Replacement Research Reactor Project

SAR CHAPTER 17
OPERATIONAL LIMITS AND CONDITIONS

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For
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TABLE OF CONTENTS

End of Table of Contents

17 OPERATIONAL LIMITS AND CONDITIONS

17.1 INTRODUCTION

The objectives of this chapter are:

1. To identify the safety requirements applicable to the Operational Limits and Conditions (OLCs).
2. To identify the criteria for Limiting Conditions for Operations in OLCs.
3. To identify the methodology by which the OLCs are derived.
4. To provide a listing of nominal safety limits and limiting safety system settings and indicative limiting conditions for operation.

A summary description of the structure, contents and format of the OLCs is provided. An indicative listing of safety limits, limiting safety system settings, other functions included in the OLCs and limiting conditions for operation are also provided together with a brief indication as to their bases.

It should be noted that some OLCs may need to be modified based upon the outcome of Hot Commissioning. In addition, it is anticipated that the OLCs are likely to be modified during the life of the Reactor Facility as operational experience is gained with the facility. Any such modifications will be performed in accordance with the appropriate procedure of modifications and subject to review and approval of ARPANSA as described in Chapter 13.

The actual OLCs are separate from the Safety Analysis Report (SAR).

17.1.1 General

The OLCs form an envelope or boundary of reactor parameter values and system conditions within which the operation of the reactor facility has been demonstrated in this SAR to be safe, and that the site personnel, the public and the environment are adequately protected from radiological hazards. Thus the OLCs contribute to the prevention of accidents and the mitigation of the consequences of accidents should they occur.

The OLCs lie within the Limiting Safety System Settings and represent an important basis for the operating organisation to be authorised to operate the facility. They have been submitted for review and approval in conjunction with this SAR as a part of ANSTO's application for a Facility Licence, Operating Authorisation for the Reactor Facility.

The OLCs are consistent with the IAEA Safety Series 35 – G1 Safety Assessment of Research Reactors and Preparation of the Safety Analysis Report (1994) and the draft Safety Standards Series Guide NS261 NS-G-4.3 Operational Limits and Conditions for Research Reactors (March 2000).

The OLCs are considered mandatory and will be complied with at all applicable times.

17.1.2 Applicability

The OLCs discussed in this Chapter are applicable to the operation of the Replacement Research Reactor Facility (the Reactor Facility) after the reactor has been commissioned.

Specific limits that are applicable during the Commissioning phase following fuel loading are identified in commissioning plans and associated documentation. These OLCs will be a subset of the OLCs for normal operation. Additional OLCs that may be necessary for reactor operation under special conditions, such as the conduct of a particular experiment or the implementation of a modification to the reactor, will be defined as part of any related safety submission to ARPANSA.

17.1.3 Content and Format of the Operational Limits and Conditions

The OLCs were developed using the guidance of the U.S. Nuclear Regulatory Commission (NRC) NUREGs 1430 through 1434 (Standard Technical Specifications for Light Water Power Reactors), Revision 2 dated April 2001, as modified to reflect the specific design and licensing basis presented in the SAR and applicable regulatory processes. IAEA draft Safety Standards Series Guide NS261 NS-G-34.3, Operational Limits and Conditions for Research Reactors, dated March 2000, provided guidance to ensure consistency with the approach used to develop the OLCs as did IAEA Safety Guide NS-G-2.2, Operational Limits and Conditions and Operating Procedures for Nuclear Power Plants and ANSI/ANS-15.1-1990, The Development of Technical Specifications for Research Reactors. Nuclear Energy Institute (NEI) 01-03, Writer’s Guide for the Improved Standard Technical Specifications, dated November 2001, the writer’s guide for U.S. NRC NUREGs 1430 though 1434, ensured format, human factors principles and concepts were applied appropriately.

As a result, the OLCs are formatted in a manner consistent with international best practice and consist of the following.

17.1.3.1 Objective

To clearly identify the purpose of the Limiting Condition

17.1.3.2 Limiting Condition

The lowest functional capability or performance level of equipment or parameters required to meet the assumptions of the safety analyses is specified. When a limiting condition is not met, the required actions are followed.

An OLC is considered to be breached when a limiting condition is not met and the required actions are not carried out.

17.1.3.3 Applicability

The applicability of the OLC is identified in terms of operational state or other specific activity.

