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**American National Standard**  
**Administrative Controls and**  
**Quality Assurance for the Operational Phase**  
**of Nuclear Power Plants**  
**Revision of N18.7-1972**

Secretariat  
American Nuclear Society

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# Foreword

(This Foreword is not a part of American National Standard Administrative Controls and Quality Assurance for the Operational Phase of Nuclear Power Plants, N18.7-1976/ANS-3.2)

Preparation of the first edition of this Standard commenced in 1969 prior to the establishment of formal quality assurance requirements for the operation of nuclear power plants. Historically, the administrative controls section of Facility Operating License Technical Specifications had contained provisions for meeting many of the requirements that subsequently became identified with quality assurance for operation. It was the original intent of the Standard to define administrative controls for this purpose. The Standard was completed during a period when the subject of quality assurance was becoming of increasing interest to the nuclear community. The membership of the Subcommittee that developed American National Standard, Administrative Controls and Quality Assurance for the Operational Phase of Nuclear Power Plants N18.7-1972 is strongly oriented toward power reactor operation, and developed a document aimed at providing guidance for administrative controls over activities associated with the operation of nuclear power plants. At the same time Subcommittee N45.2, "Nuclear Quality Assurance Standards," of the American National Standards Committee N45, "Reactor Plants and Their Maintenance," was developing quality assurance standards related to design, construction, maintenance, and modification of nuclear power plant structures, systems, and components.

When N18.7-1972 was approved and issued, the U.S. Nuclear Regulatory Commission (NRC) issued its Safety Guide 33 (now Regulatory Guide 1.33) "Quality Assurance Program Requirements (Operation)," endorsing Draft 8 of ANS 3.2 (which later became ANSI N18.7-1972) and American National Standard N45.2-1971, "Quality Assurance Program Requirements for Nuclear Power Plants." This dual endorsement caused some confusion among users and the Executive Committee of the ANSI Nuclear Technical Advisory Board (now Nuclear Standards Management Board) directed that an ad hoc Task Force, comprising ANS-3 and a representative of ANSI N45.2 Subcommittees, attempt to develop a single standard that could stand alone in defining "Quality Assurance Program Requirements (Operation)." This Standard is the result of that effort.

Increased effort is being made within the standards-writing community to provide better coordination of quality assurance related standards. In particular, preparation and revision of general standards involving the various phases of a plant (design, procurement, construction and operation) should benefit from this effort in the future.

During the development of N18.7-1976, particularly as a result of reviewers' comments, it became clear to the Task Force that a lack of common understanding of several terms used in the wide variety of documents prepared by these two standards-writing bodies existed. The present revision of N18.7-1972 attempts to better clarify terminology and practices that are often confused. In addition, this Foreword has been expanded substantially to assist reviewers and users to understand the interrelationships of terminology applied by the Task Force in the preparation of the Standard.

Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," 10 CFR 50 defines the term "quality assurance" as "... all those planned and systematic activities necessary to provide adequate confidence that a structure, system, or component will perform satisfactorily in service." Inherent in this definition is recognition of the fact that quality assurance encompasses activities associated with doing a job correctly as well as verifying and documenting the satisfactory progress and completion of the work. The performance of work is itself the most fundamental aspect of quality assurance in its broadest sense.

On the other hand, the term quality assurance also has been frequently, and quite properly, used to describe the programs, the technical discipline and the organizational unit established to implement special procedural steps to verify and document the satisfactory completion of work. In this context, the term quality assurance (as a technical specialty or as a formal organization) describes a staff support function to

assist in the overall goal of the high quality performance of equipment, structures, procedures and personnel.

Historically, quality assurance as an accepted discipline has been associated with manufacturing and construction activities from which it originated as a separate function. It is identified most clearly with systems of checks, audits, inspections, and other forms of verification that can be applied to products that can be examined at various stages of manufacture or construction before they are placed in service; and with the documentation needed to show conformance to requirements and to perform investigations in the event of subsequent malfunction of those products. The nature of manufacturing or construction activities is such that time usually is available or can be taken to perform verification without affecting the quality of the product or activity.

In contrast to potential effects of deficiencies in manufacturing and construction, deficiencies in operating activities can be much more immediate in their effect. For example, it is important that the dynamic aspects of operation be monitored on an essentially continuous basis. Instrumentation for monitoring, control and actuation of safety systems, and observations by and response from the operating staff are both extensively used for this purpose in nuclear power plants. In a nuclear power plant employing proper administrative controls and quality assurance practices, the critical appraisal by supervisory personnel of plant operating evolutions, trends in parameters, maintenance, and day-to-day work practices, is the most significant portion of assuring the quality of plant operation (in the broad sense of the term "quality assurance"), whereas quality assurance (as a technical discipline or an organizational unit) of operating activities is associated principally with checking the adequacy and completeness of work after it is completed. This revision emphasizes that both operating staff and personnel performing other quality assurance functions have important roles in the ". . . planned and systematic activities . . ." specified in the Appendix B definition of quality.

After the initial start-up period of a nuclear power plant, most of the time of the operating staff is spent in operating the plant and in performing routine maintenance activities and surveillance requirements. Nevertheless, certain activities occurring during the operational phase of plant life, including start-up, are more correctly associated with design and construction activities than with operating activities. The quality assurance effort applied to design and construction activities occurring during the operational phase of plant life (e.g., design changes, equipment modifications and certain major maintenance tasks) must be comparable in nature and degree to that normally applied to design and construction occurring before the plant is placed in service.

The Task Force recognizes that it is sometimes difficult to draw a distinction between certain functions normally considered to be operating activities (e.g., routine maintenance) and those considered to be design and construction activities (e.g., nonroutine maintenance and modifications). This revision of N18.7-1972 provides guidance on this subject, but does not give rigid rules for distinguishing between them.

The Task Force devoted considerable effort to defining the manner in which review, inspection, and audit should be carried out as they apply to operational phase activities (Criteria I, X, and XVIII of Appendix B, 10 CFR 50). Review and audit program requirements are given in Section 4.0 of the Standard and include the use of either standing committees or preferably the use of separate established organizational units independent of the onsite operating organization. In either case, the personnel performing independent review are required to collectively possess the range of technical competence (including knowledge in quality assurance practices) necessary to assess the overall safety of operating phase activities.

With respect to inspection of operating activities (work functions associated with normal operation of the plant, routine maintenance and certain technical services routinely assigned to the onsite operating organization), the Task Force has followed

the historic practice in the power generation industry in Section 4.4 of the Standard. This section requires that the "inspection of activities affecting quality . . . to verify conformance with the documented instructions, procedures, and drawings for accomplishing the activity" (Criterion X of Appendix B, 10 CFR 50) be carried out by second-line supervisory personnel or by other qualified personnel not assigned first-line supervisory responsibility for conduct of the work. For modifications and nonroutine maintenance, inspections are to be conducted in a manner similar (frequency, type, and personnel performing such inspections) to that associated with construction phase activities (see also Section 5.2.7).

Section 5.2.7 of the Standard imposes inspection and performance testing requirements commensurate with the nature and extent of the maintenance or modification activity. For example, a large modification effort involving the installation of a new plant system or a major repair effort using offsite construction forces would ordinarily require an approach to inspection and performance testing prior to operation of the modified or repaired system similar to that used during original construction. On the other hand, small modifications made by the onsite operating organization (which may be equally important from a safety point of view) would ordinarily be performed using the same type of inspections and performance testing that is applied to routine maintenance. In either case, maintenance and modifications affecting the functioning of safety related structures, systems, and components must be "performed in a manner to assure quality at least equivalent to that specified in the original design bases and requirements, material specifications and inspection requirements." Further, all safety related maintenance and modification work is subject to audit and independent review as prescribed by Section 4.0 of this Standard.

This published version cites several ANSI approved standards. It is the intent of the Subcommittee to review periodically the status of other related standards and to include citations to these standards as they are published in subsequent revisions to this Standard. It is also the intent of the Subcommittee to provide additional guidance in the area of administrative controls and quality assurance for operations in any matters in which this or other standards are found to be inadequate as determined by experience.

In addition to citation of other standards, this revision of N18.7-1972 has made liberal use of wording used in other standards. In some cases applicable sections of other standards have been used verbatim; in others, portions have been paraphrased to indicate more precisely the applicability of the extracted sections to operating activities. For example, Sections 5.2.13.1, 5.2.13.3, 5.2.13.4, and 5.2.14 contain significant material or direct extracts from ANSI N45.2.

Appended to this Foreword is a chart showing the comparison of 10 CFR 50 Appendix B criteria and N45.2 requirements with the corresponding section and page of this Standard.

This revised Standard was prepared by Subcommittee ANS-3, Reactor Operations, of the American Nuclear Society Standards Committee. At the time of the revision, the membership of the Subcommittee was:

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**COMPARISON CHART OF 10 CFR 50 APPENDIX B AND N45.2-1971 REQUIREMENTS VERSUS  
N18.7-1976 REQUIREMENTS**

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I	1.3	1	1	3.1	3	
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XII	13.	—	—	5.2.16	16	Refs. ANSI N45.2.4
XIII	14.	—	—	5.2.13.4	15	Refs. ANSI N45.2.2
XIV	15.	1	1,2	5.2.6	10	
XIV	15.	1	3	5.2.14	15	
XIV	15.	2	1,2	5.2.6	10	
XIV	15.	3	—	5.2.6	10	
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XVII	18.	—	—	5.2.12	13	Refs. ANSI N45.2.9
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# Administrative Controls and Quality Assurance for the Operational Phase of Nuclear Power Plants

## 1. Scope

This Standard provides requirements and recommendations for an administrative controls and quality assurance program necessary to provide assurance that operational phase activities at nuclear power plants are carried out without undue risk to the health and safety of the public. The requirements of this Standard apply to all activities affecting the safety-related functions of nuclear power plant structures, systems, and components. It is not intended to apply to test mobile and experimental reactors nor reactors not subject to U.S. Nuclear Regulatory Commission licensing. However, applicable sections of this Standard should be used as they apply to related activities. Activities included are: design changes, purchasing, fabricating, handling, shipping, storing, cleaning, erecting, installing, inspecting, testing, operating, maintaining, repairing, refueling and modifying.

It is recommended that the administrative controls and quality assurance provisions of this Standard be applied to other important plant equipment at a level commensurate with the importance of the equipment to reliable and efficient plant operation. However, it is emphasized that this Standard is directed primarily toward administrative controls and quality assurance associated with safety-related activities, equipment and procedures.

This Standard incorporates criteria that permit a degree of flexibility, since administrative practices vary among organizations operating nuclear power plants.

The Nuclear Regulatory Commission (NRC) promulgates regulations applicable to many aspects of the design, construction and operation of nuclear power reactors. This Standard contains criteria for administrative controls and quality assurance for nuclear power plants during the operational phase of plant life. This phase is generally considered to commence with initial fuel loading, except for certain preoperational activities. Certain operating activities may commence prior to fuel loading and certain initial construction activities may extend past

fuel loading. Owner organizations should identify clearly those activities that fall in these overlapping time periods and should specify whether the activities are to be considered as operational or as construction activities.

