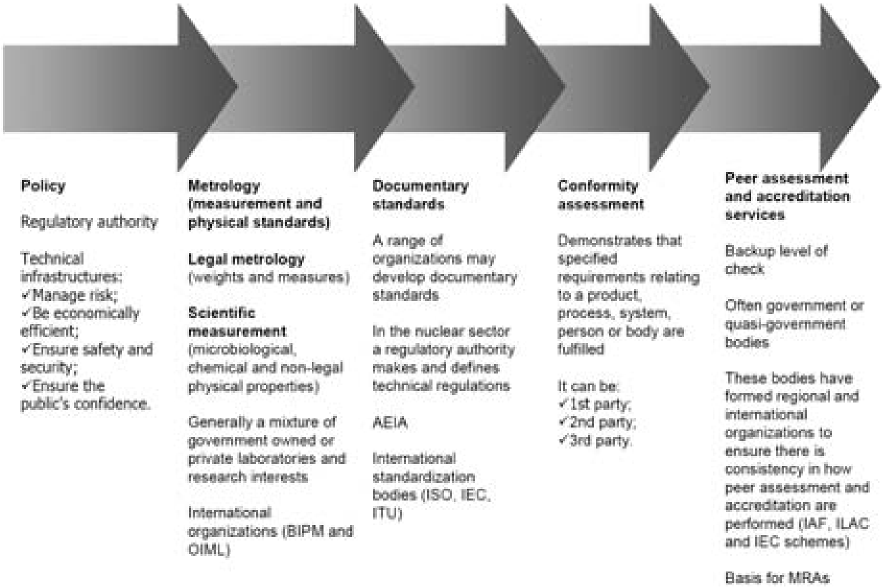

FIG. 4. Articulation of the elements for qualification in conformity assessment activities (adapted from [1]).

A third option is to follow the practice of the industrial sector and use, whenever possible, the existing competence available in the metrology and conformity assessment systems to the extent appropriate for qualifying organizations through accreditation combined with a designation mechanism. Of course, not every activity that a TSO provides is in the fields of metrology and conformity assessment. Nevertheless, the principles and mechanisms of accreditation can be applied, and it would not be difficult for the accreditation bodies to adapt their procedures accordingly.

In some cases it might be more appropriate to use the accreditation mechanism employed by the national accreditation bodies combined with the designation mechanism, while in other cases it would be desirable to develop a specific qualification process strictly within the framework of the regulatory organization.

Some issues require special attention in the qualification process, such as the independence of the TSOs, mechanisms to avoid conflicts of interest, the sustainability of the TSOs, the proprietary nature of technical information or the evaluation of the R&D activities and the assurance that the services of the TSO are not compromised. Many of these issues can be addressed in the accreditation process through the choice of appropriate criteria for granting accreditation. Some issues would be more consistently addressed by using the designation process.

For example, it could be specified that the TSOs should have in place established processes for the identification of potential situations involving conflicts of interest and measures to address them in a timely and responsible manner. This approach was successfully used in the accreditation of TSOs as evaluators of the Clean Development Mechanism.

Criteria can also be established on the basis of precise requirements to ensure the independence of TSOs, both organizational and in terms of the procedures and personnel used. The same applies to the treatment of disclosure of proprietary technical information to the customer, the regulator and the general public. The criteria can also include provisions for demonstration of the sustainability of the TSOs and for the clear separation of the technical services provided and other activities such as R&D.

In setting the criteria, it would be useful to follow international standards and guides developed for accreditation and to supplement these with specific requirements applicable to the nuclear sector. This approach contributes to the use of a common technological basis and facilitates the implementation of the qualification process, uses the accumulated knowledge and experience, takes advantage of the experience in other sectors and enhances the possibility of sharing experience and facilitating international comparisons.

The use of accreditation combined with a designation mechanism could be a useful tool to avoid the duplication of effort and to promote the rational use of resources. In many cases, TSOs are used not only by the nuclear regulatory authority but also by other regulatory authorities, such as those responsible for the environment, health or industrial safety. Therefore, the use of a common technical basis for qualification facilitates the use of TSOs by several regulatory authorities with the appropriate level of confidence. Thus it is possible to create a network of institutions dedicated to testing, calibration and inspection, all accredited under the same system, and these institutions can be used by several regulatory authorities (e.g. health, labour, agriculture, environment, nuclear, defence). This approach has already been adopted by the nuclear sector in France.

The above approach could be an intelligent way to deal with the challenge of optimizing the use of scarce resources and technological infrastructure, particularly by less developed countries. From the point of view of the regulator, this could be an interesting solution, because it allows the focus to remain on the essential functions of the regulator and avoids the need to be competent in every field of activity.

5. CONCLUSION

Qualification is an important mechanism for instilling confidence in the use of TSOs in the nuclear sector for regulators, operators and society in general. Qualification is a means to enhance the credibility of TSOs, as it deals with many of the elements that support credibility. It is a specialized activity that requires specific infrastructure, personnel and appropriate procedures. Qualification should be focused on the formal recognition of the technical competence of TSOs and should address relevant issues related to the credibility of TSOs, such as independence, transparency, sustainability and avoidance of conflicts of interest. The development of qualification mechanisms could benefit from the use of accreditation services already developed in other sectors, combined with designation mechanisms by the regulatory authority. The implementation of qualification mechanisms should take into account the use of a common technical basis already in place and use international standards and guides to the extent appropriate.

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SUSTAINABILITY OF TECHNICAL AND SCIENTIFIC EXPERTISE*

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*Although a presentation was given, no abstract or paper was made available. The author's presentation appears in the CD-ROM of contributed papers accompanying this book.

INTERNATIONAL COOPERATION, NETWORKING AND APPLICATION OF IAEA SAFETY STANDARDS

(Topical Session 3)

Chairpersons

S. MALLICK
Pakistan

E. AMARAL
IAEA

LEAD-IN PRESENTATION: STATUS OF INTERNATIONAL COOPERATION AND PERSPECTIVES ON FUTURE NEEDS AND CONVERGENCE OF TECHNICAL AND SCIENTIFIC PRACTICES: BENEFITS AND METHODS

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Abstract

The contribution of technical and scientific support organizations (TSOs) to the enhancement of the Global Nuclear Safety Regime is described from the regulator perspective and analysed systematically, taking into account current forums, programmes and practices established by the IAEA and the OECD Nuclear Energy Agency (OECD/NEA). Each TSO needs a thorough understanding of its national regulatory infrastructure and sufficient familiarity with the respective nuclear installations and safety practices, as well as adequate and stable levels of financial resources and trained personnel. Therefore, in many countries TSOs are utilized to support national regulatory bodies. To be competent in safety matters, TSOs need international cooperation, with both an intense exchange of experience and participation in current R&D activities as well as adequate access to the experience and R&D activities of the licensees and the industry. In general, the information and R&D results of the licensees and the industry are proprietary in nature and have to be kept confidential in an appropriate manner. A core function of the TSOs is to analyse and assess safety issues including verification and documentation of the current state of science and technology in such a way that the competent regulatory body can draw upon these in support of its regulatory functions. The specific needs of a nuclear regulator include well founded, explicitly verified and traceable scientific and technical bases to support its decision making process. Challenges faced by TSOs result from a shrinking nuclear infrastructure and a scarcity of experts with high level experience and knowledge in nuclear safety; diminishing educational opportunities in the nuclear field; and a reduction in the availability of finance for nuclear safety research in combination with deregulated market conditions resulting in mergers of operators and associated facilities in the nuclear industry. Technical and scientific support organizations must take related regulatory concerns seriously and develop new mechanisms, instruments and products of international cooperation. Examples and methods to promote convergence of technical and scientific practices are outlined, and potential benefits and improvements for the effectiveness of the Global Nuclear Safety Regime are highlighted to stimulate further discussion.

1. INTRODUCTION

As a result of globalization, national regulators have to deal with international vendors and utilities. Global utilities and suppliers face the challenge of different regulations in different countries. There is therefore a need for harmonization of national regulations. The IAEA and, in the European context, the Western European Nuclear Regulators' Association (WENRA) have made significant efforts to set international standards or reference levels to maintain the level of nuclear safety or to improve it where necessary.

The safety assessment of nuclear installations differs significantly worldwide. In many countries, the nuclear regulatory bodies and supervision authorities are equipped with experts who ensure that these authorities can perform technically detailed analyses by themselves and, on this basis, take administrative and legal decisions. For example, this is the situation — according to my knowledge — in Sweden, Switzerland and the United States of America (USA). In some countries like Germany — where I come from — the tradition is that the technical competence resides with technical and scientific support organizations (TSOs) external to the nuclear regulatory authorities. In Germany, about €10 million per power reactor per year is spent by the regulators to obtain the expertise of TSOs.

These TSOs also work in an international environment. They have to maintain their competence at the international, state of the art level of R&D and technology. Regulators need the assurance that their decisions are based on the best available facts and results of analyses. Thus the TSOs have to demonstrate how they maintain their level of competence. International cooperation in research and analysis is considered an adequate approach for this purpose.

Technical and scientific support organizations supporting regulatory bodies are represented in international working groups, technical meetings and international missions on behalf of their regulators. Thus the TSOs benefit from the same international organizations as the regulatory bodies.

The Global Nuclear Safety Regime, as described by the International Nuclear Safety Advisory Group (INSAG) [1], is a framework for achieving the worldwide implementation of a high level of safety at nuclear installations. At its core are the activities undertaken by each country to ensure the safety and security of the nuclear installations within its jurisdiction. But national efforts are and should be strengthened by the activities of a variety of international enterprises that facilitate nuclear safety, such as:

— Intergovernmental organizations;
— Multinational networks among operators;

— Multinational networks among regulators;
— The international nuclear industry;
— Multinational networks among scientists;
— International standards setting organizations and other stakeholders such as the public, news media and non-governmental organizations (NGOs) that are engaged in nuclear safety.

The efforts of all of these organizations should be used to enhance the achievement of safety.

The existing Global Nuclear Safety Regime is functioning at an effective level, but its impact on improving safety could be enhanced by pursuing certain measures. INSAG-21 [1] recommends action in the following areas:

— Enhanced use of the review meetings of the Convention on Nuclear Safety (CNS) as a vehicle for open and critical peer review and a source for learning about the best safety practices of others;
— Enhanced utilization of IAEA safety standards for the harmonization of national safety regulations, to the extent feasible;
— Enhanced exchange of operating experience for improving operating and regulatory practices;
— Multinational cooperation in the safety review of new nuclear power plant designs.

Some examples are presented below to demonstrate that the contributions of TSOs supporting regulatory bodies are appropriate for helping to implement these recommendations.

2. INTERNATIONAL ACTIVITIES

The worldwide expansion of nuclear power took place mainly in the 1970s, when there was a variety of reactor types and safety approaches. Since then, international cooperation has gradually increased, leading to a substantial convergence of the design and operating principles of nuclear power plants.

The need to involve all countries as active partners in a single Global Nuclear Safety Regime became evident after the accident at the Chernobyl nuclear power plant, where the main lesson was that: “An accident anywhere is an accident everywhere”. Countries that utilize nuclear energy are bound together in a risk community. Therefore, it is of high importance to exchange safety relevant insights not only between the regulators but also between their TSOs.

For this purpose, various formal and informal international platforms, safety codes and guides have been developed, including:

- The IAEA;
- International conventions such as: the CNS, the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, the Convention on Early Notification of a Nuclear Accident, and the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency;
- International committees set up by the IAEA such as: the Commission on Safety Standards (CSS), Nuclear Safety Standards Committee (NUSSC), Radiation Safety Standards Committee (RASSC), Waste Safety Standards Committee (WASSC) and Transport Safety Standards Committee (TRANSSC);
- IAEA Safety Standards Series publications such as Safety Fundamentals, Safety Requirements and Safety Guides;
- IAEA databases such as the International Nuclear Event Scale (INES) and the IAEA/NEA Incident Reporting System (IRS);
- IAEA safety services such as the Operational Safety Review Team (OSART) and the Integrated Regulatory Review Service (IRRS);
- The OECD/NEA and its committees: the Committee on Nuclear Regulatory Activities (CNRA) and the Committee on the Safety of Nuclear Installations (CSNI).

For all of us, it seems nearly impossible to follow all these activities. In the frame of this presentation it is not possible to consider all these activities.

2.1. International conventions

Some international conventions [2] are briefly explained below:

- The CNS: This convention establishes an international cooperation mechanism to achieve and maintain a high level of nuclear safety worldwide for nuclear power plants.
- The Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management: Analogous to the CNS, the Joint Convention establishes international cooperation to achieve and maintain a high level of safety at fuel cycle facilities and activities.
- The Convention on Early Notification of a Nuclear Accident: This convention establishes a notification system for nuclear accidents that

have the potential for international transboundary release that could be of radiological safety significance for another State.
— The Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency: This convention sets out an international framework for cooperation among the Parties and with the IAEA to facilitate prompt assistance and support in the event of nuclear accidents or radiological emergencies.

2.2. IAEA safety standards

In 1996, the IAEA Secretariat introduced a uniform preparation and review process for safety standards. To this end, it created a set of advisory bodies with harmonized terms of reference to assist it in preparing and reviewing all documents, namely:

— The Commission on Safety Standards (CSS);
— The Nuclear Safety Standards Advisory Committee (NUSSAC);
— The Radiation Safety Standards Advisory Committee (RASSAC);
— The Waste Safety Standards Advisory Committee (WASSAC);
— The Transport Safety Standards Advisory Committee (TRANSSAC).

The CSS is a standing body of senior government officials holding national responsibility for establishing standards and other regulatory documents relevant to nuclear, radiation, transport and waste safety. The CSS has a special overview role with regard to the IAEA safety standards and provides advice to the Director General on the overall programme on regulatory aspects of safety.

The IAEA Safety Standards Series documents fall into the following categories [2]:

— Safety Fundamentals, which state the basic objectives, concepts and principles involved in ensuring protection;
— Safety Requirements, which specify requirements that must be satisfied in order to ensure safety for particular activities or application areas, these requirements being governed by the basic objectives, concepts and principles stated in Safety Fundamentals;
— Safety Guides, which supplement Safety Requirements by presenting recommendations, based on international experience, regarding measures to ensure the observance of Safety Requirements.

2.3. Event reporting systems and IAEA services

Important issues on the cooperation of the IAEA Member States are the two international reporting systems: INES and the Nuclear Events Web-based System (NEWS), and the IRS.

The INES/NEWS comprises a scale of seven levels to grade a nuclear event regarding its safety relevance and the release of radioactive substances. It enables rapid informing of the public.

The IRS is run by the IAEA in cooperation with the OECD Nuclear Energy Agency (OECD/NEA). Regulators and TSOs exchange detailed technical information on important events and the related lessons learned. Both international agencies organize working groups and meetings to draw further generic lessons. This fruitful collaboration of experts has been in place for more than 25 years and is an important measure for maintaining and further improving the safety of nuclear power plants.

Another significant measure for strengthening international cooperation and improving the safety level by benchmarking are the services provided by the IAEA. These services are performed on the basis of current safety standards. For example, IAEA OSART missions have proved very valuable, and more than 100 missions have already been performed.

2.4. Committees under the OECD/NEA

Another important regulatory organization is the NEA, which is a specialized agency within the OECD, an intergovernmental organization of industrialized countries. The mission of the OECD/NEA is to assist its Member countries in maintaining and further developing, through international cooperation, the scientific, technological and legal bases required for the safe, environmentally friendly and economical use of nuclear energy for peaceful purposes. To achieve this, the OECD/NEA works as a forum for sharing information and experience and promoting international cooperation; a centre of excellence that helps Member countries to pool and maintain their technical expertise; and a platform for facilitating policy analyses and developing consensus based on its technical work.

The CNRA is an international committee made up primarily of senior nuclear regulators. It was set up in 1989 as a forum for the exchange of information and experience among regulatory organizations. The CNRA is responsible for the OECD/NEA programme concerning the regulation, licensing and inspection of nuclear installations with regard to safety. Its purpose is to promote cooperation among Member countries and to use the feedback from experience to develop measures to improve safety, to enhance efficiency and effectiveness in the regulatory process and to maintain adequate infrastructure and competence in the nuclear safety field. The CNRA's main task is to review developments that could affect regulatory requirements, with the objective of providing members with an understanding of the motivation for new regulatory requirements under consideration and an opportunity to offer suggestions that might improve them or avoid disparities among member countries. In particular, the Committee reviews current management strategies and safety management practices and operating experiences at nuclear facilities with a view to disseminating the lessons learned [3].

The detailed technical work of the CNRA is performed in working groups and task groups. In these groups, TSOs support or represent their regulatory bodies. For example, on behalf of the Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (BMU), experts from the Gesellschaft für Anlagen- und Reaktorsicherheit (GRS) participate in the activities of the working group on operating experiences.

A corresponding committee is the CSNI, an international committee made up of representatives from regulatory authorities and senior scientists and engineers with broad responsibilities for safety technology and research programmes. It was set up in 1973 to develop and coordinate the activities of the OECD/NEA concerning the technical aspects of the design, construction and operation of nuclear installations insofar as they affect the safety of such installations. The purpose of CSNI is to foster international cooperation in nuclear safety among OECD Member countries. The CSNI's main tasks are to exchange technical information and to promote collaboration between research, development, engineering and regulatory organizations; to review operating experience and the state of knowledge on selected topics of nuclear safety technology and safety assessment; to initiate and conduct programmes to overcome discrepancies, develop improvements and research consensus on technical issues; and to promote the coordination of work that serves to maintain competence in nuclear safety matters, including the establishment of joint undertakings [4].

Important publications from CSNI are the so called Technical Opinion Papers, which are internationally agreed statements of senior research experts, and the State-of-the-Art Reports, which show a comprehensive scientific review of specific issues.

2.5. WENRA

WENRA is an NGO comprising the heads and senior staff members of the nuclear regulatory authorities of European countries with nuclear power plants. The main objectives of WENRA are to develop a common approach to nuclear safety, to provide an independent capability to examine nuclear safety in applicant countries and to serve as a network for chief nuclear safety regulators in Europe to exchange experience and discuss significant safety issues. An important goal of WENRA is the harmonization of safety approaches within Europe. Two working groups were launched to harmonize safety approaches between the countries in Europe, one on reactor safety and one on decommissioning and nuclear waste safety. The aim is to continuously improve safety and to reduce unnecessary differences between the countries. At the time the working group on reactor safety was established, it was recognized that there was no specific indication of inadequacies in the safety level reached when the most recent national requirements in WENRA countries were met.

2.6. Developing countries

A new challenge for the Global Nuclear Safety Regime is the expected deployment of nuclear energy in countries with limited technical infrastructure. It is essential that a high level of nuclear safety be ensured in all countries, including these new entrants. These countries should appreciate the responsibilities that arise from the use of nuclear power. An infrastructure consisting of personnel, education, research, industry, and financial and regulatory capacities is needed to start and maintain a successful nuclear power programme. There is also the need ensure the availability of technical support and a reliable supply of equipment and services for the lifetime of a nuclear power plant. INSAG is preparing a separate report on the infrastructure that is necessary for starting a new national programme [1].

2.7. WANO

The licensees have also established international organizations like the World Association of Nuclear Operators (WANO) with goals and methods similar to those of the regulatory agencies. They have an established reporting system for events, organize WANO peer reviews and support their members with detailed technical assistance on issues relevant to safety and economics.

3. SUPPORT BY TSOs

In many countries, regulatory bodies have not built up extensive in-house technical know-how. Since the beginning of the peaceful use of nuclear energy, they have been relying on support from TSOs. In other countries, this technical expertise is required to be more or less internally accessible. For issues on which TSOs are contracted, their responsibility is to advise the regulatory authorities on matters related to nuclear licensing, nuclear oversight and the development of technical standards.

It is very important that a clear separation of tasks and responsibilities exist between the regulatory authority and the TSO. The TSOs have to restrict themselves to the investigation and application of the results of state of the art R&D as the bases of their assessments. The task of the regulatory authority is to make administrative and legal decisions with the aid of the results of the assessments carried out by TSOs. In my opinion, in a democratic country the executive has the right to finally decide on the question, How safe is safe enough? It would not be correct to delegate to the TSOs the responsibility for decisions on the adequacy of measures.

3.1. Technical standards development

On behalf of their regulatory bodies, TSOs perform many international tasks or advise their regulatory bodies on these tasks. Some examples that illustrate this collaboration include the following:

- The development of technical standards, including the IAEA safety standards, requires an in-depth knowledge of the issue. The German regulatory body, the BMU, for example, has contracted GRS and other organizations to provide advice on updating the German sub-legal regulations. This important activity comprises technical updating of over 450 pages of rules. The second revision of these rules has been published in the Internet for comment [5]. An English translation is also available. The goal is to finish the updated regulations by the end of 2007.
- A second task for TSOs in the area of international rules and regulations is the analysis of the international standards with respect to the existing domestic regulations. In the past few years, great efforts have been undertaken to develop the WENRA reference levels and to compare these with domestic regulations. In addition, new IAEA safety standards have to be assessed regarding their applicability to national regulations. I am a member of the CSS. Before each CSS meeting, GRS, which is BMU’s TSO, has analysed the standards to be approved regarding their potential impact on German regulation and practice. Thus each decision taken by the CSS has been supported by BMU’s TSO.
- If an international rule is approved and published, it must be decided whether and how the new regulations will be applied in a country. For example, the new German sub-legal regulation is mainly based on the

international state of the art of science and technology, which is established in the international standards. So each new domestic regulation must now be developed taking into account the IAEA safety standards.

