

IAEA Safety Standards

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Conduct of Operations at Nuclear Power Plants

Safety Guide
No. NS-G-2.14



IAEA
International Atomic Energy Agency

CONDUCT OF OPERATIONS AT NUCLEAR POWER PLANTS

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

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CONDUCT OF OPERATIONS AT NUCLEAR POWER PLANTS

SAFETY GUIDE

INTERNATIONAL ATOMIC ENERGY AGENCY
VIENNA, 2008

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FOREWORD

by Mohamed ElBaradei
Director General

The IAEA's Statute authorizes the Agency to establish safety standards to protect health and minimize danger to life and property — standards which the IAEA must use in its own operations, and which a State can apply by means of its regulatory provisions for nuclear and radiation safety. A comprehensive body of safety standards under regular review, together with the IAEA's assistance in their application, has become a key element in a global safety regime.

In the mid-1990s, a major overhaul of the IAEA's safety standards programme was initiated, with a revised oversight committee structure and a systematic approach to updating the entire corpus of standards. The new standards that have resulted are of a high calibre and reflect best practices in Member States. With the assistance of the Commission on Safety Standards, the IAEA is working to promote the global acceptance and use of its safety standards.

Safety standards are only effective, however, if they are properly applied in practice. The IAEA's safety services — which range in scope from engineering safety, operational safety, and radiation, transport and waste safety to regulatory matters and safety culture in organizations — assist Member States in applying the standards and appraise their effectiveness. These safety services enable valuable insights to be shared and I continue to urge all Member States to make use of them.

Regulating nuclear and radiation safety is a national responsibility, and many Member States have decided to adopt the IAEA's safety standards for use in their national regulations. For the Contracting Parties to the various international safety conventions, IAEA standards provide a consistent, reliable means of ensuring the effective fulfilment of obligations under the conventions. The standards are also applied by designers, manufacturers and operators around the world to enhance nuclear and radiation safety in power generation, medicine, industry, agriculture, research and education.

The IAEA takes seriously the enduring challenge for users and regulators everywhere: that of ensuring a high level of safety in the use of nuclear materials and radiation sources around the world. Their continuing utilization for the benefit of humankind must be managed in a safe manner, and the IAEA safety standards are designed to facilitate the achievement of that goal.

EDITORIAL NOTE

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

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

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1. INTRODUCTION

BACKGROUND

1.1. This Safety Guide was prepared under the IAEA programme for establishing safety standards for nuclear power plants. It provides recommendations on fulfilling the requirements established in Section 5 of the Safety Requirements publication on Safety of Nuclear Power Plants: Operation [1].

1.2. To ensure safety, it is necessary that the management of a nuclear power plant recognizes that the personnel involved in operating the plant should be cognizant of the demands of safety, should respond effectively to these demands, and should continuously seek better ways to maintain and improve safety. This is particularly important as the nuclear industry faces increasing pressure for production in a competitive energy market. This recognition will help to ensure that operating policies for nuclear power plants that result in their safe operation are implemented and that adequate margins of safety are always maintained. The organization of the operations department, the management standards and administrative controls should be such that it is ensured to a high degree that policies and decisions for safety are implemented, that safety is continuously improved and that a strong safety culture is developed and promoted.

1.3. Regardless of the extent of automation of a plant, final decisions on operation and the resulting ultimate responsibilities for the operation rest with the personnel of the operations department of the plant. The operations personnel have a direct impact on plant operations and the associated systems and components.

OBJECTIVE

1.4. The objective of this publication is to provide States with recommendations to ensure that plant operations are conducted in a safe, effective, thorough and professional manner, in accordance with the requirements established in Ref. [1] and, where possible, best international practices. The recommendations of this Safety Guide provide further details on direct activities for operations, complementing Section 6 of the Safety Guide on The Operating Organization for Nuclear Power Plants [2].

