

# IAEA SAFETY STANDARDS SERIES

## The Operating Organization for Nuclear Power Plants

### SAFETY GUIDE

No. NS-G-2.4



INTERNATIONAL  
ATOMIC ENERGY AGENCY  
VIENNA

THE OPERATING ORGANIZATION FOR  
NUCLEAR POWER PLANTS

The following States are Members of the International Atomic Energy Agency:

AFGHANISTAN	GHANA	PAKISTAN
ALBANIA	GREECE	PANAMA
ALGERIA	GUATEMALA	PARAGUAY
ANGOLA	HAITI	PERU
ARGENTINA	HOLY SEE	PHILIPPINES
ARMENIA	HUNGARY	POLAND
AUSTRALIA	ICELAND	PORTUGAL
AUSTRIA	INDIA	QATAR
AZERBAIJAN, REPUBLIC OF	INDONESIA	REPUBLIC OF MOLDOVA
BANGLADESH	IRAN, ISLAMIC REPUBLIC OF	ROMANIA
BELARUS	IRAQ	RUSSIAN FEDERATION
BELGIUM	IRELAND	SAUDI ARABIA
BENIN	ISRAEL	SENEGAL
BOLIVIA	ITALY	SIERRA LEONE
BOSNIA AND HERZEGOVINA	JAMAICA	SINGAPORE
BRAZIL	JAPAN	SLOVAKIA
BULGARIA	JORDAN	SLOVENIA
BURKINA FASO	KAZAKHSTAN	SOUTH AFRICA
CAMBODIA	KENYA	SPAIN
CAMEROON	KOREA, REPUBLIC OF	SRI LANKA
CANADA	KUWAIT	SUDAN
CENTRAL AFRICAN REPUBLIC	LATVIA	SWEDEN
CHILE	LEBANON	SWITZERLAND
CHINA	LIBERIA	SYRIAN ARAB REPUBLIC
COLOMBIA	LIBYAN ARAB JAMAHIRIYA	THAILAND
COSTA RICA	LIECHTENSTEIN	THE FORMER YUGOSLAV REPUBLIC OF MACEDONIA
COTE D'IVOIRE	LITHUANIA	TUNISIA
CROATIA	LUXEMBOURG	TURKEY
CUBA	MADAGASCAR	UGANDA
CYPRUS	MALAYSIA	UKRAINE
CZECH REPUBLIC	MALI	UNITED ARAB EMIRATES
DEMOCRATIC REPUBLIC OF THE CONGO	MALTA	UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND
DENMARK	MARSHALL ISLANDS	UNITED REPUBLIC OF TANZANIA
DOMINICAN REPUBLIC	MAURITIUS	UNITED STATES OF AMERICA
ECUADOR	MEXICO	URUGUAY
EGYPT	MONACO	UZBEKISTAN
EL SALVADOR	MONGOLIA	VENEZUELA
ESTONIA	MOROCCO	VIET NAM
ETHIOPIA	MYANMAR	YEMEN
FINLAND	NAMIBIA	YUGOSLAVIA
FRANCE	NETHERLANDS	ZAMBIA
GABON	NEW ZEALAND	ZIMBABWE
GEORGIA	NICARAGUA	
GERMANY	NIGER	
	NIGERIA	
	NORWAY	

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".

© IAEA, 2001

Permission to reproduce or translate the information contained in this publication may be obtained by writing to the International Atomic Energy Agency, Wagramer Strasse 5, P.O. Box 100, A-1400 Vienna, Austria.

Printed by the IAEA in Austria  
December 2001  
STI/PUB/1115

SAFETY STANDARDS SERIES No. NS-G-2.4

# THE OPERATING ORGANIZATION FOR NUCLEAR POWER PLANTS

SAFETY GUIDE

INTERNATIONAL ATOMIC ENERGY AGENCY  
VIENNA, 2001

**VIC Library Cataloguing in Publication Data**

The operating organization for nuclear power plants : safety guide. — Vienna :  
International Atomic Energy Agency, 2001.

p. ; 24 cm. — (Safety standards series, ISSN 1020-525X ; no. NS-G-2.4)

STI/PUB/1115

ISBN 92-0-102301-4

Includes bibliographical references.

Nuclear power plants—Management. 2. Nuclear power plants—Safety  
measures. I. International Atomic Energy Agency. II. Series.

VICL

01-00269

# FOREWORD

**by Mohamed ElBaradei  
Director General**

One of the statutory functions of the IAEA is to establish or adopt standards of safety for the protection of health, life and property in the development and application of nuclear energy for peaceful purposes, and to provide for the application of these standards to its own operations as well as to assisted operations and, at the request of the parties, to operations under any bilateral or multilateral arrangement, or, at the request of a State, to any of that State's activities in the field of nuclear energy.

The following bodies oversee the development of safety standards: the Commission for Safety Standards (CSS); the Nuclear Safety Standards Committee (NUSSC); the Radiation Safety Standards Committee (RASSC); the Transport Safety Standards Committee (TRANSSC); and the Waste Safety Standards Committee (WASSC). Member States are widely represented on these committees.

In order to ensure the broadest international consensus, safety standards are also submitted to all Member States for comment before approval by the IAEA Board of Governors (for Safety Fundamentals and Safety Requirements) or, on behalf of the Director General, by the Publications Committee (for Safety Guides).

The IAEA's safety standards are not legally binding on Member States but may be adopted by them, at their own discretion, for use in national regulations in respect of their own activities. The standards are binding on the IAEA in relation to its own operations and on States in relation to operations assisted by the IAEA. Any State wishing to enter into an agreement with the IAEA for its assistance in connection with the siting, design, construction, commissioning, operation or decommissioning of a nuclear facility or any other activities will be required to follow those parts of the safety standards that pertain to the activities to be covered by the agreement. However, it should be recalled that the final decisions and legal responsibilities in any licensing procedures rest with the States.

Although the safety standards establish an essential basis for safety, the incorporation of more detailed requirements, in accordance with national practice, may also be necessary. Moreover, there will generally be special aspects that need to be assessed on a case by case basis.

The physical protection of fissile and radioactive materials and of nuclear power plants as a whole is mentioned where appropriate but is not treated in detail; obligations of States in this respect should be addressed on the basis of the relevant instruments and publications developed under the auspices of the IAEA. Non-radiological aspects of industrial safety and environmental protection are also

not explicitly considered; it is recognized that States should fulfil their international undertakings and obligations in relation to these.

The requirements and recommendations set forth in the IAEA safety standards might not be fully satisfied by some facilities built to earlier standards. Decisions on the way in which the safety standards are applied to such facilities will be taken by individual States.

The attention of States is drawn to the fact that the safety standards of the IAEA, while not legally binding, are developed with the aim of ensuring that the peaceful uses of nuclear energy and of radioactive materials are undertaken in a manner that enables States to meet their obligations under generally accepted principles of international law and rules such as those relating to environmental protection. According to one such general principle, the territory of a State must not be used in such a way as to cause damage in another State. States thus have an obligation of diligence and standard of care.

Civil nuclear activities conducted within the jurisdiction of States are, as any other activities, subject to obligations to which States may subscribe under international conventions, in addition to generally accepted principles of international law. States are expected to adopt within their national legal systems such legislation (including regulations) and other standards and measures as may be necessary to fulfil all of their international obligations effectively.

#### EDITORIAL NOTE

*An appendix, when included, is considered to form an integral part of the standard and to have the same status as the main text. Annexes, footnotes and bibliographies, if included, are used to provide additional information or practical examples that might be helpful to the user.*

*The safety standards use the form 'shall' in making statements about requirements, responsibilities and obligations. Use of the form 'should' denotes recommendations of a desired option.*

*The English version of the text is the authoritative version.*

# CONTENTS

1. INTRODUCTION .....	1
Background (1.1–1.3) .....	1
Objective (1.4) .....	1
Scope (1.5–1.7) .....	2
Structure (1.8) .....	2
2. ORGANIZATIONAL STRUCTURE .....	3
The operating organization (2.1–2.3) .....	3
Organizational plan (2.4–2.8) .....	3
Structure of the operating organization (2.9–2.19) .....	4
3. FUNCTIONS AND RESPONSIBILITIES .....	7
Functions of the operating organization (3.1) .....	7
Responsibilities of the operating organization (3.2–3.9) .....	8
Responsibilities of the plant management (3.10–3.18) .....	10
Goals and objectives (3.19–3.24) .....	11
4. INTERFACES WITH EXTERNAL ORGANIZATIONS .....	13
Interface with the regulatory body (4.1–4.4) .....	13
Interface with external supporting organizations (4.5–4.10) .....	14
Interface with the public (4.11–4.14) .....	15
5. SAFETY MANAGEMENT .....	16
Safety management system (5.1–5.5) .....	16
Safety policy (5.6–5.11) .....	17
Performance of safety related activities (5.12–5.16) .....	18
Monitoring and review of safety performance (5.17–5.22) .....	19
6. PLANT OPERATION MANAGEMENT PROGRAMMES .....	20
General (6.1–6.10) .....	20
Staffing (6.11–6.15) .....	22
Qualification and training (6.16–6.21) .....	24



Commissioning (6.22–6.24) . . . . .	25
Plant operations (6.25–6.35) . . . . .	26
Maintenance (6.36–6.40) . . . . .	28
In-service inspection (6.41) . . . . .	29
Surveillance (6.42–6.43) . . . . .	29
Fuel management (6.44) . . . . .	30
Chemistry (6.45) . . . . .	31
Safety analysis and review (6.46–6.50) . . . . .	31
Physical protection (6.51–6.54) . . . . .	32
Radiation protection (6.55) . . . . .	33
Industrial safety (6.56) . . . . .	33
Waste management and environmental monitoring (6.57) . . . . .	33
Emergency preparedness (6.58) . . . . .	34
Fire safety (6.59) . . . . .	34
Quality assurance (6.60) . . . . .	34
Human factors (6.61) . . . . .	35
Feedback of operating experience (6.62–6.71) . . . . .	35
Plant modifications (6.72–6.74) . . . . .	37
Document control and records (6.75–6.76) . . . . .	37
Management of ageing (6.77–6.78) . . . . .	38
Decommissioning (6.79–6.81) . . . . .	38
7. SUPPORTING FUNCTIONS . . . . .	39
General (7.1–7.6) . . . . .	39
Training services (7.7–7.10) . . . . .	40
Quality assurance services (7.11–7.13) . . . . .	41
Radiation protection services (7.14–7.17) . . . . .	42
Maintenance, surveillance and in-service inspection services (7.18–7.25) . . . . .	43
8. COMMUNICATION AND LIAISON . . . . .	44
Communication (8.1–8.6) . . . . .	44
Liaison (8.7–8.11) . . . . .	46
REFERENCES . . . . .	48
GLOSSARY . . . . .	50
CONTRIBUTORS TO DRAFTING AND REVIEW . . . . .	52
BODIES FOR THE ENDORSEMENT OF SAFETY STANDARDS . . . . .	53

# 1. INTRODUCTION

## BACKGROUND

1.1. This Safety Guide was prepared under the IAEA programme for safety standards for nuclear power plants. The present publication is a revision of the IAEA Safety Guide on Management of Nuclear Power Plants for Safe Operation issued in 1984. It supplements Section 2 of the Safety Requirements publication on Safety of Nuclear Power Plants: Operation [1].

1.2. Nuclear power technology is different from the customary technology of power generation from fossil fuel and by hydroelectric means. One major difference between the management of nuclear power plants and that of conventional generating plants is the emphasis that should be placed on nuclear safety, quality assurance, the management of radioactive waste and radiological protection, and the accompanying national regulatory requirements. This Safety Guide highlights the important elements of effective management in relation to these aspects of safety.

1.3. The attention to be paid to safety requires that the management recognize that personnel involved in the nuclear power programme should understand, respond effectively to, and continuously search for ways to enhance safety in the light of any additional requirements socially and legally demanded of nuclear energy. This will help to ensure that safety policies that result in the safe operation of nuclear power plants are implemented and that margins of safety are always maintained. The structure of the organization, management standards and administrative controls should be such that there is a high degree of assurance that safety policies and decisions are implemented, safety is continuously enhanced and a strong safety culture is promoted and supported.