3.2. Operating experience feedback system

A few months ago the INSAG stated that: “the international operating experience feedback systems available today are not adequate to meet the needs of the ever-increasing number of nuclear stakeholders. There is an acute need to improve the mechanisms that are in place for sharing international operating experience....” After the May 2006 Cologne Conference on operating experience feedback, these activities were started on a European basis. With respect to the United States Nuclear Regulatory Commission clearinghouse approach [6], some regulators and some TSOs have developed, in cooperation with the European Commission, a concept for a European operating experience feedback system. The main goals of this system are:

- To evaluate operating experience reports from Member States and other international event reports with significant lessons to be learned in order to draw conclusions and to give advice with respect to the various reactor designs;
- To collect and evaluate the responses (e.g. the actions taken after foreign events) of the Member States to form the basis for additional advice on further potential actions, with special attention to avoiding recurring events;
- To develop generic reports on operating experience.

The BMU has taken into account the preceding proposals. From my point of view, a European system should only be established if it is better able than the existing system to analyse the worldwide experiences and to use them for the improvement of the safety of nuclear installations. In other words, the checking of the preceding proposals is not yet finished on the German side.

3.3. Requirements on TSOs

International cooperation at the regulatory level needs a counterpart at the TSO level. This cooperation is achieved by the continuous contracting of these organizations by the regulators. Some regulators do not have sufficient technical knowledge in their organizations. The technical support has to be ensured in these cases on a long term basis to enable their TSOs to react adequately on short notice. The regulatory bodies require the following of their TSOs:

— Technical and scientific support organizations have to employ competent personnel to be able to provide technical support to the regulator at any time on all relevant technical issues. This implies an adequate knowledge management system to preserve the knowledge of experienced experts. The experiences gained during the design and initial licensing of the nuclear power plants in the 1970s has to be transferred to young professionals joining the TSOs. In several countries, including Germany, there is a significant shortage of qualified personnel. Very few students study nuclear sciences in the universities. Thus TSOs have to provide comprehensive initial training of incoming employees on specific nuclear issues. This training should also be open for new personnel of the regulatory bodies.
— It is important for the regulator that the TSO be familiar with the international state of the art of research and technology. The regulatory body must be able to trust the advice given by TSOs, because the decisions based on this advice might have significant legal and economic consequences. Maintaining the competence level at the state of the art for both science and technology is achieved on two ways. On the one hand, the TSO should perform research by itself on significant safety topics or closely follow the progress made by research centres and institutions elsewhere. On the other hand, international exchange of knowledge between TSOs is essential to maintaining the competence. This collaboration is achieved by participation in the working groups of international organizations. The definition of the generic safety issues is a good example in this regard. These generic safety issues represent the most challenging areas in reactor safety. The solution of these issues should be the focus of all TSOs.
— The main task of a regulatory body's TSO is to support regulatory activities. Therefore, the TSO must always be familiar with the national needs of its regulatory body, in addition to being at the state of the art level with respect to science and technology. This implies close cooperation with the regulatory body. Being able to respond quickly to the demands of the regulatory body for advice on regulatory decisions is essential to the value of a TSO. This regulatory demand may arise from national or international events. The reaction of the BMU in the Swedish Forsmark event is a good example. The BMU had to react promptly after this serious event, and its response had to be based on technical information provided by GRS, which itself received the information from

the Swedish regulatory body SKI. Thus GRS had to have in-depth knowledge concerning the event, the design of the electrical power supply of Forsmark and the various designs of the domestic power plants to assess the applicability of the event to the German nuclear reactors. This may be the right place to thank SKI for their prompt and open communication regarding the event and their hosting of a related international expert meeting in September this year.
— Technical and scientific support organizations should also support their regulatory bodies on technical issues by participating in working groups in international bodies. This includes, for instance, consultancies, technical meetings and missions of the IAEA, as well as those of the CNRA and CSNI working groups.
— Technical and scientific support organizations must have comprehensive knowledge of international rules and regulations as a basis for maintaining their state of the art knowledge and competence. The IAEA safety standards and the WENRA reference levels have to be understood in detail to be used as an input in the review of national nuclear regulations and standards. On the other hand, TSOs must transfer their domestic knowledge for the development of international rules and regulations to strengthen the Global Nuclear Safety Regime.
— Major challenges result from the shrinking nuclear infrastructure in combination with mergers of operators and other organizations in the nuclear industry. National regulators are required to deal with international licensee organizations. The activities aimed at harmonizing international rules and regulations and consolidating international safety practices have already been described. International vendor companies now offer new reactor designs to international operating companies. They expect similar rules and regulations in all countries. The assessment of new designs needs the international cooperation of TSOs as well.

4. CONCLUSION

The INSAG report dealing with strengthening the Global Nuclear Safety Regime (INSAG-21 [1]) mentions four issues regarding the Regime's further enhancement:

— Use of the review meetings of the CNS as a vehicle for open and critical peer review and as a source for learning from the best practices of others;
— Enhanced utilization of the IAEA safety standards for the harmonization of national safety regulations to the greatest extent possible;

— Enhanced exchange of operating experience and the use of this experience for life cycle management and back fitting of nuclear facilities, as well as for improving operating and regulatory practices;
— Multinational cooperation for the safety review of new nuclear power plant designs.

This paper has shown how these challenges are addressed by the regulatory bodies and the role that TSOs have to play. The important missions of the IAEA and OECD/NEA have been highlighted, as well as those of WANO, a similar institution that is well established on the operator side.

In some countries the licensing and regulatory authorities do not have sufficient personnel to deal with all technical and scientific issues within those bodies themselves. Therefore, these authorities need TSOs to support their functions.

These TSOs need to be integrated into the national regulatory infrastructure, which would thereby ensure sufficient familiarity with the respective nuclear installations and safety practices.

Technical and scientific support organizations contribute to the Global Nuclear Safety Regime through their participation in the relevant international working groups established by the IAEA and OECD/NEA. To maintain adequate competence in safety matters, TSOs need to cooperate internationally and perform their own research on safety related issues. The shrinking nuclear infrastructure places an additional burden on the TSOs. They must train their new staff in the nuclear sciences, which currently is only rarely acquired at universities by the young entrants.

Regulatory bodies, and therefore their TSOs, need to be knowledgeable about the state of the art of science and technology. Technical and scientific support organizations have to provide their high level expertise in a way that is well founded, explicitly verified and traceable, so that a competent regulatory body can rely upon their support when performing its regulatory functions. In the same way, regulatory bodies have the duty to be reliable partners to their TSOs, which implies a continuous and adequate financial support.

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NETWORKING TO BRIDGE ORGANIZATIONAL, GEOGRAPHICAL AND CULTURAL BARRIERS*

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Abstract

The worldwide expansion of nuclear power generation currently under way is placing a great deal of pressure on current resources for both the industry and regulators. This challenge is made more acute by the fact that there has been no preparation of a skills pipeline. Many countries are only now starting to respond. For the regulator, the effect is felt that much more. There is increased staff mobility owing to increasing competition for the same skills with the private sector, leading to erosion of the institutional memory built up over time. Sharing of technical and safety information through cooperation and networking with international counterparts is becoming essential to the success of regulators. Further, the role of technical and scientific support organizations (TSOs) is also becoming increasingly critical. Clearly, this has its own challenges. The paper explores some of these challenges and describes the experience in South Africa.

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*Although a presentation was given, only an abstract was made available. The author's presentation appears in the CD-ROM of contributed papers accompanying this book.

TECHNICAL AND SCIENTIFIC SUPPORT IN BUILDING INFRASTRUCTURE FOR THE NUCLEAR POWER PROGRAMME IN VIETNAM

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Abstract

The paper presents an overview of the current status of R&D and technical and scientific support organizations (TSOs) in Vietnam, and the need for their development to help meet the safety milestones of the nuclear power programme established as part of the national strategy aimed at the peaceful use of atomic energy up to 2020. National R&D efforts and TSOs will provide support not only for nuclear power projects, but also for enhancing safety in both the existing research reactor and the new research reactor project. A master plan for developing an appropriate knowledge base and the expertise of national organizations is presented, along with highlights of the potential challenges. The master plan covers activities concerning the development of human resources and technical infrastructure, as well as R&D planning.

1. INTRODUCTION

Vietnam has been implementing an industrialization and modernization strategy, with the aim of becoming an industrial country by the year 2020. With the present population of 84 million and an annual economic growth rate of 7–9%, energy security and the enhancement of the scientific and technological potentials of the country are vital for achieving sustainable economic growth, social security and improved standards of living. Therefore, the Government of Vietnam has paid close attention to policies aimed at sustainable energy development, including nuclear power development. On 3 January 2006, the Prime Minister approved the Strategy for Peaceful Utilization of Atomic Energy up to 2020, emphasizing the important goals of building the first nuclear power plant in Vietnam and bringing it into safe and effective operation, and establishing the infrastructure needed for the country's long term programme for nuclear power development.

Technical and scientific support organizations (TSOs) play a vital role in the national nuclear power programmes of developing countries. In Vietnam, the Vietnam Atomic Energy Commission (VAEC), which employs 90% of the State's nuclear personnel, also plays a significant role in the provision of scientific and technological support for the national nuclear power programme, including building and developing infrastructure and implementing the programme. This paper presents the major tasks of and the challenges faced by the VAEC as a nuclear TSO, as well as the roles of international support.

2. THE ROLE OF TSOs

Generally, a national nuclear power programme consists of two parts: (1) long term, programme oriented activities and (2) project oriented activities.

2.1. Long term, programme oriented activities

Long term, programme oriented activities include nuclear power planning; the establishment of legal frameworks and a nuclear regulatory body; and the strengthening of the nation's capacity to carry out R&D activities in the nuclear power field, nuclear safety analyses and assessments, studies on nuclear fuel cycle and radioactive waste management, human resource development and public information activities. As a TSO, the VAEC has the following major tasks:

— To take part in nuclear power planning;
— To take part in the drafting of an atomic energy law and the establishment of legal frameworks for nuclear related regulations and technical standards; the setting up and implementation of inspection programmes in order to ensure compliance with the laws and regulations currently in force related to the construction and operation of nuclear power plants; the formulation of standards for nuclear safety analysis and assessment;
— To study nuclear power technology in order to offer professional advice/consultancy to the Government on the technology selection for nuclear power plants in Vietnam, and to adapt, apply and develop transferred nuclear technology, including keeping up with technological changes and applications;
— To study issues related to nuclear safety in order to join in different stages of safety analysis, assessment and verification for nuclear power plant projects such as design, site selection, construction, operation and maintenance;

— To take part in the establishment and operation of a national environmental monitoring network and emergency response system to address radiation and nuclear incidents and accidents;
— To support domestic industries to enhance their participation in the first nuclear power plant project, on a step by step basis, to meet the self-reliance goals in the design, manufacture and construction of future projects;
— To offer expert advice as problems arise and provide the testing facilities required for assessing material properties and component performance, and to provide analysis in support of problem diagnosis in nuclear power plant projects;
— To enhance domestic technical capabilities for the fabrication of nuclear fuel for nuclear power plants from imported enriched uranium, and for the safe management of spent fuels and radioactive waste;
— To support the exploration for and estimation of uranium reserves, as well as the evaluation of the socioeconomic efficiency of the exploitation and processing of domestic uranium and thorium, creating the basis for making national policies on the commercial exploitation of these domestic resources for the nuclear power development programme;
— To collaborate with related agencies to establish a comprehensive plan for human resources preparation as well as the action plan for the implementation of the national nuclear power programme, in which the VAEC will take the responsibility for providing leading experts on nuclear engineering, organizing education and training programmes for the researchers, scientists, technicians and managers who will participate in the programme, and cooperating with and supporting universities in training nuclear engineers;
— To cooperate with the mass media on activities aimed at informing the public concerning nuclear power.

2.2. Project oriented activities for the construction of the first nuclear power plant

The project for the construction of the country's first nuclear power plant will be implemented by an investor, assigned and authorized by the Government, which will oversee the conduct of the project. The VAEC, as a nuclear TSO, will assist in carrying out the following aspects of the project:

— Pre-project activities such as feasibility studies.
— Preparation of criteria for tender: providing technical specifications of the nuclear power plant and provisions of the contract in terms of legal and

economic aspects, and determining the prerequisites for signing the contract such as project design, equipment/supply conditions, staff training, time frame for completing the contract, preparation for the approval procedure.

— Preparation of data for designing the nuclear power plant, such as capacity, number of units, information on geology, seismic considerations, hydrography, meteorology, topography and population settlements in the vicinity of the plant. These data will be presented in the safety analysis report.
— Investigation of safety, environmental, radiation protection and public information aspects.
— Participation in decision making concerning testing operation, fuel loading and commercial operation of the plant.
— Providing technical services to the operator for safe and effective operation and management, and dealing with the problems arising from operation and maintenance.

3. DIFFICULTIES AND CHALLENGES

The main difficulties and challenges faced by VAEC are listed below:

— Although the VAEC is a nuclear TSO, the number of its experts in the fields directly related to nuclear power is still somewhat limited. There is a large age gap among staff members, because for nearly a decade, from 1980 to 1990, students who graduated from nuclear related universities were not employed by the VAEC.
— The technical infrastructure system for R&D activities within the VAEC remains elementary. The most important research equipment — the Dalat nuclear research reactor — is no longer state of the art, leading to limits to its use.
— The VAEC has almost no equipment or tools for safety assessment and inspection for a nuclear power project.
— The legal system for nuclear power development remains insufficient; only the Ordinance on Radiation Protection and Control has been enacted. There are no regulations on nuclear safety or on investment, construction and operation of nuclear facilities.
— While the number of international nuclear related treaties and conventions is rather large, the VAEC does not have the human resources, technical infrastructure or legal system to participate in them.

4. THE ROLE OF INTERNATIONAL COOPERATION

International cooperation is always considered an important way for developing countries to cope with the difficulties and challenges mentioned above. Such cooperation contributes significantly to training of personnel, especially training experts for safety analysis and assessment and inspection of nuclear power projects. It also fosters the exchange of information and experience on the formulation and implementation of laws related to nuclear power plants. In addition, information and experience concerning entering into and implementing international nuclear treaties and conventions can be shared and exchanged through international cooperation. Finally, international cooperation helps to promote technology transfer in the design, manufacture, construction, operation and maintenance of nuclear power plants with partners from advanced nuclear power industries.

5. CONCLUSION

For many years, the VAEC has been a leading institution in the field of atomic energy development and an important partner in nuclear power plant construction projects in Vietnam. In order to successfully accomplish its duties, the VAEC must consolidate and perfect its organizational structure, develop its human resources and research equipment and facilities, and strengthen cooperation with national and international organizations/institutions, especially the IAEA and foreign partners with advanced nuclear power industries. With its own potential and the investments of the Vietnamese Government, and through effective international cooperation, which has been expanding since Vietnam joined the World Trade Organization, the VAEC will certainly make important contributions to the safe and effective implementation of the nuclear power development programme in Vietnam.

IAEA SAFETY STANDARDS AND INTERNATIONAL LEGAL INSTRUMENTS

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Abstract

The IAEA safety standards constitute a comprehensive and consistent framework of reference for the protection of people and the environment against radiation risks. As such, they are of fundamental importance for both regulators and technical and scientific support organizations (TSOs) in their duties related to nuclear safety and radiation protection. International cooperation is also favoured by the IAEA safety standards, permitting the identification of final objectives and the steps necessary to achieve them in very different national and regional contexts. The fact that groups of experts, widely representing the Member States, developed the safety standards is an additional guarantee of their applicability in different situations. Nevertheless, it should be taken into account that nuclear and radiation safety and their regulation are national competencies, and hence the safety standards should be adopted and suitably modified by the States to become a national safety reference. The clear advantages of the technical assistance that some nations can receive from the IAEA in nuclear and radiation safety favour the adoption of the safety standards. In addition, the explicit mention of the IAEA safety standards in international conventions and codes of conduct signed by several countries also helps their implementation from a legal point of view. Unfortunately, from a practical point of view, the difficulties do not disappear by officially adopting the safety standards. Problems related to insufficient resources, shortcomings in the technical infrastructure and/or the limited experience of TSO staff are real problems that require additional efforts in order to effectively implement the safety standards. Renewed efforts to facilitate international cooperation among regional TSOs are necessary, for example, to promote specific harmonization of national situations.

1. IAEA SAFETY STANDARDS

One of the most important objectives of the IAEA is the promotion of international cooperation in nuclear and radiation safety, important topics that are transnational by their nature. The IAEA safety standards are crucial to achieving this objective, as they constitute a frame of reference including the basic requirements to be fulfilled in activities that give rise to radiation risks — that is, nuclear installations, activities employing radioactive sources or radiation generators, transport of radioactive materials and the management of radioactive waste. The fundamental objective of the safety standards is to protect people and the environment from the deleterious effects of ionizing radiation.

The safety standards are published in the IAEA Safety Standards Series, which includes different categories of documents: the Safety Fundamentals, Safety Requirements and Safety Guides, plus a Safety Reports Series with practical guidance on methods that can be employed to apply the safety standards. The IAEA Safety Standards Series covers nuclear safety, radiation safety, transport safety and waste safety; up to now, this has been done through three Safety Fundamentals texts on nuclear installations [1], radioactive waste management [2] and radiation protection [3]. In 2004, the IAEA Board of Governors approved an action plan to revise the development of the safety standards, the first result of which is the reformulation of the Safety Fundamentals. Other standards are under revision, among them, the International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources (BSS).

Very recently, in November 2006, a new document was published under the title Fundamental Safety Principles [4] presenting a unified philosophy of nuclear safety and radiation protection, which is a common conceptual basis for the IAEA safety standards. This new document supersedes the previous three Safety Fundamentals publications. Its preface states that the distinction traditionally made between nuclear safety and radiation protection is hardly justifiable at the conceptual level and proposes a set of common fundamental principles valid for every safety related area.

The safety principles included in the earlier safety fundamentals for the three main areas were considered and consolidated into a coherent and consistent set of ten new principles. These are: responsibility for safety; role of government; leadership and management for safety; justification of facilities and activities; optimization of protection; limitation of risks to individuals; protection of present and future generations; prevention of accidents, emergency preparedness and response; and protective actions to reduce existing or unregulated radiation risks. In the text and before discussing the ten principles, a brief section on the fundamental safety objective is included. This fundamental objective is to protect people (individually and collectively) and the environment from the harmful effects of ionizing radiation.

A characteristic of the IAEA safety standards is that they are prepared by committees involving a considerable number of experts representing many countries and are submitted for comments to all Members States before final approval, thus ensuring international consensus. In addition, the safety standards are jointly sponsored by the IAEA together with many other international agencies or organizations. The Fundamentals Safety Principles (SF-1) document [4] was jointly sponsored by the European Atomic Energy Community (EURATOM), the Food and Agriculture Organisation of the United Nations (FAO), the International Labour Organization (ILO), the International Maritime Organization (IMO), the OECD Nuclear Energy Agency (OECD/NEA), the Pan American Health Organization (PAHO), the United Nations Environment Programme (UNEP) and the World Health Organization (WHO). The recommendations of other organizations such as the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) and the International Commission on Radiological Protection (ICRP) and the International Commission on Radiation Units and Measurements have also been taken into account.

Therefore, the IAEA safety standards constitute a body of knowledge, ranging from safety philosophy to the best practices, adequate for the development of the necessary international cooperation in radiation safety. They provide the basis for harmonization and consistency of the safety arrangements in different Member States.

2. INTERNATIONAL ADOPTION OF THE SAFETY STANDARDS

The IAEA does not have legal authority to impose the safety standards on its Member States, as safety regulation is a national responsibility. The Member States may adopt them, but only on a voluntary basis. Nevertheless, it is clear that radiation risks do not respect national borders, and accidents and emergencies can have transboundary implications. For this reason, international cooperation in radiation and nuclear safety is essential, as the assurance of nuclear and radiation safety can only be achieved globally, not locally.

Therefore, it is desirable that all States adhere to the safety standards, as the application of common international standards will improve consistency between the arrangements of different countries. International cooperation organized around common safety standards serves to promote and enhance safety globally, facilitating the interchange of experience and thus improving capabilities to control hazards, to prevent accidents, to respond to emergencies and to mitigate the consequences of accidents should they occur.

For these reasons, the IAEA strongly recommends the adoption of the safety standards as a reference for national regulations and to inspire more detailed national supplementary requirements that may be needed. The safety standards are binding on IAEA activities, especially for technical assistance activities in which the safety standards are applicable, and hence any country wishing to sign a technical assistance agreement with the IAEA will be required to follow the safety standards with respect to the activities covered by that particular agreement. The above mentioned sponsoring organizations also follow these safety standards in their activities. Therefore, the IAEA safety standards are widely used in most countries.

International instruments that legally bind the signatory States, such as conventions and treaties under the auspices of the IAEA, greatly serve international cooperation. In this respect, the safety standards are very useful tools for implementing convention requirements by the contracting parties and for demonstrating the fulfilment of the voluntarily accepted obligations and duties. The safety related conventions are:

- The Convention on Nuclear Safety;
- The Convention on Early Notification of a Nuclear Accident;
- The Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency;
- The Joint Convention the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management.

It is interesting to note that the ILO convention — the Radiation Protection Convention, 1960, No. 115 — uses the requirements of the BSS as the basis for compliance with its requirements. Some other international organizations and agencies have promoted conventions and agreements widely adopted by countries in areas related to the IAEA's work, with the IAEA safety standards playing a key role, providing the contracting parties guidance to assess their performance under these conventions.

In addition to the binding conventions, there are a few codes of conduct or codes of practice — legal instruments for promoting international collaboration that are of a non-binding nature. Safety related codes are the Code of Conduct on the Safety and Security of Radioactive Sources and the Supplementary Guidance on the Import and Export of Radioactive Sources; the Code of Conduct on the Safety of Research Reactors; and the Code of Practice on the International Transboundary Movement of Radioactive Waste. The safety standards also support the application of these codes. The implementation of safety related international instruments, conventions and codes of conduct, and their application by the signatory States is facilitated by the common reference provided by the safety standards.