This Standard is intended to be consistent with applicable criteria for quality assurance, including those given in Title 10, Code of Federal Regulations, Part 50, "Licensing of Production and Utilization Facilities," Appendix B. [1]<sup>1</sup> This Standard fully and completely describes the general requirements and guidelines of American National Standard Quality Assurance Program Requirements for Nuclear Power Plants, N45.2-1971, [2] as those requirements and guidelines apply during the operational phase of plant life.

## 2. Definitions

**2.1 Limitations.** The definitions given below are applicable specifically to this Standard. Other terms and their definitions are contained in American National Standard, Quality Assurance Terms and Definitions, N45.2.10 [3].

### 2.2 Glossary of Terms

**administrative controls.** Rules, orders, instructions, procedures, policies, practices and designations of authority and responsibility.

**audit.** A formal, independent examination with intent to verify conformance with established requirements.

**emergency procedures.** Written procedures which specify actions, including manipulation of plant controls, to reduce the consequence of an accident or potentially hazardous condition which has already occurred, to implement the emergency plan, or to prepare for possible hazardous natural occurrences.

**experiments.** Performance of those plant operations carried out under controlled conditions in order to establish characteristics or values not previously known.

<sup>1</sup>Numbers in brackets refer to corresponding numbers in Section 6, References.



**independent review.** Review completed by personnel not having direct responsibility for the work function under review regardless of whether they operate as a part of an organizational unit or as individual staff members (see review).

**inspection.** Examination, observation, or measurement to determine the conformance of materials, supplies, components, parts, appurtenances, systems, personnel performance, procedures, processes or structures to predetermined requirements.

**maintenance and modification procedures.** Written procedures defining the policies and practices by which structures; mechanical, electrical and instrumentation and control systems; and components thereof of a nuclear power plant are kept in a condition of good repair or efficiency so that they are capable of performing their intended functions. As used in this Standard, these procedures apply to those activities performed by maintenance or contractor personnel to maintain, repair or modify safety-related equipment. Related activities are those actions taken by operating personnel to determine that a planned maintenance activity can be safely performed under the existing plant operating conditions, to authorize the release of equipment to be maintained in accordance with equipment control procedures, and to assure that the equipment has been returned to normal operating status at the completion of the maintenance work including verification of functional acceptability. Procedures for these related activities by operating personnel are considered to be operating procedures, but may be included in maintenance procedures.

**nuclear power plant.** Any plant using a nuclear reactor to produce electric power, process steam or space heating.

**off-normal condition procedures.** Written procedures which specify operator actions for restoring an operating variable to its normal controlled value when it departs from its range or to restore normal operating conditions following a perturbation. Such actions are invoked following an operator observation or an annunciator alarm indicating a condition which, if not corrected, could degenerate into a condition requiring action under an emergency procedure.

**onsite operating organization.** Onsite personnel concerned with operation, maintenance and certain technical services.

**operating activities.** Work functions associated with normal operation and maintenance of the plant, and technical services routinely assigned to the onsite operating organization.

**operating procedures.** Written procedures defining the normal method, means and limits of operation of a nuclear power plant, a plant system or systems, or processes, including actions to be taken by operating personnel for removal from and return to service equipment on which maintenance is to be or has been performed (see also maintenance and modification procedures).

**operational phase.** That period of time during which the principal activity is associated with normal operation of the plant. This phase of plant life is considered to begin formally with commencement of fuel loading, and ends with plant decommissioning.

**owner organization.** The organization, including the onsite operating organization, which has overall legal, financial and technical responsibility for the operation of one or more nuclear power plants.

**quality assurance.** All those planned and systematic actions necessary to provide assurance that a structure, system or component will perform satisfactorily in service. It applies to all activities associated with doing a job correctly as well as verifying and documenting the satisfactory completion of the work.

**review.** A deliberately critical examination, including observation of plant operation, evaluation of audit results, procedures, certain contemplated actions, and after-the-fact investigations of abnormal conditions (see independent review).

**shall, should and may.** The word "shall" is used to denote a requirement; the word "should" to denote a recommendation; and the word "may," to denote permission, neither a requirement nor a recommendation.

**supervision.** Direction of personnel activities or monitoring of plant functions by an individual responsible and accountable for the activities he directs or monitors.

**surveillance testing.** Periodic testing to verify

that safety-related structures, systems and components continue to function or are in a state of readiness to perform their functions.

**system.** An integral part of a nuclear power plant comprising components which may be operated or used as a separate entity to perform a specific function.

**testing.** Performance of those steps necessary to determine that systems or components function in accordance with predetermined specifications.

### 3. Owner Organization

**3.1 General.** The owner organization shall establish an administrative controls and quality assurance program which complies with this Standard. The program shall be in effect at all times during the operational phase to assure that operational phase activities are carried out without undue risk to the health and safety of the public. The program shall require that decisions affecting safety are made at the proper level of responsibility and with the necessary technical advice and review. The owner organization may delegate to other organizations the work of establishing and executing the administrative controls and quality assurance program or any part thereof, in accordance with this Standard, but shall retain responsibility therefor.

**3.2 Assignment of Authority and Responsibility.** It is essential that all members of the organization involved in operation of nuclear power plants, including those at the highest management levels, recognize the necessity that the plants be operated under a well formulated and detailed administrative controls and quality assurance program to assure safety and efficiency. Lines of authority, responsibility and communication shall be established from the highest management level through intermediate levels to and including the onsite operating organization (including those offsite organizational units assigned responsibility for procurement, design and construction, quality assurance, and technical support activities). These relationships shall be documented and updated, as appropriate, in the form of organizational charts, functional descriptions of de-

partmental responsibilities and relationships and job descriptions for key personnel positions or in equivalent forms of documentation.

The owner organization shall specify in writing the authority and responsibility assigned to individuals and organizations involved in establishing, executing and measuring the overall effectiveness of the administrative controls and quality assurance program required by this Standard.

The persons or organizations responsible for defining and measuring the overall effectiveness of the program shall be designated, shall be sufficiently independent from cost and scheduling considerations when opposed to safety considerations, shall have direct access to responsible management at a level where appropriate action can be accomplished, and shall report regularly on the effectiveness of the program to the plant manager and the cognizant offsite management.

Persons or organizations performing functions of assuring that the administrative controls and quality assurance program is established and implemented or of assuring that an activity has been correctly performed shall have sufficient authority and organizational freedom to: identify quality problems; initiate, recommend or provide solutions, through designated channels; and verify implementation of solutions.

The organizational structure and the functional responsibility assignments shall be such that:

(1) Attainment of program objectives is accomplished by those who have been assigned responsibility for performing work. This may include interim examinations, checks, and inspections of the work by the individual performing the work.

(2) Verification of conformance to established program requirements is accomplished by a qualified person who does not have responsibility for performing or directly supervising the work. The method and extent of such verification shall be commensurate with the importance of the activity to plant safety and reliability.

In structuring the organization and assigning responsibility, quality assurance should be recognized as an interdisciplinary function involving many organizational components and, therefore, should not be regarded as the sole domain of a single quality assurance group. For

example, it may be more appropriate for nuclear engineers to perform reviews of plant nuclear engineering activities rather than quality assurance engineers because of the special competence required to perform these reviews. Quality assurance encompasses many functions and activities and extends to various levels in all participating organizations, from the top executive to all workers whose activities may influence quality.

**3.3 Indoctrination and Training.** Provisions shall be made for indoctrination and training of those personnel in the owner organization performing activities affecting quality to assure that suitable proficiency is achieved and maintained. Such personnel also shall be provided training concerning the administrative controls and quality assurance program which, as a minimum, shall include the following areas: overall company policies, procedures, or instructions which establish the program; procedures or instructions which implement the program related to the specific job-related activity.

#### **3.4 Onsite Operating Organization**

**3.4.1 General.** A number of factors influence management in its decision regarding the establishment of an onsite operating organization. These include the owner organization's established staffing policies, the physical size and complexity of the nuclear power plant, the number of units, the extent of assistance provided by offsite technical support organizations, the extent of reliance on consultants and the availability of qualified personnel from other sources to assist in activities, such as initial start-up, refueling, maintenance or modification work.

A nuclear power plant onsite operating organization may change with time. For example, the number and qualifications of personnel making up the onsite technical support staff can generally be reduced as a plant progresses through initial operation to operational maturity. Management shall give careful consideration to the timing and extent of such changes.

**3.4.2 Requirements for the Onsite Operating Organization.** The onsite operating organization shall include one or more individuals knowledgeable in the following fields:

nuclear power plant operation; nuclear power plant mechanical, electrical and electronic systems; nuclear engineering; chemistry and radiochemistry; radiation protection; and quality assurance. Initial incumbents or replacements for members of the onsite operating organization and offsite technical support organizations shall have appropriate experience, training and retraining to assure that necessary competence is maintained in accordance with the provisions of American National Standard for Selection and Training of Nuclear Power Plant Personnel, N18.1-1971. [4] Personnel whose qualifications do not meet those specified in N18.1 and who are performing inspection, examination, and testing activities during the operations phase of the plant, including preoperational and start-up testing, shall be qualified to American National Standard Qualifications of Inspection, Examination, and Testing Personnel for the Construction Phase of Nuclear Power Plants, N45.2.6-1973 [5], except that the QA experience cited for Levels I, II, and III should be interpreted to mean actual experience in carrying out the types of inspection, examination, or testing activity being performed.

The owner organization shall designate those positions in the onsite operating organization which shall be filled by personnel holding NRC reactor operator and senior reactor operator licenses. Requirements for the minimum number of personnel holding such licenses who shall be present at the plant under various operating conditions and situations shall also be specified.

The Plant Manager shall have overall responsibility for the execution of the administrative controls and quality assurance program at the plant to assure safety. An individual or organizational unit knowledgeable and experienced in nuclear power plant operational phase activities and quality assurance practices shall be designated and assigned the responsibility to verify that the program is being effectively implemented. Depending on the organizational structure, the individual or organizational unit may report functionally to onsite plant management or an offsite organization (see also 3.2). Reporting to onsite plant management is preferable since such an arrangement usually results in improved communications in identifying problems and initiating corrective action. The individual or

organizational unit in this case may receive technical guidance from offsite support groups. This individual's or organizational unit's duties and responsibilities shall be such that the required attention can be devoted, as required, to verifying that the program is being effectively executed. The individual or organizational unit shall report on the effectiveness of the program to the Plant Manager and to other cognizant management as may be designated. Their activities shall be periodically audited by designated offsite personnel.