## OBJECTIVE

1.4. The objective of this publication is to guide Member States in setting up an operating organization which facilitates the safe operation of nuclear power plants to a high level internationally. The second objective is to provide guidance on the most important organizational elements in order to contribute to a strong safety culture and achieve good performance in terms of safety.

## SCOPE

1.5. This publication identifies the main safety objectives and responsibilities of management with respect to the safe operation of nuclear power plants and associated corporate roles of the operating organization.

1.6. This Safety Guide discusses the factors to be considered in (a) structuring the operating organization to meet these main safety objectives, (b) setting up management programmes that ensure that the safety tasks are performed, (c) establishing services and facilities that are intended to meet the above requirements and (d) maintaining a strong safety culture within the organization.

1.7. This Safety Guide primarily addresses safety matters directly related to the operation of nuclear power plants. It assumes that the safety aspects of siting, design, manufacturing and construction have been resolved. It also covers the internal interrelationships between operations and design, construction and commissioning and other organizational units, and deals with the involvement of the operating organization in reviews of safety issues, bearing in mind future operation. Finally, this publication discusses the relationship between the operating organization, the regulatory body and the general public.

## STRUCTURE

1.8. Section 2 focuses on the operating organization and its structure. Section 3 discusses the functions, responsibilities, goals and objectives of the operating organization that ensure the safe operation of nuclear power plants. Section 4 gives guidance on the interface between the operating organization and external organizations. Section 5 covers safety management aspects. Section 6 provides guidance on the major management programmes that should be established to ensure the safe operation of a nuclear power plant. Section 7 discusses additional services that are needed to support the functioning of plant operation management programmes. Section 8 provides general guidance on the communication and liaison matters that are relevant to meeting management objectives and discharging responsibilities.

## 2. ORGANIZATIONAL STRUCTURE

### THE OPERATING ORGANIZATION

2.1. For the purpose of this Safety Guide, the term ‘operating organization’ is used to designate the company or utility that is authorized by the regulatory body to operate one or more nuclear power plants (see also the Glossary). In accordance with the legal systems in the majority of States, an operating organization is the legal entity responsible for fulfilling the financial, commercial and safety obligations and any other obligations which may arise in connection with the operation of the nuclear power plants. Irrespective of the operating organization’s other obligations and responsibilities, this Safety Guide deals only with those that are necessary to ensure safe operation of the nuclear power plants that are under the control of the operating organization.

2.2. Once the operating organization accepts control over a plant, it is completely in charge of the plant, with full responsibility and commensurate authority for approved activities in the safe production of electric power. Since these activities affect safety, the operating organization, in accordance with its licensing obligations, shall establish a policy for adherence to safety requirements and procedures for safe control of the plant under all conditions, including maintenance and surveillance, and shall retain a competent, fit and fully trained staff (Section 2 of Ref. [1]).

2.3. The operating organization is authorized to operate a nuclear power plant through the licensing system in accordance with the national regulations. More information on the matters of authorization and licensing of operating organizations can be found in Ref. [2]. The operating organization, as licensee, shall retain prime responsibility for safety, but it may delegate authority for the safe operation of the plant to the plant management. In such cases the operating organization shall provide the necessary resources and support to the plant management. The management of the plant shall ensure that the plant is operated in a safe manner and in accordance with all legal and regulatory requirements [1]. The achievement of this primary objective should be regularly reviewed by the operating organization.

### ORGANIZATIONAL PLAN

2.4. The operating organization which operates or intends to operate one or more nuclear power plants should establish an organizational structure to meet the general

requirements for the safe operation of these plants, taking into consideration any particular situation or conditions involved.

2.5. The operating organization should examine the various functions that are needed for safe operation of a nuclear power plant; it should decide which functions should be performed (a) at the plant site, (b) off the site but within the operating organization, or (c) outside the operating organization.

2.6. In addition, the complexity of the planned nuclear power plant, its engineering features, the number of nuclear and other plants already in operation, under construction or planned for construction, and the general structure of the operating organization itself should be considered.

2.7. On the basis of these considerations and of all applicable regulatory requirements and national industrial practices, the operating organization should establish for plants under its control an organizational plan that indicates the general policies, lines of responsibility and authority, lines of communication, duties, and numbers of staff needed to run the plants and their required qualifications. The operating organization should take into account both operational states and accident conditions. The organizational plan should be regularly reassessed and, if necessary, updated to reflect developments in safe operation.

2.8. The organizational plan should be established well in advance so that the required structure (including recruitment and training of personnel) is operational as required for the commissioning phase and, in all cases, before commencement of operation. It should form the basis for the first recruitment and training programme as well as for all such subsequent programmes.

## STRUCTURE OF THE OPERATING ORGANIZATION

2.9. Although an operating organization may already have an organizational structure for managing non-nuclear generating plants before the advent of a nuclear power plant, the emphasis on the safety of the plant and the commitment to achieve safety will require more than a simple augmentation of the earlier organizational structure. The factors to be considered in determining the structure of the operating organization and its staffing requirements for a nuclear power programme should include, but are not limited to, the following:

- (1) the need to ensure that structures, systems and components important to safety remain in accordance with the design assumptions and intent;

- (2) the need for radiation protection and related medical provisions;
- (3) the need to ensure that systems and components are available to cool the fuel and contain the radioactive material during all operational states, design basis accidents and postulated severe accidents;
- (4) the need to ensure control of reactivity and to prevent inadvertent criticality;
- (5) the necessity for design, construction, operation and modifications to be thoroughly analysed and reviewed with the aim of ensuring safety;
- (6) the need to be prepared for emergency situations, and to co-ordinate emergency plans with those of the regulatory body, public authorities and other organizations which may be required to take action;
- (7) the need to minimize and control radioactive releases and provide for environmental surveillance;
- (8) the need to control access to the plant and to certain areas within the site in order to ensure radiological safety and to protect individuals and the plant against actions that would jeopardize safety;
- (9) the need to conduct activities affecting items important to safety in accordance with quality assurance requirements, including the need to verify whether such activities have been performed as specified;
- (10) the need for emphasis on training and retraining of personnel to achieve and maintain an adequate level of competence, and to inculcate the necessary attitude towards safety;
- (11) the need to consider all organizational factors that can affect human performance, so that work can be carried out safely and satisfactorily without imposing unnecessary physical and psychological stress on plant personnel;
- (12) the need to ensure that attitude towards safety is one of the selection criteria for recruiting staff, appraising staff performance and promoting managers;
- (13) the need to know and understand the requirements of the regulatory body, to make proposals to meet these requirements and to implement them in a timely manner;
- (14) the need to set up a system of formal corporate communication with the regulatory body;
- (15) the need for additional services and facilities for activities such as fuel management, chemistry control, in-service inspection, and monitoring and improving plant performance as well as for modifying and procuring special items;
- (16) the need for worldwide operational experience to be systematically reviewed and fed back so that appropriate actions can be taken; and
- (17) the need to ensure an open exchange of information, both upwards and downwards within the organization.

2.10. In addition, an organizational structure should ensure the following:

- That technical services and expertise, including those required for emergency situations, are provided. The extent to which these are provided from inside or outside the organization is a matter of management policy.
- That the personnel involved in the review of safety related activities are independent from cost and schedule considerations.

2.11. The document describing the plant's organizational structure should indicate the staffing arrangements within the categories of direct line operating personnel and supporting personnel. Clear lines of authority should be established to deal with matters bearing on plant safety. The extent to which the support functions are self-sufficient or dependent upon services from outside the plant organization should be demonstrated by means of functional organizational charts which include personnel resource allocations and specify the duties and responsibilities of key personnel.

2.12. The description of the structure and of the functions to be performed by the individual departments in the operating organization, on and off the site, and by the individual persons in each department, as well as the lines of responsibility, authority and communication, should be unambiguous and should leave no scope for improvisation in either operational states or accident conditions. In some Member States, this description is required as a part of the safety analysis report or of the quality assurance programme and, as far as the plant organization is concerned, is subject to prior approval by the regulatory body. Functions to be performed by external organizations or consultants should also be indicated in the description, together with the related lines of communication and authority.

2.13. The response time for obtaining services (see Section 7) from off-site sources should be taken into account in determining the structure of the organization, particularly with respect to a nuclear power plant sited in a remote location. In that case, the on-site organization should be capable of rendering all necessary immediate services.

2.14. Position descriptions or equivalent procedural guidance should be used to supplement the organizational chart. Position descriptions should clearly define the authorities, responsibilities and competences for each position or position category within the operating organization as a whole, and within the plant, department and functional group.

2.15. The description of the responsibilities and competences needed for each position should form the basis for the definition of the required qualifications and of

the prerequisites for recruiting, training and continuing training of the individual persons.

2.16. Changes to staffing levels, ways of working or organizational structure should be subject to analysis and independent review when proposed. Changes should be monitored during and after implementation to ensure that they are not detrimental to safety.

2.17. For significant organizational changes, an implementation plan should be drawn up to scrutinize their effects on safety in order to ensure that any changes in the organizational structure are properly considered in terms of safety before being implemented. For such changes, independent internal review may also be required. The regulatory body should be informed about changes with potentially significant effects on safety so that it can independently assess the proposed changes, conduct inspections and, if necessary, intervene if it concludes that safety is being jeopardized. For more guidance on organizational changes see Ref. [3].

2.18. When there are several operating organizations within one country, these operating organizations should establish special arrangements for an effective exchange of experience, services and facilities.

2.19. In developing its structure, the operating organization may be influenced by the character (centralized, federalized or regionalized) of the national and local authorities, including the regulatory body. Regardless of the organizational structure adopted, consideration should be given to the implementation of the plant operation management programmes covered in Section 6.

### **3. FUNCTIONS AND RESPONSIBILITIES**

#### **FUNCTIONS OF THE OPERATING ORGANIZATION**

3.1. In establishing the structure of the operating organization, consideration should be given to the management functions in the following areas [1]:

- Policy making functions, which include: setting management objectives; establishing a policy for nuclear safety and for quality; allocating resources; providing material and human resources; approving the contents of management programmes; setting policies on fitness for duty; and establishing



a programme to make the necessary changes to any of these functions on the basis of the performance in achieving objectives.

- Operating functions, which include executive decision making and actions for the operation of a plant, both in operational states and in accident conditions.
- Supporting functions, which include obtaining from both on-site and off-site organizations the technical and administrative services and facilities necessary to perform the operating functions.
- Reviewing functions, which include critical monitoring of the performance of the operating and supporting functions, and review of the design. The purpose of monitoring is to verify compliance with the stipulated objectives for safe operation of the plant, to reveal deviations, deficiencies and equipment failures, and to provide information for the purpose of taking timely corrective action and making improvements. Reviewing functions should also include review of the overall safety performance of the organization in order to assess the effectiveness of safety management and to identify opportunities for improvement.

## RESPONSIBILITIES OF THE OPERATING ORGANIZATION

3.2. The operating organization management should have the following main responsibilities:

- (1) Ensuring safe operation of its plants by implementing an adequate organizational structure, allocating responsibilities and delegating authority within the organization with a view to achieving proper management and minimizing interface problems;
- (2) Establishing safety policies and implementing management programmes for safe operation (see Section 6), and verifying their effectiveness;
- (3) Establishing and implementing an appropriate policy on an individual's suitability for duty, addressing adequate physical and mental fitness and aspects such as the illicit use of drugs or tobacco and alcohol abuse, in consonance with national regulations. This policy should be addressed to all employees, contractors and visitors, as applicable;
- (4) Establishing liaison with public authorities and the regulatory body for the purposes of considering, understanding and ensuring compliance with regulatory requirements;
- (5) Establishing liaison with design, construction, commissioning, manufacturing and other organizations involved with the nuclear power plant or plants, to ensure proper transfer and understanding of the plant design intent and assumptions, information and experience;

- (6) Providing resources, services and facilities to plant management;
- (7) Providing adequate information for the purposes of liaison and public relations;
- (8) Ensuring the collection, evaluation, implementation and dissemination of operational experience; and
- (9) Ensuring that the decision making process gives adequate consideration to the selection of priorities and the organization of activities.

