

SAFETY REPORTS

safety series

Safety Culture

A REPORT BY THE
INTERNATIONAL NUCLEAR SAFETY ADVISORY GROUP



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SAFETY CULTURE

A report by the International Nuclear Safety Advisory Group

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SAFETY CULTURE

A report by the
International Nuclear Safety Advisory Group

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 SAFETY SERIES IS ALSO PUBLISHED IN
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FOREWORD

by the Director General

With the intention of strengthening the IAEA's contribution to ensuring the safety of nuclear power plants, leading experts in nuclear safety were invited by the Agency to form the International Nuclear Safety Advisory Group (INSAG). This group serves mainly as a forum for the exchange of information on nuclear safety issues of international significance and formulates, where possible, common safety concepts.

The term 'Safety Culture' was first introduced in INSAG's *Summary Report on the Post-Accident Review Meeting on the Chernobyl Accident*, published by the IAEA as Safety Series No.75-INSAG-1 in 1986, and further expanded on in *Basic Safety Principles for Nuclear Power Plants*, Safety Series No.75-INSAG-3, issued in 1988. Since the publication of these two reports, the term Safety Culture has been used increasingly in the literature in connection with nuclear plant safety. However, the meaning of the term was left open to interpretation and guidance was lacking on how Safety Culture could be assessed. The present report deals with the concept of Safety Culture as it relates to organizations and individuals engaged in nuclear power activities, and provides a basis for judging the effectiveness of Safety Culture in specific cases in order to identify potential improvements.

The report is intended for use by governmental authorities and by the nuclear industry and its supporting organizations. Prepared by a highly authoritative body, it should help to promote Safety Culture. It is intended to stimulate discussion and to promote practical action at all levels to enhance safety.

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SUMMARY

The response to a previous publication by the International Nuclear Safety Advisory Group (INSAG), No. 75-INSAG-3, *Basic Safety Principles for Nuclear Power Plants*¹, indicated a broad international interest in expansion of the concept of Safety Culture, in such a way that its effectiveness in particular cases may be judged. The present report responds to that need. It is directed especially to the senior management of all organizations whose activities affect nuclear plant safety.

In embarking on a report on Safety Culture, INSAG was faced with the fact that the concept has not been fully charted in previous studies, and there is no consensus on the meaning of Safety Culture. In seeking to develop views that will be commonly shared and have important value in application, INSAG found it necessary to explore deeply the general factors which contribute to a satisfactory nuclear safety regime. The outcome is a document which represents the common view of INSAG members.

The first proposition presented by INSAG is the definition of Safety Culture:

Safety culture is that assembly of characteristics and attitudes in organizations and individuals which establishes that, as an overriding priority, nuclear plant safety issues receive the attention warranted by their significance.

This statement was carefully composed to emphasize that Safety Culture is attitudinal as well as structural, relates both to organizations and individuals, and concerns the requirement to match all safety issues with appropriate perceptions and action.

The definition relates Safety Culture to personal attitudes and habits of thought and to the style of organizations. A second proposition then follows, namely that such matters are generally intangible; that nevertheless such qualities lead to tangible manifestations; and that a principal requirement is the development of means to use the tangible manifestations to test what is underlying.

INSAG takes the view that sound procedures and good practices are not fully adequate if merely practised mechanically. This leads to a third proposition: that Safety Culture requires all duties important to safety to be carried out correctly, with alertness, due thought and full knowledge, sound judgement and a proper sense of accountability.

¹ INTERNATIONAL NUCLEAR SAFETY ADVISORY GROUP, *Basic Safety Principles for Nuclear Power Plants*, Safety Series No. 75-INSAG-3, IAEA, Vienna (1988).

In its manifestation, Safety Culture has two major components: the framework determined by organizational policy and by managerial action, and the response of individuals in working within and benefiting by the framework. Success depends, however, on commitment and competence, provided both in the policy and managerial context and by individuals themselves.

Sections 1 to 3 of the report develop the complementary ideas of the framework provided at the policy and managerial level and of individual responses. This is done in a general way so that the views expressed are applicable in any organization with responsibilities affecting nuclear safety.

To make practical use of the work towards improving nuclear plant safety requires more substance. All those engaged in matters touching on nuclear safety are likely to insist that what is described is entirely characteristic of their own approach. All will say: "But this is what we do already". INSAG therefore judged it right to go further, and so the latter part of the report provides more detail on the tangible characteristics of a satisfactory Safety Culture in different kinds of organizations. In the main text this is in the form of statements of what should be expected. In the Appendix it is in the form of a series of questions, provided as an aid to self-examination by organizations rather than as a Yes/No checklist.

Finally, in preparing this report, INSAG took care to avoid merely listing sound practices and requirements for satisfactory individual behaviour which, while no doubt worth restating, take matters little further. Instead, INSAG sought by way of propositions to analyse and illustrate the topic in more general ways, and to provide means by which organizations may examine and improve their own practices, performance and working methods. On this basis, INSAG offers the report as a contribution to the further enhancement of nuclear plant safety.

1. INTRODUCTION

1. Except for what are sometimes called 'Acts of God', any problems arising at a nuclear plant originate in some way in human error. Yet the human mind is very effective in detecting and eliminating potential problems, and this has an important positive impact on safety. For these reasons, individuals carry heavy responsibility. Beyond adherence to defined procedures, they must act in accordance with a 'Safety Culture'. The organizations operating nuclear plants, and all other organizations with a safety responsibility, must so develop Safety Culture-as to prevent human error and to benefit from the positive aspects of human action.

2. The substance of Safety Culture is the means by which close attention to safety is achieved for both organizations and individuals. INSAG introduced the term Safety Culture in its Summary Report on the Post-Accident Review Meeting on the Chernobyl Accident². In its subsequent report, Basic Safety Principles for Nuclear Power Plants³, referred to in the following as INSAG-3, Safety Culture was highlighted as a fundamental management principle. The present report responds to comments received after publication of INSAG-3 proposing that the concept of Safety Culture be clarified and so defined that its effectiveness could be confirmed in specific instances.

3. This report gives particular attention to operating organizations, because the link between human performance and plant safety is closest there. Yet the discussion extends to Safety Culture in all concerned, because the highest level of safety is achieved only when everyone is dedicated to the common goal.

