INSAG-21

Strengthening the Global Nuclear Safety Regime

INSAG-21

A REPORT BY THE
INTERNATIONAL NUCLEAR SAFETY GROUP

INSAG

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STRENGTHENING THE GLOBAL NUCLEAR SAFETY REGIME

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A report by the International Nuclear Safety Group

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The Agency's Statute was approved on 23 October 1956 by the Conference on the Statute of the IAEA held at United Nations Headquarters, New York; it entered into force on 29 July 1957. The Headquarters of the Agency are situated in Vienna. Its principal objective is "to accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world".

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INTERNATIONAL ATOMIC ENERGY AGENCY
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The International Nuclear Safety Group (INSAG) is a group of experts with high professional competence in the field of nuclear safety working in regulatory organizations, research and academic institutions and the nuclear industry. INSAG is constituted under the auspices of the International Atomic Energy Agency (IAEA) with the objective of providing authoritative advice and guidance on nuclear safety approaches, policies and principles for nuclear installations (defined as nuclear power plants, fuel cycle facilities, research reactors and support facilities). In particular, INSAG provides recommendations and informed opinions on current and emerging nuclear safety issues, to the international nuclear community and public through the offices of the IAEA.

FOREWORD

by the Chairman of INSAG

The International Nuclear Safety Advisory Group (INSAG) was originally constituted as an advisory group to the IAEA Director General to help ensure the safety of nuclear power plants. For almost two decades, it served as a forum for the exchange of information and views on nuclear safety issues of significance to the IAEA. It sought to formulate, where appropriate, common safety concepts.

In 2003, INSAG was reconstituted under a slightly different name as the International Nuclear Safety Group. The subtle change was intended to indicate that INSAG should seek to serve the international community as a whole, and is not limited to advising the IAEA. Under its revised charter, INSAG was invited to address issues that affect not only the IAEA, but also nuclear design organizations, nuclear power plant operators, national regulatory authorities, vendors, and other stakeholders, including members of the public, interested in specific nuclear issues and the environment in general.

With this expanded role in mind, INSAG concluded that it should evaluate the worldwide context for ensuring safety — what we term the 'Global Nuclear Safety Regime'. It is our view that the international dimensions of the nuclear enterprise have grown ever more important. The nuclear option is being considered by more and more nations. The principal vendors are international enterprises that seek to market their specific reactor types or designs around the world. Some operating organizations are multinational conglomerates that provide power in several countries. And, of course, all of those involved in the nuclear enterprise are linked to each other because the performance of each has implications for all; a serious accident, for example, will affect the prospects and environment for nuclear power around the globe. This report deals with the implications of the new global context, and presents views and concepts as to how best to deal with the opportunities and challenges that it presents.

This report is intended for use by all stakeholders in the nuclear community. It seeks to define the Global Nuclear Security Regime and provide some thoughts about current trends in an extremely dynamic and changing energy environment. We are hopeful that it will assist in the development of a web of international relationships that can help ensure the further enhancement of safety in nuclear activities.

CONTENTS

SUMMARY

The Global Nuclear Safety Regime is the framework for achieving the worldwide implementation of a high level of safety at nuclear installations. Its core is 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 augmented by the activities of a variety of international enterprises that facilitate nuclear safety — 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. All of these efforts should be harnessed to enhance the achievement of safety.

The existing Global Nuclear Safety Regime is functioning at an effective level today. But its impact on improving safety could be enhanced by pursuing some measured change. This report recommends action in the following areas:

— Enhanced use of the review meetings of the Convention on Nuclear Safety 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; and
— Multinational cooperation in the safety review of new nuclear power plant designs.

These actions, which are described more fully in this report, should serve to enhance the effectiveness of the Global Nuclear Safety Regime.

1. INTRODUCTION

1.1. BACKGROUND

1. The application of nuclear energy for electricity generation started with national programmes in a few pioneering countries in the mid-1950s. Major worldwide expansion of nuclear power took place in the late 1960s and early 1970s, with a variety of reactor types and safety approaches. Since then, international cooperation has gradually increased, and has led to a substantial convergence of the design and operating principles for nuclear power plants.

2. The necessity 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. Several international conventions relevant to nuclear safety and security have been signed, and much progress has been achieved in the joint development of safety regulations and in the establishment of international networks among nuclear power plant operators and national regulators.