All these responsibilities should be documented.

3.3. The prime responsibility for the safety of nuclear power plants rests with the operating organization. It is responsible for specifying safety criteria and assuring itself that the design, construction and operation of nuclear power plants meet the applicable safety criteria. In addition, it is responsible for the establishment of procedures and arrangements to ensure the safe control of nuclear power plants under all conditions, for the establishment and maintenance of a competent and motivated staff and for the control of the fissile and radioactive materials utilized or generated. These responsibilities should be discharged in accordance with applicable safety objectives and requirements established or approved by the regulatory body.

3.4. Management of the operating organization should ensure that its organization is well structured, with clear lines of authority and communication and well defined responsibilities, and that its safety policies are established, understood and observed by all involved. However, the assignment of tasks among organizations should not reduce or divide the prime responsibility for safety, which lies with the management of the operating organization. As a result, the operating organization remains in a supervisory position for delegated tasks.

3.5. To ensure that there is a clear understanding of responsibilities and relationships between organizational units and between personnel within the operating organization, detailed job specifications should be defined. In particular, these relationships should be clearly defined for all activities having a direct or indirect bearing on safety.

3.6. The operating organization should establish high performance standards for all activities relating to safe operation of a plant, and should effectively communicate these standards throughout the organization. All levels of management should promote and require consistent adherence to these high standards. Management of the operating organization should foster a working environment that encourages the achievement of high standards in safe operation of the plant.

3.7. The operating organization should be responsible for providing all equipment, staff, procedures, training and management practices necessary for safe operation, including the fostering of an environment in which safety is seen as a vital factor and a matter of personal accountability for all staff. Reliability in the long term should not be served by compromising safety in the short term.

3.8. The operating organization often delegates operating authority to the on-site management of the nuclear power plant which has direct day to day control. Accordingly, the operating organization should have a responsibility to monitor the effectiveness of safety management at the nuclear power plant and to take necessary measures to ensure that safety is continuously improved or at least maintained at the level established by design.

3.9. Within the operating organization, powers of authority that are delegated should be specified at the appropriate levels of management.

## RESPONSIBILITIES OF THE PLANT MANAGEMENT

3.10. The responsibilities of the plant managers encompass: implementation of the safety policy of the operating organization, establishment and perpetuation of a strong safety culture, and control and verification of safety related activities.

3.11. The chief executive member of the operating organization on the site is the plant manager (sometimes called the station superintendent). The plant manager is the representative of the licensee on the site and has the overall responsibility for safe and reliable operation of the plant. In discharging this responsibility the plant manager may, depending on the structure of the operating organization, also be responsible for overall co-ordination of technical support functions, whether performed by site personnel or by personnel from off-site departments or external organizations. The plant manager is therefore responsible for the qualification (including adequate initial and continuing training) of the operating personnel.

3.12. The plant manager is responsible for ensuring that the relevant requirements of both the operating organization and the regulatory body are complied with, and, in addition, may be involved in public information activities and in maintaining relationships with local authorities.

3.13. If services are provided outside the direct control of the plant manager, then functional relationships should be defined to clarify the responsibilities of the two parties. It is the usual practice for the plant manager, as the senior on-site member of

the operating organization, to be designated as representative of the operating organization and to be accountable for ensuring that the second party (who is providing the service) meets the operating organization's objectives and statutory requirements, including those established by the regulatory body.

3.14. In cases where functions are wholly or partly unamenable to direct control, the plant manager is still responsible for promoting in a documented manner the satisfactory execution of plant related actions stemming from these functions.

3.15. To improve human performance, senior managers in each organization should understand and support the need to develop the management and technical skills of all individuals involved in plant activities to the extent necessary to perform their assigned tasks. This support should be in the form of modelling the new behaviours and providing resources including adequate funds to develop and implement management and technical skills programmes.

3.16. This is part of a manager's role in setting the standards and expectations for all staff in all aspects of safe management of a plant. In addition, managers themselves should visibly meet these standards and should help staff to understand why they are appropriate.

3.17. In assigning responsibilities and accountabilities for safety, managers should ensure that the individuals concerned have the capability and the appropriate resources to carry out these safety responsibilities effectively. They should also ensure that their staff are aware of and accept their safety responsibilities. Staff should also be aware of how their responsibilities relate to others in the organization.

3.18. Line managers should be responsible for the safety of all operations under their control. The structure of the organization thus needs to reflect this accountability of line management for safety. However, the exact management structure will also need to reflect the specific requirements of the organization. The roles, responsibilities and authorities of managers and management units within the organization should be clearly specified and should be compatible with each other.

## GOALS AND OBJECTIVES

3.19. Since the operating organization has overall responsibility for the safe operation of its nuclear power plants, its management objectives should be to ensure that:

- the approved design enables the plant to be operated safely;
- the plant is constructed in accordance with the design;
- the plant is tested, pursuant to prescribed specifications, to demonstrate that design and construction requirements have been met and that the plant can be operated in accordance with the operational limits and conditions, and design assumptions and intent;
- the plant is operated and maintained in accordance with the operational limits and conditions, authorized procedures and design assumptions and intent, by a sufficient number of competent persons who are adequately trained to cope with abnormal situations, including emergency situations;
- adequate facilities and services are available in a timely manner during normal operation and for responding to all kinds of anticipated operational occurrences, design basis accidents and postulated severe accidents;
- for all levels of requirements, the arrangements with participating organizations are adequate and effective; and
- adequate arrangements for response to all kinds of anticipated operational occurrences and accident conditions have been made and appropriate actions have been taken to provide for protection of the health and safety of the site personnel and the public, and for protection of the environment.

3.20. The plant management should develop goals and objectives that support and complement established corporate goals. The plant goals and objectives should be commensurate with the expectations of the management of the operating organization, and should include key performance areas of the plant and areas recognized as needing improvement. Suitable goals and objectives should be established at the departmental level to support the goals of the plant management. Departmental goals and objectives should be co-ordinated among the departments to ensure that they are consistent and mutually supportive and reflect management's priorities.

3.21. Where it is reasonable, the goals and objectives of all management levels should be measurable and stated in terms that allow measurement of progress and clear determination of achievement. They should be challenging, realistic and focused on specific improvements in performance, and should be limited in number to prevent dilution of efforts in key areas. They should be communicated, understood and supported within the organizational structure responsible for their accomplishment.

3.22. Management, at the appropriate level, should periodically review progress towards the accomplishment of goals and objectives. Formal reviews of progress should be conducted and results should be communicated periodically to the personnel of the operating organization.

3.23. The performance objectives and targets of each department should be known and understood by its staff, who should also know the current position with respect to their achievement.

3.24. Personnel should be held accountable for the achievement of goals and objectives assigned to them and should be recognized for the achievement of goals and objectives and for actions performed to this end.

## **4. INTERFACES WITH EXTERNAL ORGANIZATIONS**

### INTERFACE WITH THE REGULATORY BODY

4.1. The operational safety of a nuclear power plant should be subject to surveillance by a regulatory body that is independent of the operating organization. For the achievement of their common objective — safe operation — there should be mutual understanding and respect between the regulatory body and the operating organization to support a frank, open and yet formal relationship. Further information on the role of the regulatory body can be found in Ref. [2].

4.2. The operating organization should submit or make available documents and other information in accordance with the regulations and requirements of the regulatory body.

4.3. The operating organization should give the regulatory body all necessary assistance and access to the plant, and, when necessary, undertake special analyses, tests and inspections. If any request is made to the operating organization which in its opinion could have an adverse effect on safety, then, in view of its responsibility for safety, the operating organization should make its opinion known to the regulatory body.

4.4. The operating organization should develop and implement a procedure for reporting incidents and abnormal events of significance to safety to the regulatory body in accordance with established criteria. The operating organization and the regulatory body should establish complementary programmes to analyse operating experience so as to ensure that lessons are learned and acted upon. Such experience

should be shared with relevant national and international bodies (see also paras 6.62–6.71).

## INTERFACE WITH EXTERNAL SUPPORTING ORGANIZATIONS

4.5. Contractor personnel may be used to perform tasks that are of a specialized or temporary nature for which it is not feasible to hire or maintain a full-time plant employee. When contractor personnel are used, their duties and authorities should be clearly defined. Contractor personnel should be trained and qualified for the task to be performed and held to the same performance standards as plant personnel performing similar tasks.

4.6. The operating organization should ensure that contractor and temporary personnel who perform activities on safety related structures, systems and components are qualified to perform their assigned tasks. Documented assurance should be obtained that contractor personnel have the required qualifications prior to independent involvement in these activities.

4.7. The roles and responsibilities of external supporting organizations (e.g. external maintenance organizations, plant vendors, research institutes and technical support organizations) should be clearly defined and understood. Where these supporting organizations play a significant role in the operation of a plant, the safety management system for the operating organization needs to embrace their activities, while at the same time ensuring that overall control and responsibility for safety rests with the operating organization as licensee.

4.8. The operating organization should contain an adequate number of personnel, with the knowledge, training and skills necessary to supervise and evaluate the work of contractor personnel. Staff of the operating organization required to supervise contractors or other temporary support staff should be clearly identified.

4.9. Personnel external to the organization who are providing a service or advice, although they may be personally or professionally responsible for the quality of the service or advice given, should have no direct authority over plant personnel unless this is specifically granted. The plant manager's staff should always be responsible for making decisions after taking all aspects into account and after giving careful consideration to any specialist advice provided.

4.10. A wide range of contractual arrangements is possible between the operating organization and suppliers, from individual procurement to a turnkey contract. For

procurement, the operating organization faces an extensive task and will need corresponding resources. It should assign knowledgeable and skilled personnel in the pre-operational stages to meet these responsibilities. For turnkey contracts the supplier plays a more wide-ranging role in the construction and testing of the plant. However, as the operating organization retains the responsibility for safe operation of the plant, it should still assign a sufficient number of knowledgeable and skilled personnel during the pre-operational phase. Examples of areas where close co-operation with the supplier is necessary are:

- training of operating staff,
- commissioning of the plant,
- maintenance and in-service inspections,
- technical assistance during operation, and
- preparation of normal and emergency operating procedures.

## INTERFACE WITH THE PUBLIC

4.11. The operating organization should declare publicly in its policy statement that one of its corporate objectives is its commitment to nuclear safety — this objective overrides the demands of production.

4.12. The public has the right to know the hazard which arises from a nuclear power plant. The operating organization should appropriately disseminate such information.

4.13. The operating organization should provide information on the status of the plant to the public in a regular and timely manner. The public should be informed of any significant event on the International Nuclear Event Scale (INES) [4] and of any enforcement action taken by the plant.

4.14. The operating organization should keep the public informed on a regular basis, even when there is nothing new to report. The public should be provided with information on the measures that would be taken in emergencies.



## 5. SAFETY MANAGEMENT

### SAFETY MANAGEMENT SYSTEM

5.1. ‘Safety management’ is the term used for the measures required to ensure that an acceptable level of safety is maintained throughout the lifetime of a nuclear power plant, including decommissioning. The safety management system should comprise those arrangements made by the operating organization that are needed to promote a strong safety culture and to achieve and maintain good safety performance. It is the management’s responsibility to recognize the safety significance of the organization’s activities.

5.2. It should be clearly understood that safety management is not separate from or complementary to other business activities of the operating organization. Safety management should be an integral component of the management of the entire organization; in effect the safety significance of the operating organization’s activities should be understood and recognized and the plant’s safety given the utmost priority — overriding, if necessary, the demands of production and project schedules.

5.3. The safety management system should comprise such organizational elements as: definition of safety policy; identification of the main responsibilities, competences and activities that are needed to ensure safety; arrangements to ensure that the required activities are implemented safely; monitoring of safety management plans and improvements of safety performance on the basis of lessons learned at the plant concerned and at other plants. In addition, the safety management system should set up the framework that will enable individuals involved in plant activities to carry out their tasks safely and successfully.