#### 4. Reviews and Audits

4.1 General. Programs for reviews and for audits of activities affecting plant safety during the operational phase shall be established by the owner organization to:

(1) Verify that these activities are performed in conformance with this Standard and with company policy and rules, approved operating procedures and license provisions

(2) Review significant proposed plant changes, tests and procedures

(3) Verify that reportable events, which require reporting to NRC in writing within 24 hours, are promptly investigated and corrected in a manner which reduces the probability of recurrence of such events

(4) Detect trends which may not be apparent to a day-to-day observer

These programs for reviews and audits shall, themselves, be periodically reviewed for effectiveness by management of the owner organization.

The programs provided for reviews and for audits may take different forms. For example, the owner organization may assign these functions to separate established organizational units independent of the onsite operating organization, or may appoint a standing committee comprised of individuals from within or outside the owner organization to perform reviews and to exercise overview of audits.

Historically, a committee approach was used to provide both review and audit capability for early commercial nuclear power plants. This approach was employed to make the most efficient use of personnel with pertinent experience and qualifications. In the ensuing period, the availability of competent personnel has significantly increased as the nuclear power industry

has expanded and the sources of trained manpower have responded to the resulting demand. This growing pool of talent in the aggregate, is sufficient to encourage alternative approaches to the review and audit committees commonly used in the past.

In general, the time required of individuals serving as members of independent review groups is a function of the number of nuclear power plants an owner organization has in operation. For this reason, owner organizations contemplating rapid growth and an expanding commitment to nuclear power should regard the use of committees to meet the independent review functions as an interim approach for effective utilization of available technical expertise. In addition, such owner organizations should include in their expansion planning, provisions for early establishment of organizational units to provide independent review, for recruitment of staff, and for an orderly transition to such an organizational structure in the event a committee approach has been used previously to meet the independent review function.

An independent offsite organizational unit may be assigned review responsibilities including responsibility for reviewing audit reports provided by onsite staff members, or both functions may be assigned to an organizational unit that is independent of line responsibility for operating activities. This Standard does not specify an organizational structure for meeting the review and audit functions, but in lieu thereof delineates essential elements of satisfactorily comprehensive programs for review and for audit in the manner best suited to the owner organization involved.

4.2 Program Description. Written programs for both audits and independent reviews shall be prepared that contain:

(1) Subjects to be audited and independently reviewed.

(2) Responsibility and authority of those supervising audits and conducting independent reviews. These responsibilities shall include the identification of problems and the verification of corrective action. Additional responsibilities may include recommendations to appropriate management of solutions to problems and the approval or disapproval of contemplated actions.

(3) Mechanisms for initiating audit and in-

dependent review activities.

(4) Provisions for use of specialists or subgroups.

(5) Authority to obtain access to the nuclear power plant operating records and operating personnel to perform audits and independent reviews.

(6) Requirements for distribution of reports and other records to appropriate staff members and managers in the owner organization.

(7) Identification of the management position (or positions, if auditors and reviewers have different reporting chains) to which auditors and independent reviewers report.

(8) Provisions for assuring that personnel responsible for audit and independent review are kept informed on a timely basis of matters within their scope of responsibility.

(9) Provisions for follow-up action, including reaudit of deficient areas where indicated.

(10) Other provisions required for effective audits and independent reviews.

**4.3 Independent Review Program.** Activities occurring during the operational phase shall be independently reviewed on a periodic basis. The independent review program shall be functional prior to initial core loading.

**4.3.1 Personnel.** Personnel assigned responsibility for independent reviews shall be specified, in both number and technical disciplines, and shall collectively have the experience and competence required to review problems in the following areas:

- (1) Nuclear power plant operations
- (2) Nuclear engineering
- (3) Chemistry and radiochemistry
- (4) Metallurgy
- (5) Nondestructive testing
- (6) Instrumentation and control
- (7) Radiological safety
- (8) Mechanical and electrical engineering
- (9) Administrative controls and quality assurance practices

(10) Other appropriate fields associated with the unique characteristics of the nuclear power plant involved

An individual may possess competence in more than one specialty area. If sufficient expertise is not available from within the owner organization, independent reviews shall be supplemented through outside consultants or organizations. Provisions shall be made to

assure that appropriate expertise is brought to bear in reviews of operational phase activities.

**4.3.2 Standing Committees Functioning as Independent Review Bodies**

**4.3.2.1 Committee Composition.** When a standing committee is responsible for the independent review program, it shall be composed of no less than five persons, of whom no more than a minority are members of the onsite operating organization. Competent alternates are permitted if designated in advance. The use of alternates shall be restricted to legitimate absences of principals.

**4.3.2.2 Meeting Frequency.** Formal meetings of personnel assigned to a standing committee functioning as an independent review group shall be scheduled as needed. During the period of initial operation such meetings should be held no less frequently than once per calendar quarter. Subsequently, the meeting frequency shall not be less than twice a year.

**4.3.2.3 Quorum.** A quorum for formal meetings of the committee held under the provisions of 4.3.2.2 shall consist of not less than a majority of the principals, or duly appointed alternates, and shall be subject to the following constraints: the chairman (or his duly appointed alternate) shall be present for all formal meetings; and no more than a minority of the quorum shall have line responsibility for operation of the plant.

**4.3.2.4 Meeting Records.** Minutes of all meetings of the committee shall be prepared and retained. All documentary material reviewed should be identified. Decisions and recommendations made by the committee shall be documented. Meeting minutes shall be disseminated promptly to appropriate members of management having responsibility in the area reviewed. (See also Section 5.2.12.)

**4.3.3 Organizational Units Functioning as Independent Review Bodies.** An organizational unit assigned primary responsibility for review of operational phase activities shall report to a designated management representative who is assigned authority and responsibility for effective functioning of the unit and who is not immediately responsible for the performance of the activities to be reviewed.

The supervisor of such an organizational unit should schedule periodic formal meetings of his staff, or of appropriate subparts thereof, for the purpose of fostering interaction in reviews of

specific operational phase activities.

**4.3.3.1 Documentation of Reviews.** Written records of reviews shall be prepared and retained. All documentary material reviewed should be identified. Results of reviews conducted by the unit including recommendations and proposed actions shall be subject to approval of the supervisor of the unit, and shall be disseminated promptly to appropriate members of management having responsibility in the area reviewed. (See also Section 5.2.12.)

**4.3.4 Subjects Requiring Independent Review.** The following subjects shall be reviewed by the independent review body:

(1) Written safety evaluations of changes in the facility as described in the Safety Analysis Report, changes in procedures as described in the Safety Analysis Report and tests or experiments not described in the Safety Analysis Report which are completed without prior NRC approval under the provisions of 10 CFR 50.59(a)(1). [1] This review is to verify that such changes, tests or experiments did not involve a change in the technical specifications or an unreviewed safety question as defined in 10 CFR 50.59(a)(2). [1]

(2) Proposed changes in procedures, proposed changes in the facility, or proposed tests or experiments, any of which involves a change in the technical specifications or an unreviewed safety question as defined in 10 CFR 50.59(c). [1] Matters of this kind shall be referred to the independent review body by the onsite operating organization (see 4.4) following its review, or by other functional organizational units within the owner organization, prior to implementation.

(3) Changes in the technical specifications or license amendments relating to nuclear safety prior to implementation, except in those cases where the change is identical to a previously reviewed proposed change.

(4) Violations, deviations and reportable events, which require reporting to the NRC in writing within 24 hours, such as:

(a) Violations of applicable codes, regulations, orders, technical specifications, license requirements or internal procedures or instructions having safety significance

(b) Significant operating abnormalities or deviations from normal or expected performance of plant safety-related structures, systems, or components

(c) Reportable events, which require reporting to the NRC in writing within 24 hours, as defined in the plant technical specifications

Review of events covered under this subsection shall include the results of any investigations made and the recommendations resulting from such investigations to prevent or reduce the probability of recurrence of the event.

(5) Any other matter involving safe operation of the nuclear power plant which an independent reviewer deems appropriate for consideration, or which is referred to the independent reviewers by the onsite operating organization or by other functional organizational units within the owner organization.

**4.4 Review Activities of the Onsite Operating Organization.** The onsite operating organization shall provide, as part of the normal duties of plant supervisory personnel, timely and continuing monitoring of operating activities to assist the Plant Manager in keeping abreast of general plant conditions and to verify that the day-to-day operating activities are conducted safely and in accordance with applicable administrative controls. These continuing monitoring activities are considered to be an integral part of the routine supervisory function and are important to the safety of plant operation.

The onsite operating organization should perform reviews periodically and as situations demand, to evaluate plant operations and to plan future activities. The important elements of the reviews should be documented. Such reviews serve a useful purpose but shall not take the place of the reviews and audits described in Sections 4.3 and 4.5, respectively. The onsite operating organization should screen subjects of potential concern to independent reviewers and perform preliminary investigations (see 4.3.4). The Plant Manager, in carrying out his responsibility for overall safety of plant operations, shall be responsible for timely referral of appropriate matters to management and independent reviewers.

**4.5 Audit Program.** A comprehensive system of planned and documented audits shall be carried out to verify compliance with all aspects of the administrative controls and quality assurance program. Audits of selected aspects of operational phase activities shall be performed with a frequency commensurate with their

safety significance and in such a manner as to assure that an audit of all safety-related functions is completed within a period of two years.

Audits shall include as a minimum verification of compliance and effectiveness of implementation of internal rules, procedures (for example, operating, design, procurement, maintenance, modification, refueling, surveillance, test, security and radiation control procedures and the emergency plan), regulations and license provisions; programs for training, retraining, qualification and performance of operating staff; corrective actions taken following abnormal occurrences; and observation of performance of operating, refueling, maintenance and modification activities, including associated record keeping. Written reports of such audits shall be reviewed by the independent review body and by appropriate members of management including those having responsibility in the area audited.

Those performing the audits may be members of the audited organization; however, they shall not audit activities for which they have immediate responsibility. While performing the audit, they shall not report to a management representative who has immediate responsibility for the activity being audited. Appropriate and timely followup action, including reaudit of deficient areas, shall be taken.

Periodic review of the audit program shall be performed by the independent review body or by a management representative at least semiannually to assure that audits are being accomplished in accordance with requirements of technical specifications and of this Standard.

Further guidance on requirements for auditing of quality assurance programs for nuclear power plants exists in draft form.<sup>2</sup>

## 5. Program, Policies and Procedures

**5.1 Program Description.** The total program for providing administrative controls and quality assurance during the operational phase may be described in many diverse documents. For example, operating procedures may be compiled in one manual, maintenance procedures in a second manual and Quality Assurance procedures in a third. It is not intended that all source documents be compiled in one master document. However, a summary document shall be compiled by each owner organization to identify the sources, to index such source documents

to the requirements of this Standard and to provide a consolidated base for description of the program. The owner organization shall identify in the program description those structures, systems and components to be covered by the program and the major organizational units and their responsibilities. The program shall provide control over activities affecting the quality of the structures, systems and components to an extent consistent with their importance to safety. The program shall take into account the need for special controls, processes, tests, equipment, tools, and skills to attain the required quality and the need for verification of quality by inspections, evaluation or test.