17.1.3.4 Actions

Conditions that result in the lowest functional capability or performance level not being met are identified clearly and in the event that a limiting condition is not met, required actions are specified to be taken. A time limit within which the action must be completed is identified. Completion times are based on engineering judgement and operational experience. Where practical, the Probabilistic Safety Assessment is used to establish appropriate completion times.

17.1.3.5 Surveillance Requirements

The surveillance requirements specifying the frequency and the scope of testing to show that the performance requirements associated with the limiting condition are clearly identified. Further explanation relating to the surveillance requirements is contained in Section 17.5.

17.1.3.6 Bases

Sufficient information is provided in the bases to allow a clear understanding of the nuclear safety significance of the OLC. The bases ensure that the consequences associated with any future modification or change to the OLC can be readily understood. No bases for design or administrative requirements are necessary.

Allowable values are specified for required protective functions. A channel is considered inoperable if its actual trip setpoint is not within its required allowable value.

Setpoints are determined from the analytic limits, corrected for defined process, calibration, and instrument errors. The allowable values are then determined based on the trip setpoint values, by accounting for the calibration-based errors. These errors are limited to reference accuracy, instrument drift, errors associated with measurement and test equipment, and calibration tolerance of loop components. The setpoints and allowable values determined in this manner provide adequate protection because instrument uncertainties, process effects, calibration tolerances, and instrument drift are accounted for and appropriately applied for the instrumentation.

Individual protective functions are required to be operable in the states or other conditions specified. A Reactor Protection System trip may be required to mitigate the consequences of a Design Basis Accident or transient. To ensure reliability for each Design Basis Accident, separate functions are provided within the Reactor Protection Systems. .

End of Section

17.2 SAFETY LIMITS

17.2.1 General

Safety limits are established to protect the integrity of the principal physical barrier that guards against uncontrolled radioactive release. This principal physical barrier is the cladding of the fuel material. The safety limits are set on dominant measured process variables that may affect the integrity of the barrier and can be readily monitored and controlled.

Design criteria require that specified acceptable fuel design limits are not exceeded during steady state operation, normal operational transients, and anticipated operational occurrences. This is accomplished by having a departure from nucleate boiling (DNB) and flow instability (redistribution flow) design basis. This approach ensures that fuel temperatures remain well below the limit by providing a very high probability and confidence level that DNB and flow instabilities will not occur.

The restriction of a safety limit prevents overheating of the fuel and cladding, which could result in the release of fission products to the coolant. Because operation above the boundary of the nucleate boiling regime could result in excessive cladding temperatures, normal operation is restricted to within the subcooled regime. This very conservative measure prevents overheating of the fuel under the most extreme transients.

Sufficient information is provided in the basis of the safety limit to allow a clear understanding of its nuclear safety significance.

17.2.2 Fuel Plate Cladding

For the core of the Reactor Facility, the principal physical barrier is the cladding on the fuel plates and the safety limit relates to the maximum allowable temperature below which cladding integrity is ensured. As there is no direct measurement of the fuel cladding temperature, the safety limit is expressed in terms of related parameters.

Definition of the safety limit in terms of these parameters ensures that flow instability, Departure from Nucleate Boiling (DNB), and other potentially damaging thermal-hydraulic phenomena are avoided for all operational states and design basis accident conditions.

Safety limits are derived from the nucleonic and thermal-hydraulic analyses and demonstrated to be acceptable by the safety analysis. Appropriate margins are incorporated into the safety limits.

Because both forced circulation and natural circulation can cool the core depending on the reactor’s thermal power, different safety limits may be defined for each case.

When operating at power, there is a minimum acceptable combination of operating parameters for which the minimum DNB ratio is not less than the safety analysis limit and the enthalpy of the coolant in the reactor core is less than the enthalpy of saturated liquid. There exist acceptable combinations of parameters to avoid flow instabilities and an unacceptably low DNB ratio.

End of Section

17.3 LIMITING SAFETY SYSTEM SETTINGS

17.3.1 General

The Safety Analysis identifies Safety Limits to process variables that are measured. To ensure that these are never exceeded Analytical Limits are derived which take account of a range of systems factors.

The parameter trip set points are determined from the Analytical Limits after allowance is made for process, calibration and instrument errors.

Each trip setpoint has a limiting allowable value which is the limit that the setpoint may have at any time that it is tested. If this limit is exceeded then corrective action will be required.