3. In parallel with increasing international cooperation, the importance of full national responsibility for nuclear safety deserves strong emphasis and is a key element in the safety conventions. This involves full responsibility for safety by the organizations licensed to operate nuclear facilities and the establishment of a national legislative and regulatory framework that is implemented by a strong independent regulatory body provided with adequate authority, competence and resources. Independent regulatory decision making is more extensively discussed in INSAG-17 [1]. Nonetheless, the emphasis on national responsibility should not be allowed to lead to a situation where differences in national safety approaches and regulations restrict global convergence on standards and good safety practices, or serve to diminish the effectiveness of international cooperation.

4. Vendors are key participants in the Global Nuclear Safety Regime. First and foremost, vendors have an obligation to design nuclear facilities that have the capacity to ensure safety in the face of both natural events and human error. In addition, vendors have detailed knowledge of the nuclear systems in their plants and should maintain the expertise to support operators throughout the life of a facility. To be most effective, this support should be proactive — designers and operators should work together to ensure a high level of safety. The latter relationship is particularly important when nuclear facilities are being introduced into a country for the first time.

5. INSAG believes it is time to agree upon common safety principles and to undertake worldwide implementation of good safety practices in the siting, design, operation and decommissioning of nuclear facilities. These principles should then be documented in international safety standards and international conventions. For example, a unified set of ten fundamental safety principles is contained in the Safety Fundamentals in IAEA Safety Standards Series publications. Furthermore, INSAG seeks to support the enhancement of international structures, networks and methodologies to ensure the effective application of lessons learned from operating experience and the exchange of information on corrective actions.

6. The commitment by all users of nuclear energy to cooperate on a global scale should lead to a general enhancement of nuclear safety and to the reduction of unnecessary differences in approach. Such differences may interfere with the effective and efficient allocation of the resources for nuclear safety.

7. A new challenge for the Global Nuclear Safety Regime is the expected development of nuclear energy by countries with limited technical infrastructure. It is essential to ensure a high level of nuclear safety in all countries, including these new entrants. These countries should appreciate the responsibilities that arise from the use of nuclear power. An infrastructure involving personnel, education, research, industry, and financial and regulatory capacities is needed to start and maintain a successful nuclear programme. There is also a necessity for ensuring the availability of technical support and of 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.

8. This report is addressed to all stakeholders concerned with nuclear safety worldwide, including intergovernmental organizations, national regulatory authorities, plant owners and operators, the community of nuclear safety experts in research and education, vendors, service companies, political decision makers, NGOs, the media, and the public.

2. ELEMENTS OF THE GLOBAL NUCLEAR SAFETY REGIME

9. The Global Nuclear Safety Regime is defined here as the institutional, legal and technical framework for ensuring the safety of nuclear installations throughout the world. The objective of this regime is to lead to a world where all nuclear installations are operating safely.

10. A schematic picture of the Global Nuclear Safety Regime is presented in Fig. 1. Its central and most important component continues to be a strong national nuclear infrastructure in each Member State. The active participants in each country's national infrastructure include:

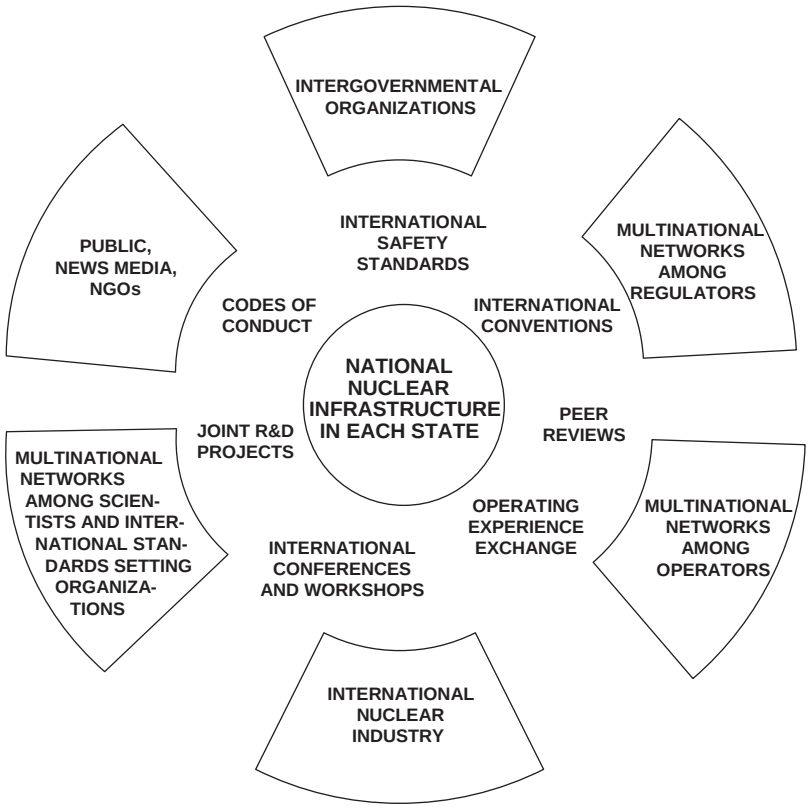

FIG. 1. Main elements of the Global Nuclear Safety Regime.

