INSAG-8

A Common Basis for Judging the Safety of Nuclear Power Plants Built to Earlier Standards

INSAG-8

A REPORT BY THE
INTERNATIONAL NUCLEAR SAFETY ADVISORY GROUP

INSAG

IAEA

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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".

Printed by the IAEA in Austria
August 1995

INSAG SERIES No. 8

A COMMON BASIS FOR JUDGING THE SAFETY OF NUCLEAR POWER PLANTS BUILT TO EARLIER STANDARDS

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A report by the
International Nuclear Safety Advisory Group

INTERNATIONAL ATOMIC ENERGY AGENCY
VIENNA, 1995

The International Nuclear Safety Advisory Group (INSAG) is an advisory group to the Director General of the International Atomic Energy Agency, whose main functions are:

(1) To provide a forum for the exchange of information on generic nuclear safety issues of international significance;
(2) To identify important current nuclear safety issues and to draw conclusions on the basis of the results of nuclear safety activities within the IAEA and of other information;
(3) To give advice on nuclear safety issues in which an exchange of information and/or additional efforts may be required;
(4) To formulate, where possible, commonly shared safety concepts.

THIS INSAG REPORT IS ALSO PUBLISHED IN
FRENCH, RUSSIAN AND SPANISH

VIC Library Cataloguing in Publication Data

A common basis for judging the safety of nuclear power plants built to earlier standards : INSAG-8 / a report by the International Nuclear Safety Advisory Group. — Vienna : International Atomic Energy Agency, 1995.
p. ; 24 cm. — (INSAG series, ISSN 1025-2169 ; INSAG-8)
STI/PUB/991
ISBN 92-0-102395-2

1. Nuclear power plants—Safety measures. I. International Atomic Energy Agency. II. International Nuclear Safety Advisory Group. III. Series.

VICL 95-00126

FOREWORD

by the Director General

The IAEA Conference on 'The Safety of Nuclear Power: Strategy for the Future', held in September 1991, discussed 'treatment of nuclear power plants built to earlier safety standards' as one of the five issues considered. The conference arrived at recommendations for future actions on the basis of the background papers prepared in advance and discussions during the conference.

Subsequently, the IAEA General Conference endorsed the recommendations and urged the development of a process to provide a common basis on which an acceptable level of safety for all operating nuclear power plants built to earlier standards can be judged. INSAG took up the task of preparing such a report.

I am pleased to have received this report and am happy to release it to a wider audience.

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1. INTRODUCTION

1. Safety standards for nuclear power plants have undergone evolution and development since the first plants were designed in the 1950s. Many changes have occurred as the nuclear industry has matured and changes will continue to occur, as a result of increased knowledge and experience in both design and operation, and owing to a raising of the objectives for safety and reliability.

2. Most plants have a design life of 30 to 40 years or more, and it is inevitable that all plants will eventually be overtaken by the developing technologies and standards. This is not necessarily a criticism of the safety of older plants. Most operating organizations have made improvements to plants, enhancing their safety over the original design, as part of a continuing effort to maintain and raise safety levels.

3. Safety requirements for nuclear power plants have not always been set consistently between plants and between countries. Although safety records and reliability data show that the majority of nuclear plants around the world are producing power safely and reliably, this claim cannot be made of all nuclear plants. For many reasons, including deficient design, inappropriate feedback of operating experience, ageing processes that have not been managed and absence of a programme of safety reassessment coupled with lack of appropriate safety assessment and verification by the regulatory authority, there are plants operating today with levels of safety that are inadequate in comparison with those of the majority of operating plants. This has led to a need for a common basis for judging whether the level of safety of a plant is acceptable.

4. In addition to defining principles and standards to be used to provide this common basis for judgment, there is also a need for more consistent policies on implementation of the assessment process. Entry into force of the Convention on Nuclear Safety will highlight the need for consistent approaches to assessment.

2. HISTORICAL BACKGROUND

5. Concern about the need for a common basis for judging the safety of nuclear power plants came into sharp focus in the late 1980s and early 1990s as awareness grew of the inadequate levels of safety at some plants. In some cases the concerns focused on particular designs that safety experts were increasingly judging to be inadequate by current safety standards. In other cases, the concerns were focused less

on a particular design and more on deficiencies in safety, such as poor operations, a weak safety culture or a weak national infrastructure for supporting safe operation of a plant. Also of concern was the recognition that some site related external events had not been adequately taken into consideration in plant design or in procedures at the plant.