**5.2 Rules of Practice.** The owner organization shall establish rules and instructions pertaining to personnel conduct and control, including consideration of job-related factors which influence the effectiveness of operating and maintenance personnel, including such factors as number of hours at duty station, availability on call of professional and supervisory personnel, method of conducting operations, and preparing and retaining plant documents. These rules and instructions should provide a clear understanding of operating philosophy and management policies.

**5.2.1 Responsibilities and Authorities of Operating Personnel.** The responsibilities and authorities of the plant operating personnel shall be delineated. These shall include, as a minimum:

(1) The reactor operator's authority and responsibility for shutting the reactor down when he determines that the safety of the reactor is in jeopardy or when operating parameters exceed any of the reactor protection system set-points and automatic shutdown does not occur.

(2) The responsibility to determine the circumstances, analyze the cause, and determine that operations can proceed safely before the reactor is returned to power after a trip or an unscheduled or unexplained power reduction.

<sup>2</sup>"Requirements for Auditing of Quality Assurance Programs for Nuclear Power Plants," proposed American National Standard N45.2.12, trial use (Draft 4, Revision 2) January 1, 1976; correspondence should be sent to: Secretary, American National Standards Committee N45, The American Society of Mechanical Engineers, United Engineering Center, 345 East 47 Street, New York, New York 10017. The provisions of this draft standard shall be used for audits performed under this section except the audit frequency specified herein shall be used.

(3) The senior reactor operator's responsibility to be present at the plant and to provide direction for returning the reactor to power following a trip or an unscheduled or unexplained power reduction.

(4) The responsibility to believe and respond conservatively to instrument indications unless they are proved to be incorrect.

(5) The responsibility to adhere to the plant's Technical Specifications.

(6) The responsibility to review routine operating data to assure safe operation.

**5.2.2 Procedure Adherence.** Procedures shall be followed, and the requirements for use of procedures shall be prescribed in writing. Rules shall be established which provide methods by which temporary changes to approved procedures can be made, including the designation of a person or persons authorized to approve such changes. Temporary changes which clearly do not change the intent of the approved procedure, shall as a minimum be approved by two members of the plant staff knowledgeable in the areas affected by the procedures. At least one of these individuals shall be the supervisor in charge of the shift and hold a senior operators license on the unit affected. Such changes shall be documented and, if appropriate, incorporated in the next revision of the affected procedure. In the event of an emergency not covered by an approved procedure, operations personnel shall be instructed to take action so as to minimize personnel injury and damage to the facility and to protect health and safety.

Guidance should be provided to identify the manner in which procedures are to be implemented. Examples of such guidance include identification of those tasks that require:

(1) The written procedure to be present and followed step by step while the task is being performed

(2) The operator to have committed the procedural steps to memory

(3) Verification of completion of significant steps, by initials or signatures of checkoff lists

The types of procedures that shall be present and referred to directly are those developed for extensive or complex jobs where reliance on memory cannot be trusted, e.g., reactor start-up, tasks which are infrequently performed, and tasks in which operations must be performed in a specified sequence. Procedural steps for which

actions should be committed to memory include, for example, immediate actions in emergency procedures. Routine procedural actions that are frequently repeated may not require the procedure to be present. Copies of all procedures shall be available to appropriate members of the plant staff. If documentation of an action is required, the necessary data shall be recorded as the task is performed. Examples of procedures requiring verification are furnished in 5.3.4.1 and 5.3.4.2.

**5.2.3 Operating Orders.** A mechanism shall be provided for dissemination to the plant staff of instructions of general and continuing applicability to the conduct of business. Such instructions, sometimes also referred to as standing orders or standard operating procedures, should deal with job turnover and relief, designation of confines of control room, definition of duties of operators and others, transmittal of operating data to management, filing of charts, limitations on access to certain areas and equipment, shipping and receiving instructions, or other such matters. Provisions should be made for periodic review and updating of standing orders.

**5.2.4 Special Orders.** A mechanism shall be provided for issuing management instructions which have short-term applicability and which require dissemination. Such instructions, sometimes referred to as a special orders, should encompass special operations, housekeeping, data taking, publications and their distribution, plotting process parameters, personnel actions, or other similar matters. Provisions should be made for periodic review, updating and cancellation of special orders.

**5.2.5 Temporary Procedures.** Temporary procedures may be issued during the operational phase: to direct operations during testing, refueling, maintenance and modifications; to provide guidance in unusual situations not within the scope of the normal procedures; and to insure orderly and uniform operations for short periods when the plant, a system, or a component of a system is performing in a manner not covered by existing detailed procedures or has been modified or extended in such a manner that portions of existing procedures do not apply. Temporary procedures shall include designation of the period of time during which they may be used and shall be subject to the review process prescribed in 4.3 and 5.2.15 as





applicable.

Temporary procedures shall be approved by the management representative assigned approval authority.

**5.2.6 Equipment Control.** Permission to release equipment or systems for maintenance shall be granted by designated operating personnel. Prior to granting permission, such operating personnel shall verify that the equipment or system can be released, and determine how long it may be out of service. Granting of such permission shall be documented. Attention shall be given to the potentially degraded degree of protection when one subsystem of a redundant safety system has been removed for maintenance.

After permission has been granted to remove the equipment from service, it shall be made safe to work on. Measures shall provide for protection of equipment and workers. Equipment and systems in a controlled status shall be clearly identified. Strict control measures for such equipment shall be enforced.

Conditions to be considered in preparing equipment for maintenance include, for example: shutdown margin; method of emergency core cooling; establishment of a path for decay heat removal; temperature and pressure of the system; valves between work and hazardous material; venting, draining and flushing; entry into closed vessels; hazardous atmospheres; handling hazardous materials; and electrical hazards. When entry into a closed system is required, control measures shall be established to prevent entry of extraneous material and to assure that foreign material is removed before the system is reclosed.

Procedures shall be provided for control of equipment, as necessary, to maintain personnel and reactor safety and to avoid unauthorized operation of equipment. These procedures shall require control measures such as locking or tagging to secure and identify equipment in a controlled status. The procedures shall require independent verifications, where appropriate, to ensure that necessary measures, such as tagging equipment, have been implemented correctly.

Temporary modifications, such as temporary bypass lines, electrical jumpers, lifted electrical leads, and temporary trip point settings, shall be controlled by approved procedures which shall include a requirement for independent verification. A log shall be maintained of the

current status of such temporary modifications.

The procedures shall also require that the status of inspections and tests performed upon individual items on the nuclear power plant be indicated by the use of markings such as stamps, tags, labels, routing cards, or other suitable means. Suitable means include identification numbers which are traceable to records of the status of inspections and tests. Procedures shall also provide for the identification of items which have satisfactorily passed required inspections and tests, where necessary to preclude inadvertent bypassing of such inspections and tests. In cases where required documentary evidence is not available, the associated equipment or materials must be considered nonconforming in accordance with Section 5.2.14. Until suitable documentary evidence is available to show the equipment or material is in conformance, affected systems shall be considered to be inoperable and reliance shall not be placed on such systems to fulfill their intended safety functions.

When equipment is ready to be returned to service, operating personnel shall place the equipment in operation and verify and document its functional acceptability. Attention shall be given to restoration of normal conditions, such as removal of jumpers or signals used in maintenance or testing or such as returning valves, breakers or switches to proper start-up or operating positions from "test" or "manual" positions. When placed into service, the equipment should receive additional surveillance during the run-in period.

**5.2.7 Maintenance and Modifications.** Maintenance or modifications which may affect functioning of safety-related structures, systems, or components shall be performed in a manner to ensure quality at least equivalent to that specified in original design bases and requirements, materials specifications and inspection requirements. A suitable level of confidence in structures, systems, or components on which maintenance or modifications have been performed shall be attained by appropriate inspection and performance testing (see also 5.2.17 and 5.3.5).

Maintenance or modification of equipment shall be preplanned and performed in accordance with written procedures, documented instructions or drawings appropriate to the circumstances which conform to applicable codes,

standards, specifications, and criteria. Skills normally possessed by qualified maintenance personnel may not require detailed step-by-step delineations in a written procedure.

Means for assuring quality of maintenance and modification activities (for example, inspections, measurements, tests, welding, heat treatment, cleaning, nondestructive examination and worker qualifications in accordance with applicable codes and standards) and measures to document the performance thereof shall be established. This documentation shall be retained as specified in Section 5.2.12. Measures shall be established and documented to identify the inspection and test status of items to be used in maintenance and modification activities. Normally, the point of control for such items should be the plant storage area.

The following standards contain useful guidance concerning design and construction-related activities associated with modifications and shall be applied to those activities occurring during the operational phase that are comparable in nature and extent to related activities occurring during initial plant design and construction: American National Standard Installation, Inspection and Testing of Instrumentation and Electric Equipment During the Construction of Nuclear Power Generation Station, N45.2.4-1972 (IEEE 336-1972) [6]; American National Standard Supplementary Quality Assurance Requirements for Installation, Inspection and Testing of Structural Concrete and Structural Steel During the Construction Phase of Nuclear Power Plants, N45.2.5-1974 [7]; American National Standard Qualifications of Inspection, Examination and Testing Personnel for the Construction Phase of Nuclear Power Plants N45.2.6-1973 [5]; American National Standard Supplementary Quality Assurance Requirements for Installation, Inspection and Testing of Mechanical Equipment and Systems for Construction Phase of Nuclear Power Plants, N45.2.8-1975 [8] American National Standard Quality Assurance Requirements for the Design of Nuclear Power Plants, N45.2.11-1974 [9]; and American National Standard Quality Assurance for Protective Coating Applied to Nuclear Facilities N101.4-1972 [10]. Considerable care is required in assessing which operational phase activities are comparable in nature and extent to activities normally

associated with design and construction.

**5.2.7.1 Maintenance Programs.** A maintenance program shall be developed to maintain safety-related structures, systems and components at the quality required for them to perform their intended functions.

Maintenance shall be scheduled and planned so as not to compromise the safety of the plant. Planning shall consider the possible safety consequences of concurrent or sequential maintenance, testing or operating activities. Equipment required to be operable for the prevailing mode shall be available, and maintenance shall be performed in a manner such that license limits are not violated. Planning for maintenance shall include evaluation of the use of special processes, equipment and materials in performance of the task, including assessment of potential hazards to personnel and equipment.

General rules for the development of procedures under a maintenance program which is consistent with the provisions of 5.2.7 shall be written before start-up. These general rules shall form the basis for developing the repair or replacement procedures at the time of failure. Procedures required for maintenance of equipment expected to require recurring maintenance should be written prior to plant operation. As experience is gained in operation of the plant, routine maintenance should be altered to improve equipment performance, and procedures for repair of equipment shall be improved as appropriate. Approved procedures shall be available for repair of safety-related equipment prior to the performance of such repairs (see also Sections 5.2.2 and 5.2.7).