4. The safety of the plant also depends critically on those who previously designed, constructed and commissioned it. A partial list of other contributors includes the background community of science and engineering, the governmental bodies responsible for regulation and those responsible for the underlying research.

5. INSAG-3 identified particular aspects of Safety Culture. It also dealt with matters not so identified but which represent practices important for achievement of the required human responses. What follows treats these practices as an essential component of Safety Culture.

² INTERNATIONAL NUCLEAR SAFETY ADVISORY GROUP, Summary Report on the Post-Accident Review Meeting on the Chernobyl Accident, Safety Series No. 75-INSAG-1, IAEA, Vienna (1986).

³ INTERNATIONAL NUCLEAR SAFETY ADVISORY GROUP, Basic Safety Principles for Nuclear Power Plants, Safety Series No. 75-INSAG-3, IAEA, Vienna (1988).

2. DEFINITION AND CHARACTER OF SAFETY CULTURE

6. **Safety Culture is that assembly of characteristics and attitudes in organizations and individuals which establishes that, as an overriding priority, nuclear plant safety issues receive the attention warranted by their significance.**
7. In INSAG-3 it was stated that Safety Culture “refers to the personal dedication and accountability of all individuals engaged in any activity which has a bearing on the safety of nuclear power plants”. It was further stated to include as a key element “an all pervading safety thinking”, which allows “an inherently questioning attitude, the prevention of complacency, a commitment to excellence, and the fostering of both personal accountability and corporate self-regulation in safety matters”.
8. Attributes such as personal dedication, safety thinking and an inherently questioning attitude are intangible. Yet it is important to be able to judge the effectiveness of Safety Culture. INSAG has addressed this problem by starting from the perception that the intangible attributes lead naturally to tangible manifestations that can act as indicators of Safety Culture.
9. Good practices in themselves, while an essential component of Safety Culture, are not sufficient if applied mechanically. There is a requirement to go beyond the strict implementation of good practices so that all duties important to safety are carried out correctly, with alertness, due thought and full knowledge, sound judgement and a proper sense of accountability.
10. Thus what follows presents the relevant good practices, provides comments on the less tangible individual attitudes necessary and identifies characteristics that may be considered as measures of the effectiveness of Safety Culture.

3. UNIVERSAL FEATURES OF SAFETY CULTURE

11. In all types of activities, for organizations and for individuals at all levels, attention to safety involves many elements:

- *Individual awareness* of the importance of safety.
- *Knowledge and competence*, conferred by training and instruction of personnel and by their self-education.
- *Commitment*, requiring demonstration at senior management level of the high priority of safety and adoption by individuals of the common goal of safety.
- *Motivation*, through leadership, the setting of objectives and systems of rewards and sanctions, and through individuals' self-generated attitudes.
- *Supervision*, including audit and review practices, with readiness to respond to individuals' questioning attitudes.
- *Responsibility*, through formal assignment and description of duties and their understanding by individuals.

12. *Safety Culture has two general components. The first is the necessary framework within an organization and is the responsibility of the management hierarchy. The second is the attitude of staff at all levels in responding to and benefiting from the framework.*

13. These components are dealt with separately under the headings of Requirements at Policy Level (Section 3.1) and Requirements on Managers (Section 3.2) and Response of Individuals (Section 3.3). Since Safety Culture particularly concerns individual performance, and since many individuals carry safety responsibilities, Section 3.3 is especially important.

14. Figure 1 illustrates the major components of Safety Culture, relating the text headings to this overall scheme.

15. *In keeping with the practice of INSAG-3, throughout the report the presentation is in accordance with the assumption that the practices are in current use. The sense of the usage is that the circumstances described are those which this report seeks to promote.*

3.1. REQUIREMENTS AT POLICY LEVEL

16. *In any important activity, the manner in which people act is conditioned by requirements set at a high level. The highest level affecting nuclear plant safety is the legislative level, at which the national basis for Safety Culture is set.*

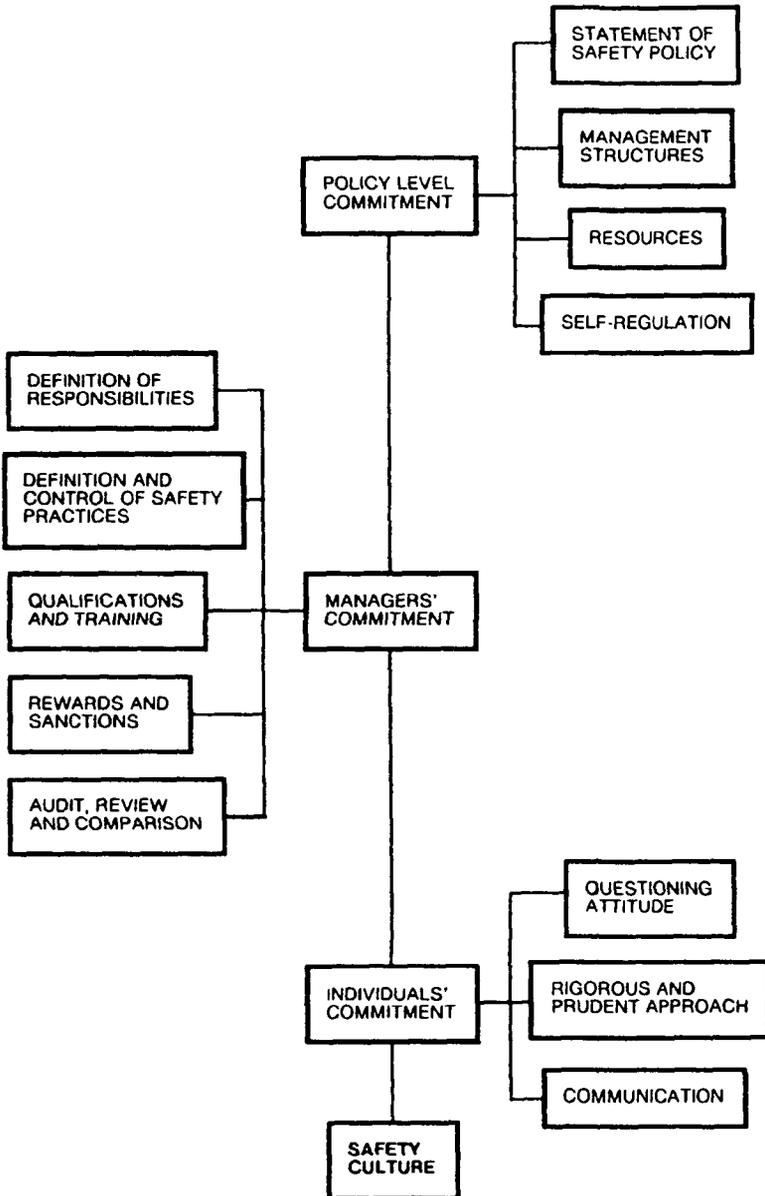


FIG. 1. Illustration of the presentation of safety culture.