Obviously, the adoption of the safety standards does not preclude the development of national safety initiatives. As stated in the introduction to the new safety standards series SF-1 [4]: "the IAEA safety standards provide an objective basis for decisions concerning safety; however, decision makers must also make informed judgements and determine how best to balance the benefits of an action or an activity against the associated radiation risks and other risks and any other detrimental impacts to which it gives rise.”

3. INTERNATIONAL COLLABORATION AMONG NATIONAL REGULATORS AND TSOs

Although the formal adoption of the safety standards by the authorities of the Member States is important, it is not sufficient to guarantee their practical application. The active involvement of the national regulators and TSOs is also required, as they are, in practice, the main actors with respect to the establishment of the safety procedures at the national level.

Another aspect that should be considered when designing activities for the promotion of safety standards is the very different technical infrastructure and available resources, human and financial, among the different Sates. This is so even for signatory states of conventions or adherents to codes of conduct, in principle, subscribing to and adopting the safety standards. These differences show that the degree of implementation of the safety requirements varies widely among countries. This de facto situation has long been recognized by the IAEA, and through technical cooperation programmes, the IAEA has been developing activities to assist Member States, providing direct safety related assistance, favouring the exchange of safety related information, promoting education and training, rendering a wide range of safety review services, and coordinating and supporting safety related research. The vast effort dedicated to technical assistance is well known and can be appreciated by reading the successive General Conference reports and the annual Nuclear Safety Review available through the IAEA web site.

Important attention has been devoted to assisting the national safety regulators in different aspects and to improving the capabilities of the technical supporting laboratories where they exist or promoting the creation of reference laboratories that could play the role of TSOs in the future. All this is essential to achieving the implementation of the safety standards and the adequate fulfilment of the obligations associated with the conventions and codes of conduct.

In a prospective way, perhaps the actual assistance programmes should be refined to address new necessities or to achieve their objectives more efficiently. A possible line could be to reinforce the international cooperation among national regulators and TSOs trying to favour harmonization. Specific harmonization activities for specific safety related areas identifying affordable target objectives and for specific periods, involving national regulators and TSOs could help to attenuate differences among different countries. Surely, such harmonization activities should be organized regionally, much in the same way as other assistance activities of the IAEA.

This proposal is suggested after the reasonably good experience we have had at the Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas (CIEMAT) in our participation in the European Radiation Dosimetry Group (EURADOS) harmonization working group in the field of personal dosimetry for external radiation. The working group started ten years ago and included representatives from the main dosimetry laboratories of the then 15 European Union (EU) member states. Since then, new members have joined the working group and now more than twenty laboratories are represented. The working group is structured into three subgroups dealing with different aspects of individual dosimetry. Although the IAEA is not formally represented in the working group, IAEA experts have participated in the working group meetings, and the IAEA sponsored some of the intercomparisons organized within this EURADOS activity.

The EU can be seen as a comparatively homogeneous group of more or less well developed countries. Moreover, individual dosimetry is a rather well regulated matter, subjected to well established and well disseminated working procedures. Despite these favourable conditions, the situation at the beginning of the working group activities was one of large differences among the different national situations with respect to individual dosimetry. Some of these differences have now been eliminated or at least smoothened. One example relates to the quantities employed: initially, not every laboratory employed the operational quantities or comparable calibration procedures. Now the situation with respect to technical aspects is more harmonized. Some differences remain with respect to the authorization and accreditation regime without too much change. Thus, there is room for new activities towards an effective harmonization in Europe in the particular field of individual external radiation dosimetry.

A very positive point of the harmonization working group is that the people responsible for the most important dosimetry services have been working together. This has enabled the recognition of the weaknesses and the merits of the respective national situations, favouring bilateral or multilateral projects in addition to own and common working group activities. Also interesting is the recognition that there is no unique solution to complex technical problems. As was stated in progress reports of the EURADOS harmonization working group [5, 6], harmonization is not synonymous with uniformity and there are different ways to reach appropriate and compatible solutions. In this respect, the situation can be viewed as being similar to that of a symphony orchestra, with each member playing a different instrument yet producing a beautiful and harmonic outcome. The safety standards of the EU or those of the IAEA would be analogous to the common musical score that is interpreted by an international orchestra.

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INTERNATIONAL COOPERATION, NETWORKING AND APPLICATION OF IAEA SAFETY STANDARDS — PERSPECTIVES OF THE IAEA

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Abstract

The fundamental objective of safety is to protect people and the environment from the harmful effects of ionizing radiation arising from the operation of nuclear fuel cycle facilities and the utilization of radiation in general. This protection rests on the availability and international acceptance and use of a complete set of safety standards, strong management for safety of all licensees, effective regulatory bodies and a sustainable infrastructure with professionals trained in the application of the safety standards. The nuclear safety community is faced with many new challenges in the nuclear installations safety and radiation safety areas. The potential for accidents will increase as more and more countries turn to wider application of nuclear power and radiation sources, and if ageing of technology is not managed properly. The complexity of these issues requires the enhancement of the exchange of knowledge and cooperation among all nuclear and radiation professionals. Operators and regulators need to base their decisions on a robust knowledge base supported by institutions where high quality R&D activities are carried out. Institutions tracking new scientific information, new technologies and new challenges in a proactive manner play an important role in this context. The technical, scientific and safety support to operators and regulators differs significantly among countries, but whatever organizational framework has been chosen, international cooperation, networking and technical and scientific information sharing are essential. This conference deals with the challenges faced by technical and scientific support organizations (TSOs) in dealing with the important task of enhancing nuclear

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Note: Safety in this paper and in the IAEA safety standards includes the safety of nuclear installations, radiation safety, the safety of radioactive waste management and safety in the transport of radioactive material.

and radiation safety. This is indeed a challenge, not only to the TSOs themselves, but also to both the nuclear and the radiation communities. High quality technical and scientific information coming from well recognized, authoritative sources is of prime importance to operators and regulators. The discussions during this conference will lay important groundwork to cultivate a favourable environment for continued research, education and feedback of experience in nuclear and radiation safety worldwide. Also, how to avoid ethical conflicts and how to establish and demonstrate credibility to a sceptical public are issues to be addressed. The IAEA looks forward to the recommendations from this conference and is prepared to take on new challenges using the network of institutions with excellent knowledge and competence to support enhancing radiation and nuclear safety worldwide.

1. INTRODUCTION

According to its statute, the IAEA has the obligation to establish or adopt, where appropriate, standards for the protection of health and minimization of danger to life and property, and to provide for the application of these standards. The conduct of safety review services, such as the Integrated Regulatory Review Service (IRRS) and the Operational Safety Review Team (OSART) programme, training activities and peer review meetings form part of the IAEA's work to provide for application of and feedback on the IAEA safety standards. In addition, legally and non-legally binding instruments such as conventions and codes of conduct constitute fora for sharing nuclear and radiation safety experience.

2. THE GLOBAL NUCLEAR SAFETY REGIME

The IAEA is strongly promoting the Global Nuclear Safety Regime (GNSR) to provide the framework for achieving worldwide implementation of a high level of nuclear safety. The origins of the GNSR can be traced back to the aftermath of the 1986 Chernobyl accident, when worldwide consensus emerged on the need for more effective international cooperation and openness and the need to effectively separate nuclear power promotion from nuclear safety oversight. Other radiological events, such as the radiological accident in Goiania, together with the lessons learned from these events have further reinforced the need for a global approach to encompass nuclear and radiation safety.

During the years following the accident at Chernobyl, legally binding safety instruments were developed, starting with the Convention on Early

Notification of a Nuclear Accident and the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency and later including the Convention on Nuclear Safety and the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management. In the years since, the implementation of these instruments has been notable. Most recently, two non-binding codes of conduct have been developed, the Code of Conduct on the Safety and Security of Radioactive Sources and the Code of Conduct on the Safety of Research Reactors.

The essence of the GNSR is the activities undertaken by each Member State to ensure nuclear safety within its jurisdiction. But national efforts are and should be augmented by the activities of a variety of bodies that facilitate nuclear safety, including contributions by international organizations and the scientific and technical expert community. The International Nuclear Safety Group (INSAG) has recently published a report providing a review and recommendations on strengthening the GNSR (INSAG-21) [1]. Member States are obliged to adhere to the commitments and must be encouraged to adopt the entire framework of the GNSR. In particular, countries that choose the nuclear power option should see themselves as an active, participating member of this 'club'. The framework has significant potential for further developments, particularly as a means to better share operational information and to learn from experience, and as a tool for knowledge management concerning safety. It recognizes that the safety strategies must incorporate international cooperation, assistance, standard setting and information networking. We must learn from each other, and we must continually stimulate each other towards greater effectiveness. In short, we must build a global safety culture. Ultimately, our success will only be as strong as our weakest link.

3. THE IAEA SAFETY STANDARDS

The IAEA safety standards comprise three levels:

- Safety Fundamentals, which represent universally agreed upon principles for the safe use of nuclear, radiation, transport and waste technology;
- Safety Requirements, which represent the conditions for a sound regulatory framework and the safe use of nuclear facilities and radiation in general;
- Safety Guides, which represent good practices and increasingly reflect best practices for meeting the safety requirements.

The complete structure of the safety standards can be found on the IAEA web site (www.iaea.org).

The safety standards programme is managed by the Commission on Safety Standards (CSS) and four committees, the Nuclear Safety Standards Committee (NUSSC), the Radiation Safety Standards Committee (RASSC), the Waste Safety Standards Committee (WASSC) and the Transport Safety Standards Committee (TRANSSC). The process for the development and approval of the safety standards includes participation by all Member States in an open and transparent manner. This sets the groundwork for including in the safety standards experience from all over the world on good and best practices in safety. The core elements of the standards are a structure based on thematic and facility specific safety standards, their application and feedback for continuous improvement.

The successful implementation of the programme has led to standards of high quality and wide utilization by the Member States. Recent reports by several countries including China, Pakistan and the United Kingdom, and organizations such as the Western European Nuclear Regulators' Association (WENRA) confirm the increasing use of IAEA safety standards both as a benchmark for harmonization and as the basis for the review of national regulations or their incorporation into the body of national regulations. Moreover, at the IAEA Board of Governors meetings, many countries have expressed appreciation and support for the IAEA safety standards.

Furthermore, IAEA assistance to Member States in the use of nuclear and radiation technology is conditional upon Member States' having national safety infrastructures in compliance with the requirements of the IAEA safety standards.

However, the increasing utilization of the IAEA safety standards as a cornerstone of the GNSR has introduced new challenges to make the standards more comprehensive and ensure regulatory stability. Of significant importance to all Member States (non-nuclear and nuclear alike) is that the current safety requirements and the BSS are being revised with a view to providing a more user friendly document with improved clarity and coherence, yet retaining the regulatory stability so desired by Member States.

International initiatives for advanced reactors will generate the need for the development of new safety standards. Also, there are emerging needs for the development of a safety framework and related safety standards for the community dealing with reactors for operation in outer space. The IAEA has already been requested by the Committee on the Peaceful Uses of Outer Space (COPUOS) to include these needs in the formulation of its safety standards programme. Additional challenges relate to facilitating harmonization of safety standards, providing for their application and improving the feedback mechanisms for their continuous improvement.

Therefore, at its meeting in November 2006, the CSS examined a progress report prepared by the IAEA Secretariat entitled “Beyond the Action Plan: Proposed Structure for the IAEA Safety Standards”, taking into account the above issues and discussions among the safety standards committees. The CSS concluded that the progress report provides a good basis for the review of the structure. It also indicated that the publication of the Fundamental Safety Principles (SF-1) [2] has provided an incentive to take a top–down approach to the further development of safety standards in order to improve the integration of radiation protection and nuclear safety requirements and guidance into the hierarchical structure of the safety standards. The role of the scientific and technical expert community in supporting the IAEA’s safety standards work, in particular on the guide level, is extremely valuable.

4. THE SAFETY REVIEW SERVICES

As part of the application of the standards, the IAEA continues to put significant effort into developing and implementing an integrated safety approach through international safety review services and the promotion of peer reviews. There is also increasingly broad acceptance and use of the IAEA safety review services. This is, in particular true for the OSART, the IRRS and the Integrated Safety Assessment of Research Reactors (INSARR). These integrated services have built on the earlier experiences gained performing more limited appraisals. For example, the knowledge gained in performing Radiation Safety and Security of Radioactive Sources Infrastructure Appraisal (RaSSIA) missions for assessing the regulatory infrastructure in non-nuclear countries contributed significantly to the success of the IRRS.

The IAEA has taken the opportunity provided by the publication of the new Fundamental Safety Principles to enhance the effectiveness and usefulness of these activities through an integrated approach. The participation in these services of highly recognized and experienced experts is very important for providing high quality advice to service users. This new approach, and the involvement of experts from developed countries with strong nuclear power programmes and strong regulatory infrastructures, will allow the identification and use of varying policies and strategies while reaching the same level of safety.

5. TECHNICAL SUPPORT

The IAEA provides a wide range of technical expertise to its Member States through its staff or through external experts who produce advisory and technical publications. These documents, including the Safety Reports Series and Technical Documents (TECDOCs), provide guidance on the application of the safety standards. While these publications do not represent international consensus, they provide a useful contribution to global nuclear and radiation safety programmes. Because they tend to be quite specific in nature, the availability of the requisite scientific and technical expertise from external organizations is essential.

Common software packages contribute to global radiation safety. The Regulatory Authority Information System (RAIS) is one example, providing Member States with a means for establishing and maintaining a national register of radiation sources. Ongoing development of such packages, such as the extension to web based platforms, requires special expertise from the wider community.

6. EDUCATION AND TRAINING

Education and training in nuclear and radiation safety remains a priority for the IAEA's safety programme. Resolutions of the IAEA General Conference have repeatedly emphasized the role of education and training. The IAEA Secretariat, in 2001, prepared a strategic plan for education and training in radiation safety aimed at having sustainable programmes in Member States by 2010.

Mechanisms used by the IAEA in assisting Member States to build competence and move to self-sustainability include the post-graduate education courses (PGECs) run at six regional centres, specialized training courses on a specific theme or practice, on the job training at appropriate institutions, distance learning and 'train the trainers' workshops.

The strategy and approach for providing training and the quality of the training material are assessed continuously in order to adapt them to the needs of Member States. The IAEA foresees a continuing contribution from the scientific and expert community in these areas.

7. COORDINATED RESEARCH PROJECTS

The IAEA also provides a coordinated approach to research on some technical issues at the international level. One example of this is in the safe transport of radioactive material. The need to reconsider the applicability of transport regulations to naturally occurring radioactive material (NORM) was identified by the International Conference on the Safety of Transport of Radioactive Material in 2003. It was recognized that additional research would be useful to identify any unnecessary regulatory burden related to the transport of very low activity NORM, such as ores, tailings and backfill from large mining operations (e.g. phosphate, coal, gold and monazite), which have been brought within the scope of the regulations. A coordinated research project on the appropriate regulatory control for the safe transport of NORM has recently been initiated by the IAEA for this purpose.

8. GLOBAL EXCHANGE OF KNOWLEDGE

Technical and scientific expertise and capabilities are essential for the success of the GNSR. Only through sharing knowledge, skills and experience can we jointly develop safety approaches that encompass the collective wisdom of the nuclear and radiation communities. This is essential in order to understand and accept the most effective means to ensure safety and to prevent accidents.

The IAEA promotes information exchange and networking among Member States, the Secretariat and international organizations. Conferences constitute a traditional means for fostering the exchange of safety related information. An increasing number of people have access to the Internet, which provides the means for the efficient and effective exchange of knowledge. The IAEA is now providing specialized web sites, networks, and web based databases to foster the exchange of information on nuclear, radiation, transport and waste safety. The incident reporting systems for nuclear installations are extremely important tools for sharing operational and regulatory information.

An example of a specialized web site is the IAEA web site on radiological protection of patients, providing information to millions of people. The database on discharges of radionuclides to the atmosphere and the aquatic environment (DIRATA) is an example of a web based database providing, in this case, a worldwide central repository of data submitted by Member States.

The intercomparison exercises of safety assessment methodologies are another powerful tool to share experience. These types of exercise started as international projects on radioecological assessment and modelling that were aimed at refining existing information and improving models to be applied for the purposes of radiation protection of the public and the environment (e.g. the IAEA programmes on Biosphere Modelling and Assessment (BIOMASS) and Environmental Modelling for Radiation Safety (EMRAS)). With the same idea, and to promote safety assessment methodologies, the IAEA launched several other exercises in the field of public protection and radioactive waste management (safety assessment of near surface disposal facilities, safety assessment driving radioactive waste management solutions, evaluation and demonstration of the safety of decommissioning of nuclear facilities, safety case for geological disposal). These exercises, which involved all interested parties in safety assessment (operators, TSOs, regulators), have become international references.

Pursuant to IAEA General Conference resolution GC(43)/RES/13, the IAEA Secretariat is organizing international intercomparison exercises for monitoring purposes with a view to helping Member States comply with dose limitation requirements and to harmonizing the use of internationally agreed upon quantities and assessment methods recommended in the IAEA standards. Measurement methods applied for occupational exposure assessment, environmental dose assessment and emergency response actions are included in the intercomparison exercises at the regional and international levels.

Regional and international networks are a powerful means of communication. The IAEA has already facilitated the development of networks that are currently operational and that could serve as a framework for both networks in other regions and the further development of the GNSR. Examples are the Asian Nuclear Safety Network (ANSN) and the Ibero-American Radiation Safety Network. Such networks are established to promote pooling, analysing and sharing nuclear and radiation safety knowledge and experiences at the national, regional and international levels. The ANSN started in the area of education and training, but has now expanded to other areas, such as operational safety of nuclear installations and waste safety.

Other examples are the recently created network of reference centres for decommissioning, the already well established network in the area of occupational radiation protection and the Information System on Occupational Exposure (ISOE) jointly coordinated by the IAEA and the OECD Nuclear Energy Agency (OECD/NEA) and used for promoting the IAEA safety standards in nuclear power plants. Additional networks are under development for the medical and industrial areas.

The strengthening of cooperation, collaboration and experience sharing and the building of new enlarged networks or alliances should be encouraged. The IAEA is willing to support efforts in this regard.

9. ISSUES AND TRENDS IN NUCLEAR SAFETY

The IAEA Department of Nuclear Safety and Security has recently released an 'Issues and Trends' paper on nuclear safety, prepared at the request of the contracting parties of the Convention on Nuclear Safety. Although the operating performance is good in general, many challenges remain. Issues such as safety infrastructure, regulatory effectiveness and the legal framework, openness and transparency, leadership, safety management, safety culture, sharing operational experience and human and knowledge resources continue to dominate the nuclear safety landscape. Also, it is pointed out that continued research and analysis of operating experience feedback is needed to maintain a high level of nuclear safety worldwide. In this regard, reducing the time between the onset of the event and when actions have been taken to prevent recurrence needs to be pursued by more integrated national, regional and international efforts.

10. SAFETY INFRASTRUCTURE IN MEMBER STATES

The overall theme of the Nuclear Safety Review presented to the IAEA Board of Governors continues to be the increasingly global nature of the issues and challenges relating to nuclear safety. In order to meet these challenges, it is essential to promote a globally harmonized approach, technically robust infrastructure, administrative consistency and international cooperation for nuclear safety management and regulation.

Many Member States benefit from IAEA assistance in the application of the safety standards. A methodology has been developed to systematically identify a Member State's needs in a given area of radiation safety and then, in partnership with the Member State, to develop an action plan to meet those needs. The approach is based on the extensive experience gained through the Model Project on Upgrading Radiation Protection Infrastructure.

Today, there is a common perception that a strong and sustainable GNSR rests on the national safety infrastructures, legally binding and non-binding international instruments, the IAEA safety standards and their application, and a vigorous sharing of knowledge and experience to support mutual learning. While the development of the GNSR reflects the joint safety commitment and efforts of Member States, it is essential to ensure that this cooperation does not dilute the prime responsibility for safety that, as established in the first principle of the newly published IAEA unified Fundamental Safety Principles [2], must rest with the operator or user. The second fundamental principle requires that an effective legal and governmental framework for safety, including an independent and competent regulatory body, be established and sustained. It is equally essential to have a common perception that safety cannot be outsourced. To maintain and build a strong technical and scientific infrastructure is of importance to all Member States, but in particular to the emerging nuclear power countries, where the domestic experience may be limited. The view of the IAEA is that a decision to embark on nuclear power must be accompanied by a commitment to develop a strong and dynamic safety culture. Moreover, application of radiation in industry and medicine also present many challenges, and the lack of appropriate control may cause significant harm to people and the environment.

11. ENHANCED SUPPORT FROM TSOs TO THE GNSR

As mentioned above, the GNSR must rely on the best knowledge, skills and experience in the world. This is even more important today, as the utilization of nuclear and radiation applications is increasing. Also, many countries with less experience in such activities are expressing interest in these technologies. As a consequence, issues related to emergency response, transport and waste safety are also becoming more and more important. Therefore, for the IAEA to be able to make available high quality safety standards and effective assistance to Member States, it needs to keep abreast of state of the art advances in addressing safety solutions and the development of new technologies. In this context, the IAEA's cooperation with the scientific and technical community needs further enhancement.

- First, the specific knowledge and skills required for nuclear and radiation applications are ageing, and a renewal of this body of skills is needed. Also, the capacity of expertise in this area needs to be expanded worldwide. The area of knowledge management, including training, should be more systematically included in the deliberations within the framework of the GNSR. Also, attention must continue to be paid to the nuclear safety aspects of the reactors currently in operation and to the design, fabrication, construction and safety management of reactors being built on the basis of existing designs. Training in nuclear and radiation safety will continue to draw on the capabilities of the expert community.
- Second, the evolution of the IAEA safety standards, particularly in relation to the keeping safety guides updated, will need continuing support by the international community including experts from all Member States. Moreover, efforts need to be devoted to developing more

specific guidance advising the Member States on the competencies and skills that need to be available for nuclear regulators and licensees to be able to fulfil their role as efficient, effective and transparent regulators, and using effective safety management approaches.