— Operators of nuclear facilities;
— Nuclear safety regulators;
— Scientific and technical support organizations;
— Research organizations and universities;
— Suppliers of equipment and services;
— Other stakeholders with interests in securing nuclear safety.

11. International participants in the Global Nuclear Safety Regime are:

(a) Intergovernmental organizations dedicated to the nuclear field, such as the:

— IAEA;
— Organisation for Economic Co-operation and Development/Nuclear Energy Agency (OECD/NEA);

(b) Multinational networks among regulators, such as the:

— International Nuclear Regulators Association (INRA);
— Network of Regulators of Countries with Small Nuclear Programmes (NERS);
— Western European Nuclear Regulators Association (WENRA);
— Forum of the State Nuclear Safety Authorities of the Countries Operating WWER Type Reactors.

(c) Multinational networks among operators, such as the:

— World Association of Nuclear Operators (WANO);
— "Owners groups" of different types of nuclear power plants vendors;
— International Network for Safety Assurance of Fuel Manufacturers (INSAF).

(d) Stakeholders in the international nuclear industry, such as:

— Nuclear power plant vendors;
— The World Nuclear Association;
— Suppliers of equipment;
— Suppliers of services;

(e) Multinational networks among scientists;
(f) The public and the news media;
(g) NGOs;
(h) International standards setting organizations.

12. The assurance of nuclear safety is reinforced by a number of intergovernmental agreements. These include certain Conventions that are legally binding on the participating States. Since 1986, five legally binding conventions that have the aim of increasing nuclear safety and security worldwide have been ratified in the areas of nuclear, radiation and waste safety. These are the:

— Convention on Early Notification of a Nuclear Accident — 1986 [2];
— Convention on Assistance in the Case of Nuclear Accident of Radiological Emergency — 1987 [2];
— Convention on the Physical Protection of Nuclear Material — 1987, scope extended 2005 [3];
— Convention on Nuclear Safety (CNS) — 1994 [4];
— Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management — 2001 [5].

13. In addition, there are Codes of Conduct that the IAEA General Conference has endorsed and that many Member States are politically committed to observe. These include the:

— Code of Conduct on the Safety and Security of Radioactive Sources — 2003 [6];
— Code of Conduct on the Safety of Research Reactors — 2004 [7].

14. International and national standards are available and widely used to support harmonization of the national safety practices. The IAEA Safety Standards are of paramount importance. They consist of three levels: Safety Fundamentals, Safety Requirements and Safety Guides. More detailed practical guidance on commendable technical requirements is provided in standards issued by international and national standards organizations. Many national regulatory organizations have endorsed certain standards as appropriate requirements in their countries.

15. Well established channels for interaction at the international level are:

— Systems for the exchange of operating experience, such as the Incident Reporting System (IRS) operated jointly by the IAEA and the OECD/NEA; a related system of WANO for communication among nuclear power plant operators; networking in owners groups of nuclear power plant vendors; and topical database systems maintained by the OECD/NEA.

— Peer review missions conducted by the IAEA (e.g. Operational Safety Review Team (OSART), Integrated Regulatory Review Services (IRRS)) and by WANO.
— Meetings of the Parties to the CNS.
— Meetings of the Parties to the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management.
— Joint research and development projects, including projects arranged with the support of the OECD/NEA or the IAEA.
— Meetings of the competent authorities of the Conventions on Early Notification and Assistance.
— Senior regulators meetings during the IAEA General Conference.
— WANO meetings and meetings of owners groups of nuclear power plant vendors.
— International conferences and workshops.
— Participation by foreign members in national nuclear safety advisory committees and international standards setting organizations.

16. Although all elements of the Global Nuclear Safety Regime are functional today, some should be strengthened. This report is written with the aim of achieving this end. To be specific, it encourages:

— Use of the review meetings of the CNS as a vehicle for open and critical peer review and 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 degree 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.

17. This report will not focus on safety culture, which has been addressed in detail in INSAG-4 [8] and INSAG-15 [9]. However, the establishment and maintenance of a strong safety culture in every nuclear facility is a central feature of a successful Global Nuclear Safety Regime. As stated in INSAG-15, "…the attitudes and practices necessary to achieve good performance in nuclear safety, including visible commitment by management, openness, care and thoroughness in completing tasks, good communication and clarity in recognizing major issues and dealing with them as a priority, have wide applicability."