5.4. The principles of safety management should be broadly applied through all organizational structures. Thus, the practices described for the operating organization at the corporate level should be applied, where relevant, to other organizational structures with delegated authority to carry out functions on behalf of the operating organization.

5.5. In order to maintain high effectiveness of safety management at the plant, the operating organization should ensure a very high level of commitment to safety. The starting point for safety management is the involvement of top managers in all organizational structures. The lead in safety matters should come from the highest levels of management. Their safety policies and attitudes should be of the highest standard, and should permeate the operating organization at every level and extend to other organizations performing delegated tasks. There can be no complacency at any

level about the continuous attention demanded by safety. Safety management should imply a learning attitude to safety matters and the open exchange of information both upwards and downwards within the organization. Additional information on the safety management system can be found in Ref. [5].

## SAFETY POLICY

5.6. A clear safety policy should be developed by the operating organization and implemented by all site personnel and relevant operating organization personnel. The safety policy should demonstrate the organization's commitment to high safety performance and should be supported by reference to safety standards, the development of targets and provision of the resources necessary to achieve these targets.

5.7. This policy should give plant safety the utmost priority, overriding, if necessary, the demands of production and project schedules. It should require a commitment to excellent performance in all plant activities important to safety and should encourage a questioning attitude and a rigorous and prudent approach to all safety related activities. The formal statement of safety policy should be documented and submitted or made available to the regulatory body and the public.

5.8. To be effective, the safety policy requires the endorsement and active support of senior managers, who should also be involved in disseminating the policy throughout the organization. All personnel in the organization should understand the policy and be aware of their function in ensuring safety.

5.9. The operating organization should adopt or develop safety standards that specify expectations for the arrangements that are significant to the implementation of the safety policy in different operational areas such as operation, maintenance, technical support, training and qualification. Safety standards and management expectations should be clearly communicated to ensure that they are understood by all those involved in their implementation.

5.10. The operating organization should ensure that adequate resources are available to implement the safety policy. This should include the provision of safe operating plant, the necessary tools and equipment, and a sufficient number of competent staff (supplemented as necessary by consultants or contractors, including plant vendors). In particular, sufficient resources should be ensured to carry out activities in a safe manner, avoiding undue physical or mental stress on individuals.

5.11. The operating organization should demonstrate a commitment to achieving improvements in safety wherever it is reasonably practicable to do so as part of a continuing commitment to the achievement of excellence. The organization's improvement strategy for achieving higher safety performance and for more efficient ways to meet existing standards should be based on a well defined programme with clear objectives and targets against which to monitor progress.

## PERFORMANCE OF SAFETY RELATED ACTIVITIES

5.12. Safety related activities should be properly planned to ensure that they can be carried out safely and effectively. Suitable and sufficient assessments of the risks to health and safety arising from particular activities should be carried out. The nature of the required risk assessment will depend on the extent of the risks involved and may be qualitative or quantitative in nature. The purpose of the risk assessment is to identify the acceptability of the proposed activity and the appropriate control measures required to ensure that risks are as low as reasonably achievable (ALARA). The results of the risk assessment should be incorporated into work instructions or control documentation associated with the activity, for example, the documentation for the permit to work system.

5.13. Appropriate arrangements should be in place to ensure that safety related activities are adequately controlled to minimize the risks to health and safety. The level of control should depend on the safety significance of the task. Activities with a high level of safety significance may require a specially authorized person to carry out the task, such as the reactor operator. In addition, certain critical activities such as tests and experiments will need to be authorized in advance and will involve the use of a permit to work system. Other control measures may include the use of hold points and verification stages during complex tasks and the control of stores items and test equipment.

5.14. All safety related activities should be carried out in accordance with written procedures. These define how the activity can be carried out safely and, where appropriate, identify the steps to be taken in the event of an abnormal situation. The procedures should be issued and controlled in accordance with the organization's quality assurance programme. Further guidance on operating procedures can be found in Ref. [6].

5.15. All the proposed plant modifications, including organizational changes, should be thoroughly planned. The operating organization should establish a procedure to ensure that the safety significance of any changes is assessed in advance, with the

level of assessment based on the safety significance of the changes. This procedure should ensure that the plant limits and conditions are observed and applicable codes and standards are met. Further guidance on the management of plant modifications can be found in Ref. [3].

5.16. Arrangements should be in place to manage the situations that fall outside normal operating or fault procedures, e.g. abnormal findings from inspections and special tests. These arrangements should ensure that appropriate control is maintained and due consideration is given to the safety implications of the situation. Arrangements to deal with emergencies also need to be at hand. These should cover on-site and off-site responses, including the timely notification of appropriate government, regulatory and support organizations.

## MONITORING AND REVIEW OF SAFETY PERFORMANCE

5.17. The safety performance of the operating organization should be routinely monitored in order to ensure that safety standards are maintained and improved. An adequate audit and review system should be established to provide assurance that the safety policy of the operating organization is being implemented effectively and lessons are being learned from its own experience and from others to improve safety performance. The features of the organizational structure and management aspects should be taken into consideration when monitoring and assessing the safety performance of the operating organization or of an individual nuclear power plant.

5.18. The operating organization should provide a means for independent safety review. The key to this process is the establishment of an objective internal self-evaluation programme supported by periodic external reviews conducted by experienced industry peers using well established and proven processes. The principal objective is to ensure that, in those matters that are important to safety, safety accountability is supported by arrangements that are independent of the pressures of plant operation. The safety review should be independent of plant operation, and should be conducted on a continuing basis to verify that plant management establishes verified and authorized practices and implements changes as required. The reports resulting from this activity should be formal and should be provided directly to the top management of the operating organization. Particular attention should be paid to the feedback from experience.

5.19. Safety review procedures should be maintained by the operating organization to provide a continuing surveillance and audit of plant operational safety and to support the plant management in its overall safety responsibilities.

5.20. To monitor safety performance in an effective and objective way, wherever possible and meaningful, the relevant measurable safety performance indicators should be used. These indicators should enable senior corporate managers to discern and react to shortcomings and early deterioration in the performance of safety management within the train of other business performance indicators. More information on the use of safety performance indicators, in particular to identify early signs of degradation in safety performance, can be found in Ref. [5].

5.21. However, it should be borne in mind that there is no one single indicator that provides a measure of the safety of a plant. A range of indicators should be considered in order to provide a general sense of the overall performance of a nuclear power plant and its trend over time [7].

5.22. The appropriate corrective actions should be identified and implemented as a result of the monitoring and review of safety performance. Arrangements should be in place to ensure that appropriate corrective actions in response to audit and review findings are identified and taken. Progress in taking proposed actions needs to be monitored to ensure that actions are completed within the appropriate time-scales. The completed corrective actions should be reviewed to assess whether they have adequately addressed the issues identified in the audits and reviews.

## **6. PLANT OPERATION MANAGEMENT PROGRAMMES**

### **GENERAL**

6.1. In order to achieve the objectives and discharge the responsibilities listed in Section 3 and to exert effective control over the related activities, the operating organization should establish appropriate documented management programmes. For the purpose of this Safety Guide, a ‘management programme’ consists of a systematic application of planning schedules, procedures, reviews and audits supported by appropriate resources to administer a specific management policy.

6.2. The areas to be covered by various management programmes for the safe operation of plant should include, but are not limited to, the following:

- staffing,
- qualification and training,
- commissioning,
- plant operations,

- maintenance,
- in-service inspection,
- surveillance,
- fuel management,
- chemistry,
- safety analysis and review,
- physical protection,
- radiation protection,
- industrial safety,
- waste management and environmental monitoring,
- emergency preparedness,
- fire safety,
- quality assurance,
- human factors,
- feedback of operational experience,
- plant modifications,
- document control and records,
- management of ageing, and
- decommissioning.

6.3. These programmes should be addressed to administrative as well as technical aspects of plant operation and should cover all related activities. Due consideration should also be given to quality assurance requirements as stated in Ref. [8] (in particular, Safety Guide Q13).

6.4. The relevant parts of these programmes should be documented and should be available sufficiently in advance to allow the corresponding activities to be reviewed and assessed by plant staff prior to implementation.

6.5. In order to ensure that adequate and appropriate practices are followed in implementing the management programmes, the operating organization should make arrangements for the requisite information to be available from designers, manufacturers and other organizations. Arrangements should also be made with other appropriate operating organizations in order to benefit from their experience.

6.6. These programmes should take account of the management of ageing and decommissioning and therefore should include any requirements that may facilitate the planning of this activity.

6.7. When establishing such programmes, due consideration should be given to:

- objectives to be achieved,
- applicable regulatory requirements,
- policies to be implemented,
- allocation of responsibilities and delegation of authority,
- qualification of personnel involved,
- scheduling of activities to be performed,
- services and facilities required,
- documentation and basic information required,
- feedback of experience,
- reviews to be conducted of programmes and associated procedures,
- the timely resolution of safety problems,
- reports to be produced and records to be kept, and
- the information flow required.

6.8. A prerequisite for implementing the appropriate management programme is the establishment of a comprehensive system of instructions and procedures to cover all relevant technical and administrative aspects. These documents should be prepared by knowledgeable persons and should be ready at the start of each programme. This imposes a major workload which should be taken into account when recruitment and training schedules are being drawn up. The co-operation of experts from manufacturing, design, construction and other organizations can be utilized where such expertise is required.

6.9. When activities which are not included in the normal procedures are proposed, special procedures should be written down in accordance with established procedures which include the contents and the operational details of the proposed activity. Such activities and procedures should be carefully reviewed by appropriate technical staff and approved by management for safety implications. However, the plant management should have the ultimate responsibility to perform the proposed activity. The proposed procedure should be submitted to the regulatory body for approval if so required.

6.10. The operating organization should establish a document control system to ensure that all documents affecting activities important to safety are issued, updated, filed and distributed in such a manner as to prevent the use of superseded documents (see Ref. [8], Safety Guide Q3).

## STAFFING

6.11. A long term staffing programme tied to the long range objectives should be developed by the operating organization to anticipate future personnel needs. This

plan should be reviewed and updated periodically to ensure that it is consistent with and supports the long range objectives of the operating organization and the needs of the plants. The staffing programme should include anticipated changes in authorized staffing levels, job assignments for the development of professional and managerial experience and a forecast of personnel needs, losses due to retirement and attrition being taken into account. The long term staffing plan should allow sufficient time for individuals to turn over job responsibilities and should allow for continuity in the conduct of duties.

6.12. On the basis of the objectives, functions and responsibilities of the operating organization discussed in Section 3, a proper definition and detailed analysis of tasks and activities to be performed should be made; the appropriate staffing and qualification requirements at the different levels in the organization should be determined, and the selection, training and retraining requirements should be specified.

6.13. In establishing the above requirements, the management of the operating organization should recognize that a nuclear programme requires a complex and evolutionary technology, and that such a programme would consequently require highly qualified personnel capable of ensuring efficient and safe operation under normal conditions and proper response under emergency conditions. In particular, proper expertise with respect to plant control under transient conditions should be available at all times on the site. The qualifications, training and experience of all personnel in the operating organization should therefore be suited to their responsibilities and activities.

6.14. Staffing arrangements should take into account:

- the need to involve the operating organization in the review of activities, including those that are conducted during the design, construction and commissioning stages;
- the need to establish timely liaison with the regulatory body, public authorities and other organizations;
- the minimum number of persons necessary for performing all functions with respect to plant operation and emergency situations, with a view to avoiding excessive loads being placed on individuals;
- the need, particularly in the case of remotely located plants, for adequate expertise, special equipment and spare parts to be available locally for dealing with emergency situations until such time as they are augmented from off-site sources;
- the statutory requirements on working conditions;



- the turnover of personnel in the operating organization;
- long term personnel needs for future projects;
- the policy of the operating organization with respect to maintenance and other functions (such as the extent of maintenance carried out on shift, the extent of employment of contractors, repair versus replacement of components, centralized workshops); and
- the need for training and retraining of plant personnel.