17. Governments discharge their responsibilities to regulate the safety of nuclear plants and other potentially hazardous installations and activities in order to protect individuals, the public at large and the environment. Legislation is backed by the necessary advisory and regulatory bodies, which have sufficient staff, funding and powers to perform their duties and the freedom to do so without undue interference. In this way, national climates are fostered in which attention to safety is a matter of everyday concern. Governments also encourage international exchanges aimed at safety improvements and seek to minimize any commercial or political impediments to such exchanges.

18. *Within an organization, similar considerations apply. Policies promoted at a high level create the working environment and condition individual behaviour.*

19. Safety policies and their detailed implementation vary depending on the nature of the organization and the activities of its staff, but important common features can be defined. Sections 3.1.1 to 3.1.5 show how such commitment at the policy level is declared and supported.

3.1.1. Statements of safety policy

20. *An organization pursuing activities with a bearing on nuclear plant safety makes its responsibilities well known and understood in a safety policy statement. This statement is provided as guidance to staff, and to declare the organization's objectives and the public commitment of corporate management to nuclear plant safety.*

21. Safety policy statements by different bodies with differing functions vary in both form and content. An operating organization has full and formal responsibility for the safety of its nuclear plants. Its safety policy statement is clear and is provided to all staff. This statement declares a commitment to excellent performance in all activities important for the safety of nuclear plants, making it plain that nuclear plant safety has the utmost priority, overriding if necessary the demands of production or project schedules.

22. A regulatory body has a weighty influence on the safety of nuclear plants within its purview and an effective Safety Culture pervades its own organization and its staff. The basis is again set down in a safety policy statement. This makes a commitment to implement legislation and to act to promote plant safety and the protection of individuals and the public, and to protect the environment.

23. Supporting organizations, which include those responsible for design, manufacture, construction and research, influence greatly the safety of nuclear

plants. Their primary responsibility is for quality of the product, whether this is a design or a manufactured component, installed equipment, a safety report or software development, or any other output important to safety. The basis for Safety Culture in such an organization is the directive establishing policy and practices to achieve quality, and thereby to meet the safety objectives of the future operator.

3.1.2. Management structures

24. *Implementation of these safety policies requires that accountability in safety matters is clear.*

25. The detailed way in which this is achieved depends on the role of the organization, but one key requirement is common to all: strong lines of authority are established for those matters bearing on nuclear plant safety, by means of clear reporting lines and few and simple interfaces, supported by the definition and documentation of duties.

26. The formal responsibility for plant safety lies with the operating organizations and the delegated authority with the plant manager. In the contributing organizations, the equivalent requirement is to ensure by management structure and definition of duties that responsibility for the quality of the product is well defined.

27. *Large organizations with significant impact on nuclear plant safety provide independent internal management units with responsibility for the surveillance of nuclear safety activities.*

28. In operating organizations, these units have the role of scrutinizing safety practices at the plant. They report at a senior management level, ensuring the integration of safety responsibilities into the management chain with a prominence matching that of other main functions. Supporting organizations adopt similar methods to achieve product quality, involving audit and review practices with arrangements for reporting at a senior level.

3.1.3. Resources

29. *Adequate resources are devoted to safety.*

30. Sufficient experienced staff are available, supplemented as necessary by consultants or contractors, so that duties relevant to nuclear plant safety may be carried out without undue haste or pressure. Staffing policies ensure that competent individuals can advance through the key posts. Training of staff is recognized as vital and the necessary resources are devoted to it. Funding is sufficient to ensure that staff

in all safety related tasks have available to them the necessary equipment, facilities and supporting technical infrastructure. The working environment for such staff is conducive to the effective performance of their duties.

3.1.4. Self-regulation

31. *As a matter of policy, all organizations arrange for regular review of those of their practices that contribute to nuclear plant safety.*
32. This includes, for example, staff appointments and training, the feedback of operating experience, and the control of design changes, plant modifications and operating procedures. The intent is to bring fresh judgement to bear and to allow new approaches to be suggested by involving fully competent individuals or bodies outside the normal chain of command. Such arrangements are promoted as natural and helpful aids to the practitioners, and they avoid the appearance of a punitive search for shortcomings.

3.1.5. Commitment

33. *Paragraphs 16–32 cover activities which define the working environment and which require corporate level commitment for success. This commitment is publicly asserted and well known, shows the stance of corporate management in relation to its social responsibilities, and demonstrates also an organization's willingness to be open in safety matters.*
34. On a personal basis, managers at the most senior level demonstrate their commitment by their attention to regular review of the processes that bear on nuclear safety, by taking direct interest in the more significant questions of nuclear safety or product quality as they arise, and by frequent citation of the importance of safety and quality in communications to staff. In particular, nuclear plant safety is an important agenda item at meetings of boards of operating organizations.

3.2. REQUIREMENTS ON MANAGERS

35. *The attitudes of individuals are greatly influenced by their working environment. The key to an effective Safety Culture in individuals is found in the practices moulding the environment and fostering attitudes conducive to safety. It is the responsibility of managers to institute such practices in accordance with their organization's safety policy and objectives.*

36. The requirements so placed on managers are discussed in the following. Except as specifically indicated, the comments apply to all organizations engaged in activities affecting nuclear safety.

3.2.1. Definition of responsibilities

37. *Discharge of individual responsibilities is facilitated by unique and clear lines of authority.*

38. The responsibility assigned to individuals is defined and documented in sufficient detail to prevent ambiguity. The collective definitions of the authority and responsibility of individuals are reviewed to ensure that there are no omissions or overlaps and no problems of shared responsibilities. Definitions of responsibility are approved at a higher level of authority. Managers ensure that individuals understand not only their own responsibilities but also those of their immediate colleagues and of their management unit, and how these responsibilities complement those of other groups. This requirement for careful definition of responsibilities applies with special force to operating organizations since they carry the formal responsibility for plant safety. The delegated responsibility of the plant manager for the safety of the plant is given particular emphasis.