SCOPE

1.5. The personnel of the operations department have a direct impact through the conduct of operations on the operation of the plant and its associated systems and components. This publication identifies the main responsibilities and operating practices of the operations department, which controls the safe operation of the plant.

1.6. This Safety Guide discusses the factors to be considered in (a) structuring the operations department of a nuclear power plant; (b) setting high standards of performance and making safety related decisions in an effective manner; (c) conducting control room activities in a thorough and professional manner; and (d) maintaining a nuclear power plant within the established operational limits and conditions.

STRUCTURE

1.7. Section 2 focuses on the organizational and administrative aspects of the operations department. Section 3 provides recommendations relating to the shift complement of operators and their duties. Section 4 provides recommendations on shift routines and on good operating practices. Section 5 provides recommendations for the control of plant equipment and of the plant status. Section 6 provides recommendations on the use and maintenance of facilities for operation and operator aids, and Section 7 provides recommendations on work control and authorization.

2. MANAGEMENT AND ORGANIZATION OF PLANT OPERATIONS

FUNCTIONS AND TASKS OF PLANT OPERATIONS

2.1. The management and organization of plant operations should be such as to ensure a high level of performance in operations. This should be achieved through the effective implementation and control of operations activities.

2.2. A clear understanding by operations personnel of their authorities, responsibilities, accountabilities and interfaces is essential for the proper functioning of a nuclear power plant. For operations personnel to achieve this understanding, the organizational structure of plant operations should be clearly defined and the administrative controls for implementing the structure should be formally documented.

2.3. While the structure of the operations department will vary depending on the specific plant or utility, it is normally composed of personnel who carry out shift work and additional support staff who are present during normal office hours. The following tasks, functions and responsibilities should be taken into consideration in determining the structure for the operations department:

- Planning the overall activities and work of the operations department in cooperation with other departments at the plant, to develop an integrated programme for plant operations;
- Human resources planning and staff development;
- Direct operation of the power plant by monitoring and controlling the plant systems in accordance with relevant rules, operating procedures, established operational limits and conditions and administrative procedures;
- Supervision of shift operations by the shift supervisor and periodic evaluation of shift operations by the operations management (i.e. the management of the operations department);
- Organization of supervision of refuelling and shutdown activities;
- Development of operating procedures and instructions and coordination of their preparation to ensure the safe and reliable operation of plant equipment and systems;
- Coordination of the development and implementation of programmes and policies to ensure that plant operations are carried out in a safe and reliable manner;
- Involvement in the development of surveillance programmes for structures, systems and components important to safety and coordination of their implementation;
- Development and implementation of work management processes to ensure that shift personnel are cognizant of the work in the plant and maintain the correct plant configuration;
- Maintenance of proper plant configuration by the correct handling of changes in the plant status resulting from maintenance, modifications and testing activities;

- Identification of deficiencies in equipment and in the plant to ensure that maintenance activities can be structured effectively;
- Support of outage activities through the involvement of knowledgeable plant operations personnel in schedule development, testing, special projects, alignment of systems¹, tracking of system operability and return to service of systems;
- Establishment and implementation of a system to prevent unauthorized access to, or interference for any reason with, structures, systems and components important to safety;
- Identification of training needs, involvement in the development of training programmes and in the monitoring of training sessions, and evaluation of training programmes;
- Verification of good housekeeping and material conditions in the areas of the plant for which the operations department is responsible;
- Establishment of operating goals and objectives that are in accordance with the overall goals and objectives for the plant;
- Reporting on, and participation in, the investigation of any abnormal event, including near misses and low level events, and deciding on measures to be taken to reduce the probability of a similar situation recurring as an actual plant event;
- Dissemination of information on operating experience to appropriate personnel so that operating crews and other operations staff are made aware of relevant in-house and external events in a timely manner;
- Production of operational reports for management and other groups and authorities as required.