6. These concerns were extensively discussed at the IAEA Conference on The Safety of Nuclear Power: Strategy for the Future, held in Vienna, 2–6 September 1991. Much debate took place in an attempt to define a method of identifying those plants that needed to be improved and to decide what improvements to make. Some participants suggested that the problem could be simplified to one of selecting all plants of a certain design(s), or plants in a certain region, or plants categorized as 'old' as the set of plants requiring improvement. However, the evidence clearly defied such simplistic approaches. The difficulties inherent in identifying and improving the less safe plants became apparent. Longer term objectives were discussed and recommendations were formulated.

7. The Conference on The Safety of Nuclear Power: Strategy for the Future made the following two declarations:

> "The IAEA should initiate a process to develop a common basis on which the acceptable level of safety of all operating nuclear power plants built to earlier standards can be judged. In some cases, international co-operation and support will be necessary to ensure the completeness of safety reviews and the adequacy of implementation of measures to achieve that acceptable level of safety."

> "Operating organizations and National Authorities should identify operating nuclear power plants which do not meet the high safety performance levels of the vast majority of operating plants and undertake improvements with assistance from the international community."

8. Subsequently, in 1991, the IAEA General Conference invited, and in 1992 urged, that the Director General develop a process to provide a common basis on which the acceptable level of safety of all operating nuclear power plants built to earlier standards can be judged. INSAG took up the task of preparing such a document.

3. OBJECTIVES AND SCOPE

9. The primary objectives of this report are:

— To develop a common basis on which an acceptable[1] level of safety of all operating nuclear power plants built to earlier standards can be judged; and
— To provide a basis for deciding:
  - who has the responsibility for conducting an assessment;
  - which overall approach should be used in that assessment; and
  - what criteria should be used to decide what corrective actions are needed.

The report specifically encourages risk assessment for plants that have not followed comprehensive systematic approaches for safety review, or for plants with which for other reasons high risks are judged to be associated.

10. The report sets out a framework or process to achieve the goal of safe operation, including an extremely low likelihood of an accident with major consequences. The practical processes for the conduct of safety reviews are outlined. The report identifies the criteria for decision making by national authorities. It discusses the role of quantitative criteria and recognizes their limitations. It stresses that international collaboration is vital because of the scale of the resources needed and the public reaction to accidents, even those occurring far away or having only limited or localized consequences. Economic and social aspects, although playing a significant role in national decisions, are not within the scope of this report.

4. SAFETY STANDARDS AND PRACTICES

11. There exists today a set of international consensus documents and standards related to safety, as well as industrial standards and national requirements, which are recommended as the basis for the review of the actual status of safety at a plant.

12. On the one hand, safety standards are developed to be applied prospectively in the planning of designs and operations of nuclear power plants. On the other hand, the safety of existing plants is reassessed retrospectively, i.e. with account taken of operating experience and evolving safety standards. The safety standards can be used in these reassessments as a reference to determine whether a safety issue exists and

[1] The term 'acceptable' is used here to mean acceptable according to a scientific and technical judgement and not necessarily a decision as part of a regulatory process.

whether it warrants some kind of intervention, i.e., whether further analysis, improvements in safety or other actions are required. It should be clear, however, that the retrospective application of safety standards should be limited to safety significant issues. It is neither necessary nor feasible for an existing plant to comply with all new standards, many of which would require individual small improvements or adaptations for new technology. Should safety significant issues be identified in existing plants, the aim should be to do all that is reasonably possible to make improvements case by case. These standards should be applied with judgement, in recognition that, for normal operations, a plant should meet a set of deterministic and probabilistic criteria and there should be an adequate safety culture.

13. The approach to safety that INSAG recommends be followed for plants built to earlier safety standards is consistent with safety principles that experience has shown to be adequate for all plants. These safety principles cover the fundamentals areas of: good design (including high quality manufacturing and construction); good operation and maintenance (including feedback of operating experience); and a strong safety culture. Basic Safety Principles for Nuclear Power Plants, INSAG-3, sets forth objectives and principles that can be adopted for this purpose, and emphasizes the importance of maintaining defence in depth in design and operation.