— Third, the increased use of the IAEA's safety review services will require consolidated effort by the international community to provide high level and specialized experts for such reviews. This is related not only to experience from regulatory work, or from work related to the operation of nuclear power plants or radiation facilities and practices, but also to experts with experience in safety assessment, design review, safety management, safety culture, modelling, dosimetry services and waste solutions.
— Fourth, the slowdown of R&D in safety worldwide over the past few decades requires a strong commitment by all Member States to contribute to the maintenance of research facilities and the development of new knowledge. Also, innovative concepts, many of which feature new approaches to safety research cooperation, have become an important part of the future of nuclear energy and radiation applications.
— Fifth, the renewed interest in nuclear and radiation technologies in countries not previously employing such technology, in particular nuclear power plants, will require significant efforts to build strong infrastructure elements to support the safe use of the technology. Both operators and regulators need to establish close links to TSOs for their continuing support.

Finally, let us reiterate the importance of networking to share and create new knowledge. As mentioned above, the IAEA has already facilitated the development of various networks that are currently operational and that could serve as an example for the further development of the GNSR. The IAEA is prepared to facilitate the creation of such a network for nuclear and radiation safety.

12. CONCLUSION

Technical and scientific support organizations have an important role to play in enhancing the GNSR, in particular to support work on the IAEA safety standards and their application. Moreover, TSOs need to provide high quality technical and scientific knowledge, skills and expertise to the nuclear and radiation safety community in general and to regulators and operators in particular. They need to continue to be strong contributors to the maintenance and production of new knowledge in nuclear and radiation safety, including training and research. The challenge for the entire nuclear and radiation communities as a whole is to act in a manner that cultivates a technical knowledge foundation that supports and promotes such development, taking into consideration the political environment nationally, regionally and internationally. In particular, the research community, including the universities, has an important role in this context. The TSOs are expected to continue to contribute to the enhancement of excellence in all phases of radiation and nuclear installation safety. In this context, a stronger network must be built to ensure the exchange of knowledge among them.

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PERSPECTIVES ON THE EVOLVING NEEDS FOR TECHNICAL AND SCIENTIFIC SUPPORT

(Topical Session 4)

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LEAD-IN PRESENTATION:
PERSPECTIVES ON THE EVOLVING NEEDS OF TSOs AND THE REGULATOR'S PERSPECTIVE

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Abstract

Different countries have different situations regarding the use of nuclear power, nuclear fuel cycle facilities and/or other nuclear technologies. In some countries that have experienced stagnation in the growth of nuclear power, there is a renewed interest in its use. The shortage of skilled personnel will be one of the constraints to the expected growth. Both nuclear regulators and the operator/industry are increasingly using technical and scientific support organizations (TSOs). The paper outlines the challenges facing the TSOs and the use of their services by the regulators and the industry in order to stimulate and focus the discussions.

1. INTRODUCTION

Countries are faced with widely varying situations regarding the status of nuclear power, depending on whether or not they operate nuclear power plants, research reactors and other nuclear facilities such as fuel cycle, waste disposal and irradiation facilities. Countries also differ according to the actual stage they have reached in their nuclear development.

The variety of nuclear situations may be appreciated on the basis of a few examples:

- First, two European countries — Finland and France —have decided to expand their nuclear production capabilities and are now engaged in the process of constructing new reactors. Indeed, both have started building European pressurized water reactors (EPRs). This decision marks a significant event after a long period of no construction in Europe.
- Second, Canada, the United Kingdom and the United States of America, which already have well developed networks of nuclear power plants, are considering increasing their nuclear production capabilities. Over the past few months, there has been an incentive to build new reactors in

these countries. This trend has been designated a ‘nuclear renaissance’ in order to show the renewal of interest in nuclear power.
- However, in discussing the cases of some Asian countries, such as China, India and the Republic of Korea, such a term is not really appropriate, as the nuclear programmes in these countries have never stopped and are still very strong.

2. CHALLENGES FACED BY TSOs

In the context of reactivated nuclear development, numerous challenges are emerging:

- To optimize the use of the resources and knowledge of nuclear safety authorities around the word, the US Nuclear Regulatory Commission (NRC) has initiated the Multinational Design Evaluation Program (MDEP). Its purpose, during the initial phase, is to enhance multilateral cooperation within the existing regulatory frameworks of the respective countries; during the subsequent phase, the objective will be to harmonize codes, standards and safety goals for future reactors.
- In contrast, the Western European Nuclear Regulators’ Association (WENRA) deals with existing installations. Its main objectives are:

  - To develop a common approach to nuclear safety;
  - To set up a network of major nuclear safety regulators;
  - To harmonize national practices throughout member countries.

  Two working groups have been created: the first is devoted to existing nuclear power plants; the second, to radioactive waste management and decommissioning.

A broader vision of safety leads to an integrated approach that encompasses nuclear safety, radiation protection, environmental protection, labour inspection and the evaluation of human and organizational factors.

This new context may increase regulatory needs in terms of the number of skilled experts and the competencies required in new fields of expertise, such as human and organizational factors or criticality. Consequently, for TSOs, this entails a number of open issues, such as:

- Should the TSO or the regulatory body be entrusted with the research overview?

— Does the TSO have the capability to conduct research and to operate the associated research facilities?
— How many research facilities have to be run worldwide?
— How should they be funded?
— What about the harmonization of practices among TSOs?
— Would it be appropriate to consider sharing competencies and/or structures?
— Should TSOs be submitted to international audits?

3. CONCLUSION

In conclusion, the situation described in this paper raises a large number of challenges with regard to nuclear safety and radiation protection, as well as a significant number of issues for TSOs and regulators, all of which must be dealt with on both the national and international levels.

EVOLVING NEEDS FOR TECHNICAL AND SCIENTIFIC SUPPORT – PERSPECTIVES OF THE INDUSTRY

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Abstract

Well developed technical and scientific expertise is a prerequisite for indigenously supporting the nuclear power programme in a country. The development of the Indian nuclear power programme was preceded by the development of the basic infrastructure for the necessary expertise in technical and scientific domains. A sound research base in almost all areas related to nuclear facilities was created. All facets of the nuclear fuel cycle were developed before the nuclear power programme was launched. In the initial part of the programme, two boiling water reactors with a capacity of 200 MW(e) were obtained from General Electric (USA), and later two CANDU units of 220 MW(e) capacity were obtained from Atomic Energy of Canada Limited. Construction and commissioning of these units provided certain insights into design, field engineering and technical support for equipment manufactured in India, plant construction, safety assessment, commissioning, operation and maintenance. This led to the evolution within the country of the technical and scientific capability needed to carry out nuclear power projects. At present, the Nuclear Power Corporation of India Limited (NPCIL), a Government company, is responsible for the design, construction, commissioning, operation and maintenance of nuclear power plants in India. Another company, Bharatiya Nabhikiya Vidyut Nigam Limited (BHAVINI), also a Government company, is responsible for construction of fast reactors. With the help of Indian R&D organizations, consultants and industry, an established framework exists for the design, engineering, equipment supply, construction and commercial operation of nuclear power stations. At present, 13 PHWRs of 220 MW(e) each and two of 540 MW(e) each are in operation. In addition, three units of 220 MW(e) are in the final stages of construction. Two 1000 MW(e) Russian PWR WWER type units are under construction in cooperation with the Russian Federation. A fast breeder reactor of 500 MW(e) capacity is also under construction. In the near term, the programme includes construction of a series of 700 MW(e) PHWR units. Thus, NPCIL today is operating plants that are over 30 years old while it is launching new projects with state of the art features. Competent technical support to cover the full spectrum of activities involved in the nuclear power programme has made this possible. The technical and scientific support organizations (TSOs) have very challenging tasks in sustaining the technology and meeting the ever moving targets of improved safety and performance. The responsibilities of the TSOs

are to manage ageing, extend the life of plants, overcome obsolescence and provide features for minimizing error in operation and maintenance, on the one hand, and to develop new designs using passive features through continued research, on the other hand.

1. INTRODUCTION

The development of the nuclear power programme in India was preceded by the development of the required basic infrastructure. This included facilities for training university graduates with engineering and scientific backgrounds in nuclear technology subjects. In addition, a research base covering all domains of nuclear technology was created and production facilities for all areas related to the nuclear fuel cycle and nuclear facilities were launched. In the first part of the programme, which began in the mid-1960s, two boiling water reactors (BWRs) of 200 MW(e) capacity were obtained from General Electric (USA) and two CANDU units of 220 MW(e) capacity were obtained from Atomic Energy of Canada Limited. Indian engineers participated in the construction and commissioning of these reactors and gained insights into design, field engineering and technical support for equipment manufactured in India, construction, safety assessment, commissioning, operation and maintenance. There was also a significant contribution from R&D facilities towards the development of the technical and scientific capability within the country to take up additional nuclear power projects. Since that time, the Indian nuclear power programme has been primarily based on pressurized heavy water reactors (PHWRs). Fifteen units, including the two BWR units, are operating at present. This includes two units of 540 MW(e) PHWRs commissioned in recent years. Three units of 220 MW(e) are in the final stages of construction. In addition, two 1000 MW(e) Russian pressurized water reactor (WWER) type units are under construction in cooperation with the Russian Federation. Construction of a fast breeder reactor of 500 MW(e) capacity is also progressing and is expected to be completed by 2011.

2. EVOLUTION OF TSOs

At present, the Nuclear Power Corporation of India Limited (NPCIL), a Government company, is responsible for the design, construction, commissioning, operation and maintenance of nuclear power projects in India. Another Government company, the Bharatiya Nabhikiya Vidyut Nigam Limited (BHAVINI), is responsible for the construction of fast reactors. With the help of Indian R&D organizations, consultants and industry, an established framework exists for design, engineering, equipment supply, construction and operation of nuclear power stations on a commercially competitive basis.

In the beginning, the design, construction and operation of nuclear power plants were carried out as a departmental activity by the Department of Atomic Energy (DAE) of the Government of India. In 1967, the Power Projects Engineering Division (PPED) was created within the DAE and was entrusted with this responsibility. In 1984, the PPED became the Nuclear Power Board (NPB), an autonomous organization with increased delegation of powers. In 1987, the NPB became the NPCIL, a public sector enterprise wholly owned by the Government of India, under the administrative control of the DAE. The objective of the NPCIL is to undertake the design, construction, commissioning, and operation and maintenance of nuclear power stations for generation of electricity as part of the programmes of the Government of India. The design, construction, commissioning and operation of nuclear power plants have evolved over the years, taking into account national and international safety standards.

The evolution of nuclear requirements has led to a corresponding growth in the national industry providing services for fabrication, equipment supply and construction. The R&D organizations within the DAE have played a key role in developing systems, components and even fabrication/manufacturing procedures for critical equipment. Such developed technology has been provided to local industry to facilitate production on an industrial scale. The NPCIL has also entered into a memorandum of understanding with several R&D and academic institutions for obtaining engineering and technical support. Such organizations have worked to meet the expectations of the nuclear industry and continue to provide expert support in special areas like material development, testing, seismic design, geotechnical and hydrological studies, and equipment qualification. These efforts have led to progressive improvements in the safety, reliability and availability of the units over the years. Every event in an operating nuclear power plant is reviewed for lessons to be learned. Analysis of internationally reported events and their applicability in Indian nuclear power plants are checked, and the systems, procedures and aspects related to training and safety are modified accordingly. An elaborate review and approval system for effecting any changes in the design and procedures important to safety during operation has been put in place and has evolved with experience. The inputs from operational experience are utilized for design improvements in new reactors.

3. TSOs FOR OPERATION

All the nuclear power plants currently operating in India are owned by NPCIL and operated by its Directorate of Operation, set up at the headquarters in Mumbai. This Directorate monitors the operational and safety performance of nuclear power plants and is in communication with each station through staff designated for this purpose. The Directorate of Operations analyses the operational and safety needs of operating units and organizes the necessary engineering and technical support. The Directorate also acts as the interface between plant management and the Atomic Energy Regulatory Board (AERB).

The technical support to operating stations can be divided into two categories:

— Support required for routine operation, maintenance and upkeep of the plant;
— Support involving special expertise for design changes; changes having an impact on the technical specifications for operation or involving configuration changes, the addition of new features and/or changes in safety or safety related systems; and other special jobs arising from unusual events/ equipment failures, etc.

The first level of support is provided by the technical units available at each operating station. These units are generally responsible for:

— Routine engineering assistance required to operate the station/systems efficiently at the optimal performance level;
— Performing engineering/technical studies and reviews;
— Issuing the work plans for specific jobs during operation and shutdowns;
— Reactor physics and fuel management;
— Chemistry control of the systems;
— Upkeep and updating of all technical documents, including all design manuals and drawings.

The second tier of technical support is obtained from the Directorates of Engineering, Safety, Quality Assurance and Procurement at headquarters for all specialized areas of work. The design and engineering group, which provided the design, engineering, procurement, safety analysis and quality assurance services during the project construction stage, is the most competent group to provide specialized technical support to operating stations. Engineers from these groups participate actively during the commissioning of a plant, in providing safety related information for regulatory purposes and in confirming that design targets are met for plant structures/systems as evaluated through commissioning tests. As the plant is put into regular operation, they continue to provide specialized technical support in the areas of their expertise to the operation and maintenance groups of the operating stations. This centralized arrangement puts the expertise and knowledge base to optimum use. This group organizes services covering the full spectrum of operational performance and safety analysis.

Operation and maintenance staff at Indian nuclear power stations mainly consist of graduate engineers and scientists with further training in the nuclear field and plant operations. With this background, they are in a position to analyse the operation and maintenance issues and translate them into well defined engineering problems, where technical support may be required from the centralized group. This arrangement also has the built-in advantage to designers of providing feedback from the operating stations so that necessary improvements can be made to other operating units and subsequent new designs.

A corporate level safety committee for operation reviews all issues pertaining to safety in nuclear power plants. This committee is composed of experts in operation, design, engineering and safety analysis. All safety related proposals emanating from stations and analysed by the respective design group are reviewed in this committee before being forwarded to AERB. The discussions in this group also have the indirect benefit of developing an in-depth, multidisciplinary understanding on the part of those engineers presenting and debating the issue.

4. KNOWLEDGE BASE

Nuclear technology and its associated operational goals and safety targets have been continuously improving all over the world. The success of a TSO lies in the upgrading of the knowledge base to contribute innovations to meet the ever evolving operational targets and regulatory requirements. The analytical tools in thermal hydraulic analysis, stress analysis, and reliability and probabilistic evaluations have also advanced considerably. Current decisions on backfits, design changes and safety analysis of events as well as periodic safety assessments of operating plants require the use of these state of the art techniques and analytical tools. Therefore, TSOs must continuously update their expertise and knowledge base to keep pace with the changing parameters for success in this technology. India's nuclear power programme has been growing at a steady pace. The centralized TSO thus has maintained its knowledge base as a necessity to provide inputs for new construction projects. It also provides services to update the knowledge base of technical units at operating stations by organizing specific interim training courses and promoting the interaction of staff at operating units with peers from the design and engineering group. The Indian regulatory practice of conducting periodic safety assessments for operating units with regard to the current national safety standards also prompts the TSOs to develop and maintain the technical and scientific knowledge base at the prevailing state of the art.

5. CHALLENGES FACED

The Indian nuclear power programme has been steadily progressing since the mid-1960s. The central TSO, catering to operating stations of different generations, is required to maintain the breadth of knowledge essential for handling the technical problems of older units as well as new units. Responses to and work done by a TSO towards unexpected incidents, equipment failures and special regulatory requirements test its capability and prepare it for other similar occasions in the future. Examples of the wide ranging challenges faced by TSOs in India are given below.

5.1. Boiling water reactors at the Tarapur Atomic Power Station

The Tarapur Atomic Power Station (TAPS), the first nuclear power plant in India, began operations in 1969. It is a two unit, BWR based nuclear power plant that was supplied by General Electric (USA) under a turnkey contract. The technical support for these units has been provided entirely indigenously since 1974. This has required a full understanding of the design and the development of associated tools for core physics analysis, thermal hydraulics, safety analysis, etc. In addition to providing routine support for analysis of the operation and safety needs of these units, certain special tasks have been performed in recent years. These tasks have developed the technical and scientific support further and are described below.

5.1.1. TAPS core shroud

In view of the cracks reported in the core shrouds of overseas BWRs and the potential risks associated with cracked shrouds, inspection of the core shroud was initiated in stages at both units of TAPS during their respective refuelling outages, from 1994–1995 onwards. All accessible welds and the internal reactor structures/components pertaining to core shrouds were inspected. The inspections carried out so far have indicated that all the accessible welds are in good condition. Since not all the welds were accessible for inspection, a structural integrity analysis for the core shroud of TAPS was also carried out with an assumed full/part circumference wall crack. This work required the involvement of many agencies, such as those engaged in the development of remote inspection tools, stress analysis, safety analysis, etc.

5.1.2. Comprehensive safety review for continued operation of TAPS

In 2000, after the station had completed more than thirty years of operation, a comprehensive assessment of the safety of the TAPS units was conducted for obtaining permission from AERB for their continued operation. The review covered the following aspects:

— Review of design basis of plant systems and safety analysis vis-à-vis the current requirements;
— Seismic re-evaluation;
— Review of ageing management and residual life of systems, structures and components;
— Review of operational performance;
— Probabilistic safety assessment (PSA).

The original safety analysis of TAPS was reviewed with respect to (i) the adequacy of original analytical techniques (ii) the list of events analysed and (iii) the plant design/configuration changes that have taken place over the years. On the basis of this review, the safety analysis was redone using current analytical methodologies/computer codes covering the following:

— Loss of coolant accident (LOCA) analysis for a double ended break in the reactor re-circulation line;
— LOCA analysis for a double ended break in the main steam line;
— LOCA analysis for a range of break sizes in the reactor re-circulation line and main steam line;
— Fatigue analysis of reactor pressure vessel.

A level 1 PSA for the TAPS units with internal events was carried out to develop insight into the existing design weaknesses and the impact of proposed design changes. For seismic re-evaluation, the design basis ground motion (DBGM) used for Tarapur Atomic Power Project (TAPP) units 3 and 4, with newly built PHWRs, each of 540 MW(e) capacity, at the same site, was used for TAPPs units 1 and 2.

5.1.3. Safety system upgrades and modifications

On the basis of the above studies and assessments, several modifications were identified and executed, including: modification of the emergency power supply system; segregation of shared systems to the greatest extent practicable; strengthening of the emergency feed water supply to the reactor; provision of supplementary control centres/points; strengthening of supporting arrangements to meet seismic requirements; and upgrading of the fire protection system.

5.2. Pressurized heavy water reactors

The major challenges faced in PHWRs are described below.

5.2.1. Pressure tube replacement and safety upgrades

The pressure tube material used in the initial set of PHWRs in India was Zircaloy-2, which had the problem of unacceptable hydriding owing to its tendency toward accelerated hydrogen pickup in later years of operation, as shown by the experience in Canada. Special inspection tools to monitor the condition of pressure tubes in the Indian PHWRs and analytical approaches to analyse the data were developed and deployed to assess the condition of pressure tubes until they were due for replacement.

The pressure tubes replacing the old tubes use a zirconium alloy having 2.5% niobium by weight (Zr2.5%Nb). The pressure tube replacement has been completed in four reactor units, and the last two units of this type will be due for replacement next year. This activity required the development of special tools, the preparation of procedures and the training of operators to perform the activity. The R&D groups of DAE and the design office of the NPCIL have provided all the technical support in this regard.

The long shutdown necessary for pressure tube replacement was used for an extensive review of operational performance and a comparison of the reactor safety performance in the light of current safety standards. Based on these reviews, several safety upgrades and design modifications were incorporated after obtaining the necessary regulatory clearances. This included the following:

— Introduction of a high pressure emergency core cooling system in older units;
— Provision of a supplementary control room in older units;
— Segregation of power and control cables based on the two group concept;
— Augmentation of the fire protection system;
— Replacement of boilers in the reactors of the Madras Atomic Power Station (MAPS);
— Replacement of all heat transport system feeder elbows affected by flow accelerated corrosion (FAC) in MAPS-2 and Narora Atomic Power Station (NAPS) unit 1.

5.2.2. Failure of moderator inlet

A failure of the moderator inlet manifold occurred in MAPS-2, and a similar failure took place in MAPS-1 in 1989. The calandria moderator inlet manifold prevents direct impingement of moderator inlet flow on the calandria tube in front of the inlet line and possible flow induced vibration of the neighbouring coolant channels. It facilitates proper flow distribution inside the calandria, especially for those channels in zones away from the central radial plane, and distributes the moderator evenly. Some of the broken pieces of the manifold were recovered from one of the moderator pump casings after a seal leak was observed in the pump.

After a detailed investigation using remote video inspection techniques, it was confirmed that the studs bolted to the manifold and welded to the calandria shell were broken. Based on a detailed study of flow, vibration and jet impingement, velocity and temperature distribution, and a stress analysis, a modified scheme for operation was developed. Under this scheme, the original inlet pipe was capped. The outlet piping was converted into the inlet piping. The outgoing flow from the calandria was routed into the dump tank through dump ports, and the dump tank was connected to moderator pump suction. The reactor was de-rated to 75% of full power, as the calculations indicated that moderator flow distribution inside the calandria would cause hot spots above this power level. Both reactors operated satisfactorily until a new scheme involving installation of spargers was implemented at the time of pressure tube replacement.