6.15. Recruitment should start early enough to permit the establishment and proper implementation of selection methods and the timely availability of personnel for preparatory training. This is in order to allow the personnel to perform planned activities effectively and to be involved in commissioning and, if practical, in construction activities. Further guidance on the recruitment and selection of plant personnel can be found in Ref. [9].

## QUALIFICATION AND TRAINING

6.16. The operating organization should establish a training and qualification programme to ensure that the needs of the operating organization are evaluated and that the qualification requirements for positions in the organization are established. Only qualified persons should be entrusted with functions important to the safe supervision, operation and maintenance of a nuclear power plant. For each category of personnel, there should be the requirement to develop and maintain appropriate competence through education, experience and formal training.

6.17. Training programmes, based on the specific needs of the organization and the individual, should be established to develop and maintain the technical knowledge and skills of all personnel. A systematic approach to training should be used which will enable a training programme for nuclear power plant personnel to be prepared, analysed, designed, developed and implemented on the basis of an analysis of the responsibilities and tasks of a job.

6.18. The programme should provide training plans and schedules for the various categories of personnel, taking into account the background of the individuals to be trained and the facilities available.

6.19. A training programme should ensure that personnel at all levels of operation of nuclear power plants have the requisite competence. It should identify the activities in which safety is involved, should provide for acquisition of the knowledge and

practical experience needed for these activities and should foster a responsible attitude towards all safety matters.

6.20. Consideration also should be given to the training needs of contractor personnel to ensure that they are qualified to perform their assigned tasks. Assurance should be obtained that contractor personnel have the required qualifications prior to independent involvement in these activities.

6.21. Further guidance on the establishment and implementation of the training and qualification programme for nuclear power plant personnel can be found in Ref. [9].

## COMMISSIONING

6.22. Notwithstanding the contractual arrangements for the supply of a new plant, the operating organization should ensure that a comprehensive commissioning programme is established and implemented to demonstrate that the plant has been constructed as specified and may be operated in a safe manner. Details of the establishment and implementation of the commissioning programme are given in Ref. [10].

6.23. In view of its role in the subsequent operating phase of the plant, the operating organization should verify that the commissioning programme checks as exhaustively as possible the characteristics of the plant; specifically, the commissioning programme:

- should confirm that the plant as built is consistent with the provisions of the safety analysis report;
- should ensure that the plant meets the requirements of the regulatory body;
- should demonstrate the validity of operating instructions and procedures and provide an opportunity for operating personnel to improve their competence; and
- should supply information and data necessary to verify the adequacy of provisions made for implementing the management programmes.

6.24. When commissioning activities are conducted under the responsibility of the supplier or other groups, the operating organization should make the necessary arrangements to review and approve these activities at all stages. On completion of a stage of activity, regulatory approval should be obtained by the operating organization before moving on to the next stage.

## PLANT OPERATIONS

### **Operational limits and conditions, operating procedures**

6.25. For the safe operation of the plant, administrative controls should be established that include operational limits and conditions and operating instructions and procedures. Requirements for review and approval of operating instructions and procedures, particularly at the corporate level, should be specified. These controls constitute the operations programme and should be established before the commencement of operation. In developing operating procedures, consideration should be given to decommissioning where applicable.

6.26. The operating organization should provide for the development of operating instructions and procedures that:

- ensure that all activities affecting safe operation are covered by appropriate instructions or procedures;
- ensure compliance with operational limits and conditions and regulatory requirements;
- are written and verified by properly qualified persons in accordance with relevant quality assurance requirements;
- are written in clear and understandable language and avoid any confusion and ambiguities;
- are in accordance with design assumptions and intent; and
- provide sufficient details to allow the person assigned to perform the activity to do so without direct supervision.

6.27. Further guidance on operational limits and conditions and operating procedures can be found in Ref. [6].

### **Operations by shift crew**

6.28. Regardless of the extent of automation of the plant, the final decisions and resulting final responsibilities of the operation should rest with plant operating staff. The operating organization of a site, therefore, should establish shift crews for continuity of the responsibilities in the tasks of plant operation. Examples of tasks or activities to be executed by a shift crew include, but are not limited to, the following:

- (1) For normal operation:
  - to change the mode of operation;

- to maintain the existing mode of operation;
- to monitor whether selected plant parameters which are displayed in the control room are in the range of normal readings;
- to monitor whether there are any indications of deviations from normal operation by plant walk-through;
- to issue work permits and prepare working conditions by isolation of structures, systems or components or modification of their configurations;
- to cancel work permits and restore normal plant conditions by returning structures, systems or components into service or into normal configurations; and
- to keep operational records and make reports.

(2) For anticipated operational occurrences:

- to monitor the status of the plant when any deviation from normal operation is detected, and to verify that the plant is responding to the situation as designed;
- to take corrective actions in accordance with procedures if the plant is identified to be not responding properly; and
- to proceed to a safe state and remain in this condition until exhaustive analysis of the causes of the deviation is completed.

(3) For accident conditions:

- in case a deviation is not corrected, to initiate emergency measures in accordance with procedures.

6.29. The number of operators on each shift and their responsibilities should be determined on the basis of the complexity of the plant, the degree of automation and regulatory requirements.

6.30. A shift crew should be headed by a shift supervisor and should consist of a sufficient number of trained, qualified and authorized operators and other support staff for all operational states and for unanticipated situations, especially for coping with emergencies. The qualification and authorization of the shift members should be in accordance with regulatory requirements and with the safety standards of the operating organization. Each member of the shift crew should be assigned with a clearly defined authority and responsibility and be positioned in a clear line of command.

6.31. A formal communication system should exist between the plant organization and the shift crew for the transmission of orders and for the transfer of information relating to safe operation. As part of this system, plant modifications and major tests

should be properly authorized by plant management and controlled by the shift crew. This should include recording of orders and instructions, with affirmations that these orders and instructions have been received and understood by the shift crew.

6.32. Shift turnover should be carried out in a structured and professional manner. The effectiveness of shift turnover should be enhanced by a written account of the shift activities. The process of shift turnover should identify the persons involved, their responsibilities, the locations and the conduct of shift turnovers, and the method of reporting plant status, including provisions for special circumstances such as abnormal plant status and staff unavailability.

6.33. The shift crew should perform regular rounds through the plant. The shift supervisor or authorized staff should also walk through the plant periodically.

6.34. There should be an effective interface among the shift crew, the technical support group and maintenance groups including contractors. After finishing their work, the shift crew, technical support group and maintenance groups should ensure that structures, systems and components affected by the work are tested and returned to the original or a satisfactory operational state that complies with the operational limits and conditions.

6.35. Planning of work, outages, modifications and tests should be co-ordinated among the shift crew, the technical support group and maintenance groups to ensure that the plant remains in a safe condition at all times and in accordance with the operational limits and conditions.

## MAINTENANCE

6.36. The maintenance programme should ensure that the levels of reliability and effectiveness of all plant structures, systems and components important to safety remain in accordance with the current plant safety analysis and that the safety status of the plant is not adversely affected after the commencement of operation. Additionally, the results of periodic reviews should be incorporated into the maintenance programme.

6.37. The development of the maintenance programme should be initiated early in the design phase in close liaison with the design organization to ensure that the plant is designed to facilitate maintenance. Maintenance activities should be planned in order to achieve the required reliability and availability of plant structures, systems and components while keeping the exposure of personnel ALARA. The results of

probabilistic safety assessments (PSAs) may be incorporated. The operating organization should collect information on the maintenance needs from designers, manufacturers and other operating organizations, to ensure that only the appropriate maintenance practices are established and the necessary maintenance equipment is acquired. The maintenance programme should be reviewed at regular intervals throughout the life of the plant to optimize the programme on the basis of PSAs and operating experience. This optimization should ensure that there is a correct balance between preventive maintenance, predictive maintenance, maintenance during power operation and minimization of breakdown maintenance on safety systems.

6.38. The programme should be established at such a time that it can be implemented to the extent necessary to cope with the plant systems as they are put into operation or transferred to the responsibility of the operating organization, whichever comes first.

6.39. The maintenance programme should include provisions for decontaminating plant items to prevent the spread of contamination.

6.40. Detailed guidance on the establishment and implementation of the maintenance programme can be found in Ref. [11].

## IN-SERVICE INSPECTION

6.41. In-service inspection is necessary to assess against possible deterioration whether the structures, systems and components important to safety are in an acceptable condition for continued safe operation or whether remedial measures are necessary. Emphasis should be placed on examining critical systems and components of the primary reactor coolant system because of their importance to safety and the possible severity of the consequence of failures.

## SURVEILLANCE

6.42. The surveillance programme should ensure that items important to safety continue to perform in accordance with the original design assumptions and intent and may incorporate the results of PSAs and feedback from operating experience. The programme should include requirements for evaluation and review to detect in a timely manner degradation and ageing of structures, systems and components that could lead to unsafe conditions. This programme should cover monitoring, checks and calibration, and testing and inspection complementary to the in-service inspection.

6.43. The programme should be developed sufficiently in advance of plant commissioning to permit it to be properly implemented as plant items become operational during the commissioning phase, and to ensure that the safety of the plant is not dependent upon untested or unmonitored structures, systems and components. Additional guidance on the surveillance programme can be found in Ref. [12].

## FUEL MANAGEMENT

6.44. The fuel management programme should address those activities that are needed in order to allow optimum reactor core operation without compromising the limits imposed by the design safety considerations relating to the nuclear fuel and the plant as a whole. Special consideration should be given to the safety aspects of core management, fuel procurement, site storage, irradiation, and handling and transport of fuel, for which the operating organization is responsible. In particular, the fuel management programme should cover:

- the establishment of detailed technical specifications and quality assurance requirements for fuel procurement;
- special studies to be undertaken to demonstrate the ability of new or modified fuel to meet the provisions of the safety analysis report, especially when fuel from different suppliers is to be placed in the reactor core;
- arrangements to ensure safety during transport, storage and handling of new and irradiated fuel;
- establishment of core calculation programmes to define fuel and absorber loading patterns, so as to maintain compliance with reactivity, temperature and irradiation or burnup limits;
- core monitoring to ensure that core parameters which are indicative of conformance with design and operational limits are monitored, trended and evaluated to detect abnormal behaviour;
- fuel monitoring to ensure that fuel cladding integrity is maintained under all core operating conditions;
- implementation of applicable requirements for the examination of irradiated fuel, and use of the results to monitor fuel performance; and
- verification of the startup testing methods and establishment of associated surveillance requirements.

More detailed guidance on core management and fuel handling can be found in Ref. [13].

## CHEMISTRY

6.45. The chemistry programme should provide the necessary chemical and radiochemical assistance to ensure safe operation, the long term integrity of systems and components, and control and reduction of radiation levels in working areas. The programme should include monitoring, analyses, instructions for operations involving chemical processes and evaluation of operating results. In many power plants, the chemical and radiochemical activities may include environmental monitoring, in particular when the activities relating to chemistry and radiation protection are all performed by one group.

## SAFETY ANALYSIS AND REVIEW

6.46. To ensure a high degree of safety, the operating organization should establish a safety review process that could be implemented by a safety review group or independent reviewers and which provides an independent evaluation of the operational activities of the plant. Safety reviews should be considered for activities such as:

- reviewing the safety related aspects of plant operation;
- reviewing malfunctions, failures and precursors to assess their importance to safety and suggesting actions both to correct adverse situations and to improve safety;
- reviewing proposals for modification to ascertain that they promote safety;
- reviewing the effectiveness of the safety management system and its implementation against the best international practices; and
- suggesting corrective actions and/or modifications.

6.47. Safety reviews should be conducted in sufficient depth to ensure that all issues and questions raised by the review can be satisfactorily resolved. Safety review activities should be performed by personnel who have sufficient education, nuclear experience, expertise and training to allow a thorough understanding and evaluation of the items reviewed.

6.48. In some countries the self-assessment of operational safety has been identified as an important safety review mechanism that the operating organization can use to improve safety. Self-assessment is a structured, objective and visible procedure or set of procedures whereby individuals, groups and management within an operating organization evaluate the effectiveness of their own operational safety against predetermined targets, goals and other performance expectations. The self-



assessment process is only complete when the corrective actions have been implemented and their adequacy has been confirmed. More information on the self-assessment programme can be found in Ref. [14].