2.4. The overall responsibility for establishing and implementing the operations programme and for managing the operations department should normally rest with the operations manager. The operations manager has responsibility for the day to day running of the operations department, which is responsible for the fulfilment of the tasks and functions specified in para. 2.3.

2.5. The operations department should be involved in prioritizing all work that may affect the safe operation of the plant and should be assigned the responsibility for overseeing the planning and scheduling of such work.

¹ The alignment of a system or equipment is the configuration of the system or equipment that is created by operating switches, valves or breakers to ensure the appropriate functioning of the system or equipment for a given purpose.

OPERATING POLICY

2.6. The operating policy should establish that safety has an overriding priority in all aspects of plant operations, including challenges resulting from production demands and project schedules. The policy should encourage a questioning attitude and a rigorous and prudent approach to all safety related activities. The defence in depth concept should be generally applied to all safety related activities.

2.7. Only authorized staff should be permitted to undertake plant operations that are critical to safety (Ref. [3] provides recommendations on the authorization of nuclear power plant personnel). The assignment to operate control room keys or equipment in the field should be specified in administrative procedures. Only personnel who are physically and mentally fit for operational duties should be allowed to perform activities for plant operation in the main control room or in the field.

2.8. Operations personnel should maintain the reactor and its supporting systems within the bounds of proper equipment alignments and approved operational limits and conditions. All operations affecting safety should be undertaken only in accordance with written procedures. The nuclear power plant should be maintained in a safe condition by deliberate control and monitoring to ensure that basic safety functions (such as controlling the power, cooling the nuclear fuel and confining radioactive material) are fulfilled.

2.9. The operating approaches and practices should ensure that doses due to exposure to ionizing radiation in the plant or due to any planned release of radioactive material from the plant are kept below prescribed dose limits in all operational states, and that they remain ‘as low as reasonably achievable’ (ALARA). Requirements for protection against exposure to ionizing radiation are established in the International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources [4].

HUMAN RESOURCES AND QUALIFICATION OF PERSONNEL

2.10. The operations manager should ensure that an adequate number of competent staff are available at all times to operate the plant safely in both normal and abnormal conditions. There should be sufficient numbers of operations staff to allow staff members to be periodically released to meet requirements for training and development. A long term succession plan for

staff should be put in place, supported by reviews of career development, associated action plans and recruitment plans. These reviews should aim to foster continuous improvement and learning.

2.11. The shift operator crews should be staffed in such a way that a sufficient number of authorized operators² and other staff are available for the reliable accomplishment of assigned tasks in normal and abnormal operating conditions, including fires and accident conditions of different types. Special attention should be paid to ensuring that staffing levels provide adequate redundancy and diversity of the competences needed in both normal and abnormal conditions.

2.12. During particularly busy periods, for example during reactor outages, line managers should ensure that sufficient staffing cover is provided to permit rest periods. Line managers should be particularly vigilant in noticing any signs of fatigue in staff.

2.13. A comprehensive programme of continuing training and requalification for all operations personnel should be established. Additional briefing and, if necessary, training should be provided when an individual has been away from the plant for a significant period of time (e.g. owing to illness). Additional training or briefing may also be necessary for operations critical to safety or for infrequent operations, or for some routine operations that are carried out rarely owing to improved operational performance (e.g. startup of the plant). Changes to regulations and procedures, modifications to plant equipment and changes to the organizational structure should be addressed in continuing training. Special training should be provided on internal and external events relevant for the safety of the plant.

2.14. Support for the training department should be provided through the involvement of members of the operations department as subject matter experts in the analysis of training requirements and the development of training material and training tools, and also as part-time or occasional instructors.

² In some States, some positions of the shift operator crew are subject to a licensing process.

2.15. More detailed recommendations on the training and qualification of operations personnel for nuclear power plants, including a systematic approach to training, are provided in Ref. [3].