The work of providing moderator inlet spargers required extensive theoretical studies of the flow patterns in the reactor vessel, confirmed further by experimental verification on scaled models. The mechanical design of the spargers and their fixing arrangements on irradiated tube sheets, machining and other tools for installation of the spargers were the other developments required. These challenging development activities were successfully completed with the help of various R&D facilities in the country and implemented in both units of MAPS, making it possible to restore the power level of both units to full power. The operation of these units with this new feature incorporated is very satisfactory.

Some of the major incidents that disrupted operation of Indian nuclear power plants, posed sudden challenges to the TSOs to engineer the recovery of the affected reactor units and make appropriate modifications to the design of subsequent units to avoid the reoccurrence of such events. Such incidents include the fire at NAPS-1 and the flooding incident in the Kakarapar Atomic Power Station. Tackling such operation related problems indirectly strengthens technical and scientific skills to provide improved design features in new units.

6. FUTURE CHALLENGES

The challenges for the future are more diverse in nature. Ageing management activities, increased in-service inspections and handling obsolescence are some of the immediate challenges in the older units. The current regulatory emphasis on PSA, risk informed regulation and demonstrating quality, with the extensive incorporation of computer based systems in safety, poses a challenge to designers, safety analysts and regulators. At the same time, the competitive energy market calls for power uprating and reductions in operational margins and reactor shutdowns, etc.

The evolutionary reactor designs ready to be launched make a marked shift from the existing design philosophy. Consideration of severe accidents in the design and safety analysis, the adoption of passive features, taking care of security concerns and ensuring the economic competitiveness of the new designs necessitate many additional design missions. These features have to be added to the current designs to bring them to the level of Generation III reactors. The regulatory review of such features is also evolving at present. The review process may make additional demands on proving new features analytically/experimentally.

7. CONCLUSION

The ever evolving needs for technical and scientific support of the nuclear industry can be effectively met by continuity of the programme. The day to day challenges of keeping the operating plants in perfect and safe condition and incorporating design features and analytical approaches for new plants help to keep the knowledge base up to date.

For a country like India, which runs its programme entirely indigenously, the IAEA provides a very valuable forum for interacting with peers from the nuclear industry. With regard to operation and maintenance, well organized forums exist to share information. For example, the World Association of Nuclear Operators (WANO) provides opportunities for the exchange of best practices to be incorporated into operation and maintenance activities. Similar networking possibilities do not exist for design organizations. Thus, for those engaged in technical support, information is exchanged in technical journals and through participation in international technical and scientific meetings. Providing the forums necessary for networking among experts from around the world in order to exchange information and best practices to be embedded in the design engineering is necessary for promoting safe nuclear power. It is desirable that a forum along the lines of WANO be created as a platform for networking among TSOs.

UNITED STATES NUCLEAR REGULATORY COMMISSION PERSPECTIVES ON TECHNICAL AND SCIENTIFIC SUPPORT ORGANIZATIONS

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Abstract

The Office of Nuclear Regulatory Research (RES) of the United States Nuclear Regulatory Commission (NRC) is a technical and scientific support organization (TSO). As such, RES supplies the technical tools, analytical models and experimental data needed to support the NRC's regulatory decision making mandate. As a TSO, RES does not conduct research for the single purpose of developing improved technologies, a function that is more appropriately that of the nuclear industry. The NRC also does not conduct research for the purpose of continually enhancing safety. Rather, RES conducts research in support of the licensing and regulatory process to confirm the methods and data generated by the industry to ensure that adequate safety is maintained. In addition to conducting confirmatory research, as a TSO, RES has a role in beyond the horizon, or forward looking, research. To provide the technical bases for future regulatory decisions, RES looks where the regulated industry is moving and conducts exploratory research as needed to prepare the NRC to respond to industry requests and initiatives. In addition to regulating the commercial use of radioactive materials to protect public health and safety and to protect the environment, the NRC has responsibility for protecting and safeguarding nuclear materials and nuclear power plants in the interest of national security. Thus, while its primary focus is on supporting the licensing and regulatory process, the research conducted by and for the NRC plays an important role in supporting broad, Government wide initiatives associated with national security.

1. INTRODUCTION

The United States Nuclear Regulatory Commission (NRC) makes use of a variety of technical and scientific support organizations (TSOs) in order to fulfil its mandate to protect public health and safety. The NRC uses TSOs to help ensure the timely and technically sound review of operating reactor licensing issues, to help the staff review a potentially large wave of new reactor applications, to provide modern information technology resources and to help resolve the difficult technical issues that invariably come with a technology as complex as nuclear power.

Unique among these TSOs is the Office of Nuclear Regulatory Research within the NRC. When the NRC was established as an independent Government agency in 1975, the legislation [1] specified that the Office be established and that it have as its functions: “developing recommendations deemed necessary for performance by the Commission of its licensing and related regulatory functions,” and “engaging in or contracting for research, which the Commission deems necessary for the performance of its licensing and related regulatory functions.”

The Office’s mandate can be further defined by the set of principles by which the NRC operates. In 1991, the NRC issued the NRC Principles of Good Regulation as a guide to both NRC decision making and to the individual conduct of NRC employees [2]. These principles of independence, openness, efficiency, clarity and reliability are fundamental guideposts in ensuring the quality, correctness and consistency of our regulatory activities. With respect to the Office’s work, these principles are explained below:

- *Independence:* The Office provides technical information that is independent of that provided by the applicant or licensee.
- *Openness:* The Office’s interactions and products are available to the general public (subject to the normal restrictions on releasing proprietary or otherwise sensitive information).
- *Efficiency:* The Office uses sound business practices to manage its resources, including leveraging its limited resources with those of other regulatory or research organizations. Further, the Office identifies potential improvements in the NRC’s regulatory processes to improve efficiency.
- *Clarity:* The Office’s products include a characterization of their intended regulatory use and their technical insights, written to the extent possible for a non-technical audience.
- *Reliability:* The NRC’s regulatory decisions are based on the best available knowledge from research and operational experience.

In the light of this mandate and set of principles, the functions of the Office are summarized below.

2. FUNCTIONS OF THE NRC'S OFFICE OF NUCLEAR REGULATORY RESEARCH

2.1. Confirming the technical basis for regulatory decisions

The principal responsibility for the safety of nuclear installations, and the technical basis for ensuring safety, resides with the licensee. That is, NRC decisions on the initial and continued operation of a facility depend primarily on technical information provided to the agency. However, as specified in the NRC's original authorizing legislation, the Office of Nuclear Regulatory Research does perform 'confirmatory' research, that is, technical studies to confirm the information provided by an applicant or licensee. One example of such confirmatory research is the testing of fire barriers. In Generic Letter 92-08 [3], the NRC informed the nuclear industry of issues associated with testing and fire endurance ratings of Thermo-Lag electrical raceway fire barrier systems. In this generic letter, the staff also noted similar potential problems with other barrier systems. To support regulatory oversight, the Office of Nuclear Regulatory Research performed three full scale ASTM E119 tests on these barrier systems and found a new issue — thermal shrinkage of the outer covering that resulted in the barrier's joints opening during the test. Results from this NRC confirmatory research were communicated to the industry in Information Notice 2005-07 [4].

While the preceding discussion focused on the need for independent, confirmatory NRC research, it should be noted that the NRC and the regulated industry do perform cooperative research. This collaboration is limited to obtaining experimental data cooperatively; no joint evaluation or analysis is conducted. A recent example of this type of research is the fire research with the Electric Power Research Institute (EPRI). In 2001, the Office of Nuclear Regulatory Research entered into an agreement with EPRI to work on fire risk programmes. The first major product of this agreement was a report that documents the state of the art methods, tools and data necessary for conducting a nuclear power plant probabilistic risk assessment (PRA) [5]. The NRC/EPRI also completed a report documenting the validation of five fire models commonly used in the US nuclear power industry. In addition to the NRC and EPRI, the US National Institute of Standards and Technology and Electricité de France were partners on this project. The report will be published in May 2007.

The NRC's Office of Nuclear Regulatory Research also interacts extensively with other governments and international organizations to address difficult technical issues. The Office has over 75 agreements with specific countries, as well as broad agreements with the Nuclear Energy Agency and the IAEA. An example of such an agreement is the Phebus project, an experimental effort to study the processes governing the transport, retention and chemistry of radioactive material under light water reactor severe accident conditions.

2.2. Assessing technical issues

Like all regulatory bodies, the NRC continually reviews operating experience, new research data and other information for their implications on regulatory activities and decisions. In these reviews, issues sometimes arise that have potentially important implications for nuclear safety, but for which insufficient data exist to support taking (or not taking) regulatory action. The NRC has an explicit process by which such issues are assessed, and, if appropriate, research is performed. Recognizing that licensees have the primary responsibility for safety, any such research is narrowly focused on determining whether the NRC has a sufficient basis to instruct licensees to take action.

A recent example concerns chemical effects. In 2003, the NRC's Advisory Committee on Reactor Safeguards identified an issue concerning the potential impact on emergency core cooling functionality of chemical interactions between containment spray additives and insulation and other substances located inside the containment building [6]. After an initial review, the NRC initiated research on the chemical interactions themselves, as well as research on equipment (the containment sump and downstream pumps and valves) performance in the presence of resulting chemical byproducts. This research confirmed that sump clogging due to chemical effects was a real issue and demonstrated that licensees needed to conduct research and obtain experimental data applicable to their plants [7, 8]. Licensees are now performing this work.

2.3. Developing methods and tools

The staff of the NRC makes use of a number of methods and tools, often in the form of computer codes, to help make regulatory decisions. Many of these methods and tools are developed in the Office of Nuclear Regulatory Research. Examples of methods and models developed and maintained by the Office of Nuclear Regulatory Research include:

— SPAR models, which are plant specific risk assessment models used in support of risk informed activities related to the reactor inspection programme, incident investigations, licence amendment reviews,

performance indicator verification, generic safety issue resolution and special studies [9].
- Human reliability analysis job aids and training tools, which are being developed for non-reactor regulatory issues such as medical mis-administrations of radioactive material.
- RESRAD, used to estimate radiation doses from residual radioactive materials to humans through a series of physical, chemical and environmental pathways. NRC staff and licensees use the code to demonstrate compliance with the decommissioning dose standards [10].

2.4. Looking for emerging technologies and issues

The majority of the Office of Nuclear Regulatory Research's programmes focus on supporting near term regulatory decisions. However, the Office is also looking more broadly to identify potential issues that could emerge in five to fifteen years and to define research programmes that could address the issues. Examples of such emerging issues include:

- *Plant operations beyond 60 years:* The staff expects the regulatory process for evaluating applications for licence renewal beyond 60 years to be similar to the current licence renewal process. However, current evaluations do not address the adequacy of the technical basis for plant life extension beyond 60 years. Therefore, a new technical basis may be needed to support the evaluation of licence extension applications and pre-application topical reports.
- *Technology advancements:* Crosscutting regulatory research (i.e. research that addresses technical issues common to multiple regulatory programmes and initiatives) is an important component of the NRC's research portfolio. Such long term crosscutting research activities could address potential new safety technologies (e.g. applications of nanotechnology in sensor devices) and the potential for improved analytical tools (e.g. for performing multiphase computational fluid dynamics analysis) enabled by advances in computer hardware and software.

2.5. Translating technical information into regulatory guidance

As discussed earlier, the NRC's Office of Nuclear Regulatory Research is a TSO within the NRC. As such, it has an additional role not typically found in TSOs — explicitly translating research results into regulatory guidance. The Office performs this role mostly through the development of regulatory guides and by working with standards setting organizations.

The NRC's set of regulatory guides supplements its rules and regulations by describing acceptable (voluntary) approaches to addressing specific regulatory issues. In 2006, the NRC initiated a multi-year update of the guides, with the 29 'most important' guides addressed first. All of this first set of guides were issued in final form in early 2007, and, as examples, included the following:

— Regulatory Guide 1.208, A Performance-Based Approach to Define the Site-Specific Earthquake Ground Motion [11];
— Regulatory Guide 1.209, Guidelines for Environmental Qualification of Safety-Related Computer-Based Instrumentation and Control Systems in Nuclear Power Plants [12].

United States Federal Government agencies such as the NRC are required by law to maximize the use of consensus codes and standards. The Office of Nuclear Regulatory Research facilitates the use of its research results, as well as the technical and regulatory positions of the rest of the agency, in these standards. The Office's work focuses on consensus building within the staff on the technical merits of proposed or existing standards, ensuring that standards committees have appropriate NRC membership, and providing a single agency point of contact and spokesperson at the executive level on standards matters.

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FLAMANVILLE AND COTENTIN: A POPULATION'S TRUST IN BUILDING NUCLEAR POWER FOR TOMORROW

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Abstract

What do inhabitants of local municipalities require from technical and scientific support to preserve their trust in nuclear power? In over twelve years of shared experience among representatives of municipalities in Europe, several basic principles were constantly reaffirmed: the population's safety is not negotiable, transparency and access to information are necessary to enable each citizen to forge his or her own opinion and make independent assessments, local communities should take part in the decision making process, radioactive waste must be managed in a responsible manner and the economic development of affected areas must be sustained and integrated. Several examples of industrial development affecting a small locality are discussed, from granite quarries and an iron mine to nuclear facilities and the next nuclear power plant in France. In all these cases, and in the nuclear field, where controversy exists, strong and acknowledged technical and scientific support is essential to ensure a serious and objective public debate. Such support is key to giving confidence to the population and to avoiding decisions linked, not to nuclear or energy goals, but to short term political goals.

1. WHAT DO WE NEED FOR TECHNICAL AND SCIENTIFIC SUPPORT?

It may seem to some to be useless, uninteresting or ill-advised, if not completely presumptuous, to speak of a population's trust regarding a town with fewer than 2000 inhabitants located at the end of the Cotentin peninsula in Normandy, when opinion polls on the nuclear issue are regularly conducted at the national and European levels. I simply want to add a complementary view: the testimony of the representative of a municipality that, in 1975, voluntarily offered to host a power plant, who for twenty years has been living very near two 1300 MW(e) reactors and who for forty years has been living 20 km from the treatment centre of La Hague — a centre that more than once has been on the front page of different newspapers (too many cases of leukaemia, contamination of transport bundles, etc.). In 2004, this municipality, Flamanville, a candidate with all the region's communities (region, department, association of municipalities) and with the support of the economic partners and the trade unions, was chosen by the French electric utility EDF to host the next European pressurized water reactor (EPR) unit.

This paper addresses the following points:

— The shared experience of the representatives of nuclear municipalities in Europe;
— The lasting commitment of the inhabitants of Flamanville to live and work in their native region;
— The challenge of the debate.

2. THE SHARED EXPERIENCE OF THE REPRESENTATIVES OF NUCLEAR MUNICIPALITIES IN EUROPE

Back in 1993, our colleagues in the association of nuclear municipalities in Spain (Asociación de Municipios en Áreas de Centrales Nucleares (AMAC)) had the good idea of organizing meetings of representatives of municipalities in Spain and across Europe located near nuclear power plants, and in 2000, the Group of European Municipalities with Nuclear Facilities (GMF) was established.

Having organized these meetings at twelve year intervals — in October 1994 and September 2006 — we are pleased to continue our work, since the enlargement of the European Union, with our colleagues from the Czech Republic, Hungary, Lithuania, Romania and Slovenia, who are optimistic about nuclear power in their countries. How far have these two ambitions advanced — the construction of Europe and support for nuclear power — from a respect for some basic principles to preserve or recuperate the trust of our populations?

In France, there are numerous similarities between the construction of Europe and the acceptance of nuclear power. The French 'no' to the European Constitution in 2005 revealed the following:

— The limits of an often dualistic debate between a very offensive 'no' group of people, which took advantage of all the means within its reach, even uniting the most extreme differences, and a 'yes' group, which had trouble explaining its project to the population and was carrying it out from a frequently defensive position;

— The citizenry's ignorance of the subject because of a lack of education and information, which prevented them from understanding — or allowed them to only half understand — the facts and challenges of the proposed option, thus thwarting their involvement and participation when consulted;
— The obstacles that impede a fundamentally national society from becoming more open and willing to engage in dialogue in a constantly changing international environment;
— The complexity of interpreting the vote after the event and the difficulty of understanding the message it conveyed.

Thanks to the possibility of better listening to our neighbours and taking advantage of their experiences, our network of European players, the GMF, has modestly tried, always on a realistic basis and from the perspective of the local population, to be a demanding facilitator of the acceptance of nuclear power.

The bases of this acceptance were published in April 1995 in Oskarshamn, Sweden, and they continue to be constantly reaffirmed:

— The safety of the population is not negotiable.
— Transparency and access to information are necessary so that each citizen can forge his or her own opinion and make independent assessments.
— The local communities should take part in the decision making process when these decisions directly affect them in the short, medium and long term.
— Radioactive waste must be managed in a responsible manner.
— The economic development of areas affected by nuclear implementations must be sustained and integrated.

What is the current situation in France? Specifically addressing these criteria, several regulatory laws have been enacted, numerous decisions adopted and different actions carried out:

— In June and October 2004, before Flamanville was selected, the regional players at the three candidate sites (Flamanville, Penly and Tricastin) were consulted.
— The first public national debate on the nuclear issue was organized between September 2005 and February 2006, before:
  - EDF confirmed its project to build the EPR plant in Flamanville;
  - the bill on the program for sustainable radioactive waste and material management was enacted.

— A law was passed establishing the framework and funding for the development actions at the site, where the underground laboratory will be implemented.

All the above actions have resulted in a positive evolution of the nuclear issue and helped to reinforce the decisions of the different players at all levels, who have different expectations and challenges:

— The population and representatives of Flamanville and Cotentin — concerned with economic activity and jobs;
— The industrial sector — concerned with industrial strategy and future of the enterprise;
— Political parties — concerned with elections and governmental coalitions.

3. THE DECISION OF FLAMANVILLE'S INHABITANTS

The lasting commitment of the inhabitants of Flamanville in an insecure industrial and economic world is to one goal — to live and work in their native region. In the department of La Manche in Lower Normandy, a traditionally agricultural region, where livestock and dairy production predominate, the industrial town of Flamanville is an exception because of its decisions, debates, differences and uncertainties in a rural space that seems practically immutable.

On this small cape, three successive industrial activities have succeeded each other over the centuries to exploit the local natural resources: granite, iron mineral and, today, the capacity of this coastal site to host a nuclear power plant. The granite and iron mineral are excellent products that came at an excessively high cost (exploitation and transport).

3.1. The granite quarries

The Flamanville quarries, spread out along the cliffs of the Diélette coast to Sciotot, employed almost 300 workers (stonemasons, blacksmiths, carters, etc.) between 1830 and 1850. Due to competition from the granite quarries of Brittany and the region of Vire, where transportation costs were lower thanks to the nearby railroad lines, the Flamanville quarries had to close down after centuries of activity.

Since 1980, the coastal protection act forbids the exploitation of new granite quarries in the municipality. Can you guess where the granite used for the square and the sidewalks of our latest housing development comes from? From Spain and China! This would be a good subject for debate and comparison, when speaking of electricity transport, network interconnections or European energy trade.

3.2. The iron mine

The iron ore mine in Diélette lasted approximately one century, from 1855 to 1962. In contrast, effective exploitation of a deposit of excellent quality (45–55%) located under the sea lasted only 30 years. From the mine in Diélette, less than 2 million tons of mineral were mined in just over a century, and there are still more than 30 million tons to be extracted. The mine was closed due to transport costs and energy problems, and today we produce energy at the same location. Is this a paradox, a joke on history or continuity?

3.3. The nuclear power plant

The iron mine closure has guided the decisions of the village. In a land of tradition, moderation and determination, the local population decided to undertake the construction of the first two nuclear units. On 6 April 1975, the inhabitants of Flamanville were called to the ballot box by my predecessor, Mayor Varin, and the result was 435 votes for and 260 votes against the implementation of two nuclear units. After the debates, disputes and demonstrations, there was a voter turnout of more than 60% and a favourable vote with a large margin.

Thirty years after that decision, we can measure the impact of the nuclear option on the magnificent, wild natural setting of Cotentin:

— More than 7000 inhabitants currently work in the La Hague and Flamanville facilities.
— In EDF Flamanville, of the 700 salaried workers, one out of every three was born in the district of La Manche.
— In AREVA NC, La Hague, of the more than 3000 salaried workers, almost six out of every ten were born in our district.

This commitment has never wavered during these thirty years, and representatives of both the right and the left, except for the Greens, united to defend the local candidature to host the first EPR in 2003.

As we live very close to the plant, we never forget that the accidents at Three Mile Island in 1979 and at Chernobyl in 1986 largely shaped the opposition of some people to nuclear power. They also revealed the great chasm that separated, and still separates, the specialists (experts, scientists, engineers, etc.) from the general public. Much progress has been made in achieving greater participation in the decision making process by the general population and greater access to information through public debates, surveys, local information committees and independent audits. In addition, we can find evidence for the following progress in the local nuclear facilities:

— The reality of and respect for the commitments made to safely condition waste and return it to foreign customers (glass containers);
— The decreasing amount of waste and insignificant impact on the environment;
— The decreasing dose to personnel at the facilities.

4. THE CHALLENGE OF THE DEBATE

In all these steps, especially when there is a strong controversy and a media crisis, we need strong and acknowledged technical and scientific support to have a calm, informed debate and to take good decisions. However, as a Spanish trade union leader said in Tarragona last October: "We are neither anti-nuclear nor pro-nuclear. What we want, and I insist on this, is a franker, more radical and more integral debate. Several things will come out of that debate…."