3. FURTHER DEVELOPMENT OF THE CONVENTION ON NUCLEAR SAFETY PROCESS

18. Among the legally binding international conventions in the nuclear safety field, the most relevant for strengthening the Global Nuclear Safety Regime is the CNS [4]. The periodic review meetings provide an opportunity for the peer review of technical and administrative aspects of nuclear safety, and this process provides a useful instrument for enhancing the level of nuclear safety on a global scale. Although the CNS is an incentive agreement with no enforcement mechanisms beyond peer review, it has the potential to strengthen significantly the Global Nuclear Safety Regime.

19. Meetings of the Parties to the CNS are held at regular three-year intervals to review how the various articles of the CNS are being implemented by the Contracting Parties. Specifically, the Contracting Parties report on the developments they have made with respect to each article. Each national report is subject to a peer review by other countries, and usually the review leads to recommendations and respective commitments for further improvement. The first meeting, in 1999, provided a good start for improving national nuclear safety practices in many countries. Significant measures for enhancing nuclear safety were reported in the subsequent meetings in 2002 and 2005. It is evident that many countries are using the CNS process to strive for excellence in nuclear safety.

20. In the second review meeting it was generally recognized that the CNS process has served its original objective of promoting upgrades to the safety systems at nuclear facilities built to earlier design specifications, and supporting independent nuclear regulation in many participating countries. In the third meeting, the participants indicated a clear willingness to further strengthen the reporting and review process and to increase its transparency among all participants to the review meetings.

21. Nonetheless, some modifications in the CNS process should be considered by the Contracting Parties in order to maintain the momentum for productive change that the CNS has provided. The main concern with the current peer review mechanism is that the scope of issues to be covered is very wide with respect to the time available for reporting and discussion. This limits the possibilities for focused discussion of the most important safety issues. Some Contracting Parties may see preparation of the report and participation in the review meeting as more of a burden than a learning opportunity.

22. Now that the Contracting Parties have addressed the most evident safety concerns at their existing nuclear installations and are working towards establishing an appropriate national legislative and regulatory framework, more attention should be given to those specific areas that are found to be in general need of development in most countries. The peer reviewers can provide useful and well-founded recommendations on specific issues only if the discussions in the meeting are properly focused and lead to universal understanding of the actual conditions in need of change.

23. In order to improve the focus of discussions, the second review meeting requested that the IAEA Secretariat prepare a report for the subsequent meeting presenting generic information about significant safety issues. This report was to be based on the results of the IAEA safety review missions and services. Such a report was provided to the Contracting Parties on time and was of good quality. However, the Contracting Parties were not specifically notified of its existence and its intended use was not evident to the participants of the third review meeting. As a result, the report was perhaps not utilized as effectively as could have been the case in the meeting. Nonetheless, INSAG believes that the request of the second review meeting was well founded and IAEA support in highlighting the current safety issues before each review meeting brings added value to the peer review process. INSAG recommends that the IAEA continue to provide these summary reports and present a list of common safety issues to the Contracting Parties as part of preparations for the future review meetings. Each Contracting Party could then perform a self-assessment against the generic concerns reported by the IAEA and discuss the results under appropriate articles in its national report. Also, the discussions on the national reports in the review meetings should address, among other country specific concerns, those safety issues highlighted by the IAEA that might need corrective actions in the respective country. This focus is not intended to discourage any national report from covering additional issues of particular concern.

24. A successful CNS process requires that all Contracting Parties demonstrate an attitude of openness and a genuine commitment to make improvements as recommended by peers. The key goal for each Contracting Party in the review meetings should be to collect as many useful ideas and lessons as possible for further safety enhancements, rather than to demonstrate their own self-perceived excellence. No Contracting Party should come to the review meeting in a spirit of complacency.

25. Article 6 of the CNS was of great importance when the Convention was initially approved by the Parties. This article required that the safety of existing nuclear installations be reviewed as soon as possible, and that all reasonably practicable improvements be made urgently in order to upgrade the safety of the deficient installations or, if upgrading cannot be achieved, to shut down the nuclear installation as soon as possible. This first stage of implementing the CNS is now over and significant achievements have been reached. Despite this, INSAG recommends that the Parties voluntarily demonstrate their policy for enhancing safety and provide a summary of important developments in plant design and safety management, since the previous review meeting as a regular part of their national reports.