39. Since operating organizations carry the formal responsibility for the safety of operating plants, they have a further obligation. This is the duty to assure themselves, by means of third parties if necessary, that other organizations whose activities contribute to the technical basis of plant safety discharge their responsibilities satisfactorily.

3.2.2. Definition and control of working practices

40. *Managers ensure that work on matters related to nuclear safety is carried out in a rigorous manner.*

41. While the necessity is obvious in operating organizations, the requirements for product quality in supporting organizations call for similar attention. The necessary basis is generally a hierarchy of up to date documents ranging from policy directives to detailed working procedures. These procedures are clear and unambiguous and they form an integral series. The documents receive formal scrutiny, checking and testing under the organizations' quality assurance arrangements, and formal means are adopted for their control.

42. Managers ensure that tasks are carried out as defined. They institute systems for supervision and control and insist upon orderliness and good housekeeping.

3.2.3. Qualifications and training

43. *Managers ensure that their staff are fully competent for their duties.*
44. Selection and appointment procedures establish satisfactory initial qualifications of personnel in terms of intellect and education. Any necessary training and periodic retraining are provided. The assessment of technical competence is an integral part of training programmes. For critical tasks in plant operations, judgement of fitness for duties includes physical and psychological considerations.
45. *Instruction instils more than technical skills or familiarity with detailed procedures to be followed rigorously. These essential requirements are supplemented by broader training, sufficient to ensure that individuals understand the significance of their duties and the consequences of mistakes arising from misconceptions or lack of diligence.*
46. Without this additional understanding, nuclear safety issues arising may not receive the attention they warrant or wrong actions may be taken, out of lack of comprehension of the risks involved.

3.2.4. Rewards and sanctions

47. *Ultimately, satisfactory practice depends on the behaviour of individuals, as influenced by motivation and attitudes, both personal and group. Managers encourage and praise and seek to provide tangible reward for particularly commendable attitudes in safety matters.*
48. Importantly, at operating plants, systems of reward do not encourage high plant output levels if this prejudices safety. Incentives are therefore not based on production levels alone but are also related to safety performance.
49. Errors, when committed, are seen less as a matter of concern than as a source of experience from which benefit can be derived. Individuals are encouraged to identify, report and correct imperfections in their own work in order to help others as well as themselves to avert future problems. When necessary, they are assisted to improve their subsequent performance.
50. Nevertheless, for repeated deficiency or gross negligence, managers accept their responsibility for taking disciplinary measures, since safety may otherwise be prejudiced. There is, however, a delicate balance. Sanctions are not applied in such a way as to encourage the concealment of errors.

3.2.5. Audit, review and comparison

51. *Managerial responsibilities include the implementation of a range of monitoring practices which go beyond the implementation of quality assurance measures and include, for example, regular reviews of training programmes, staff appointment procedures, working practices, document control and quality assurance systems.*
52. These practices depend on the activities of the organization. In design, manufacturing and operating organizations, they include scrutiny of the means by which design or engineering changes are controlled. In the plant operational context, they include scrutiny of changes to operating parameters, maintenance requirements, modifications to plant, plant configuration control and any non-routine operation of the plant.
53. By these means, the working of safety management systems is checked by internal processes. It is good practice to augment such processes by calling on experts from functions other than that concerned or from outside the organization. This ensures the availability of broadly based views and experience, provides a basis for emulation and encourages the introduction of good practices that have been adopted elsewhere.
54. Managers make arrangements to benefit from all sources of relevant experience, research, technical developments, operational data and events of safety significance, all of which are carefully evaluated in their own contexts.

3.2.6. Commitment

55. In these ways, managers demonstrate their commitment to Safety Culture and encourage it in others. The practices identified structure the environment in which people work. The attitude of mind that produces satisfactory performance by people in groups or as individuals is fostered by demands for orderly work, by clarity of understanding of duties, by rewards and any necessary sanctions, and by the invitation of external scrutiny.
56. *It is the task of managers to ensure that their staff respond to and benefit from this established framework of practices and, by attitude and example, to ensure that their staff are continuously motivated towards high levels of personal performance in their duties.*

3.3. RESPONSE OF INDIVIDUALS

57. *Sections 3.1 and 3.2 present the means by which the framework is set for an effective Safety Culture and emphasize the responsibilities of management. As is pointed out in the introduction to these sections, it is the task of staff at all levels to respond to and benefit from this framework.*
58. The question remains: How? To emphasize this key question, what follows is set out in a different style. It is expressed in terms most relevant to operating staff since they bear the most direct responsibility, though in different ways the points apply to all persons with duties important to nuclear safety.
59. *The response of all those who strive for excellence in matters affecting nuclear safety is characterized by:*

A QUESTIONING ATTITUDE

plus

A RIGOROUS AND PRUDENT APPROACH

plus

COMMUNICATION

The result will be a major contribution to:

S A F E T Y

60. Before an individual begins any safety related task, his or her *questioning attitude* raises issues such as those listed in the following:
- Do I understand the task?
 - What are my responsibilities?
 - How do they relate to safety?
 - Do I have the necessary knowledge to proceed?
 - What are the responsibilities of others?
 - Are there any unusual circumstances?
 - Do I need any assistance?

- What can go wrong?
- What could be the consequences of failure or error?
- What should be done to prevent failures?
- What do I do if a fault occurs?

In the case of relatively routine tasks, for which the individual has been fully trained, question and answer will be automatic to a large extent. For tasks with a novel content, the thought process becomes more deliberate. New and unusual tasks which have an important safety content will be the subject of written procedures clarifying these matters.

61. Individuals adopt a *rigorous and prudent approach*. This involves:

- understanding the work procedures;
- complying with the procedures;
- being alert for the unexpected;
- *stopping and thinking if a problem arises*;
- seeking help if necessary;
- devoting attention to orderliness, timeliness and housekeeping;
- proceeding with deliberate care;
- forgoing shortcuts.

62. Individuals recognize that a *communicative* approach is essential to safety. This involves:

- obtaining useful information from others;
- transmitting information to others;
- reporting on and documenting results of work, both routine and unusual;
- suggesting new safety initiatives.

