

IAEA SAFETY STANDARDS SERIES

Operational Limits and Conditions and Operating Procedures for Nuclear Power Plants

SAFETY GUIDE

No. NS-G-2.2



INTERNATIONAL
ATOMIC ENERGY AGENCY
VIENNA

IAEA SAFETY RELATED PUBLICATIONS

IAEA SAFETY STANDARDS

Under the terms of Article III of its Statute, the IAEA is authorized to establish standards of safety for protection against ionizing radiation and to provide for the application of these standards to peaceful nuclear activities.

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**OPERATIONAL LIMITS AND
CONDITIONS AND
OPERATING PROCEDURES FOR
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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FOREWORD

by Mohamed ElBaradei
Director General

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

The following advisory bodies oversee the development of safety standards: the Advisory Commission for Safety Standards (ACSS); the Nuclear Safety Standards Advisory Committee (NUSSAC); the Radiation Safety Standards Advisory Committee (RASSAC); the Transport Safety Standards Advisory Committee (TRANSSAC); and the Waste Safety Standards Advisory Committee (WASSAC). Member States are widely represented on these committees.

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

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

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

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

Non-radiological aspects of industrial safety and environmental protection are also not explicitly considered; it is recognized that States should fulfil their international undertakings and obligations in relation to these.

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

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

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

EDITORIAL NOTE

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

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

The English version of the text is the authoritative version.

CONTENTS

1.	INTRODUCTION	
	Background (1.1–1.3)	1
	Objective (1.4)	1
	Scope (1.5)	1
	Structure (1.6)	2
2.	SAFETY OBJECTIVE (2.1)	2
3.	THE CONCEPT OF OPERATIONAL LIMITS AND CONDITIONS AND THEIR DEVELOPMENT	2
	The concept of operational limits and conditions (3.1–3.7)	2
	Development of operational limits and conditions (3.8–3.16)	4
4.	SAFETY LIMITS (4.1–4.5)	5
5.	LIMITING SAFETY SYSTEM SETTINGS (5.1–5.4)	6
6.	LIMITS AND CONDITIONS FOR NORMAL OPERATION (6.1–6.9)	8
7.	SURVEILLANCE REQUIREMENTS (7.1–7.5)	9
8.	OPERATING PROCEDURES	10
	General (8.1–8.7)	10
	Particular aspects of emergency procedures (8.8–8.18)	11
	Procedures for operation in the commissioning phase (8.19–8.20)	13
9.	DEVELOPMENT OF OPERATING PROCEDURES (9.1–9.7)	14
10.	COMPLIANCE WITH OPERATIONAL LIMITS AND CONDITIONS AND OPERATING PROCEDURES (10.1–10.7)	15
	APPENDIX I: SELECTION OF LIMITS AND CONDITIONS FOR NORMAL OPERATION	19

APPENDIX II: DEVELOPMENT OF OPERATING
PROCEDURES (OUTLINES) 28

REFERENCES 31

ANNEX: EXAMPLE TO EXPLAIN SOME TERMS USED 33

GLOSSARY 37

CONTRIBUTORS TO DRAFTING AND REVIEW 39

ADVISORY BODIES FOR THE ENDORSEMENT
OF SAFETY STANDARDS 41

1. INTRODUCTION

BACKGROUND

1.1. This Safety Guide was prepared as part of the Agency's programme for establishing safety standards relating to nuclear power plants. The present Safety Guide supersedes the IAEA Safety Guide on Operational Limits and Conditions for Nuclear Power Plants which was issued in 1979 as Safety Series No. 50-SG-O3.

1.2. For a nuclear power plant to be operated in a safe manner, the provisions made in the final design and subsequent modifications shall be reflected in limitations on plant operating parameters and in the requirements on plant equipment and personnel. Under the responsibility of the operating organization, these shall be developed during the design safety evaluation as a set of operational limits and conditions (OLCs). A major contribution to compliance with the OLCs is made by the development and utilization of operating procedures (OPs) that are consistent with and fully implement the OLCs.