4. ENHANCED UTILIZATION OF THE IAEA SAFETY STANDARDS

26. The IAEA Safety Standards provide a widely accepted basis for nuclear safety and have reached a level of maturity that permits their use as a vehicle for the harmonization of global safety practices. The Safety Standards consist of three levels: Safety Fundamentals, Safety Requirements and Safety Guides, and these provide good references and models for developing national safety regulations.

27. The degree to which the national safety requirements and practices are expected to be in compliance with the IAEA Safety Standards depends on the level of the publication in the hierarchy. Safety Fundamentals should not be amenable to significant changes over time, and they are intended to be met without exception. Safety Requirements should be met by new facilities and related new activities and are a target that should be met over a period of time that is reasonable and achievable for existing facilities and practices. Safety Guides are practical guidance on achieving state-of-the-art nuclear safety. Meeting them is recommended unless alternative means can be taken to provide the same level of safety. The Safety Guides are written to facilitate meeting the Requirements. The Fundamentals, Requirements and Guides are meant to be complementary.

28. Although the coverage of the Safety Standards is comprehensive, those addressing nuclear power plants are written to a large extent with currently operating plants in mind. In the future, the scope of the IAEA Safety Standards

needs to be broadened to permit their application to innovative reactor designs. Other facilities in the nuclear fuel cycle have been identified as needing standards and efforts to develop them are ongoing. The principle of defence in depth plays a central role in nuclear safety, yet there is a need for more clear guidance on how to apply this principle to innovative designs. Similarly, guidance should be provided on the effective application of probabilistic approaches.

29. Every new and revised Safety Standard should take into account best international practices, and consequently set ambitious but realistic objectives, recognizing that on some issues a particular standard may exceed common practices in some Member States. Such an approach is in line with the general goal of enhancing nuclear safety whenever reasonable and feasible.

30. All IAEA Safety Standards need to be subject to periodic review and possible revision. The aim of the review and revision process should be to maintain standards that reflect the contemporaneous international consensus on measures necessary to ensure a high level of safety for protecting people and the environment from potential hazards associated with nuclear power plant operations. In particular, the Safety Guides associated with each Requirements publication should be regularly revisited to document state-of-the-art practices in nuclear safety, with the aim of providing operators of nuclear facilities with challenging safety objectives and encouraging them to strive for excellence.

31. It is most important that all countries using nuclear energy support the development of the Safety Standards. Furthermore, the IAEA should give the international nuclear operating industry an opportunity to contribute to the development of these standards. Input from the nuclear industry and nuclear operating organizations (licensees) must be incorporated into the early stages of standards preparation. Therefore, INSAG encourages further action by the IAEA to ensure adequate industry and operator involvement in developing drafts of the standards.

32. The expectation that the IAEA Safety Standards should continuously evolve has the corollary that it is not practical to use them automatically as mandatory legal requirements in Member States. For example, the Safety Standards addressing the design aspects of safety are intended to apply primarily to new facilities. The determination whether such a new Safety Standard should be applied to an operating facility built to earlier standards, or whether the existing practices of managing nuclear safety should be modified

to comply with most advanced approaches, requires careful consideration. This issue is discussed extensively in INSAG-8 [10].

33. INSAG recommends that each new Safety Standard published by the IAEA be reviewed by all Member States and compared with existing national requirements and practices. It is also recommended that design features or practices that may need to be modified to meet the new standard be assessed on a case by case basis. When setting requirements for new plants or developing safety management practices, the Safety Standards should be given a high priority as reference material.

34. To encourage enhanced use of the Standards and to promote global harmonization of nuclear safety practices, the IAEA Safety Standards should be translated promptly after their publication into all official languages of the IAEA, distributed widely, and made easily available across the world to utilities and fuel cycle operators, regulatory bodies, nuclear power plant vendors and other stakeholders.

5. ENHANCED EXCHANGE OF OPERATING EXPERIENCE

35. A general lesson from serious accidents is that they are almost always preceded by less serious precursor events. Likewise, the degradation of equipment status or safety culture is frequently signalled by precursors. By taking action to eliminate the risk factors early and to prevent the recurrence of similar events, one can significantly reduce the probability of serious accidents.

36. Operating experience of general interest is not limited to events, but also covers conditions, observations and new information that could affect nuclear safety. In addition, information should be exchanged on good practices that have the potential to assist others with their safety based programmes.

37. Continuous improvement in operational indicators suggests that operating experience feedback (OEF) processes within each country are functioning reasonably well. Nuclear installation operators, technical support organizations and national regulatory organizations are learning from their own experiences. However, because the number of nuclear installations in any single country is only a fraction of the global nuclear fleet, useful operating

experience is also available from foreign facilities and can be an equally valuable contributor to nuclear safety. Therefore, an OEF process cannot yield its full benefit unless it includes worldwide operating experience.