63. A questioning attitude, a rigorous and prudent approach, and necessary communication are all aspects of an effective Safety Culture in individuals. The product contributes to a high level of safety and generates a personal pride in dealing with important tasks in a professional manner.

4. TANGIBLE EVIDENCE

64. In Section 3, Safety Culture was considered as the assembly of commendable attributes of any organization or individual contributing to nuclear plant safety. This general treatment needs extending to cover the separate attributes of different organizations. Also, examples are needed:

- to show that Safety Culture is a concrete concept essential to safety;
- to provide a basis for judging the effectiveness of Safety Culture in specific cases;
- to identify options for improvements.

65. This section identifies some broad characteristics of an effective Safety Culture in different groups of organizations: governmental, operational and supporting. Its objective is to provide insight from several standpoints into factors that promote the safety of nuclear plants. The list is not exhaustive and can be extended by the reader. It is intended to be used as a starting point for self-examination by organizations.

66. The Appendix approaches the same issue in a different way. It comprises sets of questions which can be used to aid judgement of the effectiveness of Safety Culture in a particular case.

4.1. GOVERNMENT AND ITS ORGANIZATIONS

67. The practical approach that governments adopt towards safety in general and nuclear safety in particular has a major effect on all organizations influencing nuclear safety. The following aspects demonstrate government commitment:

- Legislation and government policies for the use of nuclear power set broad safety objectives, establish the necessary institutions and ensure adequate support for its safe development.
- Governments assign the responsibilities of such institutions clearly, arrange that conflict of interest in important safety matters is minimized, and ensure in particular that safety matters are addressed on their merits, without interference or undue pressure from bodies whose responsibility for nuclear safety is less direct.
- Governments provide strong support for regulatory agencies, including adequate powers, sufficient funds for all activities and guarantees that the regulatory task can be pursued without undue interference.
- Governments promote and contribute to the international exchange of safety related information.

68. Regulators have considerable discretionary authority in matters of nuclear safety. This is conferred by legislation and the more detailed instruments under which they operate, and is manifested in several general ways:

- The management style of a regulatory agency ensures that common concern for safety leads to relations with operating organizations that are open and co-operative and yet have the formality and separateness appropriate for bodies with recognizably different accountabilities.
- Controversial topics are dealt with in an open fashion. An open approach is adopted to setting safety objectives so that those whom they regulate have an opportunity to comment on the intent.
- Standards are adopted that call for appropriate levels of safety while recognizing the inevitable residual risk. By this means a consistent and realistic approach to safety is achieved.
- Regulators recognize that the primary responsibility for safety rests with the operating organization and not the regulator. To this purpose, they ensure that regulatory requirements are clear but not so prescriptive as to set undue constraints.
- In dealing with new problems, while a generally conservative approach may be taken, innovation is not stifled by insistence on adherence only to approaches that have been used in the past. Improvements in safety result from a well judged combination of innovation and reliance on proven techniques.

69. Those who regulate economic aspects of nuclear power take into account the fact that decisions based on purely economic factors could be prejudicial to reactor safety

4.2 OPERATING ORGANIZATION

4.2.1. Corporate policy level

70. Safety Culture flows down from actions by the senior management of an organization. In judging the effectiveness of Safety Culture in an operating organization, it is necessary to start at the corporate policy level since it is there that attitudes, decisions and methods of operation demonstrate the real priority given to safety matters.

71. The primary indication of corporate level commitment to Safety Culture is its statement of safety policy and objectives. This is prepared and disseminated in such a way that the objectives are understood and made use of by staff at all levels. Particularly, reference is made in the statement to the vital importance of safety, such that concern for safety may on occasion override production objectives.

72. Establishment of a management structure, assignment of responsibilities within it and allocation of resources are all primary responsibilities at corporate policy level. These arrangements are compatible with the organization's safety objectives.

73. Senior management initiates regular reviews of the safety performance of the organization. Such reviews and the responses to their findings are important pointers to the effectiveness of Safety Culture in the organization. As specific examples:

- Training is reviewed to ensure that it is satisfactory and that the resources devoted are adequate.
- Documentation systems are reviewed to ensure that the resources devoted are sufficient.
- Staff appointment arrangements are reviewed, in particular to ensure that evaluation of the attitudes of individuals to safety is part of the process of selection and promotion of personnel.

4.2.2. Power plant level

74. At the plant itself, safety is an immediate concern, and an effective Safety Culture is an essential feature of day to day activities. Three different aspects are considered:

- the environment created by the local management, which conditions individuals' attitudes;
- the attitudes of individuals, in all departments and at all levels from the plant manager down;
- actual safety experience at the plant, which reflects the real priority given to safety in the organization.

4.2.2.1. The working environment

75. Safety responsibilities and detailed practices at all levels at the plant are defined. Particular care is taken in the treatment of special activities, such as tests or plant modifications with safety implications. In such cases, a systematic independent examination is required. Reviews of documentation and records are carried out to ensure that safety requirements have been met.

76. Training and education ensure that all staff are knowledgeable about errors that might be committed in their area of activity. Such training is founded on a basic understanding of the safety questions involved, includes consideration of the possible consequences of such errors, and deals specifically with how they may be avoided, or corrected if committed.

By way of specific example:

- For control room personnel, simulator retraining takes into account operating experience, difficulties encountered by staff and the questions they have raised.
- Training sessions are held before a complex maintenance activity, with mock-ups or video recordings, to refresh the knowledge of the staff and to illustrate potential errors.
- The results of safety analyses, including probabilistic safety analysis, are consulted regularly to support decisions as specific issues arise, as well as to provide staff with insight into the important safety features of plant design and operation.

77. Nuclear safety is kept constantly under scrutiny through plant inspections and audits, visits by senior officers, and internal discussions and seminars at the plant on safety matters. Findings are evaluated and acted upon in a timely way.

78. For staff to carry out their duties with ease, satisfactory facilities must be provided. Aspects include: the physical features of work locations; the suitability of controls, instruments, tools and equipment; the availability of necessary information; standards of housekeeping; and, of particular importance, the work-loads of individuals.

79. The relationship between the plant management and the regulatory authority and its local representatives is open and based on a common concern for nuclear safety, but with a mutual understanding of the different accountabilities.