A preventive maintenance program including procedures as appropriate for safety-related structures, systems and components shall be established and maintained which prescribes the frequency and type of maintenance to be performed. A preliminary program based on service conditions and experience with comparable equipment should be developed prior to fuel loading. The program should be revised and updated as experience is gained with the equipment.

The causes of malfunctions shall be promptly determined, evaluated and recorded (see also Sections 4.3 and 4.4). Experience with the malfunctioning equipment and similar components shall be reviewed and evaluated to determine whether a replacement component of

the same type can be expected to perform its function reliably. If evidence indicates that common components in safety-related systems have performed unsatisfactorily, corrective measures shall be planned prior to replacement or repair of all such components. Replacement components should have received adequate testing or should be of a design for which experience indicates a high probability of satisfactory performance. Consideration shall be given to phased replacement to permit inservice performance of the new component to be evaluated and thereby minimize the possibility of a hidden deficiency producing a systematic failure. An augmented testing and inspection program should be implemented following a large scale component replacement (or repair) until such time as a suitable level of performance has been demonstrated.

**5.2.7.2 Modifications.** Design activities associated with modifications of safety-related structures, systems, and components shall be accomplished in accordance with N45.2.11-1974. [9]

**5.2.8 Surveillance Testing and Inspection Schedule.** A surveillance testing and inspection program shall be prescribed to insure that safety-related structures, systems, and components will continue to operate, keeping parameters within normal bounds, or will act to put the plant in a safe condition if they exceed normal bounds. Provisions shall be made for performing required surveillance testing and inspections, including inservice inspections. Such provisions shall include the establishment of a master surveillance schedule reflecting the status of all planned inplant surveillance tests and inspections. Frequency of surveillance tests and inspections may be related to the results of reliability analyses, the frequency and type of service, or age of the item or system, as appropriate.<sup>3</sup> Additional control procedures shall be instituted, as necessary, to assure timely conduct of surveillance tests and inspections and appropriate documentation, reporting, and evaluation of the results.

**5.2.9 Plant Security and Visitor Control.** Procedures shall be developed to supplement

<sup>3</sup>Surveillance testing which may increase the probability of plant trips or major transients with accompanying safety concerns should be deferred to periods when such plant trips or transients have a minimum impact on safety and reliability.

features and physical barriers designed to control access to the plant and, as appropriate, to vital areas within the plant. Information concerning specific design features and administrative provisions of the plant security program shall be confidential and thus accorded limited distribution. The security and visitor control procedures should consider, for example, physical provisions, such as: fences and lighting; lock controls for doors, gates and compartments containing sensitive equipment; and provisions for traffic and access control. Also to be considered are administrative provisions, such as: visitor sign-in and sign-out procedures; escorts and badges for visitors; emphasis on inspection, observation and challenging of strangers by operating crews; and a program of preemployment screening for potential employees. See American National Standard Industrial Security for Nuclear Power Plants, N18.17-1973, for guidance and provisions for security measures adequate to protect nuclear power plants. [11]

**5.2.10 Housekeeping and Cleanliness Control.** Housekeeping practices shall be utilized recognizing requirements for the control of radiation zones and the control of work activities, conditions and environments that can affect the quality of important parts of the nuclear plant. Housekeeping encompasses all activities related to the control of cleanness of facilities, materials, equipment fire prevention and protection including disposal of combustible material and debris and control of access to areas, protection of equipment, radioactive contamination control and storage of solid radioactive waste. Housekeeping practices shall assure that only proper materials, equipment, processes and procedures are utilized and that the quality of items is not degraded as a result of housekeeping practices or techniques. Where necessary, procedures and work instructions needed to assure compliance with specific requirements shall be available; e.g., inspection and cleaning of electrical bus and control centers, cleaning of control consoles, radioactive decontamination. Particular attention should be given to housekeeping in work and storage areas where important items are handled and stored to preclude damage or contamination. American National Standard Housekeeping During the Construction Phase of Nuclear Power Plants, N-45.2.3-1973 [12] shall be applied to those ac-

tivities occurring during the operational phase that are comparable in nature and extent to related activities occurring during construction.

During maintenance or modification activities, certain portions of safety-related systems may be subject to potential contamination with foreign materials. To prevent such contamination, control measures, including measures for access control, shall be established. Immediately prior to closure an inspection shall be conducted to assure cleanness and the result of such inspection shall be documented. American National Standard Cleaning of Fluid Systems and Associated Components during Construction Phase of Nuclear Power Plant, N45.2.1-1973 [13] shall be applied to activities occurring during the operational phase that are comparable in nature and extent to related activities occurring during construction. Measures for minimizing the introduction of foreign materials during maintenance or modification, or cleaning following maintenance or modification of radioactively contaminated systems or of equipment of high radiation fields require special consideration.

**5.2.11 Corrective Actions.** The program shall provide measures to ensure that conditions adverse to plant safety, such as failure, malfunctions, deficiencies, deviations, defective material and equipment, abnormal occurrences, and non-conformances are promptly identified and corrected. In the case of significant conditions adverse to safety, the measures shall assure that the cause of the condition is determined and corrective action taken shall be documented and reported to appropriate levels of management and for independent review in accordance with Section 4.3.

**5.2.12. Plants Records Management.** Provisions shall be made for preparation and retention of plant records as appropriate. The responsibility for maintaining records and storing them at a specified location or locations shall be assigned. Retention periods of sufficient duration to assure the ability to reconstruct significant events and satisfy any statutory requirements which apply shall be specified. American National Standard Requirements for Collection, Storage and Maintenance of Quality Assurance Records for Nuclear Power Plants, N45.2.9-1974, shall be used for management of plant records during the operational phase. [14]

**5.2.13 Procurement and Materials Con-**

**trol.** Measures shall be provided for procurement, documentation and control of those materials and components including spare and replacement parts necessary for plant operation, refueling, maintenance and modification. These measures shall utilize American National Standard Quality Assurance Requirements for the Control of Procurement of Items and Services for Nuclear Power Plants, N45.2.13-1976. The Appendix to N45.2.13 is particularly useful in determining the quality assurance requirements depending on the complexity or safety of the item. [15]. Procedures shall be established and implemented to ensure that purchased materials and components associated with safety-related structures or systems are:

(1) Purchased to specifications and codes equivalent to those specified for the original equipment, or those specified by a properly reviewed and approved revision. (In those cases where the original item or part is found to be commercially "off the shelf," or without specifically identified quality assurance requirements, spare and replacement parts may be similarly procured but care shall be exercised to assure at least equivalent performance. In those cases where the QA requirements of the original item cannot be determined, an engineering evaluation shall be conducted by qualified individuals to establish the requirements and controls. This evaluation shall assure that interfaces, interchangeability, safety, fit and function are not adversely affected or contrary to applicable regulatory or code requirements. The results of this evaluation shall be documented);

(2) Produced or fabricated under requirements at least equivalent to that of the original equipment, or those specified by a properly reviewed and approved revision;

(3) Packaged and transported in a manner that will ensure that the quality is not degraded during transit;

(4) Properly documented to show compliance with applicable specifications, codes and standards;

(5) Properly inspected, identified and stored to protect against damage, deterioration or misuse;

(6) Properly controlled to ensure the iden-

tification, segregation and disposition of non-conforming material.

Special nuclear material and sources shall be shipped and stored as specified in the U.S. Nuclear Regulatory Commission (NRC) fuel license and other applicable regulatory documents.

**5.2.13.1 Procurement Document Control.** Measures shall be provided to assure that applicable regulatory requirements, design bases and other requirements which are necessary to assure adequate quality are included or referenced in the procedures for procurement of items and services. To the extent necessary, procurement documents shall require suppliers to provide a quality assurance program consistent with the pertinent requirements of American National Standard Quality Assurance Program Requirements for Nuclear Power Plants, N45.2-1971. [2] Where changes are made to procurement documents, they shall be subject to the same degree of control as was used in the preparation of the original documents.

Procurement documents shall include provisions for the following, as applicable:

(1) Supplier Quality Assurance Program. Identification of quality assurance requirements applicable to the items or services procured.

(2) Basic Technical Requirements. Where specific technical requirements apply, such as drawings, specifications, and industrial codes and standards, they shall be identified by titles and dates of issue in such a way as to clearly set forth the applicable documents. Where procedural requirements apply, in such areas as test and inspection needs, fabrication, cleaning, erecting, packaging, handling, shipping and storage, they too, shall be identified clearly and in such a way as to avoid uncertainty as to source and need.

(3) Source Inspection and Audit. Provisions for access to the supplier's facilities and records for source inspection and audit when the need for such inspection or audit has been determined.

(4) Documentation Requirements. Records to be prepared, maintained, submitted or made available for review, such as drawings, specifications, procedures, procurement documents, inspection and test records, personnel and procedure qualifications, and material, chemical, and physical test results. In-

struction on record retention and disposition shall be provided.

(5) Lower Tier Procurement. Provisions for extending applicable requirements to lower tier subcontractors and suppliers, including purchaser's access to facilities and records.

**5.2.13.2 Control of Purchased Material, Equipment and Services.** Measures shall be provided to assure that purchased items and services, whether purchased directly or through contractors, conform to the procurement documents. These measures shall include provisions, as appropriate, for source evaluation and selection, objective evidence of quality furnished by the contractor, inspection and audit at the source and examination of items upon delivery.

Measures for evaluation and selection of procurement sources include the use of historical quality performance data, source surveys or audits, or source qualification programs.

Source inspection or audit shall be performed as necessary to assure the required quality of an item. Source inspection or audit may not be necessary when the quality of the item can be verified by review of test reports, inspection upon receipt, or other means.

Where required by code, regulation, or contract requirements, documentary evidence that items conform to procurement requirements shall be available at the nuclear power plant site prior to installation or use of such items. This documentary evidence shall be retrievable and shall be sufficient to identify the specific requirements such as codes, standards and specifications met by the purchased item. Where not precluded by other requirements, such documentary evidence may take the form of written certifications of conformance which identify the requirements met by the items, provided means are available to verify the validity of such certifications.

The effectiveness of the control of quality shall be assessed by the purchaser at intervals consistent with the importance, complexity and quality of the item or service.

**5.2.13.3 Identification and Control of Materials, Parts and Components.** Measures shall be provided for the identification and control of materials, parts, and components including partially fabricated subassemblies. These procedures shall be implemented to

provide insurance that only correct and accepted items are used and installed, and relating an item of production (batch, lot, component, part) at any stage, from initial receipt through fabrication, installation, repair or modification, to an applicable drawing, specification, or other pertinent technical document. Physical identification shall be used to the maximum extent possible. Where physical identification is either impractical or insufficient, physical separation, procedural control or other appropriate means shall be employed. Identification may be either on the item or on records traceable to the item, as appropriate.