The allowable values therefore represent the design basis envelope of parameters that, if not exceeded, ensures the health and safety of the public against undue exposure to radiation. They are a means of preventing accidents and of mitigating their consequences should they occur.

Only those protective functions credited in the safety analysis are specified in the OLCs.

Instrumentation settings are defined for all states.

Not all trips are for the protection of the reactor.

End of Section

17.4 LIMITING CONDITIONS FOR OPERATION

17.4.1 General

The Limiting Conditions for Safe Operation are constraints on equipment and operational parameters which shall be adhered to in all applicable operational states of the reactor.

17.4.2 Derivation of Limiting Conditions for Operation

The limiting conditions for safe operation include prescribed actions to be taken by the operating personnel in the event of a limiting condition not being met.

In some cases process variable or parameters that reach a Limiting Condition for Safe Operation initiate alarms to enable operating personnel to take appropriate action to prevent safety system settings from being exceeded. For example, some aspects of the minimum plant configuration are ensured by the limiting safety system settings of the Reactor Protection Systems.

The scope and content of the OLCs are based on the facility design described in this SAR. OLCs have been developed for any system, structure, component, limitation, analysis assumption or initial condition that meets safety-related criteria.

There are design features, such as materials of construction and geometric arrangements, which could have an effect on safety if altered. Such design features are not operational in nature, however, and therefore are not reflected in OLCs. Compliance with design features shall be guaranteed by means of the procedures to be implemented to address any future modification to the facility.

End of Section

17.5 SURVEILLANCE REQUIREMENTS

17.5.1 General

The surveillance requirements specify the frequency and the scope of testing to show that the performance requirements associated with the limiting conditions for operation are being met.

17.5.2 Types of Surveillance

Surveillance requirements relate to testing, calibration, or inspection to assure that systems and components are operable. A system or component is operable when it is capable of performing its intended safety function. Surveillance requirements are established in order to provide a program for verifying operability. Although surveillance requirements must be met at all applicable times, performance is confirmed in accordance with the frequencies stipulated in the OLCs.

Surveillance testing is conducted in accordance with appropriate written procedures and instructions that are within the Quality Management System.

17.5.3 Derivation of Surveillance Requirements

Surveillance requirements are derived from international best practices, manufacturer recommendation, codes and standards, engineering judgement and design requirements as described in the SAR. Personnel safety and operational aspects are also taken into consideration in the derivation of the surveillance requirements.

End of Section

17.6 ADMINISTRATIVE REQUIREMENTS

17.6.1 Introduction

Administrative requirements are controls concerning organisational structure and responsibilities, staffing, training of facility personnel, review and audit requirements, operating procedures, modifications, experiments, records and reports, and required actions following violation of an OLC. Administrative requirements relating to security and access control are the subject of a separate document.

17.6.2 Organisation and Staffing

The Reactor Facility organisation is addressed in Chapter 13. The organisational structure combined with the competencies and responsibilities of the staff demonstrates the ability of the management to ensure the safe operation of the plant.

Chapter 13 includes organisational charts, defines duties, and identifies responsibilities and minimum qualification and training requirements. It also demonstrates the bases for the minimum staffing levels to apply for each operating state.

17.6.3 Review

The operation of the reactor facility will be reviewed by a Safety Committee which will have a membership competent in relevant fields associated with the design and operation of nuclear reactors.

The terms of reference of the Committee will be determined and submitted to ARPANSA for approval prior to the commencement of Cold Commissioning. Items to be reviewed by the Committee will include:

a) Proposed changes in the OLCs or facility licence

b) Proposed changes to existing tests, experiments, equipment, systems or procedures; and new tests, experiments, equipment, systems or procedures that have safety significance

c) Modifications to the reactor facility

d) Breaches of the OLCs, the licence or procedures having safety significance

e) Events that are required to be reported or have been reported to the regulatory body

f) Audit reports

g) Periodic reviews of the operation and safety performance of the facility

17.6.4 Reporting Requirements

The requirements for reporting certain information to the Reactor Facility management and ARPANSA, including those items above, are provided in the OLCs.

17.6.5 Quality Assurance

A Quality Management System has been developed for the Reactor Facility drawing on the experience of implementation of the Quality System at HIFAR, and extending it to take account of changing regulatory requirements, and quality and environmental standards. The QMS includes the necessary administrative controls over the OLC, including development, modification, and compliance. Quality Assurance for the Reactor Facility is described in Chapter 18.

End of Section