1.3. The requirements for the OLCs and OPs are established in Section 5 of the IAEA Safety Requirements publication Safety of Nuclear Power Plants: Operation [1], which this Safety Guide supplements.

OBJECTIVE

1.4. The purpose of this Safety Guide is to provide guidance on the development, content and implementation of OLCs and OPs. The Safety Guide is directed at both regulators and owners/operators.

SCOPE

1.5. This Safety Guide covers the concept of OLCs, their content as applicable to land based stationary power plants with thermal neutron reactors, and the responsibilities of the operating organization regarding their establishment, modification, compliance and documentation. The OPs to support the implementation of the OLCs and to ensure their observance are also within the scope of this Safety Guide. The particular aspects of the procedures for maintenance, surveillance, in-service inspection and other safety related activities in connection with the safe operation of nuclear power plants are outside the scope of this Safety Guide but can be found in other IAEA Safety Guides (see, for example, Refs [2] and [3]).

STRUCTURE

1.6. Section 2 indicates the relation between the fundamental safety objective and the OLCs. The concept and development of OLCs are introduced in Section 3. Sections 4 to 7 describe in some detail the characteristics of the types of OLCs, safety limits, limits on safety system settings, limits and conditions for normal operation, and surveillance requirements. Sections 8 and 9 address the question of OPs, including their development. In Section 10 guidance is provided on how to ensure compliance with OLCs and procedures, including reference to the need to retain records of such compliance. Appendix I presents a sample list of the items for which limits and conditions are generally established and Appendix II gives outlines for the development of OPs. In the Annex an example is provided to explain some terms used in the Safety Guide. A Glossary is included at the end.

2. SAFETY OBJECTIVE

2.1. To achieve the fundamental technical safety objective directed to the prevention of situations from arising which might lead to accident conditions, and the mitigation of the consequences of such accident conditions should they arise: "The operation of the installation must be controlled in accordance with a set of operational limits and conditions, derived from the safety analysis, which identify safe boundaries of operation. These limits and conditions must be revised as necessary in the light of experience from commissioning and operation. Minimum requirements must be set for the availability of staff and equipment... Operations must be carried out by adequately trained and authorized personnel in accordance with detailed, validated and approved procedures..." (Ref. [4], para. 510).

3. THE CONCEPT OF OPERATIONAL LIMITS AND CONDITIONS AND THEIR DEVELOPMENT

THE CONCEPT OF OPERATIONAL LIMITS AND CONDITIONS

3.1. The Agency's Safety Requirements for Operation [1] state that OLCs shall be developed to ensure that plants are operated in accordance with design assumptions and intent. In order to achieve this requirement the plant safety analysis report should be developed in such a manner as to identify clearly the OLCs that must be met to

prevent situations from arising which might lead to accident conditions or to mitigate the consequences of accidents if they do occur.

3.2. The OLCs shall contain operational requirements for different operational states including shutdown [1]. These operational states should include starting up, power production, shutting down, maintenance, testing and refuelling. The OLCs should also define operational requirements to ensure that safety systems, including engineered safety features, perform the necessary functions in all operational states and also in design basis accidents (DBAs).

3.3. The technical aspects of the OLCs cover the limitations to be observed, as well as the operational requirements that structures, systems and components important to the safety of the nuclear power plant be able to perform their intended functions as assumed in the plant safety analysis report. Safe operation depends upon personnel as well as on equipment; OLCs should therefore also cover actions to be taken and limitations to be observed by operating personnel.

3.4. With regard to operating personnel, the OLCs include those principal requirements for surveillance and corrective or complementary actions that are necessary to supplement the functioning of equipment involved in maintaining the established OLCs. Some OLCs may involve combinations of automatic functions and actions by personnel.

3.5 The OLCs at the power plant should include the following items:

- (a) Safety limits,
- (b) Limiting safety system settings,
- (c) Limits and conditions for normal operation,
- (d) Surveillance requirements,
- (e) Action statements for deviations from the OLCs.

In addition, OLCs may include objectives for all or some of the most significant OLCs in order to justify their application, as well as a basis for their derivation. These items should be included in the documentation on OLCs to increase consciousness on the part of plant personnel of their application and observance.