It is a theme shared by most of the stakeholders, including non-governmental organizations and politicians, as in the current elections period. After three years of Parliamentary debate, national public debate and public inquiries, some politicians are still analysing the debates and have proposed a new debate. At the local level, we do not need a lasting debate but a lasting decision. I think this is the key to instilling confidence in the population for the future. I hope that technical and scientific support organizations can contribute to the process of making lasting decisions.

We are confident at the local level that we will turn this new EPR into a demonstration of how, at present, the nuclear industry can be fully integrated into the society and the environment. We do not envisage that a new Government will decide to stop the construction of EPR, as in the case of the Superphoenix plant in the 1990s, by deciding to shut it down without consulting the local citizens, thus showing a total lack of respect for the views of the local population.

OECD/NEA ACTIVITIES TO ENHANCE COOPERATION AMONG TECHNICAL ORGANIZATIONS INVOLVED WITH NUCLEAR SAFETY ASSESSMENT AND RESEARCH

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Abstract

The first priority for the member countries of the OECD Nuclear Energy Agency (OECD/NEA) is nuclear safety and regulation. This fact is clearly recognized in the OECD/NEA strategic plan for 2005–2009 and directs the activities of the OECD/NEA's programme of work, in particular, those carried out by the safety committees — the Committee on the Safety of Nuclear Installations (CSNI) and the Committee on Nuclear Regulatory Activities (CNRA). To accomplish these objectives, the CSNI is organized into six permanent working groups, each covering a different set of technical disciplines. The CSNI has produced numerous state of the art reports (SOARs) or international standard problems (ISPs), which have been key contributors to national safety assessment practices. The CSNI is also responsible for organizing and monitoring cooperative research projects, which are generally organized to share costs and information on research programmes of common interest to many member countries and/or to ensure that key facilities/programmes related to the nuclear safety infrastructure are maintained. Currently, there are 15 ongoing safety research projects. OECD projects like LOFT (Loss of Fluid Test) and Halden are recognized worldwide. The paper underlines the main findings from past OECD/NEA experience, focusing on specific safety activities and showing the added value provided to member countries. From the OECD/NEA perspective, any concerted action among technical institutions addressing safety should build on the successful cooperation existing today.

1. THE OECD NUCLEAR ENERGY AGENCY AND THE COMMITTEE ON THE SAFETY OF NUCLEAR INSTALLATIONS

The first priority for the member countries of the OECD Nuclear Energy Agency (OECD/NEA) is nuclear safety and regulation. This fact is clearly recognized in the OECD/NEA strategic plan for 2005–2009 and directs the activities of the OECD/NEA's programme of work, in particular, those carried out by the safety committees — the Committee on the Safety of Nuclear Installations (CSNI) and the Committee on Nuclear Regulatory Activities (CNRA).

The CSNI has been supporting the safety institutions in OECD/NEA member countries for more than forty years, particularly in two areas: safety assessment and safety research. The CSNI consists of high level experts from regulatory organizations and technical institutions, responsible in their countries for providing technical support to the licensing authority. In some OECD/NEA countries, both the licensing and technical assessment functions reside in the regulator, while in others a different institution provides the technical support. The CSNI was the first concerted international response to share and address common safety concerns, using the expertise and resources provided by both these safety institutions.

The main objectives of CSNI are to:

- Keep all member countries involved in and abreast of developments in safety technology;
- Review operating experience with the objective of identifying safety issues that need to be addressed by new research;
- Review the state of knowledge on selected topics of nuclear safety technology and safety assessment;
- Promote training and research projects that serve to maintain competence in nuclear safety matters;
- Promote research as needed to reach consensus on nuclear safety issues of common interest;
- Consider the safety implications of scientific and technical developments.

To accomplish these objectives, CSNI is organized into six permanent working groups, each covering a different set of technical disciplines. The CSNI has performed numerous state of the art reports (SOARs) or international standard problems (ISPs), which have been key contributors to national safety assessment practices.

The CSNI is also responsible for organizing and monitoring cooperative research projects, which are generally organized to share costs and information on research programmes of common interest to many member countries and/or to ensure that key facilities/programmes related to the nuclear safety infrastructure are maintained. Currently there are 15 ongoing safety research projects. OECD projects like LOFT (Loss of Fluid Test) and Halden are recognized worldwide.

This paper underlines the main findings from past OECD/NEA experience, focusing on three specific safety activities: the Safety Margins Action Plan (SMAP), the senior experts on safety research (SESAR/SFEAR) and the OECD/NEA joint research projects. From the OECD/NEA's perspective, any concerted action among technical institutions addressing safety should build on the successful cooperation existing today within the OECD/NEA framework.

2. ACTION PLAN ON SAFETY MARGINS (SMAP)

2.1. Background

The decision by the CSNI to develop the SMAP arose from the possibility that some changes in existing nuclear power plants could challenge safety margins despite fulfilling all the regulatory requirements. Possible examples are power up-rates, plant life extension or increased fuel burnup as well as cumulative effects of simultaneous or subsequent modifications in a plant, which can conceivably be larger than the accumulation of the individual effects of each individual modification. The magnitude of the problem gets bigger as the design modifications push the plant closer to (or possibly even beyond) the edge of the original design envelope. In order to monitor the impact of such modifications on the safety margin, analysis methodologies capable of treating the problem in an integrated manner must be developed.

Safety analyses are performed using either the deterministic or the probabilistic approach. The deterministic approach typically considers a reduced number of limiting transients for which conservative rules for system availability and parameter values are often applied. The accident scenario and the related timing are estimated as completely as necessary. The probabilistic approach emphasizes the completeness of the set of different scenarios and best estimate methods. The two approaches have been developed independently of each other. The problem is to integrate the two approaches consistently into a single comprehensive methodology necessary to explore safety margins in a general sense. Additional motivation derives from the observation of an increasing trend toward using information on risk (where the term 'risk' means 'results of the probabilistic safety assessment (PSA)/probabilistic risk assessment (PRA) analysis') to support regulatory decisions in many countries. Hence, a generalization of the concept of safety margin is needed in order to make it applicable in both the probabilistic and deterministic fields of application, while maintaining the traditional meaning to the maximum extent possible.

With this aim, the CSNI approved the SMAP in December 2003 and established an international working group for developing a methodological framework for integrated safety assessments of the changes to plant safety as a consequence of simultaneous plant modifications related to the design and the operational envelopes.

2.2. Objective of the SMAP working group

The main objective of the SMAP task group has been to develop guidance on assessing the safety margins of nuclear power plants. The target audience of this guidance includes the evaluators in regulatory organizations, who decide on the acceptability of plant changes from the regulatory safety point of view. Nevertheless, other users could also benefit from the results of the SMAP work.

In order to achieve the general objective, three more detailed objectives were defined that have guided the development of the work:

— To agree on a common conceptual framework based on both deterministic and probabilistic considerations that could address the safety margins problem;
— To develop guidance on how safety analysis methods and tools can be used to address the safety margins problem;
— To exchange information and experience among the participating organizations.

2.3. Description of the work

In the traditional safety analysis framework, safety margins are introduced in recognition of the fact that uncertainty exists about the proper values of the set of safety variables characterizing the onset of some type of damage. By setting the regulatory acceptance limits conservatively with respect to the onset of damage, sufficient margin is assured in design basis accidents (DBAs). Safety margins are introduced at several stages of the analysis, where successive acceptance criteria are defined on the basis of decoupling criteria, with the ultimate goal of protecting the public and the environment from radiological hazards of potential releases from the plant. The complexity of the analysis and the fact that these margins are defined only at the level of specific scenarios included in the safety analysis make it difficult to establish a clear relationship between safety margins and overall plant safety, especially when significant concurrent plant modifications are implemented.

The extension of the reduced set of design basis scenarios (the 'design basis space') to the almost complete set of credible scenarios, including out of design situations, leads to the concept of 'risk space', where the safety margin assessment framework proposed by the SMAP group should be applied.

As in any other safety approach, including the traditional deterministic one, the ‘set of triplets’ scheme, where each triplet is composed of an identified scenario, its likelihood and its associated consequences, is useful to guide both the description and the application of the proposed analysis approach.

According to this scheme, the first step is the identification of the risk space, that is, the set of scenarios to be included in the analysis. Event tree techniques, similar to those used in traditional PSA have been found useful for developing a description of the risk space. Both PSA sequences and design basis scenarios are taken as initial references for this development, while trying to overcome the limitations of the traditional approaches. On the one hand, unlike DBA, risk space scenarios include consideration of non-safety-grade equipment as well as failures of qualified safety systems. On the other hand, the PSA scope is extended to include any type of safety objective and an explicit consideration of safety margins for each particular sequence. Risk space event trees should have the capability to address, among other possible safety objectives, safety limits and acceptance criteria traditionally applied to DBAs. These extensions make the risk space event trees potentially very different from those of traditional PSA, keeping in mind that traditional PSA focuses only on the safety limits used as acceptance criteria for large break loss of coolant accident (LOCA) analysis, which are the sequence success criteria in level 1 PSA.

A consequence of the above is that the determination of the end state of a risk space sequence is more difficult because the success criteria of the safety functions (represented by event tree headers) depend on the safety objective being analysed. Hence, identification of the end states with the aid of dynamic models is highly recommended. At the same time, it provides additional support for sequence delineation, since the actual involvement of the event tree headers in each sequence can be confirmed. Extensive dynamic verification also allows for better accounting of dynamic dependencies of probabilities and even opens the possibility of considering stochastic events (such as hydrogen combustion) as particular cases of event tree headers.

In summary, the capability of a risk space model (i.e. a particular set of event trees) to address a given set of safety objectives depends mainly on the following three elements:

— What safety functions and associated systems have been considered?
— How have initiating events and subsequent transient paths been grouped into event tree sequences?
— To what extent are fault trees reusable for analyses of different safety objectives? A high degree of decoupling between sequence success criteria and fault tree structure is needed for this aim.

The quantification process in the risk space shows a high degree of coupling between dynamic and probabilistic aspects of the safety evaluation. Extending the scope of the analysis from classical PSA to the risk space appears very difficult owing to the mostly decoupled treatment of dynamic and probabilistic aspects in PSA. The proposed safety margin assessment framework provides a way to treat these aspects in a more integrated manner.

The third element of the safety description 'triplets' addresses the consequences of each identified scenario. Estimation of consequences at any level, from process or safety variable values up to radiological doses outside the plant, is based on dynamic models representing the plant behaviour and the dispersion mechanisms. However, the consequences can be defined to fit the scope of a specific safety analysis, and thus the effort involved in quantifying the change of margins can be limited.

Two proofs of concept examples are provided. In the first, the effect of debris in containment sumps after a LOCA is analysed, using core damage frequency (CDF) as a risk indicator subject to existing acceptance criteria. The debris may cause a loss of net positive suction head (NPSH) in the emergency core cooling system (ECCS) and containment spray pumps, potentially resulting in the loss of function of these important safeguards. Substantial uncertainties in this type of scenario make the use of an integrated approach recommendable, where uncertainty becomes part of the calculated CDF, thus avoiding both the overly pessimistic and overly optimistic results that would be obtained from pure deterministic or probabilistic approaches. A change in the size of debris screens from 125 to 1100 square feet is analysed. The loss of NPSH is assimilated to loss of core integrity; therefore, the calculated probability of NPSH loss is equivalent to the conditional probability of loss of function for the first barrier, and can be used directly to determine the impact on CDF. The second example attempts to quantify the peak clad temperature (PCT) margin for the design changes due to the power up-rates for Kori unit 3 (in the Republic of Korea), for which the safety and other analyses are being performed regarding power up-rate.

2.4. Main results and their significance

The developed framework for safety margin evaluation provides a means for estimating the effect of a broad range of plant modifications. It allows for a quantitative response to concerns about erosion of safety margins as a result of multiple plant modifications. The method augments existing deterministic decision making tools when adequate margin cannot be shown, especially when the possible loss of safety margin involves probabilistic aspects (e.g. reliability issues) not explicitly addressed in this type of analysis.

The proposed framework integrates existing methodologies on safety margins and risk evaluations. As a result, the figures of merit that characterize the overall plant safety are a set of risk indicators that include explicit consideration of safety margins in the calculation process. These risk indicators are given in the form of expected frequencies of specified plant damage states or expected amount of damage for a specified period of time.

This integration allows for a sufficiently accurate and precise evaluation of the overall impact of a modification that has simultaneous positive and negative effects on safety margins. Uncertainties are treated in such a way that they become part of the calculated risk indicators and also the differentiation between epistemic and aleatory uncertainties is suitably addressed throughout the evaluation process.

The proposed approach merges information from all the disciplines that are important in nuclear regulatory decision making: deterministic safety analysis, probabilistic risk assessments and material science and engineering. The integration is done using existing, tested tools and methods, yet the integrated framework has the potential to evolve as new tools and methods become available.

The two pilot applications show how the framework can be applied to issues of current regulatory interest and they illustrate some of its advantages.

2.5. Conclusions

To fulfil the objectives of the action plan on safety margins, the SMAP group has issued two technical notes as working documents and a final report. These documents taken together provide guidance on the assessment of changes in safety margins due to significant plant modifications.

The agreed framework results from the integration of existing safety analysis methodologies and allows the implementation of all current regulatory practices, while providing additional capabilities for analysis of plant changes whose implications are difficult to evaluate with traditional analysis techniques applied individually.

A key element of the success of the SMAP activities has been the fruitful exchange of ideas and information among the group members, which was stated as an explicit objective of the action plan.

The following features characterize the SMAP framework:

— The standard model from reliability theory (and other engineering sciences) using probabilistic density functions for both the load and the strength (of the barriers) forms one basic element of the SMAP methodology. However, consistency with current practices is maintained since they can be viewed as particular approximations of the general approach.

— Naturally, the accident frequency has been chosen as a scenario independent indicator for ‘loss of function’. This quantity represents a very general measure of safety margin and quantifies the ‘distance’ between the safety variables (e.g. pressure, temperature, oxidation level) and the respective acceptance limits in the whole set of possible plant scenarios. At the same time, it naturally allows for comparison of the margin available in different physical process parameters (safety variables).
— The methodology proposed by the SMAP group is based on a combination of deterministic and probabilistic approaches and uses the existing analysis technologies (e.g. deterministic safety analysis and PSA). The aggregation of the risk contributions from different event scenarios uses the mathematical concepts of PRA, while the evaluation of the consequences is performed using existing transient analysis simulation tools. The two pilot applications propose the application of best estimate plus uncertainty (BEPU) analysis for the consequence evaluation.

3. SENIOR EXPERTS ON SAFETY RESEARCH (SESAR/SFEAR)

3.1. Description of the work

At its December 2002 meeting, the CSNI approved the organization of a senior group of experts on nuclear safety research (SESAR) to assess the need for and strategy of maintaining key research facilities. This activity is a follow-up to a similar activity conducted by CSNI in the late 1990s that led to a number of actions by CSNI to establish cooperative research projects directed at developing information relevant to safety issues on operating light water reactors (LWRs) and pressurized heavy water reactors (PHWRs), while at the same time preserving key facilities and programmes. A report on this activity was issued by the OECD/NEA in 2000 titled “Senior Group of Experts for Nuclear Safety Research: Facilities and Programmes (SESAR/FAP)”. In response to the recommendations expressed in that report, the CSNI has undertaken initiatives, notably in the thermal–hydraulic and severe accident areas. These initiatives mainly consisted of initiating and carrying out internationally funded OECD cooperative projects on relevant safety issues, centred on the capabilities of key facilities identified in the SESAR/FAP report. Four such projects (involving five facilities) were initiated and are currently ongoing, constituting a means for effectively maintaining basic technical infrastructure through international cooperation.

Since publication of the SESAR/FAP report, research facilities have continued to be shut down worldwide. In fact, about 35% of the facilities listed in the SESAR/FAP report in the areas of thermal–hydraulics, fuel, reactor physics, severe accidents and integrity of equipment and structures (i.e. those areas most unique to the nuclear power industry) have been shut down in the past five years. Accordingly, loss of critical research infrastructure (i.e. facilities, capabilities and expertise) remains a concern and is a major factor in conducting the current study. However, it should be recognized that the SESAR/FAP effort led to CSNI actions that preserved five key facilities during the 2000–2006 time period.

This activity builds upon and updates the SESAR/FAP work, but also expands its scope to cover advanced LWRs (ALWRs), Russian pressurized water reactors (WWERs), advanced PHWRs (APHWRs) and high temperature gas cooled reactors (HTGRs). Accordingly, the title of this activity is “SESAR: Support Facilities for Existing and Advanced Reactors (SESAR: SFEAR)”. The need to maintain databases of experimental data is also recognized as an important issue, but is not treated in this report, since preservation of data is being addressed separately by the OECD/NEA.

The focus of this activity is on the safety issues, research needs and supporting research facilities associated with currently operating water cooled reactors in OECD/NEA member countries. These reactors include pressurized water reactors (PWRs), boiling water reactors (BWRs), PHWRs and WWERs. For these reactors, the main purpose is to:

— Summarize the currently identified safety issues, whose resolution depends upon additional research work;
— Provide the current status of those research facilities unique to the nuclear industry that support resolution of the safety issues;
— Recommend actions that the CSNI could take in the short term to help maintain facilities, which represent a substantial investment of resources and are in danger of premature closure;
— Provide recommendations on long term nuclear safety research facility infrastructure needs and preservation.

In addition, areas are identified where research facilities do not exist but may be useful to address currently identified safety issues. The report also provides information on safety issues and research needs not unique to the nuclear industry and on safety issues and research needs associated with

HTGRs. This information is presented for completeness and for use by designers, operators and researchers in planning and conducting future work.

The issues addressed in this report are those associated with nuclear reactor safety (excluding spent fuel storage) and are organized into the following technical areas:

— Those unique to the nuclear industry:
  - Thermal–hydraulics;
  - Fuel;
  - Reactor physics;
  - Severe accidents;
  - Integrity of equipment and structures;

— Those not unique to the nuclear industry:
  - Human and organizational factors;
  - Plant control and monitoring;
  - Seismic effects;
  - Fire assessment;

— Those unique to HTGRs.

In general, in developing recommendations for CSNI consideration, the group focused on those facilities that have unique capabilities, would be very expensive to replace and have high relevance to the resolution of current safety issues (as indicated by their relative numerical ranking), as well as the potential to be highly relevant in support of the resolution of ALWR and APHWR safety issues. Accordingly, such facilities represent an infrastructure of substantial resource investment; if lost, it is unlikely that such facilities would be replaced owing to the reality of cutbacks in nuclear safety research funding over the past few years. Because of the cost of operating such facilities, cooperative efforts would most likely be needed to maintain them in the longer term.

3.2. Conclusions

The conclusions are organized into general, short term and long term items.

3.2.1. General conclusions

Efforts by the CSNI aimed at facility preservation should focus on large facilities, whose loss would mean the loss of unique capability as well as the loss of substantial investment that in the current climate of tight resources would not likely be replaced. Such preservation also includes maintaining the expertise, knowledge, capabilities and personnel essential to infrastructure preservation. In this regard, it should be noted that, owing to previous CSNI efforts, several large facilities (i.e. PANDA, PKL, MACE, ROSA) have been kept active over the past five years, thus helping the current SFEAR effort. However, many large, expensive and unique facilities are projected to close over the next 1–5 years. Examples include thermal–hydraulic and severe accident facilities. In addition, many of the test reactors are old and will reach the end of life cycle without substantial refurbishment. The loss of such facilities would severely detract from the nuclear safety research infrastructure. Additional discussion on a strategy for long term facility preservation is discussed in Section 3.2.3., below.

To help stimulate industry interest in facility and infrastructure preservation, it is recommended that both the CSNI and the CNRA take steps to encourage industry cooperation by emphasizing (i) the responsibility of industry to develop sufficient data to support their applications, (ii) the benefits of cooperative research and (iii) the value of preserving critical research infrastructure.

Hot cells and autoclaves are essential to nuclear safety research. However, owing to the large number of hot cells and autoclaves, it is impractical for the CSNI to monitor their status. Accordingly, each country should monitor the status of these facilities and bring to the CSNI's attention any concerns regarding loss of critical infrastructure.

Certain safety issues have no large scale facilities identified for the conduct of relevant research. The appropriate CSNI working groups should evaluate whether or not large scale facilities are needed to support resolution of these issues. The issues that fall in this category are:

— ECCS strainer clogging (thermal–hydraulic issue No. 6);
— 3D core flow distribution (thermal–hydraulic issue No. 12);
— Long term behaviour of concrete structures (structural integrity issue No. 7);
— Flow induced vibrations (structural integrity issue No. 9).

3.2.2. Short term actions

The following recommendations are directed toward those actions that the CSNI could take in the short term (2006–2007) to prevent the loss of key facilities in imminent danger of closure.

In the thermal–hydraulics area, both existing large integral BWR thermal–hydraulic test facilities (PANDA and PUMA) are in danger of being closed in the next 1–2 years. These facilities are unique and expensive, and at least one should be maintained to be available for supporting research related to current or future BWR safety issues. Accordingly, preservation of one integral BWR thermal–hydraulic test facility (either PANDA or PUMA) is considered essential for preserving a BWR thermal–hydraulic research infrastructure. SESAR is of the view that PANDA is the preferred facility for preservation owing to its scale, replacement cost and versatility (i.e. it is useful in the severe accident as well as thermal–hydraulic area). Accordingly, CSNI action is recommended in the short term to support a cooperative research programme in PANDA. It should be noted that CSNI actions resulting from the SESAR/FAP report have played a major role in the preservation of PANDA over the past five years.

In the severe accident area, most facilities supporting the resolution of the following safety issues for BWRs, PWRs, WWERs and ALWRs are in danger in the short term:

— Pre-core melt conditions;
— Combustible gas control;
— Capability to cool overheated cores.

On the basis of a review of the facilities in short term danger, their importance to the resolution of the above safety issues and long term infrastructure preservation, the group concluded that the following should be preserved owing to their replacement cost, high relative ranking and versatility: PHEBUS, QUENCH and MISTRA.