Where identification marking is employed, the marking shall be clear, unambiguous and indelible, and shall be applied in such a manner as not to affect the function of the item. Markings shall be transferred to each part of an item when subdivided and shall not be obliterated or hidden by surface treatment or coatings unless other means of identification are substituted.

When codes, standards or specifications require traceability of materials, parts or components to specific inspection or test records, the program shall be designed to provide such traceability.

**5.2.13.4 Handling, Storage and Shipping.** Measures shall be provided to control handling, storage and shipping, including cleaning, packaging and preservation of material and equipment in accordance with established instructions, procedures or drawings, to prevent damage, deterioration and loss. When necessary for particular items, special coverings, special equipment and special protective environments, such as inert gas atmosphere, specific moisture content levels and temperature levels shall be specified, provided, and their existence verified.

For critical, sensitive, perishable or high-value articles, specific written procedures for handling, storage, packaging, shipping and preservation should be used. Special handling tools and equipment should be provided and controlled as necessary to ensure safe and adequate handling.

Special handling tools and equipment shall be inspected and tested in accordance with written procedures and at specified times, to verify that the tools and equipment are adequately

maintained.

Attention shall be given to providing adequate instructions for marking and labeling of items for packaging, shipment and storage. Marking shall be adequate to identify, maintain and preserve the shipment, including indication of the presence of special environments or the need for special control.

American National Standard for Packaging, Shipping, Receiving, Storage and Handling of Items for Nuclear Power Plants (During the Construction Phase), N45.2.2-1972, shall be applied to those activities occurring during the operational phase that are comparable in nature and extent to related activities occurring during construction. [16]

**5.2.14 Nonconforming Items.** Measures shall be provided to control items, services or activities which do not conform to requirements (see also Section 5.2.6). These procedures shall include as appropriate, instructions for identification, documentation, segregation, disposition and notification to affected organizations. Nonconforming items shall be reviewed and accepted, rejected, repaired or reworked in accordance with documented procedures. The responsibility and authority for the disposition of nonconforming items shall be defined. Repaired and reworked items shall be reinspected in accordance with applicable procedures.

Measures which control further processing, delivery or installation of a nonconforming or defective item pending a decision on its disposition shall be established and maintained. Nonconforming items may be disposed of by acceptance "as is," by scrapping or repairing the defective item, or by rework to complete or correct to a drawing or specification. Such measures shall provide assurance that the item is identified as nonconforming and controlled. The measures shall require documentation verifying the acceptability of nonconforming items which have the disposition of "repair" or "use as is." A description of the change, waiver or deviation that has been accepted shall be documented to record the change and denote the as-built condition.

As a guideline, control of nonconforming items by tagging, marking or other means of identification is acceptable where physical segregation is not practical, although physical segregation and marking are preferred.

**5.2.15 Review, Approval and Control of Procedures.** The administrative controls and quality assurance program shall provide measures to control and coordinate the approval and issuance of documents, including changes thereto, which prescribe all activities affecting quality. Such documents include those which describe organizational interfaces, or which prescribe activities affecting safety-related structures, systems, or components. These documents also include operating and special orders, operating procedures, test procedures, equipment control procedures, maintenance or modification procedures, refueling, and material control procedures. These measures shall assure that documents, including revisions or changes, are reviewed for adequacy by appropriately qualified personnel and approved for release by authorized personnel; and are distributed in accordance with current distribution lists and used by the personnel performing the prescribed activity, and that procedures are provided to avoid the misuse of outdated or inappropriate documents.

Procedures for operational phase activities of a nuclear power plant reflect the conditions that exist at the time the procedures are written. These conditions include the technical information available, industry experience, and in the case of the initial procedures for a new plant, assumptions made regarding the detailed behavior of the plant that may not be fully known prior to operation. In order to ensure that the procedures in current use provide the best possible instructions for performance of the work involved, systematic review and feedback of information based on use is required.

Each procedure shall be reviewed and approved prior to initial use. The frequency of subsequent reviews shall be specified and may vary depending on the type and complexity of the activity involved, and may vary with time as a given plant reaches operational maturity. Applicable procedures shall be reviewed following an unusual incident, such as an accident, an unexpected transient, significant operator error, or equipment malfunction. Applicable procedures shall be reviewed following any modification to a system.

Plant procedures shall be reviewed by an individual knowledgeable in the area affected by the procedure no less frequently than every two years to determine if changes are necessary or

desirable. A revision of a procedure constitutes a procedure review.

Procedures shall be approved as designated by the owner organization before initial use. Rules shall be established which clearly delineate the review of procedures by knowledgeable personnel other than the originator and the approval of procedures and procedure changes by authorized individuals.

Changes to documents shall be reviewed and approved by the same organizations that perform the original review and approval unless the owner organization designates another qualified organization.

The reviewing organizations shall have access to pertinent background information upon which to base its approval and shall have adequate understanding of requirements and intent of the original document.

Those participating in any activity shall be made aware of, and use, proper and current instructions, procedures, drawings, and engineering requirements for performing the activity. Participating organizations shall have procedures for control of the documents and changes thereto to preclude the possibility of use of outdated or inappropriate documents.

Document control measures shall provide for:

- (1) Identification of individuals or organizations responsible for preparing, reviewing, approving, and issuing documents and revisions thereto
- (2) Identifying the proper documents to be used in performing the activity
- (3) Coordination and control of interface documents
- (4) Ascertaining that proper documents are being used
- (5) Establishing current and updated distribution lists

**5.2.16 Measuring and Test Equipment.** The method and interval of calibration for each installed instrument and control device shall be defined and shall be based on the type of equipment, stability and reliability characteristics, required accuracies and other conditions affecting calibration.

Tools, instruments, testing equipment and measuring devices used for measurements, tests and calibration shall be of the proper range and type and shall be controlled, calibrated and adjusted and maintained at specified intervals or prior to use to assure the necessary accuracy of

calibrated devices. When calibration, testing, or other measuring devices are found to be out of calibration, an evaluation shall be made and documented concerning the validity of previous tests and the acceptability of devices previously tested from the time of the previous calibration. If any calibration, testing or measuring device is consistently found to be out of calibration, it shall be repaired or replaced. It is not the intent of this Standard to imply a need for special calibration and control measures on rulers, tape measures, levels and other such devices if normal commercial practices provide adequate accuracy.

Special calibration shall be performed when the accuracy of either installed or calibrating equipment is questionable. Records shall be made and equipment suitably marked to indicate calibration status. American National Standard N45.2.4-1972 shall be applied to those activities occurring during the operational phase that are comparable in nature and extent to related activities occurring during construction. [6]

**5.2.17 Inspections.** A program for inspection of activities affecting safety shall be established and executed by or for the organization performing the activity to verify conformance with applicable documented instructions, procedures, and drawings.

Inspections, examinations, measurements, or tests of material, products, or activities shall be performed for each work operation where necessary to assure quality. Such inspections shall be performed by qualified individuals other than those who performed or directly supervised the activity being inspected. Inspection of operating activities (work functions associated with normal operation of the plant, routine maintenance, and certain technical services routinely assigned to the onsite operating organization) may be conducted by second-line supervisory personnel or by other qualified personnel not assigned first-line supervisory responsibility for conduct of the work. These independent inspections, i.e., those performed by individuals not assigned first-line supervisory responsibility for the conduct of the work, are not intended to dilute or replace the clear responsibility of first-line supervisors for the quality of work performed under their supervision.

For modifications and nonroutine maintenance, inspections shall be conducted in a

manner similar (frequency, type, and personnel performing such inspections) to that associated with construction phase activities (see also Section 5.2.7).

Inspections of safety-related activities shall be performed in accordance with approved written procedures, which set forth the requirements and acceptance limits and specify the inspection responsibilities. If mandatory inspection hold points are required, the specific hold points shall be indicated in appropriate documents. Information concerning inspection shall be obtained from the related design drawings, specifications and/or other controlled documents. When inspection techniques require specialized qualifications or skills, personnel performing the inspection shall meet applicable licensing requirements, codes, and standards appropriate to the discipline involved (see also Sections 5.2.7, 5.2.6 and 5.3.10).

If inspection is impossible or disadvantageous, indirect control by monitoring processing methods, equipment and personnel shall be provided. Both inspection and process monitoring shall be provided when control is inadequate without both. In cases where documented verification of quality implied by the above requirements is not possible or feasible, the extent of inspection or performance testing to verify adequacy of structures, systems, or components for service should be, in general, greater than otherwise required.

The owner organization shall evaluate inspection results along with test results (see Section 5.2.19) to determine whether the individual inspection and test programs demonstrate that the plant can be operated safely and as designed. Records shall be kept in sufficient detail to permit adequate confirmation of the inspection program. The person recording the data as well as the person approving the inspection results shall be identified. Deviations, their cause, and any corrective action completed or planned as a result of the deviations shall be documented. Inspection records shall be identified as such and shall be retrievable (see also Section 5.2.12).

**5.2.18 Control of Special Processes.** Measures shall be established and documented to assure that special processes, accomplished under controlled conditions in accordance with applicable codes, standards, specifications, criteria, and other special requirements, use



qualified personnel and procedures. Qualification of personnel, procedures, and equipment shall comply with the requirements of applicable codes and standards. Special processes are those that require interim inprocess controls in addition to final inspection to assure quality including such processes as welding, heat treating, chemical cleaning, and nondestructive examination. For special processes not covered by existing codes or standards, or where item quality requirements exceed the requirements of established codes or standards, the necessary qualifications of personnel, procedures, or equipment shall be defined.

**5.2.19 Test Control.** A test program shall be established to assure that testing required to demonstrate that the item will perform satisfactorily in service is identified and documented, and that the testing is performed in accordance with written test procedures which incorporate or reference the requirements and acceptance limits contained in applicable design documents. The test program shall cover all required tests including:

(1) Tests during the preoperational period to demonstrate that performance of plant systems is in accordance with design intent and that the coordinated operation of the plant as a whole is satisfactory, to the extent feasible.

(2) Tests during the initial operational phase to demonstrate the performance of systems that could not be tested prior to operation and to confirm those physical parameters, hydraulic or mechanical characteristics that need to be known, but which could not be predicted with the required accuracy, and to confirm that plant behavior conforms to design criteria. The initial start-up test program shall be planned to permit safe fuel loading and start-up; to increase power in safe increments; and to perform major testing at specified power plateaus. If tests require the variation of operating parameters outside of their normal range, the limits within which such variation is permitted shall be prescribed. Prerequisites and record keeping shall be given attention and the scope of the testing shall demonstrate insofar as practicable that the plant is capable of withstanding the design transients and accidents. The suitability of plant operating procedures should be checked to the maximum extent possible during the preoperational and initial start-up test programs.

(3) Surveillance tests during the operational phase to provide assurance that failures or substandard performance do not remain undetected and that the required reliability of safety-related systems is maintained (see Section 5.2.8).