14. In general, INSAG-3 did not differentiate between new and existing plants, or between plants built to earlier standards and those built to current standards. It was implicitly assumed that some existing plants would not observe all its principles; but to the extent that the principles could be applied at existing plants, their application would enhance safety. Current national and international safety standards reflect the principles and objectives of INSAG-3.

5. RESPONSIBILITIES

15. The ultimate responsibility for the safety of a nuclear power plant rests with the operating organization. This responsibility is in no way diminished by the separate activities and responsibilities of designers, suppliers, constructors and regulators. The operating organization is responsible for all aspects of operation, maintenance, training, documentation and related activities. If deficiencies in design, construction or operation are identified, the operating organization should take appropriate corrective action.

16. The national regulatory authority sets regulations, codes and standards, taking into account principles agreed internationally, such as those of INSAG. The role of

the regulatory authority includes responsibility for independently verifying that the design meets the safety standards, and that the plant has been constructed as designed and continues to be operated safely. The regulatory authority must have the legal authority, the means and the will to express itself on safety matters and to make independent judgements on matters such as deficiencies in safety and safety culture.

17. Safety issues may be complex and may require deeper consideration than can be expected of the plant operator's technical staff or the regulatory authority. In such instances these organizations could seek expert advice, either nationally or internationally. The external assistance typically sought is that of the design organization, the architect/engineer/constructor organization(s) and operators of similar plants, as well as that of experts in specialized fields such as characteristics of materials, human factors or probabilistic safety assessment (PSA).

18. National bodies and international agencies such as the IAEA, the Nuclear Energy Agency of the Organisation for Economic Co-operation and Development (OECD/NEA) and the World Association of Nuclear Operators (WANO) have programmes and activities to respond to requests for expert advice. Even when the plant operator and the regulatory authority have the necessary technical expertise to make sound decisions on safety matters, it is still desirable to establish national advisory groups and to invite international groups of technical experts to perform independent reviews. These external experts and advisory groups are responsible for the advice that they give but not for how their advice is used. The advice must not replace or diminish the basic responsibilities of operators and regulators. When external support is obtained, the operating organization and the regulatory authority must nevertheless assume responsibility for the subsequent practical decisions and their implementation. Advisors do not relieve those they advise of the responsibility for making decisions.

19. Some nuclear power plants in operation may not have been subjected to an adequate safety evaluation; there are indications that some plants may be operating below currently acceptable levels of safety. For this reason, greater urgency is needed in assessing plants suspected of not having an acceptable level of safety than for plants previously assessed and found to have an acceptable level. The operating organization is responsible for initiating and maintaining a programme for safety evaluation. For plants found to be operating below acceptable levels of safety, the operating organization has responsibility for defining and implementing the corrective actions with whatever resources and outside guidance are required. The regulatory authority has the responsibility for ensuring that the operating organization initiates a safety evaluation process, for verifying that this has been performed adequately and for confirming that the corrective actions are appropriate. It is the responsibility of both the operator and the regulator, acting within the national legal framework, only to

permit operation provided that there is an acceptable level of safety. In some instances, interim solutions to compensate for a deficiency may be acceptable in the short term until solutions can be effected.

6. METHODS OF ASSESSMENT

20. The situation at most plants built to earlier standards will be sufficiently distinct to necessitate specific assessment. Some decisions may be plant specific, some may be generic for a given type of plant and some may be independent of the original design. A two phase approach to the assessment with a preliminary review and a review in depth is outlined. Figure 1 presents a simplified flow chart of the approach to the assessment. Both phases of the assessment require careful consideration of defence in depth and of safety culture. Some plants built to earlier standards may have been subjected to various reviews, for instance to address new safety issues and the feedback of experience. In such cases it may be justifiable to omit the preliminary review and to proceed directly to a review in depth.