In the other technical areas (fuels and integrity of equipment and structures), no short term CSNI actions are recommended.

It should be recognized that implementation of the above recommendations is dependent on the interest and commitment of the 'host countries' to provide sufficient resources to attract participation of other interested parties and the ability to propose experimental programmes relevant to the resolution of the issues and of interest to member countries.

3.2.3. Long term strategy

In the longer term (beyond 2007), it is recommended that the CSNI adopt a strategy for the preservation of a research facility infrastructure based upon preserving unique, versatile and hard to replace facilities. The number and nature of these facilities should be based on supporting currently operating LWRs and PHWRs and the licensing of future ALWRs and APHWRs. The strategy should include consideration of short and long term priorities, cost of preservation (e.g. whether the cost of preservation would detract substantially from other programmes/facilities) and contingency plans in the case of facility loss. In this regard, many of the factors used in the report to arrive at conclusions and recommendations could be useful in developing a long term strategy for assessing and initiating future cooperative research projects.

These factors include:

— Facility operating and replacement cost;
— The ability to define a useful experimental programme;
— Long term resource implication and priorities;
— Industry participation;
— Host country long term plans and commitment.

4. OECD/NEA JOINT PROJECTS IN THE NUCLEAR SAFETY AREA

In many OECD member countries, nuclear power plays an important role in the overall production of electricity. As in the past, operational requirements, plant utilization and fuel designs are expected to continue evolving, even for current generation reactors, posing new challenges and new questions. Operational experience and plant ageing will also raise new questions. Research will be needed to support a high level of safety, in a context in which economic pressures on plant operators are increasing. Research will also be needed to support developments for new reactor systems, including both evolutionary designs and more advanced reactor concepts such as those under consideration by the Generation IV International Forum (GIF).

Over the past several years, a number of experimental facilities have been shut down and others are in danger of being closed in the future. Consequently, concerns have been raised as to the ability of individual OECD/NEA member countries to maintain critical competence and to focus on important safety areas unless practical countermeasures are put in place. International cooperation can help provide a solution and makes economic sense.

The responsibility of the CSNI entails, inter alia, the conduct of research in support of the resolution of outstanding safety issues, the maintenance of a sufficiently valid technical infrastructure and expertise and the promotion of cooperation on safety research in OECD member countries. The establishment and operation of OECD/NEA joint projects constitutes one means for carrying out these CSNI tasks.

This section provides an overview of the joint projects being carried out under OECD/NEA auspices with a view to preserving technical infrastructure

TABLE 1. CURRENT OECD/NEA JOINT SAFETY PROJECTS

Project name	Subject	Host country
HALDEN	Fuel and materials, I&C, human factors	Norway
CABRI	Fuel in RIA transients	France
SCIP	Fuel integrity	Sweden
ROSA	Thermal–hydraulic (T–H) transients	Japan
PKL	PWR T–H, boron dilution	Germany
SETH	Containment (T–H, CFD)	Switzerland
PSB-WWER	WWER 1000 T–H transients	Russia
MASCA-2	Severe accidents (in-vessel)	Russia
MCCI	Severe accidents (ex-vessel)	USA
PRISME	Fire propagation	France
SCAP	Ageing (SCC and cable)	Japan
COMPSIS	Database, computerized system events	
FIRE	Database, fire events	
ICDE	Database, common cause failures	
OPDE	Database, piping failures	

and competence in critical safety research areas. In particular, it describes the joint projects that were set up to address safety relevant issues by means of experimental programmes carried out at specialized facilities. The databases created in support of operating experience evaluations are also described.

4.1. Overall scope

There are currently 15 OECD/NEA joint projects being carried out in the nuclear safety area (Table 1), which can broadly be divided in the following categories:

— Fuel projects, which deal with matters related to assessments of fuel behaviour, fuel limits and fuel margins in a variety of operational or anticipated accident conditions. These investigations normally require large and expensive experimental infrastructure, and in some cases unique capabilities, such as test reactors and specialized hot cells. It is common that regulators and industry participate jointly in these projects, partly because cost sharing among several parties is a practical way to carry out the programmes, but more importantly because industry cooperation is essential for obtaining the fuel or material specimens required for the experiments.

- Thermal–hydraulic projects, mainly dealing with postulated accidents like the LOCA and other thermal–hydraulic transients that are identified as the dominant safety concern for water reactors. As full scale experimentation is not feasible in most situations, significant computational capability is needed to simulate such transients properly, as required for the safety case of these reactors. The CSNI has always considered with great attention the issue of thermal–hydraulic code validation, as well as the experimental database needed for such validation.
- Accident assessment projects, currently including two experimental projects on severe accident scenarios following core damage and melting, and one experimental project dedicated to simulations of a variety of fire propagation scenarios relevant for nuclear power plants. Prevention and control of fire propagation are considered to be major contributors to reducing accident risk in nuclear installations, while prevention and mitigation of severe accidents are the largest contributors to reducing the potential risk to the public arising from plant operation.
- Database projects, which have the main function of gathering important data and information on operating experience regarding equipment malfunction or failure. These databases are intended to form the basis for lessons learned and for measures dealing with replacements or preventive maintenance. International cooperation is essential in order to incorporate experience that is as broad as possible on events that are by nature relatively rare.

4.2. Project setup and organization

The process for setting up an OECD/NEA joint project normally begins on the initiative of a member country, as a follow-up to a specific CSNI recommendation. The CSNI determines the steps to be followed during the establishment phase, but once a project is started, the responsibility for its execution resides with those parties that have decided to join it. The projects are thus run in a relatively autonomous fashion, where the participants who have taken responsibility for funding the project define the details of the programme.

As no funding is set aside beforehand, the project financing has to be sought on a case by case basis. The ability of the proposed programme to attract a large number of participants is therefore critical in order to arrive at a satisfactory cost sharing arrangement. For the experimental projects, it is customary that a major part of the project cost, typically 50%, is covered by the host country (the country in which the experiments are to be carried out).

A so-called operating agent has responsibility for carrying out the programme according to the instructions given by the steering body, which is made up of project participants. In addition to providing technical guidance, the steering body also delineates the project's main administrative rules — concerning deliverables, for example — ways of reporting and limitations on data dissemination.

The OECD/NEA's role is to facilitate the project's establishment and execution in accordance with CSNI instructions. It ensures that the programme is run according to sound principles of transparency and efficiency, that the work scope adequately balances the expectations of the various participants and that consensus solutions are suitably reflected in the programme. The experience gained with the Halden reactor project, which has been run successfully for almost five decades, constitutes the basis and terms of reference for most other OECD/NEA joint projects.

The experience with the operation of OECD/NEA joint safety projects is generally very good. The project agreements contain provisions for dealing with situations where there is a lack of consensus, but fortunately these provisions have never been used. In general, there is a shared understanding among participants that consensus must be sought for an orderly conduct of the project and for obtaining results that will, in the end, be valuable to everyone.

It is common practice for analytical activities dealing with data prediction and interpretation, model development and computer code validation to be performed by some or all project participants in parallel with those of the project. These analyses constitute a very valuable complement and an additional benefit of the OECD/NEA safety projects. They contribute to maintaining or improving expertise and analytical tools in OECD member countries, to enhancing technical exchange among specialists and to promoting consensus building on approaches to resolving safety issues. As for the future, possible challenges might include being able to respond to multiple demands for new projects while maintaining quality and efficiency, as well as a sufficiently large degree of participation and cost sharing. Increased industry participation in the projects might help this development and would be desirable for several reasons.

Experience has shown that all OECD/NEA joint safety projects entail substantial analytical activity, which accompanies the execution of the experimental programme. This activity is centred on code assessments and validation, and where suitable, on model development. Code benchmarking or analytical exercises consisting of both pre-test and post-test calculations are organized among project participants, always bearing in mind the data utilization for the reactor case. This extensive analytical effort has proven to be a very efficient way to maintain or develop relevant technical expertise. For database projects, workshops are organized when appropriate in order to assess the main outcomes of the data collected and the main lessons learned from the events contained in the databases.

5. CONCLUDING REMARKS

The first priority for OECD/NEA member countries is safety and regulation, and the CSNI has been supporting OECD/NEA safety institutions in safety assessment and safety research. The CSNI is the first international concerted response for enhancing technical exchange, cooperation and consensus building. CSNI products like SOARs or ISPs have been key contributors to national safety assessment practices. The OECD/NEA joint research projects have contributed to addressing common safety concerns and to retaining countries technical expertise and infrastructure in strategic fields of nuclear safety. In summary, from the OECD/NEA's perspective, concerted actions among technical safety institutions should build on the successful framework existing today.

CLOSING SESSION

Chairperson

LI GANJIE
China

SUMMARY AND CONCLUSIONS OF THE CONFERENCE*

Li Ganjie
President of the Conference

BACKGROUND

The peaceful uses of nuclear energy and ionizing radiation are currently experiencing a period of unprecedented change. The nature and pace of this change is affected by many factors — technological, economic, environmental, political and social. These factors not only influence the governmental and business environment in which the nuclear industry operates, but they also impact other stakeholders, the media, the public and international organizations. These developments have already resulted in significant changes to how nuclear enterprises are organized and operated. They can be expected to continue and even accelerate as new projects and designs for reactors and other facilities and new approaches to nuclear safety emerge.

It is essential that high levels of nuclear and radiation safety be maintained worldwide throughout this period of change and for the lifetime of nuclear facilities, including site and waste management legacies. Effective, efficient and independent regulatory bodies must be established and maintained in all countries utilizing nuclear energy to ensure that nuclear activities are conducted safely and securely, consistent with national standards and international good practices. In this respect, it is of the utmost importance that all countries and expert organizations involved in nuclear related activities participate as active partners in the Global Nuclear Safety Regime.[1] This participation includes uses of ionizing radiation in medicine, industry, agriculture and the safe management of radioactive waste and transport of radioactive material.

Nuclear and radiation safety are based on technical, managerial, administrative, economic and organizational requirements. In this respect, the

* The opinions expressed in this summary — and any recommendations made — are those of the President of the Conference and the participants, and do not necessarily represent the views of the IAEA or its Member States.

[1] The Global Nuclear Safety Regime is the framework for achieving the worldwide implementation of a high level of nuclear safety.

role and quality of technical and scientific expertise in the nuclear industry and of regulatory systems are of fundamental importance.

Technical and scientific support organizations (TSOs), whether part of a regulatory body or a separate organization, are gaining increased importance in providing the technical and scientific bases for decisions and activities regarding nuclear and radiation safety. International organizations such as the IAEA and the OECD Nuclear Energy Agency (OECD/NEA) also rely on the active contribution of TSOs. In the light of the important role played by TSOs, it is essential that these organizations conduct their work consistent with the highest levels of technical competence and transparency, and with the observance of ethical principles. To enhance their capabilities in these areas, TSOs need to foster cooperative activities among themselves and other relevant organizations, whether on an ad hoc basis or in the framework of regional or multilateral arrangements and institutions.

Recognizing the need for TSOs to broaden their cooperation, the IAEA has sponsored this first international conference specifically addressing the role TSOs can play and the challenges they face in enhancing nuclear safety. It is hoped that the conference provided a platform for further promoting and strengthening international nuclear and radiation safety cooperation to enhance the Global Nuclear Safety Regime.

CONFERENCE OBJECTIVES

The objective of the conference was to provide TSOs from different countries and other organizations and experts the opportunity to discuss and develop a common understanding of the TSOs' responsibilities, needs and opportunities. A further objective was to explore appropriate approaches for addressing current and expected challenges in nuclear and radiation safety and to discuss the roles, functions and value of TSOs, sharing their knowledge and experience. These exchanges should begin a continuing dialogue on technical, scientific, organizational and legal aspects of the work of TSOs, thereby promoting expanded cooperation and networking among TSOs at the international level.

OPENING ADDRESSES

H. Revol (France), Chairman of the French Parliamentary Office for Evaluation of Scientific and Technological Options (OPECST), Standing Committee on Nuclear Affairs, welcomed the participants to Aix-en-Provence and noted that the conference would be important in confronting the challenges of nuclear energy development. He described recent progress in modernizing the legislative framework for nuclear safety in France through the adoption of three new laws in 2005 and 2006. He identified four challenges in the fields of nuclear safety and radiation protection that could benefit from the activities of TSOs. These include: waste management, older operating reactors, new generations of nuclear reactors and expansion of nuclear power to countries not previously using this energy source. He made a strong plea for international cooperation and pooling of resources to address these challenges.

T. Taniguchi (IAEA), Deputy Director General for Nuclear Safety and Security of the IAEA, noted that this was the first international conference to specifically address the activities of TSOs. The conference was intended to build on the results of the 2006 Moscow conference on effective nuclear regulatory systems. He described the current situation and developments in the field of nuclear energy, including the expected nuclear renaissance or “vita nova” that could be expected to engage the work of TSOs. He noted the gap between ambitious plans for nuclear power development and corresponding plans for nuclear safety regulation. Strengthening technical and scientific support for nuclear safety would require increased effort, including networking and knowledge sharing between TSOs and other participants in the nuclear field and development of a Global Nuclear Safety Regime. He concluded by emphasizing six actions that could be useful:

— Networking among TSOs to share information and resources;
— Identifying and addressing safety research needs;
— Ensuring adequate competence and independence of TSOs;
— Building confidence among expert communities and the public;
— Enlarging the role of TSOs in developing IAEA safety standards;
— Supporting development of safety infrastructure in countries with limited experience that are embarking on nuclear power.

J. Repussard (France), Director General of the Institut de radioprotection et de sûreté nucléaire (IRSN), noted that the purpose of the conference was to determine what TSOs could do to enhance nuclear safety. He discussed recent and near term future developments in the nuclear field that have affected the roles of TSOs. He identified several interlinked challenges that need to be addressed with support from TSOs, including:

— Technical availability;
— Human resources and capital;

— Public acceptance;
— Visibility and effectiveness of the licensing process.

He discussed the experience of IRSN as a TSO, including its competence and relationships with other relevant French bodies, including operators, Government authorities and stakeholders. He noted that there was little established doctrine on TSOs at the international level and that there were great differences in situations between regions and nations. He noted the absence of an IAEA service to assess TSO performance and the lack of an accepted vision of requirements for technical support. He outlined a possible agenda for further international cooperation including: clarification of the key concepts for TSOs; improved bases for cooperation, including networking; shared and coordinated safety and radiation protection infrastructures; and a peer evaluation system to enhance excellence.

Li Ganjie (China), President of the Conference and Vice Minister of China's State Environmental Protection Administration, noted the need to promote and enhance nuclear safety in view of the expected nuclear renaissance. He noted that much valuable work had been done in this field in establishing legislation, regulatory frameworks and developing a nuclear safety culture. He noted the increasing importance of TSOs for both regulators and operators in enhancing safety. He hoped that the conference would contribute to a Global Nuclear Safety Regime by promoting cooperation between TSOs and other relevant organizations in the nuclear field.

KEYNOTE ADDRESSES

Three keynote addresses set the scene for the conference, identifying major challenges faced by TSOs and relevant stakeholders.

P.B. Lyons (United States of America), Commissioner of the United States Nuclear Regulatory Commission (NRC), delivered a presentation on managing technical support organizations at the NRC. He noted that diverse challenges require diverse approaches and described the broad range of TSO support utilized by the NRC. He discussed the economic aspects of TSOs in view of the NRC's funding arrangements and noted the issue of maintaining the independence of regulatory decision making while taking advantage of sharing the costs of technical analysis. Avoiding conflicts of interest is an important legal requirement for the NRC, and Lyons described several means through which this was achieved. He noted the great value of collaboration between international bodies and TSOs and the need for regulatory bodies to determine their TSO support requirements. He supported a strong continuing commitment to international research collaboration.

B. Thomauske (Germany), Managing Director of Vattenfall Europe Nuclear Energy GmbH, delivered a presentation on the perspectives of the operator/industry that identified a number of factors affecting the roles of TSOs including the expected nuclear power renaissance, the merger of some TSOs with energy producing companies and differences in standards and regulatory arrangements in different countries. He felt that dependence on TSOs could pose issues in view of the need for expertise, particularly if there is an expansion of the nuclear industry. He noted the difference in expertise required for operators (specific and detailed) and regulators (generic). He noted the need to ensure both economic and institutional independence of the TSO from the supported organization. He advocated the establishment of an international TSO platform in which all TSOs could participate in harmonizing safety standards and exchanging information.

M. Sené (France), Vice President of the Association Nationale des Commissions Locales d'Information (ANCLI), presented "ANCLI-CLI: Mediators of Access to Information and Expertise — A Tool at the Service of the Public". She described the history and activities of ANCLI and the local information commissions (Commissions Locales d'Information, or CLIs). The CLIs provide a means for exchanging information on existing and proposed nuclear sites between operators, regulators and stakeholders, especially the public residing near a facility. She also described the publications issued by ANCLI on the local governance of nuclear facilities and on nuclear waste, as well as the creation of an international body in Europe (EUROCLI) to share information for the purpose of enhancing safety and the quality of decision making on nuclear related issues. She emphasized the importance of this mechanism for permitting the expression of public views on major nuclear issues, including reactor safety, waste management, radiation protection, transport and protection of the environment.

TOPICAL ISSUE 1: ROLES, FUNCTIONS AND VALUE OF TECHNICAL AND SCIENTIFIC SUPPORT ORGANIZATIONS

This session provided an overview of the role of TSOs in enhancing nuclear and radiation safety. The presentation on the roles, functions and value of TSOs gave a broad description of the concept of TSOs. The main roles of a TSO supporting a regulatory body and industry were addressed, namely:

— Supplying the technical and scientific bases for regulatory decisions (in some countries providing safety assessments and conducting inspections and drafting regulations);
— Supporting industry by providing assessments of plant operations, resolving technical issues and advising on important modifications;
— Supporting authorities in the field of emergency planning and response.

To maintain their knowledge, TSOs need to be on the frontline of technological development and should participate in national and international R&D programmes and networks for the exchange of information and lessons learned. Technical and scientific support organizations can also contribute towards increasing public confidence by providing information on the scientific bases of decisions, independent of political and economic interests.

In a presentation on independent technical and safety advice for regulatory decision making, the role of TSOs as a support for regulatory bodies was pointed out. The need for comprehensive know-how and know-why on nuclear science and technology as a whole and on the technical aspects of nuclear installations was emphasized. This comprehensive knowledge can only be achieved if the TSO is involved in the nuclear licensing and supervision process and participates in large R&D projects. The presentation discussed requirements for an effective regulatory process, emphasizing the role of contracting partners. Also discussed was TSO support for a regulator in various functions, including preparation of rules and regulations, licensing, operating experience feedback, inspection and R&D. The important role of international exchanges and networks was emphasized.

In a presentation on the relevance of TSOs in providing technical and scientific services to the operator/industry, it was emphasized that plant safety and economics are largely affected by the TSO's skill and confidence combined with those of the operator. The relationship between TSOs and their counterparts, such as architect–engineering firms, vendors and construction companies, was discussed. The role of the Korea Power Engineering Company, Inc. (KOPEC) in Korea was detailed, concluding that KOPEC is able to enhance plant safety and performance without losing the benefits of standardization.

A paper on the development and maintenance of the technical and scientific base focused on the central role of the knowledge base in supporting TSO activities, emphasizing the importance of maintaining, implementing and managing such knowledge. Suitable programmes need to be established to support acquisition and assessment of the knowledge base. To be able to respond to the expectations of stakeholders, TSOs need to be familiar with the installations, their operation and a large number of specialized technical issues. Moreover, they should possess a body of well established methodologies and concepts to perform the integration of various aspects of their assessments. Several areas for future expansion of the knowledge base in the field of operating plants were identified, including uncertainties in knowledge, fuel and ageing, public expectations, and human and organizational factors. The urgent need to begin preparation for future challenges facing TSOs for ensuring the safety of Generation IV plants was emphasized.

The paper on the role of the TSO in public information/debate, openness and transparency focused on the support provided by TSOs in public information and in the debate on nuclear energy issues in Finland. The presentation discussed means for transmitting concrete, useful information to a large spectrum of stakeholders by adopting non-specialist language and making technical subjects accessible to non-specialists. A catalogue was presented, including publication of research results, provision of background information and other material. It was emphasized that the views expressed should be balanced in the sense that they should not be interpreted as advocating nuclear power as the only acceptable alternative energy source. Finally, the presentation described the collaboration between the regulator (the Radiation and Nuclear Safety Authority (STUK)) and the TSO (the Technical Research Centre of Finland (VTT)) in applying these measures.

Discussion following these presentations focused on three subjects.

— *TSO independence:* While the principle of TSO independence was broadly supported, different opinions were expressed on specific aspects of how this was to be implemented. One participant stated that: “What is actually important for TSOs is their capacity to deliver good advice, supported by their technical competence”. One participant questioned whether it was possible to develop absolute criteria for independence. Another emphasized the need for TSOs to be separated from safety authorities and operators to ensure independence. Wide agreement on the need for functional separation was confirmed, but it was recognized that arrangements for this can vary from country to country. Seeking a reasonable compromise between protecting independent advice and maintaining technical expertise was noted as a possible issue. Strong support was expressed for separate financing of TSOs to avoid dependence.

— *Public acceptance:* It was widely agreed that open-mindedness and the capacity to present and explain technical matters to the public in a clear and accessible way are vital to a TSO’s credibility. Technical and scientific support organizations should contribute to informing the public through various available means.