6.49. In addition, periodic safety reviews should be performed to substantiate continued safe and reliable plant operation. The results of periodic safety reviews should be used, for example:

- to confirm that the nuclear power plant or individual items can be operated safely for a defined period of future operation;
- to identify and evaluate factors that could limit safe operation during the defined period;
- to revise the existing safety analysis report to meet current safety standards and requirements; and
- to provide input to life extension studies.

6.50. The prime responsibility for performing periodic safety reviews rests with the operating organization. The scope and periodicity of a periodic safety review should either be specified by the regulatory body or be developed by the operating organization and agreed upon with the regulatory body. Additional guidance on periodic safety reviews can be found in Ref. [15].

## PHYSICAL PROTECTION

6.51. The operating organization should provide physical protection that prevents or deters unauthorized access, intrusion, theft, surface attack and internal or external sabotage of systems important to safety and nuclear materials.

6.52. The operating organization should have plans and procedures in place to provide physical protection of the site through vehicle entrance and exit control, vehicle parking and traffic control and personnel access control.

6.53. Protection against external or internal malevolent actions which could jeopardize safety should be provided. Consideration should therefore be given to:

- access controls around the site and within the plant area;
- access rules to be observed for different zones of the site, and provisions to detect and prevent or delay unauthorized entry;
- establishment of procedures for access authorization;

- selection and training of physical protection personnel; and
- communication systems to be used.

6.54. Appropriate physical protection arrangements should be implemented as soon as any plant items important to safety are received on the site, before commencement of commissioning, and in any case before the arrival of fuel on the site. Additional information on the physical protection of nuclear power plants and nuclear materials can be found in Ref. [16].

## RADIATION PROTECTION

6.55. The radiation protection programme should include arrangements for monitoring and dose assessment and should ensure that doses to individuals remain within the prescribed limits; its objective should be that individual and collective doses are kept as low as reasonably achievable. The radiation protection programme is subject to the requirements of, and should be established in accordance with, the basic principles and objectives presented in Ref. [17]. Reference [18] provides further recommendations and guidance on the radiation protection programme.<sup>1</sup>

## INDUSTRIAL SAFETY

6.56. An industrial safety programme should be established and implemented to ensure that all risks to personnel involved in plant activities, in particular, those activities that are safety related, are kept ALARA. An industrial safety programme should be established for all personnel, suppliers and visitors, and should refer to the industrial safety rules and practices that are to be adopted. The programme should include arrangements for the planning, organization, monitoring and review of the preventive and protective measures. The operating organization should provide support, guidance and assistance for plant personnel in the area of industrial safety.

## WASTE MANAGEMENT AND ENVIRONMENTAL MONITORING

6.57. The environmental monitoring programme should ensure that gaseous and liquid releases from the operation of the nuclear power plant are satisfactorily

---

<sup>1</sup> A Safety Guide on radiation protection and radioactive waste management in the operation of nuclear power plants is in preparation.

controlled and monitored so that authorized discharge limits are complied with, and kept as low as reasonably achievable, as detailed in Ref. [18].

## EMERGENCY PREPAREDNESS

6.58. The operating organization should establish the necessary organizational structure and should assign responsibilities for emergency preparedness and response. This includes arrangements for (i) timely notification, alerting and activation of sufficient trained and qualified response personnel to manage the response, to take mitigatory actions, to assess the emergency, to protect people on the site, and to advise public authorities on the implementation of urgent protective actions off the site; (ii) provision for co-ordination of the response on the site with the response by off-site response organizations; (iii) provision of the necessary information and of support to, and co-operation with, the relevant public authorities; and (iv) timely notification and provision of information in the framework of the Convention on Early Notification of a Nuclear Accident [19]. Guidance on the preparedness of the operating organization for emergencies can be found in Ref. [20].

## FIRE SAFETY

6.59. The operating organization should make arrangements for ensuring fire safety on the basis of a fire hazard analysis which should be periodically updated. Such arrangements should include: application of the principle of defence in depth; assessment of the impact of plant modifications on fire fighting; control of combustibles and ignition sources; inspection, maintenance and testing of fire protection measures; establishment of a manual fire fighting capability; and training of plant personnel. For further guidance see Ref. [21].

## QUALITY ASSURANCE

6.60. The operating organization should prepare and implement a comprehensive quality assurance programme covering all activities which may have an influence on the safe operation of the nuclear power plant. The programme should meet the requirements of the Code on Quality Assurance for Safety in Nuclear Power Plants and Other Nuclear Installations [8] and should be made available to the regulatory body.

## HUMAN FACTORS

6.61. A suitable working environment should be provided and maintained so that work can be carried out safely and satisfactorily, without imposing unnecessary physical and psychological stress on personnel. Human factors which influence the working environment and the effectiveness and fitness of personnel for duty should be identified and addressed. The operating organization should establish an appropriate programme for these purposes. Examples of areas or activities to be reflected in this programme should include, but are not limited to, the following:

- adequacy of the resources, support and supervision provided to manage and perform the work;
- adequacy of lighting, access and operator aids;
- adequacy of alarms, considering factors such as their number, position, grouping, colour coding and prioritizing for audibility;
- frequency and clarity of communications;
- availability of suitable tools and equipment;
- duration of work time for personnel;
- the attention needed to be given to other factors, in particular for control room staff, including well-being, psychological and attitudinal problems, shift patterns and meal breaks; and
- the availability of procedures that take into account human factor considerations.

## FEEDBACK OF OPERATING EXPERIENCE

6.62. An effective programme for the review of operating experience should be established to provide methods to analyse both in-house events and events in the nuclear industry generally so as to identify plant specific actions needed to prevent the occurrence of similar events. In-house events of interest to other plants should be shared with the industry to prevent the occurrence of similar events. The effectiveness of the operating experience review programme should be assessed periodically to identify areas of weakness that require improvement.

6.63. Overall responsibility for implementing the operating experience review programme can be placed in either the nuclear power plant or the operating organization. However, the involvement and support of senior management of the operating organization are key for an operating experience review programme to be effective.

The line management of a plant should be responsible for assisting in the review of operating events and for specifying and taking corrective actions.

6.64. The operating experience at the plant should be evaluated in a systematic way, primarily to make certain that no safety relevant event goes undetected. Low level events and near misses should be reported and reviewed thoroughly as potential precursors to degraded safety performance. Abnormal events important to safety should be investigated in depth to establish their direct and root causes. Methods of human performance analysis should be used to investigate human performance related events. The investigation should result in clear recommendations to plant management, which should take appropriate corrective action without undue delay to prevent recurrence.

6.65. Similarly, the operating organization should obtain and evaluate information on operating experience at other plants that provides lessons for the operation of its own plant. To this end, the exchange of experience and its contribution to national and international organizations should be considered to be of paramount importance.

6.66. Operating experience should be carefully examined by designated competent persons to detect any precursor signs of possible tendencies adverse to safety, so that corrective action can be taken before serious conditions arise. Trending should identify recurring similar events and continued problems based on the causes and initiators of previous events. Event trend reviews and conclusive interpretations should be provided periodically to the plant manager and to the management of the operating organization.

6.67. The responsibilities, qualification criteria and training requirements of personnel performing activities to review operating experience should be clearly defined. Personnel who conduct investigations of abnormal events should be provided with training in investigative root cause analysis techniques such as accident investigation, human factor analysis (including organizational factors), management oversight and risk tree analysis, change analysis and barrier analysis. Event investigators should be knowledgeable of plant design, procedures and operations.

6.68. All plant personnel should be encouraged to report all events and near misses relevant to the safety of the plant. All plant personnel should be given the opportunity to report all events and near misses. It is the responsibility of plant management to review and respond to these submissions in a timely and confidential manner.

6.69. Where applicable, lessons learned from industry and in-house experience should be transmitted to the training department as soon as possible for determination

of the type of training to be implemented to most effectively communicate the lessons learned.

6.70. Data from operating experience should be collected and retained for use as input to residual life evaluation, probabilistic safety assessment and periodic safety review.

6.71. Detailed guidance on establishing the operating experience feedback system can be found in Ref. [22].

## PLANT MODIFICATIONS

6.72. The operating organization should establish a procedure to ensure the proper design, review, control and implementation of all permanent and temporary modifications. This procedure should ensure that the plant's design basis is maintained, limits and conditions are observed, and applicable codes and standards are met. A record of the review shall be made available to the regulatory body. The operating organization maintains responsibility for safety implications of the modification and for obtaining the appropriate review and approval by the regulatory body if required.

6.73. Requests for modification should be evaluated on the basis of their impact on plant safety and reliability, plant operation and performance, personnel safety and the fulfilment of regulatory requirements. Considerations should include the need for training upgrades and associated hardware.

6.74. Detailed guidance on the establishment and implementation of the plant modification programme can be found in Ref. [3].

## DOCUMENT CONTROL AND RECORDS

6.75. Documentation should be controlled in a consistent, compatible manner throughout the plant and the operating organization. This includes the preparation, change, review, approval, release and distribution of documentation. Lists and procedures for these functions should be prepared and controlled.

6.76. A records administration and documentation system should be established to ensure the appropriate keeping of all documents relevant to the safe and reliable operation of the plant, including design documents, commissioning documents, and

documents relating to the operational history of the plant as well as general and specific procedures. Particular care should be taken in order that, although all versions of each document are appropriately filed and kept as a reference, only the correct, up to date versions are available to the site personnel for day to day activity. Further guidance on the document control system can be found in Ref. [8], Safety Guide Q3.

## MANAGEMENT OF AGEING

6.77. Managing the safety aspects of nuclear power plant ageing requires implementation of effective programmes for the timely detection and mitigation of ageing degradation of plant structures, systems and components important to safety, so as to ensure their integrity and functional capability throughout the plant's service life.

6.78. The programme to manage the ageing process should contain, but is not limited to, such elements as:

- identification of the degradation processes that could adversely affect plant safety;
- identification of components that are susceptible to ageing degradation that could affect plant safety;
- adequate and current methods for the detection of ageing problems;
- appropriate records to enable the ageing process to be tracked;
- a methodology for corrective action in order to mitigate and/or remove ageing effects; and
- changes to the maintenance, testing, surveillance and in-service inspection programme to reflect the analysis of ageing test results.

More information on specific ageing management topics can be found in Refs [23, 24].

## DECOMMISSIONING

6.79. An outline decommissioning plan should normally be completed during the design phase of the nuclear power plant. This plan should be amended as necessary during the operation stage, on the basis of operating experience and the latest developments in decommissioning techniques. In implementing operational strategies, potential problems during decontamination should be taken into account. For example, consideration should be given to: replacing shielding that could become activated with material that is easier to decontaminate; minimizing the contamination

of structures and surfaces; segregating wastes of different categories; using protective coating; and containing contaminated materials.

6.80. Management should ensure that all decommissioning options are considered and that a decommissioning strategy is developed. Factors influencing all the options should be considered before a decision is taken on the final option. The overall decommissioning plan should cover all decommissioning phases of the nuclear power plant, from the start of decommissioning until the site and its adjacent areas are rendered fit for their anticipated use. To implement the strategy, a final decommissioning plan should be developed which should be made up of separate documents and should be produced in stages, with an overall plan and then more detailed plans for each decommissioning phase. Further guidance on decommissioning can be found in Ref. [25].

6.81. All important information associated with future decommissioning should be adequately recorded, categorized for retention and stored so that the information is retrievable for future use. More information on document control for decommissioning needs can be found in Ref. [8], Safety Guide Q14.

## **7. SUPPORTING FUNCTIONS**

### **GENERAL**

7.1. Certain services and facilities that are complementary to the functions for the direct operation of the nuclear power plant should be provided for the effective implementation of the management programmes and for ensuring safe operation of the plant. These are called ‘supporting functions’. The ‘services’ are the expertise and assistance made available to the plant management to support the operation of the nuclear power plant. The ‘facilities’ are the equipment and systems necessary for these services.