21. Defence in depth is a fundamental safety concept that has historically been given a high emphasis in the design and operation of nuclear power plants. The review of defence in depth is thus a key feature in the preliminary review. The evaluation of defence in depth is also an integral part of each stage of the assessment of plant safety. After the completion of detailed assessments, the results should be subjected to a further strategic and qualitative review for defence in depth. This is to ensure that full use is made of this important safety concept. This final step should also ensure that the results of the assessment are coherent. The review of defence in depth will then be useful in decision making and in setting priorities for actions needed, resulting in a balanced action plan.

22. Operating experience and a review of past incidents at plants show the importance of the human factor in maintaining high levels of safety. People make the difference and their attitudes and approaches can greatly influence the level of safety of a plant. Therefore an assessment of safety culture for those in a position to influence the safety of a plant should be an integral part of the preliminary reviews and the reviews in depth.

23. The concept of safety culture is not limited to the operating staff at a plant. The concept applies equally to maintenance and outage personnel, both permanent and temporary; to non-operations personnel within the operating organization, such as technical support staff and licensing experts; to designers, vendors and construction

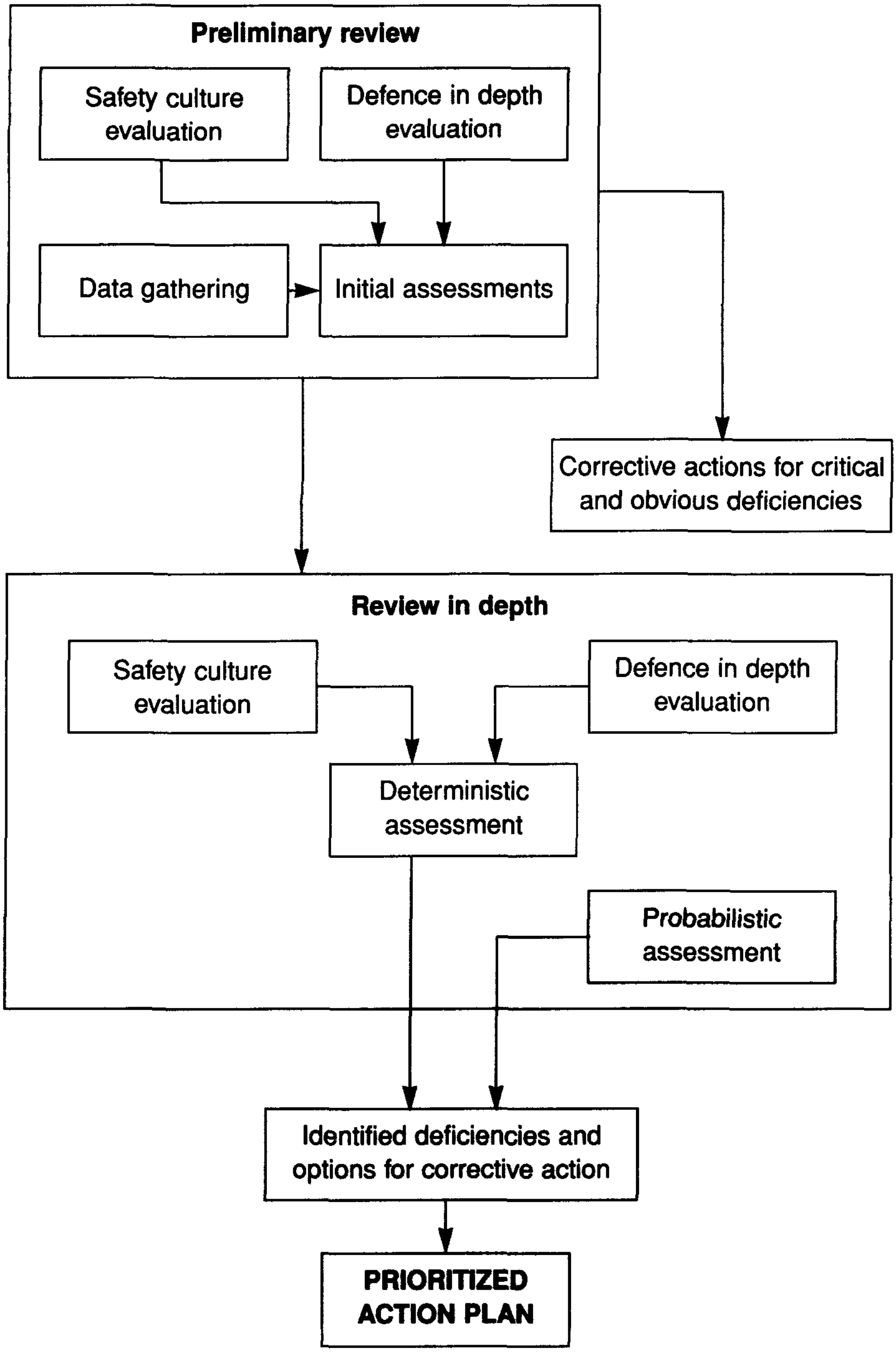

FIG. 1. Simplified flow chart of the process for assessment of the safety of nuclear power plants.

personnel who provide their services; to the regulatory authority; and to those in industry and government who could indirectly influence the safety of the plant. These areas are important to the overall safety of the plant, as demonstrated by operating experience. Also, for plants considered to need improvements for safety, corrective actions that favourably influence the safety culture are synergetic.

24. An assessment of safety culture should address the attitudes not only of individuals but also of organizations. In particular, a sound safety culture in the operating organization and the regulatory body is essential to the safety of an operating plant. Safety Culture, INSAG-4, provides guidance on assessing the safety culture of organizations and individuals.

PRELIMINARY REVIEW

25. The objectives of a preliminary review are twofold. The first objective is to determine whether a plant conforms to the standards for design and operation that were applicable when it was first licensed. The second objective is to identify any features that would constitute a significant departure from the principle of defence in depth.

26. This preliminary review starts with a rather complete picture of the specific plant being assessed. This requires that a careful and thorough gathering of data be undertaken to permit a full understanding of the design of the plant, the licensing basis and the history of the plant, including its modifications and operations. This step is critical to the quality of later steps in the assessment. Initial assessments are made as part of this data gathering process, including the following:

(1) An assessment is made of the site characteristics to determine whether any pre-existing or new features, including external hazards, were not adequately taken into account in the design.
(2) An assessment is made of the construction phase (including the quality of equipment) to identify any major deviations from approved plans and analytical bases and to determine whether the quality of construction was adequate.
(3) An assessment is made of the operational phase to determine whether the plant has operated as intended. This operational review should identify and assess abnormal transients or other abnormal occurrences and assess the adequacy of the plant response and the corrective measures taken. It should also review the reliability and performance of critical systems, structures and components for specific problems that could affect safety. Additionally, the quality of the operation should be scrutinized and assessments should be made of activities related to the conduct of operations, maintenance, training and overall organization.

(4) A review is made of major deficiencies in defence in depth, including provisions for emergency preparedness. This should include a review of the adequacy and completeness of assumptions for the design basis.

27. In assessing the siting, construction and operational phases, a specific review should be made of corrective actions taken and their effectiveness. Reviews should be made of major maintenance work done and the results of in-service inspections or any assessments of ageing. If certain limitations to the foregoing assessment steps emerge (such as inadequate documentation of the as-built plant), then alternative approaches such as additional testing or non-destructive evaluation may be necessary.

28. In this preliminary review, operating experience for plants of a similar type should also be considered for generic design or operational issues and reliability insights. The results of any safety assessments of similar plants should be reviewed for findings or recommendations that may be applicable to the plant being assessed.

29. The preliminary review should be performed expeditiously, especially where it relates to characteristics of defence in depth, in order to identify clearly acute conditions. Any obvious changes that would alleviate these acute conditions without adverse effects should be made immediately, with emphasis on short term changes related to operations, training and safety culture, maintenance or improvements in spare parts. Changes made at this stage should be limited to clearly advantageous changes or to alleviating clearly unacceptable conditions. Remaining decisions on required improvements would await the results of a review in depth.

REVIEW IN DEPTH

30. The objective of the review in depth is to assess the design, construction and operation of the plant against current standards and practices in order to identify any non-conformance, its significance and possible compensatory measures. Judgement becomes a major input to the process. There are two important and complementary tools that, together, can help in structuring the exercise of judgement.