— *Safety infrastructure and safety culture in new nuclear nations:* It was emphasized that developing countries and newcomers to nuclear power needed to develop strong regulatory structures and their own information base for nuclear safety. Although some duplication cannot be avoided, external support from developed nuclear countries and international organizations cannot replace needed expertise. Such expertise typically requires a long learning process and the means for maintaining the knowledge base. It was emphasized that each country needs its own regulatory structure, regulations and resources sufficient to make proper use of TSO expertise. In the context of this issue, the IAEA Secretariat referred to the upcoming "International Conference on Topical Issues in Nuclear Installations Safety – Sustainable Nuclear Safety in the Face of Potential Nuclear Development", to be held in 2008.

TOPICAL ISSUE 2: CHALLENGES FACED BY TSOs AND TSO EFFECTIVENESS

This session noted that TSOs are assuming greater importance in global nuclear development, making it particularly important to identify the current and future challenges they face and the means for addressing them.

The conference identified several key challenges faced by TSOs related to globalization, regulatory and management issues. These challenges seemed to fall into two categories: those that are current and newly emerging and those that have been present for some time on a long term basis.

New and current challenges include:

— A changing global environment, including renewed interest in the use of nuclear energy for electricity generation and, consequently, the likely worldwide expansion of its use;
— New concepts and technology such as Generation IV reactor designs and the International Thermonuclear Experimental Reactor (ITER);
— Keeping pace with the evolving science and technology;
— Stronger market competition in the energy sector.

Existing or long term challenges include:

— Ageing workforce and knowledge management;
— Maintaining and enhancing technical and scientific competence;
— Enhancing regulatory effectiveness;
— Ensuring adequate financial and human resources;

— Enhancing excellence in management;
— Ensuring confidence of stakeholders and the public;
— Developments in the understanding of the potential health effects of acute and chronic radiation exposure.

From this perspective, there is an urgent need to clarify the legal status, credibility and confidence regarding TSOs. In the light of the fact that no generally agreed definition of a TSO has been adopted by the international nuclear community, the importance of clarifying this matter was emphasized. Also, the independence of TSOs was discussed, and it was suggested that the primary focus in this regard should be the need to ensure independence of the advice from the TSOs to the client, rather than merely organizational relationships. However, the effective separation of functions in situations where a TSO provides advice to both the regulator and operator is important. Aspects of independence that were identified as particularly important were those related to political, legislative, financial and competence matters. Moreover, the roles of the TSO should also be discussed and clarified (e.g. whether or how a TSO should participate in regulatory functions such as inspection). Ensuring the credibility of TSOs was an issue of importance to many participants. It was suggested that various aspects of this issue should be addressed, including: competence, independence, transparency, integrity, efficiency, responsiveness and accountability. It was also suggested that external reviews or formal accreditation could play an important role in enhancing TSO credibility.

Some of the options or approaches for dealing with these issues that were discussed include the following:

— Interpretation of existing international instruments (e.g. in the framework of review meetings of relevant conventions);
— Development of a code of conduct for TSOs (elements for a possible code were discussed);
— Including aspects relating to TSOs in the revision of existing IAEA safety standards documents;
— Development of new IAEA guidance documents (an outline similar to those offered for a code of conduct was suggested as a first basis for work);
— Taking the opportunity afforded by IAEA conferences and other international meetings to clarify these issues.

The need for qualification of TSOs was addressed in the light of the importance of having adequate management and quality of the technical services delivered, as well as ensuring credibility and continuous improvements in the processes for ensuring safety. It was suggested, for TSOs supporting regulators, that regulators either designate TSOs directly, or work through a system of accreditation. For the qualification, appropriate requirements or criteria need to be developed. The qualification requirements or criteria need to address the organizational setup, personnel qualifications, work processes and equipment of TSOs. Also, the role and usefulness of international peer reviews were discussed, and a suggestion was made to start working in this direction.

In a presentation by the Australian regulator, the importance of having access to a range of expert support bodies in different countries was emphasized. Moreover, under national law in Australia, the regulator is required to consider international best practice in reaching its regulatory decisions. Therefore, broad international and bilateral cooperation made a major contribution to the quality of safety decision making on the construction of Australia's new research reactor. It was noted that the regulatory body in Australia continues to face significant challenges in maintaining a sustainable core of key expertise in-house for the purpose of assessing the quality of outside advice. This challenge is shared by many other countries with smaller nuclear programmes.

With regard to developing international guidance on TSOs, the opinion was expressed that the international nuclear community should move slowly and with caution. This view received general support in the session.

The establishment of a strong and competent regulatory body was considered essential for future nuclear development, particularly in countries moving toward nuclear power for the first time.

The need to differentiate between the enhancement of the capability of regulators and the specific needs for research was emphasized. In both areas, the need for international cooperation was supported.

The human resources issue was addressed in the paper on the situation in Canada, where stagnation of nuclear activities had been experienced. The initiative to attract young and bright professionals to the nuclear community through university networks was explained.

Regional sharing of TSO services was discussed as one means to compensate for scarce resources at the national level. Also, for countries considering the introduction of nuclear power for the first time, this was thought to be an option.

In summary, it was emphasized that a step by step approach should be adopted by the IAEA in order to pursue the issues with TSOs identified in this session. The importance of TSOs in both the national and international context and the need for enhanced networking between them was supported.

TOPICAL ISSUE 3: INTERNATIONAL COOPERATION, NETWORKING AND APPLICATION OF IAEA SAFETY STANDARDS

This session of the conference focused on continuous improvement of the technical and scientific capabilities and expertise of TSOs and the contribution of TSOs to the enhancement of the Global Nuclear Safety Regime. In particular, it addressed the need for international cooperation and for performing research on safety related issues to maintain and enhance the technical capabilities and expertise of TSOs. It was also stated that the cooperation should comprise an intense exchange of or even participation in up to date scientific and technical developments and research. The conference underlined the importance of ensuring that TSOs are always familiar with the international status of research and technology and that they have a comprehensive knowledge of international guidance documents. International exchange of knowledge and sharing of experience and feedback are essential to maintaining and enhancing TSO competence.

This cooperation could be multiform, such as multilateral, sub-regional, regional and bilateral cooperation. Cooperation at the regional level is thought to be of great value. Governments and relevant international organizations should encourage and support such cooperation.

Technical and scientific support organizations are now playing a vital role in developing national safety regulatory frameworks, in facilitating the use and application of IAEA standards and in facilitating the implementation of the international legal instruments.

IAEA safety standards are extremely valuable to guide national regulatory activities. However, they need to be continually updated to reflect new developments. Technical and scientific support organizations should be more involved in this process and make a greater contribution to developing these standards. At present, only a few TSOs are involved in the development of IAEA safety standards. Also, current IAEA guidance documents do not adequately address the status and responsibilities of TSOs. The conference underlined the need for active involvement of national regulatory bodies and TSOs in the practical application of the safety standards. It was stated that a possible means of reinforcing international cooperation among regulators and TSOs would be the effort to achieve harmonization of standards and practices.

The IAEA should develop a peer review service dedicated to TSOs, similar to the Integrated Regulatory Review Service (IRRS), to review the qualification and effectiveness of and to share good practice for the TSOs of Member States. Peer reviews between TSOs are also thought to be very beneficial.

So far, extensive bilateral technical cooperation between TSOs has been conducted. Regional cooperation is also being conducted (e.g. in the European TSO Network and the RCOP, a cooperative project among China, Japan and the Republic of Korea).

The establishment and broader use of information networks and databases to enable TSOs to share knowledge, experience and advice are necessary. At present, the Asian Nuclear Safety Network and the European TSO Network might be potentially useful models for sharing relevant information between States.

Broader international cooperation and networking are needed with regard to countries with emerging nuclear programmes to ensure that a high level of safety is achieved. The IAEA should support TSOs of Member States, especially in States with emerging nuclear programmes, with the aim of building infrastructures and developing the knowledge base for safety.

The conference suggested that the IAEA facilitate the establishment of an international platform for cooperation between TSOs. Such cooperation could include establishing a mechanism for regular communication among TSO personnel, for example, developing a professional web site for TSOs as a platform for communication. This would help overcome language barriers and regional differences, thus expediting information transfer and sharing. The IAEA might also establish a network of TSO experts, which would provide Member States with technological consultation and expert support and assistance for national TSOs when necessary.

TOPICAL ISSUE 4: PERSPECTIVES ON THE EVOLVING NEEDS FOR TECHNICAL AND SCIENTIFIC SUPPORT

This session of the conference focused on the need for TSOs to keep pace with changes in nuclear technology, so that they can continue to provide optimum support for enhancing nuclear and radiation safety. Presentations at the session emphasized the perspectives of key participants in the nuclear development process: regulatory bodies, the nuclear industry, users of nuclear applications, local authorities and an international agency, the OECD/NEA.

From the regulatory perspective, four primary challenges were identified: new installations, existing installations, a continuous process for safety and a broad vision of safety. These challenges were discussed in detail, with examples provided. It was emphasized that a broad vision of safety is necessary and that if processes to ensure safety do not progress, they regress. Consequences of these challenges for regulators were discussed. They include a change in the quantity of needed experts; developing competencies in new domains, including human and organizational factors; and developing competencies in difficult areas, such as instrumentation and control and criticality. The involvement of TSOs in nuclear safety research was also discussed, including the need to ensure the capacity to conduct such research, to operate facilities and to ensure adequate overview. Some issues for TSOs and their clients include harmonization of practices among TSOs, pooling and sharing of competencies and structures, and possible international reviews of TSOs. It was emphasized that there can be no national answers to these challenges; rather, they must be addressed on an international basis.

The presentation on the industry perspective began with a summary of the role of TSOs in the development of India's nuclear programme. The diversity of TSOs has been a positive aspect of the Indian programme, for both the industry and the regulator. Diverse challenges confront the nuclear industry, including ageing facilities and management structures, leading to the need for increased inspections and handling of obsolete features. Evolving regulatory requirements also create a moving target for industry and TSO work. For example, increasing regulatory emphasis on probabilistic safety assessment, risk informed regulation, quality assurance and computer based systems are challenges for the industry and TSOs. New reactor designs also pose issues of competence. International networking and cooperation are very important for many countries. It was pointed out that networking opportunities for design organizations do not currently exist and that it would be desirable to develop appropriate forums for information sharing in this area. A platform for networking of TSOs would be desirable for the industry.

From the user perspective, it was felt important to ensure the technical basis for continued operation of existing plants, seeking out issues that could impact either operating reactors or future designs and maintaining a clear understanding of the regulatory context of a TSO's work. The legal basis for the NRC's within-agency TSO — the Office of Nuclear Regulatory Research — and its key functions were discussed as an example of a user organization. Basic capabilities of the organization include:

— Independent technical insight;
— Issue assessment;
— Method and tool development;
— Future issue identification;
— Regulatory guidance promulgation.

An IAEA initiative to convene regional TSO workshops could be useful, possibly with separate workshops for regulatory TSOs and industry TSOs.

From the perspective of local authorities, several basic principles were emphasized. These include:

— The local population’s safety is not negotiable;
— Transparency and access to information are necessary to enable citizens to make decisions;
— Local communities should take part in decision making on nuclear development;
— Radioactive waste must be responsibly managed;
— Economic development of affected areas must be sustained and integrated.

Several examples of industrial development affecting a locality were discussed, including a nuclear facility. It was emphasized that in cases where controversy exists, strong and acknowledged technical and scientific support is vital to ensuring an orderly and deliberate debate. In this regard, TSOs can make an important contribution to decision making affecting localities.

The final presentation on this topical issue presented information concerning the activities of the OECD/NEA to enhance cooperation on nuclear safety assessment and research. Three specific areas conducted under the auspices of the OECD/NEA Committee on the Safety of Nuclear Installations (CSNI) were discussed: the Safety Margins Action Plan, the SESAR/SFEAR report to identify facilities important for safety and a significant number of joint projects on nuclear safety conducted since 2000. From the perspective of the OECD/NEA, it would be valuable to build on the successful framework developed over the past years by CSNI. Such joint research contributes to addressing common safety concerns and retaining technical expertise and infrastructure in strategic fields relevant to nuclear safety.

A number of additional contributions were made during discussions following the presentations. One person noted the variety of TSO activities, needs and demands, and suggested that the two most important conditions for public acceptance were transparency and independence. He asked what the ideal contractual arrangements and legal structure would be to secure these conditions. If multilateral cooperation was to help more than bilateral contacts, he felt that a code of conduct could be important, with distinctions between TSOs working for regulators and those working for operators, and clearer parameters for IAEA review missions. Another participant noted that such parameters do not currently exist at the IAEA and should be developed. Another person noted that there was a long term ‘road map’ for nuclear development that must be respected. Regulatory changes regarding TSOs should not negatively impact the technical capacities of these organizations. He indicated that some TSOs (including his own) have their own codes of conduct that guide their activities and that the IAEA could usefully provide help to Member States to develop common elements. The representative of a new TSO noted the difficulty of hiring sufficient qualified personnel, particularly because salaries were not equivalent to those offered by other organizations in the nuclear field. Further international cooperation could be of value, including an international association of TSOs. The head of one regulatory body suggested that further efforts regarding TSOs be modest and cautious, in view of the fact that there is no single, ideal structure for such bodies. He urged that relevant organizations be “rigorous about principles, but pragmatic about their application”. Other contributions emphasized the need for TSO independence and the need to ensure public acceptance. One individual asked how TSOs could help countries aspiring to nuclear power reduce the time necessary to introduce this technology.

PANEL DISCUSSION: STRENGTHENING TECHNICAL AND SCIENTIFIC SUPPORT: RECOMMENDATIONS FOR THE FUTURE

At the beginning of the closing session, a panel of heads of nuclear organizations (TSOs, regulatory bodies and institutes) made brief statements addressing the following questions:

— What is the main contribution of TSOs to enhancing nuclear safety?
— What is the main challenge faced by TSOs?
— What should be done in the short and medium term to enhance TSOs?

J. Repussard (France) discussed a ‘road map’ for national nuclear capability having three elements: (i) establish technical and scientific competencies; (ii) differentiate between the regulatory authority and the operator; and (iii) separate technical assessment capabilities. Technical and scientific support organizations can help in all three areas, bridging gaps though establishing a ‘toolbox’ of reference models and achieving mutualization through networking or other cooperative activities. Means for accomplishing this can include harmonizing safety doctrine, providing mutual assistance on safety tools, mutualizing safety research, facilitating peer reviews and supporting the technical dialogue between all concerned stakeholders.

J.-J. van Binnebeek (Belgium) identified human resources management as a major challenge, along with maintaining and renewing expertise. Networking can be very important in setting priorities and finding resources. He urged the consideration of qualification on the basis of the TSO’s end user specifications using a 'bottom–up' pragmatic approach that avoided 'reinventing the wheel'. Efforts should only "harmonize what needs to be harmonized".

H. Nariai (Japan) saw the need for TSOs to maintain and constantly enhance their technical expertise through collecting the latest technological knowledge, securing human resources, transferring technical knowledge to future generations and establishing effective knowledge bases. He also emphasized the importance of global and regional cooperation and networking among TSOs for coping with the current and future challenges that they face.

B. Gordon (Russian Federation) emphasized the need to focus on probabilistic analysis aimed at improving regulatory requirements as a priority. He advocated regular TSO conferences sponsored by the IAEA.

S.K. Chande (India) noted that different TSOs face different challenges depending upon their role and historical evolution. Some common challenges were resource and human resources problems, new design concepts and new technologies. Effective international cooperation is important in several areas, including harmonized technical requirements, standardized designs and technologies, and common technical problems. Such cooperation will also help in the coordination of activities of different organizations, improvement in transparency and avoidance of problems in one country that can set back the programmes in other countries. He also noted the importance of open access to technical experience feedback and sustained technical support, particularly to those countries with emerging nuclear power programmes.

J. Ždárek (Czech Republic) felt the major TSO contribution was to identify technical problems and propose solutions. Main challenges include explaining issues to different audiences, resources and financing, ageing of staff and work overloads associated with current and future technologies. Future work is needed on basic support for TSOs, including staff ageing. Networking should include both regulators and operators.

C. Waeterloos (European Commission) noted the need for an evolution of TSOs along the lines that has occurred with regulatory bodies. Clarifications are needed in the relations between TSOs and their clients. Challenges include coping with increased responsibilities in a variety of areas (radiation protection, security and safeguards), addressing global safety concerns and reassuring the public on safety issues. He noted that the European Commission is launching an initiative with senior regulators on safety and that a parallel effort is needed with TSOs.

In the discussion that followed, several points were made. Networking was supported by several speakers, noting that smaller countries in particular could benefit from such efforts. One speaker expressed the need for a conference addressing the role of TSOs in countries newly moving toward nuclear power. President Li Ganjie (China) concluded the panel discussion with a review of activities in China, joining others in the emphasis on independence and transparency of TSOs.

CONCLUSIONS OF THE CONFERENCE

The conference thanked the Government of the France, in particular the IRSN, for hosting this important conference, in partnership with the IAEA.

The conference concluded that TSOs are playing, and will continue to play, an important role in the safe and secure use of nuclear energy and associated technologies. Thus, TSOs are an essential participant in efforts to achieve global energy security and sustainable development.

Some TSOs provide technical support to both regulators and industry. However, there are important differences between the roles of TSOs that provide support only to regulatory bodies and those that support operating organizations. Consideration should be given to how these differences could impact the future activities of these organizations. To be effective, TSOs must have a strong knowledge base and technical infrastructure. Technical and scientific support organizations should be able to provide independent technical and scientific advice without pressure from regulatory bodies, industry or other stakeholders.

Technical and scientific support organizations must be competent and have adequate resources to effectively perform their mission, which is to provide credible technical and scientific expertise to their stakeholders. International cooperation between TSOs is very important for ensuring and continuously improving their ability to provide services necessary for safety.

The conference stressed that TSOs should give more attention to conducting research work aimed at ensuring the safety of existing and future facilities and activities. Common nuclear safety research projects should be developed among different kinds of TSOs, using existing frameworks to the extent possible, in particular those provided by the IAEA and the OECD/NEA.

The conference noted that existing international legal instruments and guidance documents provide only very general information on the legal status and roles and responsibilities of TSOs in enhancing the safety of nuclear energy and ionizing radiation. Developing more focused guidance regarding the status and roles of TSOs could be useful. However, it was emphasized that the IAEA should take a cautious approach to developing new guidance documents until adequate consideration has been given to basic issues regarding TSOs.

Technical and scientific support organizations should become more involved in supporting regulators in the process of developing IAEA standards and make a more active contribution to the enhancement of the Global Nuclear Safety Regime through a proactive approach.

Technical and scientific support organizations are now facing many challenges, such as confidence, independence, scientific competence, human resources, qualification, funding and long term planning.

The conference affirmed the importance of establishing means for improved international networking to share knowledge and experience on technical and scientific practices, and agreed that the TSOs should meet regularly to discuss common challenges and to share experience.

RECOMMENDATIONS

Following from the conclusions discussed above, the conference identified a number of recommendations that should be considered by TSOs, regulatory authorities, national governments, relevant international and regional organizations, the nuclear industry and stakeholders.

— The IAEA should facilitate the establishment of new networks or enhancement of existing networks on regional, international or topical bases between TSOs and other relevant bodies to enable TSOs to more effectively cooperate and share knowledge, experience and advice. In this respect, the enhanced networks between TSOs could also assist individual countries in utilizing the services of TSOs.

— Technical and scientific support organizations providing services to regulators and those supporting industry may find it to be in both their interest to work together on common research on nuclear and radiation safety using the existing frameworks where feasible, in particular those provided by the IAEA and the OECD/NEA.

— The IAEA should take the initiative in responding to the questions raised in Member States with respect to the roles and activities of TSOs in enhancing nuclear safety. The IAEA should proceed in a cautious, step by step and deliberate manner to consider relevant issues and approaches, without jeopardizing existing arrangements between regulators and TSOs.

— In this initiative the following questions may be addressed, taking into account the different needs and requirements of the end users of TSO

services and the variations at the national level and according to organizational background:
- Definition and concept of TSO;
- Clarification of terminology regarding TSOs;
- Objectives and roles of TSOs and related needs of qualification and technical competencies;
- Differences among types of TSO;
- Human and financial resources;
- Relationships of TSOs to regulatory bodies, industry, the public and other relevant stakeholders;
- Legal, technical, organizational and management aspects of TSOs;
- Independence, values and accountability of TSOs;
- Activities of TSOs in the transnational context.

— When basic concepts and principles have been sufficiently developed, consideration should be given to reflecting them in appropriate IAEA guidance documents, such as revised safety standards series documents or in a new document specifically dedicated to TSOs.

— The IAEA should consider developing peer review and self assessment approaches for the benefit of TSOs in enhancing nuclear safety.

— Information concerning the safety related activities of TSOs should be included in national reports submitted in conjunction with review meetings of the Convention on Nuclear Safety and the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management. This information should be considered at these review meetings and used to benchmark and improve TSO effectiveness.

To provide better technical support, TSOs should adopt quality management systems based on good quality management practices and implement continuous improvement programmes to maintain and develop their capabilities.

Technical and scientific support organizations should provide continuing support to the IAEA in conducting activities related to nuclear installations and radiation safety, security and protection of the environment.

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Closing Session:	LI GANJIE	China

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Technical and scientific support organizations (TSOs) are playing an increasingly important role in supporting national regulatory bodies and the nuclear industry by providing the technical and scientific expertise necessary to make optimum safety decisions. The aim of this conference was to address the challenges TSOs face in providing this support. The objective was also to provide the opportunity for TSOs from different countries and other organizations and experts to discuss and develop a common understanding of the opportunities, responsibilities and needs of TSOs; to explore appropriate approaches to addressing current and expected challenges in nuclear and radiation safety; and to discuss the roles, functions and value of TSOs. These proceedings include a summary, the opening speeches, the invited papers, and the conclusions and summary of the conference by the President. The accompanying CD-ROM contains the unedited contributed papers and the presentations that were submitted with some of the invited papers.

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