7.2. Depending on national practices and the extent of the nuclear power programme of an operating organization, these services and facilities may be provided either from within the organization or from outside sources, as appropriate. Whatever their source, they should be co-ordinated with the activities of the plant management and the arrangements should be sufficiently comprehensive to enable the management programmes to be implemented effectively.



7.3. Examples of areas or activities that should be taken into consideration in connection with the supporting services provided by the operating organization to a nuclear power plant should include, but are not limited to, the following:

- training of personnel;
- quality assurance;
- radiation protection and emergency preparedness;
- maintenance, surveillance and in-service inspection;
- waste management and environmental monitoring;
- safety review and assessment, including review of safety management;
- core management and fuel handling, including procurement arrangements; and
- major modifications.

7.4. The operating organization should arrange for the availability of personnel competent to undertake and/or sponsor independent assessments of design studies and development work for modifications on plant items important to safety. This service may be called on to provide assistance in the production of plant specifications, assessment of proposed designs and supervision of the engineering work.

7.5. Appropriate services should be provided by the operating organization to assist the plant management in such areas as probabilistic methods in safety assessment, maintenance, planning for surveillance and in-service inspection, organization for the human–technology interface and methodology for human performance analysis.

7.6. The operating organization should ensure that separate operation management programmes (see Section 6) are efficiently integrated to optimize the day to day operation of the plant. For co-ordinating activities to have a bearing on safety and to assist in the prevention or resolution of conflicts, this integration should be undertaken throughout the operating organization under the direction of a designated person.

## TRAINING SERVICES

7.7. In countries with limited educational or industrial infrastructure, special training should be fostered to achieve the required competence. The training of maintenance personnel may be augmented by periods of secondment to manufacturers' establishments or detachment to construction or commissioning crews.

7.8. When a new nuclear power plant becomes operational for the first time, some of the personnel will probably be inexperienced and a very resource intensive period

of staff training will be conducted. During this initial training period, the operating organization should provide additional support to the plant. The services offered by reactor vendors for the training of operators and by component manufacturers for the training of technicians and maintenance personnel should be used and may be supplemented by the services of research and development organizations and of consultant organizations offering training services.

7.9. In the long term, the operating organization should consider how it might influence the training and qualification system. It should establish good relations with local educational institutions and encourage the development of courses especially adapted to the needs of nuclear power plant operation.

7.10. In providing external services for training of the plant personnel, the operating organization should consider such resources as reactor vendors, manufacturers of the nuclear equipment, other nuclear utilities, consulting companies and international organizations. Training provided by external organizations should be evaluated to ensure that it meets the needs for the job and that its quality is consistent with the standards of the operating organization.

## QUALITY ASSURANCE SERVICES

7.11. Consideration should be given to the supporting services needed by the plant management to meet the recommendations of IAEA Safety Series No. 50-C/SG-Q: Quality Assurance for Safety in Nuclear Power Plants and Other Nuclear Installations [8].

7.12. The following activities should be undertaken in order to assist the plant management in obtaining uniformity of safety standards:

- assessing manufacturers' systems for the application of quality assurance at the plant;
- assessing the equipment being provided for nuclear power plant modification;
- ensuring that equipment delivered is of the specified quality;
- providing a pre-commissioning inspection service for new systems and new equipment installed on the site;
- arranging for training and, where appropriate, certifying the competence of personnel for specialized crafts and inspection techniques;
- developing and maintaining quality standards, common purchasing specifications and classification codes for systems, components and materials;

- verifying that the quality assurance programme has been implemented satisfactorily, which should include verifying co-ordination of on-site and off-site activities; and
- making available suitably qualified staff to undertake the safety analysis and review activities mentioned in paras 6.46–6.50.

For an operating organization which controls more than one nuclear power plant, these activities may be performed by centralized services.

7.13. Special arrangements should be made for commissioning and operational records, including their long term storage in accordance with the specifications provided in Ref. [8], Safety Guide Q3. Consideration should be given to the services needed for modernization of the documentation and records control system on the basis of advanced computer techniques.

## RADIATION PROTECTION SERVICES

7.14. The requirements and recommendations for radiation protection and radioactive waste management in a nuclear power plant are established in Refs [17, 18]. The extent to which these services should be augmented from off-site resources should be considered. As a minimum, suitably qualified personnel should be made available to carry out an independent review of the activities of radiological services provided at the plant.

7.15. Appropriate specialist services should be provided to give advice and technical support on:

- specification of radiological laboratories for monitoring personnel and the environment;
- radiological aspects of commissioning and operation, including emergency arrangements;
- evaluation of operating experience in the radiological area;
- radiological aspects of plant modifications;
- development of techniques and equipment to reduce personnel doses; and
- compliance with statutory requirements and methods of ensuring satisfactory evidence of compliance with these requirements in relation to: authorization to discharge radioactive effluents, transport of radioactive material and on-site management of contaminated waste (e.g. by incineration).

7.16. The operating organization, which is responsible for a number of plants and which utilizes mobile teams of personnel for certain functions, should control individual

exposure using a central record-keeping system. Similar requirements should be applied if services of contractors or other outside agencies are utilized extensively.

7.17. Suitable medical advice and appropriate bioassay facilities should be made available so that appropriate medical examinations of personnel employed in the process can be performed and advice on specific radiological medical problems can be provided. Stand-by provision of hospital services should be arranged to cover the possibility that medical assistance involving radiological factors may be required. The operating organization should utilize the services of a physician who has undergone specialized training and who is authorized by the competent authority to advise on and supervise the medical examinations and treatment of any person involved in a radiation accident.

#### MAINTENANCE, SURVEILLANCE AND IN-SERVICE INSPECTION SERVICES

7.18. A routine maintenance service should be provided to meet the requirements of the maintenance schedule, maintenance instructions and the surveillance programme. Maintenance services should provide the expertise for the independent assessment of maintenance aspects of new designs and of plant modifications during service. The extent to which this is provided from on-site or off-site sources is largely a matter of the operating organization's policy. However, the personnel of any maintenance team should possess the required standard of skills and should receive the appropriate training in radiation protection and quality assurance.

7.19. If the central off-site workshop is used for maintenance of large components, the operating organization should ensure that the same quality assurance requirements are applied at such a facility as at the nuclear power plants. Reactor components shipped to a central facility may need more stringent standards of decontamination and, when such components are dismantled, appropriate off-site radiological controls should be provided.

7.20. The surveillance programme may require the provision of a service for calibrating instruments in accordance with the details given in Ref. [12].

7.21. As the in-service inspection workload tends to be of a periodic nature, this service may be provided either centrally or by outside agencies. If uniform standards are to be achieved to the satisfaction of the plant management and the regulatory body, then any non-destructive testing should be accompanied by the most meticulous specification of the tasks, appropriate training of staff and careful calibration of

equipment. Consideration should also be given to achieving uniformity in pre-service and in-service inspection standards.

7.22. When deciding whether special equipment for inspecting primary coolant boundary and reactor internals should be retained on the site or provided from sources off the site, due consideration should be given to the decontamination requirements for off-site transport.

7.23. Qualification services for in-service inspection systems may be required to verify that a proposed non-destructive testing method, technique or procedure and associated equipment are adequate for their purpose and that the inspection personnel is able to perform the assigned inspection duties. Any organization providing qualification services should be independent from any commercial or operational consideration. If the qualification bodies are part of the operating organization, they should satisfy specific independence criteria equivalent to those laid down in the appropriate international standards (e.g. EN 45004 for a type B inspection body).

7.24. Arrangements should also be made in order for services and facilities to maintain an appropriate and adequate inventory of stores and consumables, particularly items important to safety. Storage facilities should comply with requirements for quality assurance and environmental qualification (see Ref. [8], Safety Guide Q13).

7.25. The planning of generation and transmission outages should be co-ordinated to ensure diversity of electrical supplies on the site and to satisfy the special safety requirements of a nuclear power plant. In addition, the load dispatch control of the system in which the nuclear power plant operates should conform to an operational regime for the plant that takes into account any restrictions on startup and rate of loading that arise from fuel or temperature limitations.

## **8. COMMUNICATION AND LIAISON**

### **COMMUNICATION**

8.1. Management of the operating organization at all levels should encourage and cultivate effective communication. Downward communication should provide assurance that management's direction and expectations are understood; upward communication should help encourage the identification of problems directly to

management; horizontal communication should support effective work co-ordination and collaboration.

8.2. An effective communication system should be in place in order to explain safety policy and implement an effective safety management system. There needs to be good open communication about safety throughout the organization. Individuals should be led to understand and accept why particular standards of safety are required. A communication system can be both formal or informal, depending on the importance of the information provided. A good communication system should be in place to reinforce teamwork. In particular, there should be communication between shifts both in normal operation and in emergencies. Horizontal communication should be reinforced to encourage open lines of communication between interacting groups that work together to perform specific functions.

8.3. Appropriate arrangements should be established to promote feedback from individuals on safety concerns. These could include both formal mechanisms such as safety meetings and informal mechanisms such as feedback to line managers. The organization should be open and responsive to feedback received from individuals, to avoid inhibiting effective communication. Management should be responsive to constructive criticism and feedback from the plant staff.

8.4. In addition to good communications within the organization, good communications should be established with outside organizations. In particular, there should be well defined and open routes of communication with regulatory bodies (see also paras 4.1–4.4). Outside communication should also recognize the broader social framework within which the organization operates, including the maintenance of a constructive dialogue with trade unions and other groups affected by the activities of the operating organization and their representatives.

8.5. Appropriate arrangements should be in place to monitor the effectiveness of communications and to act promptly to eliminate identified weaknesses.

8.6. To meet the management objectives and to discharge the responsibilities given in Section 3, an appropriate system of information flow should be established between participating organizations. Particular attention should be placed on establishing channels to ensure that:

- general safety principles and policies relevant to operation are taken into account in the design, construction, commissioning and operation stages, including decommissioning;

- there is adequate feedback of operation, maintenance and surveillance experience, particularly to design and operating personnel; and
- requisite information is provided to the regulatory body and arrangements are made for appropriate dissemination of its requirements within the operating organization.

## LIAISON

8.7. An operating organization should ensure that an appropriate liaison is established between all parties involved in the design, construction, commissioning and operation of a nuclear power plant.

8.8. Arrangements should be made for the participation of operating organization personnel in the design and design review processes early in the design stage. These arrangements should enable the operating organization personnel to make a contribution to improvements in the plant design by way of feedback of operating experience. At the same time they should provide an opportunity for the personnel to acquire a knowledge in depth of the plant design and a thorough understanding of the operational limits and conditions for operation. The operating personnel should be given the opportunity to consider the following:

- (1) the adequacy of redundancy of systems and components to meet operational limits and conditions and other operational requirements;
- (2) the general layout as regards the convenience and efficiency of operation, particularly in relation to contamination control and to keeping doses ALARA;
- (3) ergonomic aspects, especially to provide for rapid assessment of plant conditions, proper operator response and prevention of inadvertent actions;
- (4) the extent of automatic control;
- (5) specifications concerning components, and instrumentation for operational states and accident conditions;
- (6) radioactive waste handling and disposal, including provision for post-accident conditions;
- (7) the type and number of spare parts, taking account of procurement times;
- (8) provision of special tooling necessary for repairs and inspection;
- (9) requirements for maintenance, surveillance and in-service inspection, including access to and availability of equipment and facilities;
- (10) radiation protection arrangements to fulfil the ALARA principle and statutory requirements; and
- (11) assessment of on-site and off-site consequences of postulated accident conditions and post-accident conditions.

8.9. The construction phase can provide experience and useful information for future operational activities, including maintenance and surveillance. Therefore, the operating organization should arrange for the involvement of its staff, particularly of its maintenance personnel, in construction activities so that they undergo hands-on training in complex operations requiring special skills. This participation may not only help in detecting any discrepancies between approved specifications and the methods and techniques actually used during construction before they can endanger safety, but it should also assist in the development of operating and maintenance instructions and in the transfer of all requisite 'as built' documentation.