(4) Tests during design, fabrication and construction activities associated with plant maintenance and modifications during the operational phase and the demonstration of satisfactory performance following plant maintenance and modifications or procedural changes (see Section 5.2.7).

**5.2.19.1 Preoperational Tests.** Preoperational tests are generally performed sequentially in accordance with written procedures.

Procedures should ensure that prerequisite steps for equipment testing, such as completion of necessary construction, prior testing, safety precautions, and measures to preserve equipment status have been or will be performed (see also Sections 5.2.17 and 5.3.10).

A detailed prescribed physical inspection of equipment components and facilities should be performed to ensure readiness for operation. Typical items to be covered include cleanliness, lubrication, setting of limit switches, calibration of instruments and presence of safety devices. The test procedure should list the checks to be made and include acceptance criteria and reference sources, such as vendor's literature, engineering drawings or plant specifications.

A component test is a functional, operational or performance test of an individual piece of equipment or unit system under prescribed conditions. Typical parameters to be examined are direction of rotation, bearing temperatures, vibration, time delays, and ability to operate with remote and local controls. The procedure should list checks to be made and provide acceptance criteria. Consideration should also be given to providing a run-in period to minimize early failures during operation of the plant.

Individual system tests establish the functional adequacy by operation under prescribed conditions. The tests shall be designed to permit evaluation of system performance including, for example, the measurement of flow, temperature, pressure, response time and vibration, transfer of power supply to emergency power and accuracy and response of control devices.

The preoperational testing program should

demonstrate, as nearly as can be practicably simulated, the overall integrated operation of the plant systems at rated conditions, including simultaneous operation of auxiliary systems. It may be necessary to defer portions of these tests until nuclear heat is available. The procedures used should be similar to those discussed in 5.3.3 and 5.3.4, and they should be modified to require variation in control parameters, such as pump stops and restarts, cycling valves and varying flows so that system performance can be evaluated. For additional requirements in matters relating to preoperational test programs, American National Standard N45.2.8-1975 is generally applicable. [8]

**5.2.19.2 Tests Prior to and During Initial Plant Operation.** Prior to placing a nuclear power plant into operation, a preoperational test program shall be performed to demonstrate the functional adequacy of plant components, systems and structures. Following fuel loading an initial start-up test program shall be conducted to evaluate plant performance as the start-up progresses.

**Responsibilities** The ultimate responsibility for the preparation and execution of adequate preoperational and initial start-up test programs rests with the owner organization. If design or construction is performed by other than the owner organization, design organizations involved should participate in definition of the programs, and the construction organization involved may supply manpower or supervision for execution of part or all of the program, but the owner organization shall determine that the program is adequate and that the results are satisfactory.

**Scheduling** A schedule shall be provided and maintained to provide assurance that all necessary tests are performed and properly evaluated on a timely basis. Testing shall be scheduled so that the safety of the plant is never dependent on the performance of an untested system (see also Section 5.2.8).

**5.2.19.3 Tests Associated with Plant Maintenance, Modifications or Procedure Changes.** Tests shall be performed following plant modifications or significant changes in operating procedures to confirm that the modifications or changes reasonably produce expected results and that the change does not reduce safety of operations.

**5.3 Preparation of Instructions and Procedures.** The administrative controls and quality

assurance program shall be carried out throughout plant life in accordance with written procedures. Activities affecting safety at nuclear power plants shall be described by written procedures of a type appropriate to the circumstances and shall be accomplished in accordance with these instructions and procedures. These procedures shall include appropriate quantitative or qualitative acceptance criteria for determining that important activities have been satisfactorily accomplished. These procedures shall provide an approved preplanned method of conducting operations. Procedures shall be prepared and approved prior to implementation as required by 4.3 and 5.2.15.

**5.3.1 Procedure Scope.** Each procedure shall be sufficiently detailed for a qualified individual to perform the required function without direct supervision, but need not provide a complete description of the system or plant process.

**5.3.2 Procedure Content.** The format of procedures may vary from plant to plant, depending on the policies of the owner organization. However, procedures shall include, as appropriate, the following elements:

(1) **Title.** Each procedure should contain a title descriptive of the work or system or unit to which it applies, a revision number or date, and an approval status.

(2) **Statement of Applicability.** The purpose for which the procedure is intended should be clearly stated; for example, for use during reactor or plant start-up. If the purpose is not clear from the title, a separate statement of applicability should be provided, which may identify the reasons for particular operations.

(3) **References.** References, including reference to technical specifications, should be included in procedures as applicable. References should be identified within the body of procedures when the sequence of steps requires other tasks to be performed prior to or concurrent with a particular step within that task.

(4) **Prerequisites.** Each procedure should identify those independent actions or procedures which shall be completed and plant conditions which shall exist prior to its use. Prerequisites applicable only to certain sections of a procedure should be so identified.

(5) **Precautions.** Precautions should be established to alert the individual performing

the task to those important measures which should be used to protect equipment and personnel, including the public, or to avoid an abnormal or emergency situation. It may be convenient to specify precautions separately. Cautionary notes applicable to specific steps in the procedure should be included in the main body of the procedure and should be identified as such.

(6) **Limitations and Actions.** Limitations on the parameters being controlled and appropriate corrective measures to return the parameter to the normal control band should be specified. It may be convenient to specify limitations and setpoints in a separate section. Where appropriate, quantitative control guides should be provided; for example, an appropriate step of a procedure should say "Manually adjust the feedwater flow controller to maintain the reactor water level at x feet," rather than "Manually adjust the feedwater flow to maintain water level."

(7) **Main Body.** The main body of a procedure should contain step-by-step instructions in the degree of detail necessary for performing a required function or task.

(8) **Acceptance Criteria.** Procedures should contain, where applicable, acceptance criteria against which the success or failure of test-type activity would be judged. In some cases there would be qualitative criteria, i.e., a given event does or does not occur. In other cases quantitative values would be designated.

(9) **Checkoff Lists.** Complex procedures should have checkoff lists. These lists may be included as part of the procedure or may be appended to the procedure.

**5.3.3 System Procedures.** Instructions for energizing, filling, venting, draining, starting up, shutting down, changing modes of operation and other instructions appropriate for operations of systems related to the safety of the plant shall be delineated in system procedures. Procedures for correcting off-normal conditions shall be developed for those events where system complexity may lead to operator uncertainty. System procedures shall contain checkoff lists where appropriate.

**5.3.4 General Plant Procedures.** General plant procedures provide instructions for the integrated operations of the plant. In addition to the characteristics of procedures presented in 5.3.1 and 5.3.2, details concerning specific

general plant procedures are emphasized in the following sections.

**5.3.4.1 Start-up Procedures.** Start-up procedures shall be provided that include starting the reactor from cold or hot conditions and establishing power operation, with the generator synchronized to the line. Recovery from reactor trips shall be in accordance with the start-up procedure and shall be subject to the determinations set forth in 5.2.1.

(1) **Prerequisites.** Start-up procedures shall include provisions for documented determination that prerequisites have been met, including confirmation that necessary instruments are operable and properly set; valves are properly aligned; necessary systems procedures, tests and calibrations have been completed; and required approvals have been obtained. Checkoff lists are normally used for this purpose.

(2) **Main Body.** The main body of the start-up procedures shall include the major steps of the start-up sequence, including reference to appropriate system procedures. Such major steps shall include or reference detailed instructions for their performance, for example, minimum instrumentation requirements, coverage of control rod withdrawal sequence or soluble poison dilution, manipulation of controls, establishment of feed and steam flow and turbine start-up and synchronization. Checkoff lists should be used for the purpose of confirming completion of major steps in proper sequence.

**5.3.4.2 Shutdown Procedures.** Shutdown procedures shall be provided to guide operations during and following controlled shutdown or reactor trips and shall include instructions for establishing or maintaining hot standby or cold shutdown conditions, as applicable. The major steps involved in shutting down the plant shall be specified, including detailed instructions for the performance of such actions as monitoring and controlling reactivity, load reduction and cooldown rates, sequence of activating or deactivating equipment, requirements for prompt analyses of causes of reactor trips or abnormal conditions requiring unplanned controlled shutdowns, and provisions for decay heat removal. Checkoff lists should be used for the purpose of confirming completion of major steps in proper sequence.

**5.3.4.3 Power Operation and Load**

**Changing Procedures.** Procedures for steady-state power operation and load changing shall be provided that include, for example, provisions for use of control rods, chemical shim, coolant flow control or any other system available for long- or short-term control of reactivity, making deliberate load changes, responding to unanticipated load changes and adjusting operating parameters.

**5.3.4.4 Process Monitoring Procedures.** Procedures for monitoring performance of plant systems shall be required to assure that core thermal margins and coolant quality are maintained at all times, that integrity of fission product barriers is maintained at all times and that engineered safety features and emergency equipment are in a state of readiness to maintain the plant in a safe condition if needed. The limits (maximum and minimum) for significant process parameters shall be identified. The nature and frequency of this monitoring shall be covered by operating procedures, as appropriate.

**5.3.4.5 Fuel-Handling Procedures.** Fuel-handling operations shall be performed in accordance with written procedures. These procedures shall specify actions for core alterations, accountability of fuel and partial or complete refueling operations that include, for example, continuous monitoring of the neutron flux throughout core loading, periodic recording of data, audible annunciation of abnormal flux increases and evaluation of core neutron multiplication to verify the safety of loading increments.

Provisions shall be made for preparing specific procedures for each refueling outage and for receipt and shipment of fuel. Plant procedures should, nonetheless, prescribe the general preplanning for the fuel-handling program and its associated safety measures and should identify those aspects of the program for which procedures are to be prepared for each refueling outage.

(1) **Prerequisites.** Prerequisites shall be provided in the fuel-handling procedures that include, for example, the status of plant systems required for refueling; inspection of replacement fuel, control rods, poison curtains and internals; designation of proper tools; proper conditions for spent fuel movement; proper conditions for fuel cask loading and movement; and status of interlocks, reactor trip circuits and mode switches.

(2) **Main Body.** The main body of fuel-handling procedures shall include requirements for refueling, for example, the status of the core, instructions for proper sequence, orientation, and seating of fuel and components, rules for minimum operable instrumentation, actions to be followed in the event of fuel damage, rules for periods when refueling is interrupted, verification of the shutdown margin and the frequency of determination, communications between control room and the fuel loading station, independent verification of fuel and component location, criteria for stopping refueling and for reducing the size of the fuel loading increment, and a containment evacuation plan and its associated safety measures. Documentation of final fuel and component serial numbers and locations shall be maintained.

**5.3.5 Maintenance Procedures.** Maintenance procedures shall contain applicable items listed under 5.3.2 and, in addition, measures to cover the features of maintenance described below.