38. The international OEF 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, as well as to develop newer, simpler processes to expand on these overtaxed mechanisms. Both the positive (good practices) and the negative (root cause) aspects of OEF must be shared if they are to be effective at reducing and eliminating risks. The nuclear industry and the world's national regulatory authorities have pursued many courses of action to better identify learned lessons and capture the corrective actions that have been developed. However, there have been numerous inhibiting factors to the establishment of a coordinated or integrated OEF database.

39. The industry's OEF system has been most notably associated with the WANO Operating Experience Report (OER) and Significant Operating Experience Report (SOER) processes. The individual nuclear operators submit these reports as a means to share information throughout the family of nuclear power plants. However, this database is considered to be proprietary and is not available for sharing with non-member organizations or entities. This exclusion bars access by national regulatory authorities, in no small part due to the "sunshine laws" under which most such authorities operate.

40. National regulatory authorities, for the most part, capture OEF data from reports written to meet the rules that are part of each country's licensing and regulatory regime, or in some cases from their own investigations. This information is unique to the requirements and practices of each country and is not designed for international consumption or sharing. In order to exchange operating experience between the national regulatory authorities and other government organizations, Incident Reporting Systems (for nuclear power plants, research reactors and fuel cycle facilities), were developed and are co-sponsored by the IAEA and the OECD/NEA. Since neither of these organizations had specific reporting criteria that were internationally accepted, the default criterion was a practical one — namely, to urge regulators to report events that are deemed to be safety significant or that might interest a compatriot regulatory authority. It was assumed at the outset that the workload associated with these systems would be in the neighbourhood of 0.25–0.33 reportable occurrences per reactor per year. This assumption has become, for

all practical purposes, a criterion to guide and thereby limit reporting, which has constrained the effectiveness of these systems.

41. Finally, many of the owners groups for the different nuclear plant vendors have developed experience-sharing networks. While these networks are beneficial to a particular owners group membership, the insights are often limited to the technically unique issues associated with the particular reactor design, and the networks operate under the same proprietary considerations as the WANO system. Those who are not members of a particular owners group may be denied valuable insights that could be derived from the experiences that are reported to the owners group.

42. Those designing an international OEF process must keep in mind that writing reports and collecting data are not meaningful if there is no direct coupling to risk reduction and the enhancement of operational safety. International reporting systems should address all significant aspects of the issues of concern, including an assessment of the causes associated with incidents and events, and share corrective actions. Such a reporting system would provide a knowledge base that could ensure that events involving serious potential hazards occur only once. To achieve this end, the system must be coupled with aggressive programmes to ensure that the lessons learned from previous events are widely applied.

43. An effective international OEF programme must be far reaching, and should capture the experiences that have led to significant corrective actions in human factors, hardware or safety management practices. Similarly, it should provide information on safety research programmes that were started to resolve a new safety concern, even if the concern was raised for reasons other than an incident at a nuclear facility.

44. Event reports should avoid unnecessary technical details concerning the event itself, and provide only the description necessary to understand the safety concerns and the causes of the event. Event reports need to focus on root causes, and to discuss possible weaknesses and failures of safety management processes. They must also describe the actions that were taken to avoid the recurrence of similar events or to correct the technical or management deficiencies revealed by the event. Furthermore, it would be valuable if the reporting organization could make recommendations on issues it considers worth review and assessment by those receiving the report. Finally, efforts should be made to distribute the reports in a timely fashion so as to promote prompt international corrective actions.

45. Assuring quality in an international OEF reporting process is vitally important. Quality assurance practices should work to ensure that event descriptions, safety assessments and root cause analyses are accurate and permit an adequate understanding of the events, lessons learned, and corrective actions. Reviewers should also consider whether the corrective actions are presented in a manner that allows readers to assess the need for similar measures at their installations.

46. A fully effective international OEF system should include a feedback process that would enable the recipients of the original report to provide information on the safety enhancement measures that were undertaken as a result of the report. Feedback information could be collected and summarized, and summaries of the responses to the original report could be distributed through the same system as the original report. Such a system could provide important guidance to others.

47. In order to use resources more efficiently and effectively, it might be advisable to segment the international OEF process into pieces that are of manageable size and type. For example, separate segments might be devoted to common cause failures, to control systems, to fire prevention, or to piping failures. The aim of segmenting the international OEF process is to ensure that each part of the redesigned system has a clearly specified and well understood scope and objective. Each part must have a dedicated user group, such as experts who work on similar issues or managers with similar responsibilities.