8.10. Although operating personnel generally participate in the operation of the plant during the commissioning period, it is advantageous for them to have more direct involvement in commissioning. The operating organization should consider the advantages of its operating personnel participating in test preparation and performance and evaluation of test results, as this would enable them to validate the operating procedures and at the same time to obtain the preliminary operating experience needed to facilitate the transfer of responsibilities from the commissioning to the operating groups. Such participation may vary from the setting up of mixed testing teams (supplier/operating personnel) to the complete involvement of the operating organization in a given test, according to the operating organization's policy. Detailed recommendations and guidance on the involvement of operating personnel in testing are given in Ref. [10].

8.11. Liaison during the operational stage should be established to provide feedback of experience to the various groups in the operating organization, design organization, architect/engineer organization, research services and the regulatory body, as appropriate. This liaison should thereby lead to improvements in the operational aspects of design, in the operating procedures and in the planning of research programmes so that they are relevant to the operational needs of the plant. This system should also ensure the collection and evaluation of information from other operating plants on any unresolved safety questions, maintenance problems, incident and accident conditions, and component and system behaviour. Such a system may include the use of national or international information services such as data banks.



## REFERENCES

- [1] INTERNATIONAL ATOMIC ENERGY AGENCY, Safety of Nuclear Power Plants: Operation, Safety Standards Series No. NS-R-2, IAEA, Vienna (2000).
- [2] INTERNATIONAL ATOMIC ENERGY AGENCY, Legal and Governmental Infrastructure for Nuclear, Radiation, Radioactive Waste and Transport Safety, Safety Standards Series No. GS-R-1, IAEA, Vienna (2000).
- [3] INTERNATIONAL ATOMIC ENERGY AGENCY, Modifications to Nuclear Power Plants, Safety Standards Series No. NS-G-2.3, IAEA, Vienna (2001).
- [4] INTERNATIONAL ATOMIC ENERGY AGENCY, OECD NUCLEAR ENERGY AGENCY, The International Nuclear Event Scale (INES), User's Manual, 2001 edition, IAEA, Vienna (2001).
- [5] INTERNATIONAL NUCLEAR SAFETY ADVISORY GROUP, Management of Operational Safety in Nuclear Power Plants, INSAG-13, IAEA, Vienna (1999).
- [6] INTERNATIONAL ATOMIC ENERGY AGENCY, Operational Limits and Conditions and Operating Procedures for Nuclear Power Plants, Safety Standards Series No. NS-G-2.2, IAEA, Vienna (2000).
- [7] INTERNATIONAL ATOMIC ENERGY AGENCY, Operational Safety Performance Indicators for Nuclear Power Plants, IAEA-TECDOC-1141, IAEA, Vienna (2000).
- [8] INTERNATIONAL ATOMIC ENERGY AGENCY, Quality Assurance for Safety in Nuclear Power Plants and Other Nuclear Installations, Safety Series No. 50-C/SG-Q, IAEA, Vienna (1996).
- [9] INTERNATIONAL ATOMIC ENERGY AGENCY, Staffing of Nuclear Power Plants and the Recruitment, Training and Authorization of Operating Personnel, Safety Series No. 50-SG-O1 (Rev. 1), IAEA, Vienna (1991).
- [10] INTERNATIONAL ATOMIC ENERGY AGENCY, Commissioning Procedures for Nuclear Power Plants, Safety Series No. 50-SG-O4, IAEA, Vienna (1980).
- [11] INTERNATIONAL ATOMIC ENERGY AGENCY, Maintenance of Nuclear Power Plants, Safety Series No. 50-SG-O7 (Rev. 1), IAEA, Vienna (1990).
- [12] INTERNATIONAL ATOMIC ENERGY AGENCY, Surveillance of Items Important to Safety in Nuclear Power Plants, Safety Series No. 50-SG-O8 (Rev. 1), IAEA, Vienna (1990).
- [13] INTERNATIONAL ATOMIC ENERGY AGENCY, Core Management and Fuel Handling in Nuclear Power Plants, Safety Standards Series No. NS-G-2.5, IAEA, Vienna (in preparation).
- [14] INTERNATIONAL ATOMIC ENERGY AGENCY, Self-assessment of Operational Safety for Nuclear Power Plants, IAEA-TECDOC-1125, IAEA, Vienna (1999).
- [15] INTERNATIONAL ATOMIC ENERGY AGENCY, Periodic Safety Review of Operational Nuclear Power Plants, Safety Series No. 50-SG-O12, IAEA, Vienna (1994).
- [16] INTERNATIONAL ATOMIC ENERGY AGENCY, The Physical Protection of Nuclear Material and Nuclear Facilities, INFCIRC/225/Rev.4 (Corrected), IAEA, Vienna (1999).
- [17] FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, INTERNATIONAL ATOMIC ENERGY AGENCY, INTERNATIONAL LABOUR ORGANISATION, OECD NUCLEAR ENERGY AGENCY, PAN AMERICAN

- HEALTH ORGANIZATION, WORLD HEALTH ORGANIZATION, International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources, Safety Series No. 115, IAEA, Vienna (1996).
- [18] INTERNATIONAL ATOMIC ENERGY AGENCY, INTERNATIONAL LABOUR ORGANISATION, Occupational Radiation Protection, Safety Standards Series No. RS-G-1.1, IAEA, Vienna (in preparation).
- [19] INTERNATIONAL ATOMIC ENERGY AGENCY, Convention on Early Notification of a Nuclear Accident and Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency, Legal Series No. 14, IAEA, Vienna (1987).
- [20] INTERNATIONAL ATOMIC ENERGY AGENCY, Preparedness and Response for a Nuclear or Radiological Emergency, Safety Standards Series No. GS-R-2, IAEA, Vienna (in preparation).
- [21] INTERNATIONAL ATOMIC ENERGY AGENCY, Fire Safety in the Operation of Nuclear Power Plants, Safety Standards Series No. NS-G-2.1, IAEA, Vienna (2000).
- [22] INTERNATIONAL ATOMIC ENERGY AGENCY, Systems for Reporting Unusual Events in Nuclear Power Plants, Safety Series No. 93, IAEA, Vienna (1989).
- [23] INTERNATIONAL ATOMIC ENERGY AGENCY, Methodology for the Management of Ageing of Nuclear Power Plant Components Important to Safety, Technical Reports Series No. 338, IAEA, Vienna (1992).
- [24] INTERNATIONAL ATOMIC ENERGY AGENCY, Data Collection and Record Keeping for the Management of Nuclear Power Plant Ageing, Safety Series No. 50-P-3, IAEA, Vienna (1992).
- [25] INTERNATIONAL ATOMIC ENERGY AGENCY, Decommissioning of Nuclear Power Plants and Research Reactors, Safety Standards Series No. WS-G-2.1, IAEA, Vienna (1999).

## GLOSSARY

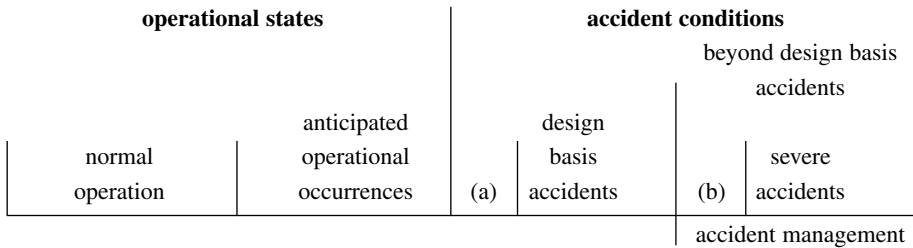
**commissioning.** The process during which systems and components of a nuclear power plant, having been constructed, are made operational and verified to be in accordance with design and to have met the required performance criteria. Commissioning may include both non-nuclear and nuclear testing.

**operating organization.** The organization authorized by the regulatory body to operate a facility.

**operation.** All activities performed to achieve the purpose for which a facility was constructed. For a nuclear power plant, this includes maintenance, refuelling, in-service inspection and other associated activities.

**operational limits and conditions.** A set of rules setting forth parameter limits, the functional capability and the performance levels of equipment and personnel approved by the regulatory body for safe operation of an authorized facility.

### plant states



(a): Accident conditions which are not explicitly considered design basis accidents but are encompassed by them.

(b): Beyond design basis accidents without significant core degradation.

**accident conditions.** Deviations from normal operation more severe than anticipated operational occurrences, including design basis accidents and severe accidents.

**accident management.** The taking of a set of actions during the evolution of a beyond design basis accident:

- to prevent the escalation of the event into a severe accident;
- to mitigate the consequences of a severe accident; and
- to achieve a long term safe stable state.

**anticipated operational occurrence.** An operational process deviating from normal operation which is expected to occur at least once during the operating lifetime of a facility but which, in view of appropriate design provisions, does not cause any significant damage to items important to safety or lead to accident conditions.

**design basis accident.** Accident conditions against which a nuclear power plant is designed according to established design criteria, and for which the damage to the fuel and the release of radioactive material are kept within authorized limits.

**normal operation.** Operation within specified operational limits and conditions.

**operational states.** States defined under normal operation and anticipated operational occurrences.

**severe accident.** Accident conditions more severe than a design basis accident and involving significant core degradation.

**regulatory body.** An authority or a system of authorities designated by the government of a State as having legal authority for conducting the regulatory process, including issuing authorizations, and thereby regulating nuclear, radiation, radioactive waste and transport safety. The national competent authority for the regulation of radioactive material transport safety is included in this description, as is the Regulatory Authority for radiation protection and safety.

## CONTRIBUTORS TO DRAFTING AND REVIEW

Moir, I.	Scottish Nuclear Limited, United Kingdom
Vlček, J.	Dukovany Nuclear Power Plant, Czech Republic
Sacher, H.	TÜV Energie- und Systemtechnik GmbH, Germany
Taylor, R.	International Atomic Energy Agency
Vaišnys, P.	International Atomic Energy Agency

## **BODIES FOR THE ENDORSEMENT OF SAFETY STANDARDS**

### **Nuclear Safety Standards Committee**

*Argentina:* Sajaroff, P.; *Belgium:* Govaerts, P. (Chair); *Brazil:* Salati de Almeida, I.P.; *Canada:* Malek, I.; *China:* Zhao, Y.; *Finland:* Reiman, L.; *France:* Saint Raymond, P.; *Germany:* Wendling, R.D.; *India:* Venkat Raj, V.; *Italy:* Del Nero, G.; *Japan:* Hirano, M.; *Republic of Korea:* Lee, J.-I.; *Mexico:* Delgado Guardado, J.L.; *Netherlands:* de Munk, P.; *Pakistan:* Hashimi, J.A.; *Russian Federation:* Baklushin, R.P.; *Spain:* Lequerica, I.; *Sweden:* Jende, E.; *Switzerland:* Aeberli, W.; *Ukraine:* Mikolaichuk, O.; *United Kingdom:* Hall, A.; *United States of America:* Murphy, J.; *IAEA:* Hughes, P. (Co-ordinator); *European Commission:* Gómez-Gómez, J.A.; *International Organization for Standardization:* d'Ardenne, W.; *OECD Nuclear Energy Agency:* Royen, J.

### **Commission for Safety Standards**

*Argentina:* D'Amato, E.; *Brazil:* Caubit da Silva, A.; *Canada:* Bishop, A., Duncan, R.M.; *China:* Zhao, C.; *France:* Lacoste, A.-C., Gauvain, J.; *Germany:* Renneberg, W., Wendling, R.D.; *India:* Sukhatme, S.P.; *Japan:* Suda, N.; *Republic of Korea:* Kim, S.-J.; *Russian Federation:* Vishnevskij, Yu.G.; *Spain:* Martin Marquínez, A.; *Sweden:* Holm, L.-E.; *Switzerland:* Jeschki, W.; *Ukraine:* Smyshlayaev, O.Y.; *United Kingdom:* Williams, L.G. (Chair), Pape, R.; *United States of America:* Travers, W.D.; *IAEA:* Karbassioun, A. (Co-ordinator); *International Commission on Radiological Protection:* Clarke, R.H.; *OECD Nuclear Energy Agency:* Shimomura, K.