4.2.2.2. *Individual attitudes*

80. The attitudes of individuals may be examined in exchanges with staff members at various levels, to support judgement of the effectiveness of Safety Culture and to cause lessons to be derived. To illustrate the broad concerns to be tested by more detailed questioning:

- Are procedures strictly followed even when quicker methods are available?
- Do staff members stop and think when facing an unforeseen situation?
- Is a good safety attitude respected by management and within peer groups of the staff?
- Do staff take the initiative in suggesting safety improvements?

81. Managers' attitudes are demonstrated, and staff attitudes are influenced, by exchanges on nuclear safety matters. In particular, managers take opportunities to demonstrate that they are prepared to place safety concerns before those of production, if necessary. As an example, discussion with staff concerned about delays in

restarting the plant for reasons of safety makes clear the commitment to safety as a primary objective.

82. The presence of managers at the work site provides opportunities for them to emphasize directly the importance assigned to safety.

83. The development of local practices for the enhancement of safety is an excellent measure of individual attitudes and management response, since it demonstrates that all staff understand the need to use their experience to improve performance. Specific examples might be in the areas of housekeeping and quality of records, or in extension of the practice of reporting errors to include even those that have no apparent important consequences.

4.2.2.3. Plant safety experience

84. In the long term, the safety performance of the plant reflects the effectiveness of the Safety Culture. The plant performance indicators commonly recognized (such as plant availability, the number of unplanned shutdowns or radiation exposure) provide a measure of the attention to safety in a plant. They are complemented by specific safety indicators, such as the number and severity of significant events, the number of pending work orders and the duration of any unavailability of safety systems. The significance of such indicators is made clear to staff.

85. All significant events that have occurred on the site are analysed in close cooperation with the staff concerned to help all staff to evaluate their strengths and weaknesses.

86. Such experience is reviewed regularly to ensure that the lessons have been learned, the necessary corrective actions identified and timely implementation pursued. The thoroughness of the reviews and the strength of the corrective responses are important Safety Culture indicators.

4.3. SUPPORTING ORGANIZATIONS

87. The important management provisions and individual attitudes which characterize an effective Safety Culture in an operating organization may be adapted to suit all supporting organizations, particularly through emphasis on the demand for product quality. Certain specific issues relating to research and design organizations are identified in the following.

88. Research organizations have in place mechanisms for monitoring relevant work around the world that may affect the conclusions of safety analysis. This monitoring is reinforced by mechanisms for ensuring that such information is brought to the attention of those accountable for safety in a timely fashion, and with the emphasis warranted by its significance.

89. Those engaged in research are alert for any potential misinterpretation or misuse of their work.

90. Design organizations may seek the input of external experts, if necessary to complement their own capabilities. By way of example:

- when a design organization lacks experience with a new technology, for example software design, it may seek the assistance of experts to supplement its in-house capability;
- design reviews, which are an important and customary component of the in-house processes, may be supplemented by involvement of external expertise.

91. Design organizations keep up to date with developments in reactor safety technology and safety analysis techniques by active participation in national and international activities. Formal mechanisms are in place to bring to the attention of the responsible operators any new information that might modify or invalidate any previous safety analyses.

5. CONCLUDING COMMENTS

92. Safety Culture is now a commonly used term. There is a need for a common understanding of its nature, however, and for means of turning what has been simply a convenient phrase into a concept of practical value.

93. This report has sought to remedy the position. The first part sets out INSAG's views on the nature of Safety Culture. The purpose is to provide clarification and to develop a commonly shared understanding. The latter part of the report and the Appendix seek to give practical value to the concept, identifying characteristics that may be used to judge the effectiveness of Safety Culture in a particular case.

94. INSAG offers this description of Safety Culture and the means for its practical use in the cause of ensuring that "as an overriding priority, nuclear plant safety issues receive the attention warranted by their significance".

Appendix

SAFETY CULTURE INDICATORS

This Appendix identifies questions worthy of examination when the effectiveness of Safety Culture in a particular case is being judged. It is recognized that the list of questions cannot be comprehensive, nor can a list which is at all extensive be applicable to all circumstances. The objective of what follows is therefore to encourage self-examination in organizations and individuals rather than to provide a checklist for Yes/No answers. The main intent is to be thought provoking rather than prescriptive. With this understanding, the list can be extended by the reader.

A1. GOVERNMENT AND ITS ORGANIZATIONS

Government commitment to safety

- (1) Is the body of legislation satisfactory?
- (2) Are there any undue impediments to the necessary amendment of regulations?
- (3) Do legislation and government policy statements emphasize safety as a prerequisite for the use of nuclear power?
- (4) Have budgets for regulatory agencies kept pace with inflation, with the growth of the industry and with other increased demands? Is funding sufficient to allow the hiring of staff of adequate competence?
- (5) Does the government provide adequate funding for necessary safety research? Are the research results made available to other countries?
- (6) How free is the exchange of safety information with other countries?
- (7) Does the country support the IAEA Incident Reporting System, the Operational Safety Review Teams (OSART) and Assessment of Safety Significant Events Teams (ASSET) programmes of the IAEA and other relevant international activities?
- (8) Are there any instances of undue interference in technical matters with safety relevance?

Performance of regulatory agencies

- (1) Are regulatory safety objectives annunciated clearly, meaningfully and so that they are neither too general nor too prescriptive? Do they permit a proper balance between innovation and reliance on proven techniques?

- (2) Are comments on regulatory requirements sought from competent bodies? Have such comments been taken into account frequently enough to encourage future comments?
- (3) Is there a predictable and logical process for dealing with issues that require a consideration of both safety and economic factors?
- (4) What is the record of project delays or loss of production due to lack of clarity of regulatory requirements or lack of timely regulatory decisions?
- (5) Are regulatory practices generally consistent with the objectives of the IAEA's Nuclear Safety Standards (NUSS) programme?
- (6) Is there an education and training programme for regulatory staff?
- (7) Does the regulatory agency participate actively in relevant international activities?
- (8) Are reports on important safety problems published routinely by the regulatory agency?
- (9) Does the regulatory agency periodically publish a summary review of the safety performances of plants?
- (10) What is the nature of the relation with licensees? Is there an appropriate balance between formality and a direct professional relationship?
- (11) Is there mutual respect between the regulatory staff and the operating organization based on a common level of competence? What proportion of regulatory technical experts have practical operating or design experience?
- (12) Is there regular joint discussion of the licensees' experience and problems and the impact of regulatory activities on these?
- (13) To what extent does the regulatory agency rely on the internal safety processes of the operating organization?
- (14) What is the nature and extent of the regulators' presence at the plant?