(1) **Preparation for Maintenance.** Maintenance procedures shall reflect considerations listed under 5.2.6. Adherence to applicable radiation protection measures shall be prescribed. These measures shall specify protective clothing and radiation monitoring needed to assure safety.

(2) **Performance of Maintenance.** The procedures shall contain enough detail to permit the maintenance work to be performed correctly and safely, and shall include provisions for conducting and recording results of required tests and inspections. References should be made to vendor manuals, plant procedures, drawings and other sources as applicable.

(3) **Post Maintenance Check Out and Return to Service.** Instructions shall be included, or referenced, for returning the equipment to its normal operating status.

(4) **Supporting Maintenance Documents.** Where appropriate sections of related documents, such as vendor manuals, equipment operating and maintenance instructions, or approved drawings with acceptance criteria provide adequate instructions to assure the required quality of work, the applicable sections of the related documents shall be referenced in the procedure, or may, in some cases, constitute adequate procedures in themselves. Such procedures shall receive the same level of review and approval as operating procedures.

**5.3.6 Radiation Control Procedures.** Procedures shall be provided for implementation of a radiation control program to meet applicable program requirements. The radiation control program involves the acquisition of data and provision of equipment to perform necessary radiation surveys, measurements and evaluations for the assessment and control of radiation hazards associated with a nuclear power plant. Procedures shall be developed and implemented for: monitoring both external and internal exposures of employees, utilizing accepted techniques; routine radiation surveys of work areas; environmental monitoring in the vicinity of the plant; radiation monitoring of maintenance and special work activities; and for maintaining records demonstrating the adequacy of measures taken to control radiation exposures of employees and others.

**5.3.7 Calibration and Test Procedures.** Procedures shall be provided for periodic calibration and testing of safety-related instrumentation and control systems. Procedures shall also be provided for periodic calibration of measuring and test equipment used in activities affecting the quality of these systems. The procedures shall provide for meeting surveillance schedules and for assuring measurement accuracy adequate to keep safety-related parameters within operational and safety limits.

**5.3.8 Chemical-Radiochemical Control Procedures.** Procedures shall be provided for chemical and radiochemical control activities. They should include, for example, the nature and frequency of sampling and analyses; instructions for maintaining coolant quality within prescribed limits; and limitations on concentrations of agents that could cause corrosive attack, foul heat transfer surfaces or become sources of radiation hazards due to activation.

Procedures shall also be provided for the control, treatment and management of radioactive wastes and control of radioactive calibration sources.

**5.3.9 Emergency Procedures.** Procedures shall be provided to guide operations during potential emergencies. They shall be written so that a trained operator will know in advance the expected course of events that will identify an emergency and the immediate action he should take. Since emergencies may not follow

anticipated patterns, the procedures should provide sufficient flexibility to accommodate variations.

Emergency procedures that cover actions for manipulations of controls to prevent accidents or lessen their consequences should be based on a general sequence of observations and actions. Emphasis should be placed on operator responses to observations and indications in the control room; that is, when immediate operator actions are required to prevent or mitigate the consequences of a serious condition, procedures should require that those actions be implemented promptly.

The emergency procedure format given in 5.3.9.1 provides a basis for coping with emergencies and is an acceptable format for prescribing operator observations and actions. Emergency procedures may contain supplemental background information to further aid operators in taking proper emergency actions, but this information shall be separated from the procedural actions.

It is extremely difficult to distinguish between procedures prepared for the purpose of correcting off-normal conditions which in themselves do not constitute actual emergency situations, but which conceivably can degenerate into true emergencies in the absence of positive corrective action, and procedures required for coping with true emergencies that have already occurred. Some owner organizations choose the term "Off-normal Procedures" for the same purpose that others choose "Emergency Procedures." When initially available intelligence provided to operating personnel via instrument readings, physical conditions, and personal observations may not clearly indicate the difference between a simple operational problem and a serious emergency, the actions outlined in the emergency procedures shall be based on a conservative course of action by the operating crew. Considerable judgment on the part of competent personnel is required before departing from the emergency procedure.

**5.3.9.1 Emergency Procedure Format and Content.** Emergency procedures shall include, as appropriate, the following elements:

(1) **Title.** The title should be descriptive of the emergency for which the procedure is provided.

(2) **Symptoms.** Symptoms should be included to aid in the identification of the

emergency. They should include alarms, operating conditions and probable magnitudes of parameter changes. If a condition is peculiar only to the emergency under consideration, it should be listed first.

(3) **Automatic Actions.** The automatic actions that will probably occur as a result of the emergency should be identified.

(4) **Immediate Operator Actions.** These steps should specify immediate actions for operation of controls or confirmation of automatic actions that are required to stop the degradation of conditions and mitigate their consequences. Examples include the following:

(a) The verification of automatic actions. This step is based on equipment operating as designed and the sequence of events following an expected course. Since variations from the expected course may occur, operators should be prepared to manipulate controls as necessary to cope with the problem. However, the procedure should caution the operator not to place systems in "manual" unless misoperation in "automatic" is apparent, and should require him to make frequent checks for proper operation of systems placed in manual control.

(b) Assurance that reactor is in a safe condition. This step usually means shutdown of the reactor with sufficient reactivity margin and establishment of required core cooling.

(c) Notification to plant personnel of the nature of the emergency.

(d) Determination that the reactor coolant system pressure boundary is intact.

(e) Confirmation of the availability of adequate power sources.

(f) Confirmation that containment and exhaust systems are operating properly in order to prevent uncontrolled release of radioactivity.

(5) **Subsequent Operator Actions.** Steps should be included to return the reactor to a normal condition or to provide for a safe extended shutdown period under abnormal or emergency conditions.

**5.3.9.2 Events of Potential Emergency.** Potential emergency conditions shall be identified and procedures for coping with them shall be prepared. The following categories of events may, depending upon the design of the plant, be considered as examples of potential emergencies for which procedures are written and for which immediate action is indicated:

(1) Loss of coolant from identified and unidentified sources, from small loss to design-basis-accident loss

(2) Reactor transients and excursions

(3) Failure of vital equipment

(4) Loss or degradation of vital power sources

(5) Civil disturbances

(6) Abnormally high radiation levels

(7) Excessive release of radioactive liquid or gaseous effluent

(8) Malfunction of reactivity control system

(9) Loss of containment integrity

(10) Conditions that require use of stand-by liquid poison systems

(11) Possible natural occurrences

(12) Fires

**5.3.9.3 Procedures for Implementing Emergency Plan.** Implementing procedures for emergency plan actions shall contain, as appropriate, the following elements:

(1) Individual assignment of authorities and responsibilities for performance of specific tasks to specific individuals or staff positions.

(2) Protective action levels and protective measures outlined for the emergency identified.

(3) Specific actions to be taken by coordinating support groups.

(4) Procedures for medical treatment and handling of contaminated individuals.

(5) Special equipment requirements for items such as medical treatment, emergency personnel removal, specific radiation detection, personnel dosimetry and rescue operations, procedures for making this equipment available, plus operating instructions for such equipment, and provisions for its periodic inspection and maintenance.

(6) Identification of emergency communications network, including communications required for personnel identification and effective coordination of all support groups.

(7) Description of alarm signals in each facility. At sites with multiple units, alarm signals should be consistent from one unit to another. (Signals for initiating protective measures should be clear and distinct from process or operational alarm system to avoid confusion.)

(8) Procedures required to restore the plant to normal conditions following an emergency.

(9) Requirements for periodically testing of procedures, communications network and alarm systems to assure that they function properly.

See also U.S. Nuclear Regulatory Com-

mission (NRC) "Guide to the Preparation of Emergency Plans for Production and Utilization Facilities." [17]

5.3.10 Test and Inspection Procedures. Test and inspection procedures shall contain a description of objectives; acceptance criteria that will be used to evaluate the results; prerequisites for performing the tests or inspections including any special conditions to be used to simulate normal or abnormal operating conditions; limiting conditions; and the test or inspection procedure. These procedures shall also specify any special equipment or calibrations required to conduct the test or inspection. Test and inspection results shall be documented and evaluated by responsible authority to assure that test and inspection requirements have been satisfied.

Where tests and inspections are to be witnessed, the procedure shall identify hold points in the testing sequence to permit witnessing. The procedure shall require appropriate approval for the work to continue beyond the designated hold point. The test and inspection procedures shall require recording the date, identification of those performing the test or inspection, as-found condition, corrective actions performed, if any, and as-left condition.

## 6. References

- [1] Title 10, Code of Federal Regulations, Part 50, Licensing of Production and Utilization Facilities, Government Printing Office, Washington, D.C.
- [2] American National Standard Quality Assurance Program Requirements for Nuclear Power Plants, N45.2-1971.
- [3] American National Standard Quality Assurance Terms and Definitions, N45.2.10.
- [4] American National Standard for Selection and Training of Nuclear Power Plant Personnel, N18.1-1971.
- [5] American National Standard Qualifications of Inspection, Examination, and Testing Personnel for the Construction Phase of Nuclear Power Plants, N45.2.6-1973.
- [6] American National Standard for Installation, Inspection and Testing of Instrumentation and Electrical Equipment During the Construction of Nuclear Power Generator Station, N45.2.4-1972 (IEEE 336-1971).
- [7] American National Standard Sup-

plementary Quality Assurance Requirements for Installation, Inspection and Testing of Structural Concrete and Structural Steel During the Construction Phase of Nuclear Power Plants, N45.2.5-1974.

- [8] American National Standard Supplementary Quality Assurance Requirements for Installation, Inspection, and Testing of Mechanical Equipment and Systems for Construction Phase of Nuclear Power Plants, N45.2.8-1975.
- [9] American National Standard Quality Assurance Requirements for the Design of Nuclear Power Plants, N45.2.11-1974.
- [10] American National Standard Quality Assurance for Protective Coating Applied to Nuclear Facilities, N101.4-1972.
- [11] American National Standard Industrial Security for Nuclear Power Plants, N18.17-1973.
- [12] American National Standard House-keeping During the Construction Phase of Nuclear Power Plants, N45.2.3-1973.
- [13] American National Standard Cleaning of Fluid Systems and Associated Components During Construction Phase of Nuclear Power Plants, N45.2.1-1973.
- [14] American National Standard Requirements for Collection, Storage and Maintenance of Quality Assurance Records for Nuclear Power Plants, N45.2.9-1974.
- [15] American National Standard Quality Assurance Requirements for the Control of Procurement of Items and Services for Nuclear Power Plants, N45.2.13-1976.
- [16] American National Standard for Packing, Shipping, Receiving, Storage and Handling of Items for Nuclear Power Plants (During the Construction Phase), N45.2.2-1972.
- [17] Title 10, Code of Federal Regulations, Part 50, Licensing of Production and Utilization Facilities, Appendix E, footnote 1, Government Printing Office, Washington, D.C.

When the preceding American National Standards referred to in this document are superseded by a revision approved by the American National Standards Institute, Inc., the revision shall apply.