48. There are promising examples from recent developments that illustrate how segmenting certain elements of the OEF can be of value. Among these are the several topical databases established under the umbrella of the OECD/NEA. The topics of current databases are: occupational exposures; common cause failures; failures in computer based control systems important to safety; fires; and piping failures. Common features of the new databases are that they:

- Define the format and collect experience into a quality assured and consistent database;
- Can be used to analyse the data over the long term;
- Generate qualitative insights into the root causes of similar events, thus permitting a better understanding of the common event causes and deriving approaches or mechanisms for their prevention or for mitigating their consequences;
- Record event attributes to enable quantification of event frequencies and risk analysis.

49. The benefit of a dedicated database is that responsibility for maintenance of the database is clearly assigned to respective experts, and in this way one can better guarantee comprehensive coverage of relevant data.

50. Data collection for such dedicated databases should be as comprehensive as possible. This would give a sound basis for trending different events worldwide and for getting improved data for probabilistic safety assessment (PSA). However, the primary objective of each database would still be to facilitate expert-to-expert communication on the means to avoid or minimize failures that may degrade nuclear safety.

51. It would also be useful to devote more attention to good practices, and thereby to enhance safety culture. This would require encouraging operators and regulators to communicate both outside and within the actual reporting systems. It would also require more proactive programmes on preventive measures and for identifying the symptoms associated with deviations and anomalies. INSAG recognizes that identifying a good practice within the organization that developed it is not always easy. In most cases, a benchmarking process is needed to understand the value of a practice. That is, there must be a link between good practices and potential events avoided. A good practice might be identified by observing that an operational safety deficiency reported by one organization has been avoided by others who have applied the good practice. In such a case, the organization that has developed a verified good practice for the purpose of avoiding a similar negative experience should inform others. This information could be provided in a feedback report, such as the one mentioned above.

52. A process to identify good practices is already available through the peer review missions conducted by the IAEA and WANO. Unfortunately, the mechanisms to disseminate information on good practices to the nuclear community more generally are not effective and often do not reach the desired users of the information. This is a problem for which innovative approaches are required.

6. MULTINATIONAL COOPERATION FOR THE SAFETY REVIEW OF NEW NUCLEAR POWER PLANT DESIGNS

53. The general safety goals and requirements for nuclear power plants in different countries, and the design solutions to meet them, have currently reached a state of reasonable harmony. Furthermore, the networks that currently exist have brought mutual understanding and trust among national regulatory authorities. It is therefore the proper time to establish multinational cooperation among nuclear regulators for the safety review of new nuclear power plant designs which are intended for construction in their respective countries.

54. The basic goal of a multinational reactor safety review should be to ensure that a design determined to be safe in one country does not have to be substantially modified to meet licensing requirements elsewhere. This can be achieved if the requirements that must be satisfied in one country are consistent with, or at least not significantly different from, those that must be satisfied in another. The importance of this basic goal reflects the general expectations of the public and the industry that fundamental safety principles must be universally satisfied. A unified set of ten fundamental safety principles is contained in the Safety Fundamentals in the IAEA Safety Standards Series. This document was approved by the Board of Governors in September 2006 and is expected to be published by the IAEA shortly.

55. Among the benefits of multinational safety review are the following:

— Multinational cooperation would help to harmonize the global safety approaches and increase safety in general. It would also improve the clarity and transparency of nuclear safety regulations across international borders.
— A thorough safety review could be provided for the benefit of each participating country through the coordinated use of the resources of both regulators and industry.
— Overlapping work resulting from the separate safety assessment processes of different countries could be minimized, and uncertainties in licensing could be reduced.
— Consistent regulatory positions could be developed, thereby promoting international trade in nuclear equipment and bringing cost savings to all parties involved in the nuclear and power production industries.

56. A multinational safety review process could be applied to any new nuclear power plant design that is presented for assessment by regulators in two or more countries. It could be conducted in various ways but in any case the key participants would be the national regulatory organizations, potential plant operators, and the power plant vendor. Coordination of a multinational safety review could be provided by one of the participating regulatory organizations or possibly an international organization.

57. Given the interest of some countries to build their first nuclear power plant, it is likely that opportunities for multinational safety review will arise among the regulatory organization of the supplier country and one or more national regulators who lack experience in modern nuclear power plants and modern safety standards. In this circumstance, the IAEA and the nuclear community at large should be prepared to support the less experienced regulators. Assistance from the regulatory body of the supplier country becomes of utmost importance.