A2. OPERATING ORGANIZATION

Corporate level safety policy

- (1) Has a safety policy statement been issued? Is it clear? Does the policy express the overriding demand for nuclear safety?
- (2) Is it brought to staff attention from time to time?
- (3) Is it consistent with the concept of Safety Culture presented in this report?
- (4) Are managers and workers familiar with the safety policy and can staff cite examples that illustrate its meaning?

Safety practices at corporate level

- (1) Does the corporate board have expertise in nuclear plant safety?
- (2) Do formal meetings at this level include agenda items on safety?

- (3) Do operating staff attend to discuss the safety performance of plants?
- (4) Is there an active nuclear safety review committee which reports its findings at corporate level?
- (5) Is there a senior manager with nuclear safety as a prime responsibility? How is he supported and assisted in his duties? What is his standing compared with that of the heads of other functions?
- (6) Are the resource requirements for the safety function reviewed periodically at corporate level? With what results?

Definition of responsibility

- (1) Has the assignment of safety responsibilities been clearly annunciated?
- (2) Has the responsibility of the plant manager for nuclear safety been clearly stated and accepted?
- (3) Are the documents that identify safety responsibilities kept up to date and reviewed periodically? With what result?

Training

- (1) Does all critical training and retraining culminate in formal assessment and approval for duties? What is the success/failure record? What is the proportion of operating staff's time devoted to training and how does this compare with the practices of other nuclear plant operators?
- (2) What resources are allocated to training? How does this compare with the allocations of other nuclear plant operators?
- (3) Is the quality of training programmes assessed at corporate and plant management levels?
- (4) Is there a periodic review of the applicability, correctness and results of training courses? Does this review take into account operating experience feedback?
- (5) How frequently are production requirements permitted to interfere with scheduled training?
- (6) Do staff understand the significance of the operating limits of the plant in their areas of responsibility?
- (7) Are the staff educated in the safety consequences of the malfunction of plant items?
- (8) Are staff trained in the special importance of following procedures? Are they regularly reminded? Are they trained in the safety basis of the procedures?
- (9) Can training staff cite examples of operating errors that have resulted in modifications to a training programme?
- (10) For control room operators, do retraining sessions on simulators take into account the difficulties that staff have experienced and the questions that they have raised?

- (11) For maintenance personnel, do training sessions make use of mock-ups and video recordings before a complex maintenance activity is performed?
- (12) Are training simulator modifications made as soon as the plant is modified?
- (13) Do training programmes address Safety Culture?

Selection of managers

- (1) Do the staff recognize that attitude to safety is important in the selection and promotion of managers? How is this recognition fostered?
- (2) Do annual performance appraisals include a specific section on attitude to safety?
- (3) Can cases be identified in which safety attitude was a significant factor in approving or rejecting a promotion to management level?

Review of safety performance

- (1) Does senior management receive regular reviews of the safety performance of the plant? Do these include comparisons with the performance of other nuclear plants?
- (2) Are the results of safety reviews acted on in a timely way? Is there feedback to managers on the implementation of lessons learned? Can managers identify changes that resulted from reviews?
- (3) Are managers aware of how the safety of their plant compares with that of others in the same company? In the country? In the world?
- (4) Do staff routinely read and understand reports on operating experience?
- (5) Is there a system of safety performance indicators with a programme for the improvement of performance?
- (6) Are the safety performance indicators understood by staff?
- (7) Are managers aware of the trends of safety performance indicators and the reasons for the trends?
- (8) What arrangements exist for reporting safety related events at a plant? Is there a formal means for evaluating such events and learning the lessons?
- (9) Is there a formal mechanism by which the staff who were involved in a significant event are consulted on the final contents of a report?
- (10) Is there a full time safety review group which reports directly to the plant manager?
- (11) Does the organization have effective safety information links with operators of similar plants?
- (12) Does the organization contribute effectively to international safety reporting systems?
- (13) What are the trends for the number of outstanding deficiencies, temporary modifications or operating manuals in need of revision?

Highlighting safety

- (1) Does the plant manager hold periodic meetings with his senior staff that are devoted solely to safety?
- (2) Are there opportunities for non-management staff to participate in meetings devoted to safety?
- (3) Do these meetings cover safety significant items at that plant? At other plants in the company? At other plants in the country? At other plants in the world?
- (4) Has consideration been given to requesting an OSART mission or similar external review?
- (5) Is there a process by which more junior staff can report safety related concerns directly to the plant manager? Is the process well known?
- (6) Is there a system for reporting individuals' errors? How is it made known to staff?
- (7) Do systems of reward include factors relating to safety performance?

Work-load

- (1) Is there a clear policy on limits to overtime worked? To which staff does it apply?
- (2) How is overtime controlled, monitored and reported to the plant manager and higher management?
- (3) What fraction of the time of the senior person on shift is spent on administrative duties?

Relations between plant management and regulators

- (1) Is the relation frank, open and yet adequately formal?
- (2) What is the nature of arrangements for access of regulators to documentation? To facilities? To operating staff?
- (3) Are required reports to the regulatory agency made in a timely fashion?
- (4) At what levels are the plant contacts for the regulatory inspectors?
- (5) Does the plant manager meet routinely with regulatory staff?

Attitudes of managers

- (1) When there is apparent conflict between safety and cost or between safety and operation, do managers discuss with staff members how it is resolved?
- (2) Are the schedules and content of work for annual shutdowns examined by an internal safety review process?
- (3) When safety considerations introduce a delay in the startup of a plant, do managers use the occasion to illustrate that safety comes first?