PERFORMANCE OBJECTIVES AND STANDARDS

2.16. Realistic, measurable and challenging goals and objectives for operation should be established by the operations department to support the goals and objectives of the organization. These goals and objectives should address areas where high standards of performance are expected. High standards of performance and the expectations of management should be reflected in the operating policy and procedures. Requirements and recommendations for the management of nuclear power plants are established in Refs [2, 5, 6], with one in preparation³.

2.17. Performance objectives and associated criteria should be established and used to monitor routinely the performance of the plant and operations staff, and in particular their attitudes to safety and their responses to safety infringements and violations of operational limits and conditions or procedures (recommendations on operational limits and conditions are provided in Ref. [7]). The performance of operations staff should be appraised regularly and the results should be used for enhancing individual performance and preventing complacency.

2.18. The management of the operations department should be explicitly committed to safety and to established performance standards in plant operations. This commitment should be clearly communicated to the operations personnel and should be supported by the frequent presence of managers at the workplaces of personnel. Safety performance should be improved through leadership and coaching.

2.19. The operations managers and supervisors should, through consistent words and actions, develop a working environment that fosters adherence to the operating policy and reflects high standards of performance. The need for

³ INTERNATIONAL ATOMIC ENERGY AGENCY, The Management System for Nuclear Installations, IAEA Safety Standards Series No. GS-G-3.5, IAEA, Vienna (in preparation).

conservative decision making, a questioning attitude and thoroughness in carrying out plant operating activities should be reinforced.

2.20. Periodic self-assessments should be carried out to reinforce high standards of performance and to identify areas for improvement. Corrective measures should be developed and implemented in a timely manner, on the basis of the results of the self-assessments and evaluations.

2.21. The operations management should support shift operations by ensuring that all necessary requirements for each shift position, such as qualification, job descriptions, training and licences, are sufficient to establish and maintain comfortable working conditions for each shift. Good and regular communication should be established between operations management and control room operators.

INTERFACES WITH OTHER PLANT GROUPS

2.22. The most senior manager of the plant, with the assistance of other managers both at the plant and outside the plant, should ensure that procedures are put in place to cover, in an unambiguous manner, the interfaces between the operations department and other groups in on-site organizations at the plant and in off-site organizations. The purpose of such procedures is to enable support to be provided, as necessary, to the operations department.

2.23. Adequate provisions should be established for providing prompt support to shift supervisors in normal working hours and outside normal working hours in the event of a problem arising in a particular field such as maintenance, reactor physics, radiation protection or water chemistry.

2.24. There should be effective interfaces between the plant shift crew (including control room and field operators), the technical support group and maintenance groups, including contractors. After completing work, the shift crew, technical support group and maintenance groups should ensure that structures, systems and components affected by the work are tested and returned to their original state or to a satisfactory operational state that complies with the operational limits and conditions. Operations staff should not tolerate equipment failures and defects and should urge the maintenance department to resolve such malfunctions within a reasonable time-frame.

2.25. Operations personnel should not normally interchange components or carry out maintenance. When something needs to be fixed, operations personnel should complete a written request for maintenance work and should allow maintenance personnel to complete the task in accordance with approved procedures. Maintenance personnel should be called in to carry out urgent maintenance when necessary.⁴

2.26. The interface between the operations department and the maintenance department should be established in particular for all aspects of outage activity, to ensure that risk from an outage is managed properly and the effectiveness of an outage is maximized. This should be achieved by means of thorough planning and scheduling, effective coordination and implementation and the timely return of systems and components to safe operational status (for the control of outages, see paras 7.18–7.20).

2.27. Effective coordination of the activities of the operations department with those of the plant chemistry department should be established to ensure proper chemistry control of the liquid and gas systems in the plant. In addition, operators should inform the personnel responsible for plant chemistry prior to commencing plant evolutions⁵ that have the potential to affect plant chemistry or to require action from plant chemistry personnel. When problems relating to chemistry arise, operations personnel and plant chemistry personnel should work closely with one another to implement corrective action promptly (for chemistry control, see paras 5.44–5.47).