(1) **Deterministic methods.** Deterministic methods, meaning the application of internationally accepted safety rules and safety standards, form a cornerstone of safety evaluations. These methods derive from the fundamental concept of defence in depth. Deterministic methods, which vary somewhat between countries, have been widely accepted, together with their associated margins of safety.
(2) **Probabilistic methods.** Probabilistic methods provide a flexible tool for assessment. This tool takes account of the probability of faults that might initi-

ate accidents and the probability of failure of the safety systems intended to limit the effects of such faults. PSA relies on deterministic analysis to specify limiting conditions for adequate performance of a particular safety system. Probabilistic methods provide insights into the relative importance of different features of systems. Even though a full PSA could provide an integrated and balanced assessment of the safety of a plant, the quality of such an analysis will be jeopardized by any lack of specific data relating to operating experience. In the initial steps of the review in depth, more limited probabilistic studies (limited, for example, to particular systems, functions, or event initiators) have significant value for analysing the interactions and weaknesses of systems, and can be performed more quickly than a full study. PSAs that have been performed on plants of similar design and which have identified design weaknesses may also provide valuable information on issues that may need attention.

31. For more detailed deterministic and probabilistic assessments, oversimplification or short cuts can invalidate the conclusions of the safety assessment. For example, a valid safety assessment of a plant must be representative of that particular plant. This means that it cannot be assumed that the safety levels of two plants of similar design will necessarily be similar. Each installation has to be reviewed individually, since several factors can affect safety. Such factors include small design differences; differences in the quality of fabrication and construction; maintenance practices; modifications that have been made; the effects of ageing on the physical condition of the plant; the training, qualification and attitude of workers; in-service inspection; and the accuracy of the 'as-built' documentation. Generic assumptions and data, where used, should be verified to be representative of the design and experience of the particular plant. The comprehensiveness of the plant data collection programme and the accessibility and fidelity of the data are important to probabilistic and to deterministic methods equally. However, PSA methods typically require more data from operating experience on the probability of various initiating events and on the performance of systems, structures and components. The availability of these data may be limited for older plants.

32. Another aspect that should be reviewed in both the deterministic and probabilistic approaches is the effect of external hazards on safety. The frequency and severity of these hazards are site related, whereas measures for protection from these hazards are incorporated into plant design. One critical aspect of external hazards to be considered is their potential to induce common cause failures. Plants built to earlier standards may have deficiencies both in the requirements relating to the derivation of the site related design basis as well as in criteria and measures (i.e. design features) for protection against effects generated by external hazards.

33. The set of internationally agreed deterministic 'current safety standards' are important to the review in depth; however, they do not directly define the 'adequacy of safety', and thus they are not fully sufficient in themselves to identify unsafe plants. In many cases, concluding that a plant fails to meet a deterministic requirement does not give a clear indication of the significance of the deficiency. For judging the significance of deterministically identified deficiencies, it may be helpful to assess the likelihood that each deficiency might contribute to plant damage and/or external radioactive releases. Care must be exercised since expert judgement is still necessary to interpret the results.

34. A Level 1 PSA which assesses only the probability of an accident leading to core damage and identifies the dominant contributors without attempting to quantify potential radioactive releases can be helpful in providing insight into the safety of most plants. Plant assessments with an adequate analysis of the capabilities of the confinement function of the plant would be useful in order to confirm the adequacy of the defence in depth. An assessment of the capability of the containment and/or the confinement on the basis of the review of its design basis, and a probabilistic review of the performance of containment and/or confinement systems, are essential to link the probability of core damage to the probability and consequences of external radioactive releases. Plants with significant deficiencies will be recognized as such without the need for long and costly analyses.

35. This discussion of deterministic and probabilistic assessment methods should be viewed in a broad context. One acute factor affecting the safety of a given plant is the degree to which defence in depth is implemented at the plant.

36. In evaluating the implementation of defence in depth, it is important to conduct assessments of plants built to earlier safety standards through an appropriate and balanced review of the plants against their own design basis and the retrospective application of current safety standards. Many older plants do not conform to all current criteria and standards for design. This does not necessarily make them unsafe, in part owing to the conservative margins of safety in many older designs. However, differences between older design criteria and current standards must be taken into account. It is important to identify compensatory measures that would meet the objectives of safety standards. Probabilistic tools and risk based decision making could be applied where appropriate.