58. Joint assessment of the design criteria is of the utmost importance at the outset of a multinational safety review. In order to ensure a consistent design basis, the nuclear safety requirements for the plant and the systems design features, as well as the technical requirements for design and manufacturing of systems, structures and components, need to be specified by the plant vendor. These should be based on well established, state-of-the-art safety approaches, references to national regulations, and widely recognized industrial standards. The IAEA Safety Standards can be useful references and tools in this regard. As mentioned earlier, vendors are key participants in the Global Nuclear Safety Regime. First and foremost, vendors have an obligation to design nuclear facilities that have the capacity to ensure safety in the face of both natural events and human error. In addition, vendors have detailed knowledge of the nuclear systems associated with their designs and should maintain the expertise to support operators throughout the life of a facility. In any event, the proposed design basis criteria should be assessed by all participating operator organizations and regulatory bodies.

59. Due to the legislative differences in the nuclear countries in the world and the evolving state of the international standards, it is not reasonable to insist, in advance, on strict application of any specific set of national or international safety requirements. Instead, the reviewers should assess the consistency of the proposed design criteria with their own national requirements and with the Safety Requirements component of the IAEA Safety Standards. Potential deviations should be identified and their safety relevance should be assessed.

IAEA Safety Guides could provide valuable input for this assessment. This process could lead to enhanced harmonization of the national safety regulations. After the joint assessment of the proposed design criteria, each national regulatory authority must exercise its responsibility to decide on what actions are needed to achieve compliance with national laws and regulations.

60. Every effort should be made to avoid different fundamental design requirements unless there are differences in site specific conditions. The process will be facilitated if the mandatory national requirements are general and non-prescriptive, thus permitting mutually acceptable judgments based on scientific and technical considerations.

61. It must be emphasized that any multinational safety review of a new design does not preclude the need for a national licensing review, nor challenge the sovereign authority of the national regulators for all licensing and regulatory decisions. A multinational safety review is an efficient way of addressing generic safety issues and could significantly reduce the workload of all participating organizations. However, each national regulator has a primary responsibility to remain fully involved in all parts of the design review in order to acquire and maintain the knowledge that is needed for regulation of the facility throughout its operational life cycle.

62. In parallel with the multinational review of the common design features, each national regulator needs to assess the adequacy of the design, taking local conditions into account. Among the issues to be taken into account separately in each country and for each site are the following:

— Site related risk factors, such as extreme natural conditions and human-made risks;
— Compliance of the design with the reliability of external power supply and grid stability, as well as with the reliability of other infrastructure needs;
— The licensee's capability to operate and maintain the plant as intended over its life cycle.

63. The national regulators would also have responsibility for inspections, tests and analyses as needed to verify the compliance of actual construction with design information, as well as for other regulatory tasks not directly related to the design.

7. CONCLUSION

64. The basic structure of the Global Nuclear Safety Regime is in place and is functioning in a fashion that augments the national nuclear infrastructure that exists in each country. This basic structure is sound. Nonetheless, there are opportunities for incremental change in the Global Nuclear Safety Regime that could serve to enhance safety significantly. INSAG believes that the recommendations in this report are achievable and should be pursued.

REFERENCES

[1] INTERNATIONAL NUCLEAR SAFETY ADVISORY GROUP, Independence in Regulatory Decision Making , INSAG-17, IAEA, Vienna (2003).

[2] Convention on Early Notification of a Nuclear Accident and Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency, Legal Series No. 14, IAEA, Vienna (1986).

[3] Convention on the Physical Protection of Nuclear Material, INFCIRC/274/Rev.1, IAEA, Vienna (1980).

[4] Convention on Nuclear Safety, Legal Series No. 16, IAEA, Vienna (1994).

[5] Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, INFCIRC/546, IAEA, Vienna (1997).

[6] Code of Conduct on the Safety and Security of Radioactive Sources, IAEA, Vienna (2004).

[7] Code of Conduct on the Safety of Research Reactors, adopted by the Board of Governors, GC(48)/7, IAEA, Vienna (2004).

[8] INTERNATIONAL NUCLEAR SAFETY ADVISORY GROUP, Safety Culture, INSAG-4, IAEA, Vienna (1991).

[9] INTERNATIONAL NUCLEAR SAFETY ADVISORY GROUP, Key Practical Issues in Strengthening Safety Culture, INSAG-15, IAEA, Vienna (2002).

[10] INTERNATIONAL NUCLEAR SAFETY ADVISORY GROUP, Common Basis for Judging the Safety of Nuclear Power Plants Built to Earlier Standards, INSAG-8, IAEA, Vienna (1995).

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