3.6. It should be understood that OLCs form a logical system in which the elements listed in para. 3.5 are closely interrelated and in which the safety limits constitute the ultimate boundary of the safe conditions. An example explaining such an interrelationship is given in the Annex. The OLCs should be readily accessible to control room personnel. For this they should be collected in one document for control

room use. Control room operators should be highly knowledgeable of the OLCs and their technical basis.

3.7. Should a situation arise in which, for any reason, operating personnel do not understand the operational state or cannot ascertain that the power plant is being operated within operating limits, or the plant behaves in an unpredicted way, measures should be taken without delay to bring the plant to a safer state.

DEVELOPMENT OF OPERATIONAL LIMITS AND CONDITIONS

3.8. The OLCs shall be based on a safety analysis of the individual plant and its environment in accordance with the provisions made in the design [1]. The OLCs should be determined with due account taken of the uncertainties in the process of safety analysis. The safety analysis report and OLCs should be reviewed and amended where necessary on the basis of the results of commissioning testing. The justification for each of the OLCs should be substantiated by means of a written indication of the reason for its adoption and any relevant background information. These justifications should be readily available when necessary.

3.9. The initial OLCs should normally be developed in co-operation with the designers well before commencement of operation to ensure that adequate time is available for assessment and approval by the regulatory body.

3.10. Each OLC should have associated surveillance requirements that support the operating personnel in ensuring compliance with the OLC.

3.11. It is also essential that the OLCs be meaningful to the responsible operating personnel and be defined by measurable or directly identifiable values of parameters. Where directly identifiable values cannot be used, the relationship of a limiting parameter with the reactor power or another measurable parameter should be indicated by tables, diagrams or computing techniques as appropriate. The limit or condition should be stated in such a way that it is clear whether a breach has or has not occurred in any situation.

3.12. Clear presentation and avoidance of ambiguity are important contributors to reliability in the use of OLCs, and therefore advice on human factors should be sought at an early stage in the development of the documentation in which the OLCs will be presented to the operating personnel. The meaning of terms should be explained to help prevent misinterpretation.

3.13. Where modifications to the OLCs become necessary, the same approach as that described in paras 3.8–3.12 should be followed. All plant modifications should be reviewed to determine whether they necessitate modifications to the OLCs. Any modification to the OLCs should be subject to assessment and approval by the regulatory body as required.

3.14. When it is necessary to modify OLCs on a temporary basis, for example to perform physics tests on a new core, particular care should be taken to ensure that the effects of the change are analysed, and the modified state, although temporary, necessitates at least the same level of assessment and approval as a permanent modification. When a reasonable alternative approach is available, this should be preferred to a temporary modification of an OLC.

3.15. Periodic review of OLCs should be undertaken to ensure that they remain applicable for their intended purpose, and, where necessary, the OLCs should be modified in the light of operating experience and technological development. This periodic review should be carried out even if the plant has not been modified.

3.16. Consideration should be given to probabilistic safety assessment (PSA) applications in the optimization of OLCs. Probabilistic assessment methods together with operating experience may be used for justification and modification of OLCs.

4. SAFETY LIMITS

4.1. The concept of safety limits is based on the prevention of unacceptable releases of radioactive materials from the plant through the application of limits imposed on the temperatures of fuel and fuel cladding, coolant pressure, pressure boundary integrity and other operational characteristics influencing the release of radioactive material from the fuel. Established safety limits are to protect the integrity of certain physical barriers that guard against the uncontrolled release of radioactive material. The safety limits should be established by means of a conservative approach to ensure that all the uncertainties of safety analyses are taken into account. This implies that exceeding a single safety limit does not always lead to the unacceptable consequences mentioned earlier. Nevertheless if any safety limit is exceeded, the reactor should be shut down and normal power operation restored only after appropriate evaluation has been performed and approval for restarting has been given in accordance with established plant procedures.

4.2. The limits are chosen with the objective of maintaining the integrity of the fuel cladding and the integrity of the pressure boundary of the reactor coolant system