37. An example of account being taken of the differences between older design criteria and current standards is the retrospective application of current seismic design criteria. Current seismic standards, which have evolved through the application of seismic hazards methods, seismic structural technology and better component fragility data, cannot be imposed retrospectively through a rigid design process. This is

because such an approach would require many changes to plant systems and structures which it would be impractical to implement. However, insights from modern seismic technology and from the study of the performance of equipment and structures in actual earthquakes can be applied to older plants and can provide substantial improvements in safety through the 'seismic margins' assessment process.

38. After completion of the in depth safety assessment of a plant, a review of the results should show the significance for the maintenance of adequate defence in depth of any deficiencies that were identified. Since each of the levels of protection should afford substantial protection for the defence in depth concept to work, deficiencies that reveal a serious weakness in one or more levels should be given high priority for corrective action. This strategic review of the results of the assessment should also place a high priority on addressing any initiators or single failures that could directly lead to serious off-site consequences. This systems level review should also help to confirm that protection is maintained in all operating modes, including the shutdown mode and refuelling. It should assist in the integration of corrective actions deriving from assessments of internal and external event sequences. Finally, this strategic review should help maintain a balance between efforts devoted to the prevention of accidents and those devoted to the mitigation of their consequences.

7. ACHIEVING ACCEPTABLE LEVELS OF SAFETY

39. INSAG-3 sets out the principles that would lead to an acceptable level of plant safety. INSAG-3 underwent extensive review by operating organizations, regulatory authorities and other experts on nuclear safety. The report has received broad acceptance from these groups and should be the primary yardstick against which the safety of plants built to earlier standards is measured. Other INSAG reports, particularly INSAG-4, Safety Culture, and INSAG-6, Probabilistic Safety Assessment, should be used to supplement a safety assessment based on INSAG-3.

40. As discussed in Section 6, plant assessment starts with a preliminary review. In the preliminary review, careful and thorough gathering of data is undertaken to provide a complete picture of the design of the plant, the licensing basis, the history of modifications and the history of operations. Initial assessments are made of site characteristics, construction and operational anomalies, and major deficiencies in defence in depth are identified. Any serious deficiencies should be corrected promptly with the emphasis on corrective actions relating to operations, maintenance and training.

41. A deterministic evaluation is then made to assess the original standards and the conditions at the plant against the current deterministic approach, including the principles set out in INSAG-3. Corrective actions should also be considered in order to ensure an appropriate response to events. Such actions could include upgrading of the capability of operators, procedures, maintenance and inspections; of the capability for coping with emergencies; and of the display instrumentation and the human–machine interface. Findings from the evaluations of defence in depth and of safety culture are also included.

42. This evaluation should also include a specific assessment for certain critical deficiencies that could lead to a significant likelihood of a severe accident endangering public health. These critical deficiencies include:

- — Any situations in which accidents of the original design basis would not be coped with adequately;
- — Deficiencies that could lead to failures that would not be coped with adequately, such as major deficiencies in the primary pressure boundary leading to an accident beyond the design basis;
- — Unstable core behaviour or other events that could lead to a severe power excursion and inadequate shutdown capability in the short or long term;
- — Inadequate shutdown capability or inadequate decay heat removal during any plant operational modes, including outages and abnormal events such as fire, flooding or complete loss of electrical power;
- — Inadequate containment or confinement capability such that credible failures or sequences of failures that cannot reasonably be excluded on probabilistic or deterministic grounds could give rise to a large external release requiring significant emergency measures;
- — Severe deficiencies in the conduct of operations.

43. It must be determined whether there are unacceptable deviations in any of these critical areas. If such deviations cannot be compensated for by other means and are confirmed to be unacceptable, the plant should be shut down. If the preliminary review of a plant does not identify any critical deficiencies but, nevertheless, deviations from current safety standards are identified, then operation could continue while reviews in depth, including reviews of defence in depth and of safety culture, are undertaken.