2.28. Good interfaces should be established between the operations department and the radiation protection department. Operators should inform radiation protection personnel prior to commencing plant evolutions that have the potential to affect radiation levels at the plant or to necessitate action from radiation protection personnel.

⁴ Operations personnel may do some minor repairs or replacements which they are competent to undertake, such as replacing light bulbs that indicate the status of equipment, replacing chart paper and ink cartridges, connecting portable sump pumps, adding oil to components and connecting steam generator sluice hoses. All such minor maintenance activities should be clearly listed in the job descriptions of the appropriate operations personnel.

⁵ Plant evolution is the development or sequence of changes in the status of a system or equipment that is initiated by plant transients or by deliberate action of the operator.

2.29. The operations department should coordinate relevant activities with the organization responsible for security at the plant and for developing measures to reduce the vulnerability of the plant to malicious acts, to be able to utilize the synergies between safety and security.

3. SHIFT COMPLEMENT AND FUNCTIONS

SHIFT SUPERVISOR

3.1. The shift supervisor should manage plant operations on each shift and should be responsible for overall safety at the plant, protection and safety of personnel, coordination of plant activities and performance of the assigned shift. The responsibilities typically should include supervision of the shift personnel and direct control of plant operations in accordance with the operational limits and conditions and operating procedures. In addition, the responsibilities of the shift supervisor should normally be:

- To assume the authority of the plant manager during off-hours. The shift supervisor should be given the authority to resolve any problem that may affect the safe operation of the plant.
- To ensure that the shift is properly staffed and to request or initiate a call-out of personnel who are fit for duty, as required; to monitor the qualification and the physical and mental condition of the operations personnel on shift.
- To coordinate the activities of the operations, chemistry, radiation protection, maintenance and technical support groups to accomplish the operating objectives of the shift.
- To oversee closely activities that support complex and infrequently performed plant evolutions, such as plant heat-up, startup and shutdown, physical tests, cooldown and refuelling.
- To perform plant inspections to identify and correct problems involving the performance of personnel, policies and procedures, housekeeping, material conditions and hazards to personnel; to ensure that deficiencies are identified and corrective action is initiated.
- To initiate an assessment of the nature and extent of any unusual occurrence and subsequently to take the first steps necessary to minimize the consequences, to ensure the protection and safety of personnel and to

initiate the action required by the emergency plan; in an emergency, to act as the senior emergency coordinator until relieved by higher management authority.

- To initiate preparation of reports of abnormal events and reportable occurrences.
- To authorize temporary alterations and the use of jumpers and lifted leads and initiate appropriate engineering reviews of such items when required.
- To authorize the tagging of plant equipment and systems to ensure the radiation protection of personnel, the protection of equipment and the status control of the tagging boundary and all components within the boundary.
- To authorize the removal from service of systems and components for maintenance, testing and/or operational activities and their subsequent return to service.
- To authorize the issue of the associated permits to carry out work or to carry out tests on systems and components important to safety.
- To direct or assume the duties of a control room operator to ensure the safe operation of the plant if such action is considered necessary.
- To review the shift records for accuracy, completeness and trends and to maintain the shift supervisor's log.
- To oversee the qualification, requalification and training of shift personnel to ensure that they are properly trained to established standards and properly qualified to perform their assigned duties.

3.2. In multiunit power plants, where one shift supervisor may be responsible for all units, other persons, designated as unit supervisors, should be made responsible to the shift supervisor for the operation of each unit.

OPERATORS

3.3. Under the authority of the shift supervisor or the unit supervisor, the control room operators⁶ are responsible for monitoring and control of the plant

⁶ The common practice is to have one or two reactor operators (of whom one, usually, has the position of senior reactor operator) in the control room and several field operators who report to the reactor operator. In some States, in addition to the reactor operators in the control room, there is a turbine operator responsible for monitoring and control of turbine equipment and its associated systems. The turbine operator usually reports directly to the shift supervisor.