- (4) During periods of heavy work-load, do managers ensure that staff are reminded that unnecessary haste and shortcuts are inappropriate?
- (5) Do managers explain their commitment to Safety Culture to their staff? Do they regularly disseminate relevant information such as objectives, expenditure, accomplishments and shortcomings? What practical steps are taken to assist management commitment, such as establishing professional Codes of Conduct?
- (6) How often have directives from management been aimed at the improvement of safety?
- (7) Do managers disseminate to their staff the lessons learned from experience at their own and similar plants? Is this a training topic?
- (8) Is there a system for bringing safety related concerns or potential improvements to the attention of higher management? Is its use encouraged by managers? Do managers respond satisfactorily? Are individuals who transmit such concerns rewarded and given public recognition?
- (9) What is the attitude of managers to safety reviews and audits affecting their activities? Do they discuss with their staff the results and the means by which deficiencies may be corrected?
- (10) What is the attitude of managers to the application of quality assurance measures to their activities?
- (11) Does management regularly review the performance of personnel, with assessment of their attitude to safety?
- (12) Do managers give public recognition to staff members who take actions beneficial to safety?
- (13) What is the response of management to safety infringements and violations of safety related technical specifications?
- (14) What systems exist to apprise managers of safety accomplishments or shortcomings? How effective are they?
- (15) Are managers alert to the need to identify weaknesses in their staff, to specify training requirements or to provide other support?
- (16) Do managers participate in staff training courses at which safety policies and procedures are explained? Do they present any of the training material? Do they follow the training of their staff and are they aware of their training status and levels of ability? Do they encourage good staff members to spend time as instructors? Do managers themselves undergo retraining in safety matters?
- (17) Do managers review regularly the assignment of their staff's duties? Are the relevant documents up to date?
- (18) Do managers attend regularly at the work-place to review safety related activities?
- (19) Do managers give attention to the physical working environment of their staff?

Attitudes of individuals

- (1) Are staff aware of the management commitment to Safety Culture?
- (2) Can personnel state ways in which safety might be prejudiced by their own erroneous actions? And by those of others working in related areas?
- (3) Can staff clearly enunciate their own responsibilities? Can they cite the documents that define them?
- (4) Can operating and maintenance personnel list any recent violations of operating limits of the plant, describe the way they happened and state what has been done to prevent repetition?
- (5) Are laid down procedures followed strictly even when quicker methods are available?
- (6) How attentive are staff to the completeness and accuracy of records, log-books and other documentation?
- (7) What steps would staff take if they observed actions that might reduce safety margins?
- (8) What attitude do individuals take towards their own mistakes that might prejudice safety?
- (9) What would an operator or a member of the maintenance staff do if in following a written procedure he came upon a step that he thought was a mistake?
- (10) What would an instructor do if he came upon a step in a procedure that he thought was a mistake?
- (11) Do staff use the mechanisms for reporting on safety shortcomings and suggesting improvements? Is the mechanism used to report individuals' errors? Is it used even when no detrimental effect is apparent?
- (12) Do staff respond satisfactorily to the investigation of safety problems, assisting effectively in seeking the causes and implementing improvements?
- (13) Do co-workers look favourably on those who exhibit a good safety attitude by actions such as attention to housekeeping, completeness of entries in log-books and adherence to procedures?
- (14) Do control room staff show a watchful and alert attitude at all times?
- (15) Are staff aware of the system of rewards and sanctions relating to safety matters?
- (16) Do staff make maximum use of training opportunities? Do they adopt a responsible approach, complete necessary preparatory work and participate actively in discussions?
- (17) Do staff stop and think when facing an unforeseen situation? In such cases are their actions 'safety inspired'?
- (18) What is the attitude of staff to safety reviews and audits affecting their area of work? How responsive are they to improvements sought as a result?
- (19) Do staff participate in peer reviews of safety activities aimed at reducing human errors?

- (20) Do staff communicate their experience effectively to other individuals and groups? What examples are there?

Local practices

- (1) Has the plant manager instituted any safety related initiatives that go beyond requirements set at the corporate level?
- (2) What mechanism is available to staff to report errors even when they were immediately corrected or had no detectable effect? Do staff make occasional use of the mechanism provided?
- (3) Are records on the performance or maintenance of components and systems easily retrievable? Complete? Understandable? Accurate? Up to date?
- (4) What is the general state of the plant in terms of general appearance and tidiness, steam and oil leaks, the tidiness of log-books and records?
- (5) What are the arrangements for supervising, reviewing and signing off maintenance work carried out by supporting organizations?

Field supervision by management

- (1) What is the working style of the senior supervisors on shift? Do they seek information? Are they well informed? Do they visit routinely the areas where safety related work is being done? Are they interested in the problems or solely the schedules?
- (2) Do middle managers often make first hand inspections of the conduct of safety related work for which they are responsible?
- (3) Does the plant manager from time to time inspect the conduct of safety related work?
- (4) Do senior managers visit the plant regularly? Do they give attention to safety matters?

A3. RESEARCH ORGANIZATIONS

Research input to safety analyses

- (1) Do researchers ensure that they understand how the results of their work will be used in safety analyses? Are they familiar with how their data are used in interpolating or extrapolating for ranges of parameters different from those in their experiments?
- (2) Do researchers identify the shortcomings and limitations of their results?
- (3) Do they keep abreast of safety analyses to permit them to identify any misuse of their work? Do they report any potential misuse or misinterpretation?

- (4) On any particular topic, is it clear which group or individual is responsible for monitoring new material or international data? What personal contacts have been developed to keep abreast of new data?
- (5) Is there a mechanism for reporting new information that may invalidate previous safety analyses? What is the appeal route if the first level of notification is ineffective? How often are these mechanisms used?
- (6) Is there a mechanism for ensuring that the relevant research to solve design and operational safety problems is pursued and carried out in a timely fashion?
- (7) How promptly are the results of research fed into the design and regulatory process?
- (8) Is there a policy for regular publication of research results in journals that insist on refereeing by peers?

A4. DESIGN ORGANIZATIONS

Codes for safety aspects of design

- (1) What processes exist for verification and validation of computer modelling codes? Do these involve the relevant researchers?
- (2) Are the safety design codes verified and validated for the specific circumstances?
- (3) Are the limitations of codes taken into account explicitly in the design review process?
- (4) In which international standard problem exercises have analysts participated to test national computer modelling codes? What efforts have been made on a bilateral or multilateral basis to compare work with that of experts in another country?
- (5) What is the formal mechanism for reporting the matter if it is considered that the previously reported outputs of a computer model may be invalid? Has there been a need to use this mechanism?

Design review process

- (1) In which areas has outside expertise been used to supplement in-house capability? How was the competence of the outside experts established?
- (2) Where are the functions and responsibilities of design review teams described?
- (3) Has the design review process been audited by internal Quality Assurance auditors? By the regulatory agency? By a peer group of national or international members?

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