44. After a complete set of plant deficiencies and potential corrective actions have been identified, the first decision to be made is whether the required corrective actions are feasible. If it is determined that feasible corrective actions can bring the plant to an acceptable level of safety, it is necessary to develop an integrated and prioritized action plan. Potential corrective actions need to be screened to determine which are

important enough to consider for implementation. Actions should be prioritized so that the initial time and resources spent on improving the situation are dedicated to the most urgent matters. The decision making process could be aided by probabilistic assessments which, in particular, can greatly assist in prioritizing corrective actions. However, plant probabilistic analyses have their limitations. Their merits and limitations are discussed in INSAG-6. The plan must be integrated to ensure that all changes being made are appropriate, that they do not conflict or adversely interact, and that they are being sequenced so that adequate safety is maintained while the changes are being made. Subject to this overriding priority, significant improvements that can be introduced quickly should be given high priority. In some situations the shortcomings identified in a plant may be of such significance that fully effective corrective actions are not feasible or practical. In such instances long term operation is not acceptable for reasons of safety.

45. As part of INSAG's technical safety objective, INSAG-3 included probabilistic safety targets. For existing nuclear plants, the target is a likelihood of occurrence of severe core damage that is below 10^{-4} events per plant operating year. INSAG-3 also recognized that management of severe accidents and mitigatory measures for accidents should reduce by a factor of at least ten the probability of major external radioactive releases requiring off-site response in the short term. PSA, owing to its inherent uncertainties, should not be used in isolation to judge the safety of a plant. Nevertheless, a PSA can be of use as an indicator of safety, particularly if performed with specific plant models and data drawn from the plant's operational experience so that uncertainties can be narrowed. Comparison of plants against the safety targets in INSAG-3 can serve as indicators of the level of safety achieved.

46. It is possible that implementing the highest priority actions on a plant requiring improvements could result in its being judged to be acceptably safe. If so, further actions would be implemented as part of longer term national plans for upgrading.

47. For those plants that are judged to have 'adequate levels of safety', it is encouraged to make further reasonably achievable improvements. Decisions on such improvements should be evaluated from a 'value–impact' or cost–benefit' perspective, in which the highest priority is given to those actions that produce the best cost–benefit ratio for risk reduction.

8. SUMMARY AND CONCLUSIONS

48. The need has arisen to establish a common basis for judging the safety of nuclear power plants built to earlier standards. A general consensus on safety princi-

ples to be adopted in making such judgements emerged in the formulation and international acceptance of INSAG-3. INSAG-3 should continue to be the basis for judging the safety of existing nuclear power plants.

49. The present report proposes the following process for assessing the safety of plants built or operated to earlier safety standards and for establishing a formal safety improvement programme where one is needed:

(1) A deterministic evaluation is made, by starting with the standards to which the plant was originally built and then assessing the safety of the plant against current principles and practices, including those set out in INSAG-3.
(2) If critical deficiencies are found and they are judged to be unacceptable and cannot be eliminated or compensated for, the plant should be shut down.
(3) If no critical deficiencies are found, but deficiencies are identified in the process of deterministic evaluation, then corrective actions should be identified which bolster the defence in depth features. Corrective measures associated with written procedures, operator training, inspections and maintenance should be acted upon relatively quickly.
(4) A PSA could be used to evaluate design weaknesses and to estimate the core damage frequency. A comparison of these results with the probabilistic safety target of INSAG-3 should be made.
(5) The results from the deterministic evaluation and the PSA will be useful in prioritizing corrective actions.
(6) For plants that have been subjected to an in-depth assessment and judged to have an acceptable level of safety, it is encouraged to make further enhancements in safety where these are reasonably achievable.

50. In extraordinary social and economic circumstances, national authorities may decide to permit the continued operation of a plant while an acceptable level of safety is achieved. Such a decision should be an interim one, should take account of international obligations and should be taken in full awareness of the safety implications. Authorities must have reliable information for making such decisions. Special social and economic considerations should not enter into the technical safety assessment process itself.

51. In order to achieve the goal of ensuring that all nuclear power plants have an acceptable level of safety, international co-operation and understanding of this proposed common basis for judging safety is necessary. Confidence in the results of this endeavour will require that the international community generally recognizes this common basis and accepts that equivalent interpretations and consistent judgements are being made from country to country.

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ISBN 92-0-102395-2
ISSN 1025-2169