Regulatory Document

Texte de réglementation

Atomic Energy Control Board

Commission de contrôle de l'énergie atomique

REGULATORY DOCUMENT R-77

Regulatory Policy Statement

OVERPRESSURE PROTECTION REQUIREMENTS FOR PRIMARY HEAT TRANSPORT SYSTEMS IN CANDU POWER REACTORS FITTED WITH TWO SHUTDOWN SYSTEMS

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Canada

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6. The Atomic Energy Control Board may be contacted as follows:

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3. ALLOWABLE SERVICE CONDITIONS

3.1 In order to define the allowable service conditions following certain events or failures, the latter have been graded in terms of probability of occurrence. This is necessary if service conditions with various shutdown system impairments are to be specified, because of the probabilistic nature of the impairments themselves. The events or failures have been graded into three categories according to the frequency at which they are expected to occur:

(a) moderate frequency,

(b) low frequency, or

(c) extremely low frequency.

Agreement is to be reached between the licensee and the AECB as to the correct placement of individual events in these categories on a case-by-case basis. To assist in this process the following numerical ranges of probability of occurrence are suggested:

(a) moderate frequency $> 10^{-2}$/year,

(b) low frequency $10^{-2} - 10^{-4}$/year,

(c) extremely low frequency $< 10^{-4}$/year.

3.2 Table I states the allowable service limit for each of the event categories assuming that either:

(a) the first shutdown system trips as intended; or

(b) the first shutdown system fails to act, but the second shutdown system trips.

The "first shutdown system" is the one which is intended to trip first for the particular event under consideration. It may be either of the two shutdown systems (i.e., either SDS1 or SDS2).

3.3 In analyses to demonstrate that the requirements of Table I are met:

(a) process system protective action (including regulating system action) must not be credited; and

(b) only second trip parameters in each of the shutdown systems may be credited (except for the special cases outlined in Sections 3.4 to 3.6 below).

This is consistent with the more general requirements of Reference 1.

3.4 The first trip parameter may be credited in the case where this trip parameter is high pressure in the system under consideration. (This recognizes the unique relevance of a high-pressure trip to overpressure protection.)

OVERPRESSURE PROTECTION REQUIREMENTS FOR PRIMARY HEAT TRANSPORT SYSTEMS IN CANDU POWER REACTORS FITTED WITH TWO SHUTDOWN SYSTEMS

1. INTRODUCTION

The overpressure protection requirements of Article NB 7000 of Section III of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code) are incorporated in the National Standard of Canada N285.1 [Ref. 1]. These requirements do not, however, refer to a particular nuclear system design. This is recognized in paragraphs NCA-2141 and NB-7120 of the ASME Code which make reference to the requirements of the appropriate regulatory authority for guidance.

For CANDU power reactors fitted with two shutdown systems, some guidance is given in the Atomic Energy Control Board (AECB) Regulatory Document R-10 [Ref. 2], but this does not address overpressure protection as a specific topic and further clarification is required. This document seeks to provide such clarification.

NOTE: In this document, references are made to Section III of the 1980 Edition of the ASME Code. This is for convenience only; the requirements stated herein apply to whichever edition of the Code is being applied at a particular reactor site.

2. PROBLEM DEFINITION

2.1 Reference 2 requires that CANDU power reactors be fitted with two independent shutdown systems, and that each of these should incorporate two diverse trip parameters for serious process failures requiring shutdown action, insofar as this is practicable. Because the reactor shutdown systems form part of an integrated overpressure protection system, it is necessary to define the role of each of the shutdown systems (and of each trip parameter) in the integrated system. Specifically, it is necessary to define appropriate service limits for events or failures which lead to overpressure and which occur coincidently with various shutdown system impairments (e.g., failure of one trip parameter of a shutdown system).

2.2 Where power-actuated relief valves are connected to instrumentation associated with one or both shutdown systems, the credit which may be given to these valves under conditions of shutdown system impairment must be specified in the overpressure protection analysis.

2.3 Shutdown system action is normally only required for overpressure protection of primary heat transport systems. Therefore, the requirements of this document apply exclusively to primary heat transport systems.

2.4 Shutdown system action can make no contribution to overpressure protection in situations where the reactor is initially at zero power and remains at zero power. The requirements of this document do not apply to such situations.

TABLE 1

OVERPRESSURE PROTECTION REQUIREMENTS FOR PRIMARY HEAT TRANSPORT SYSTEMS
IN CANDU POWER REACTORS
FITTED WITH TWO SHUTDOWN SYSTEMS

FREQUENCY OF EVENT OR FAILURE	SERVICE LIMIT WITH TRIP OF:*	
	1ST SHUTDOWN SYSTEM	2ND SHUTDOWN SYSTEM
MODERATE	B	C
LOW	C	D
EXTREMELY LOW	D	D

NOTES: 1. Process system protective action (including regulating system action) may not be credited.

2. Second trip parameters only may be credited, except as outlined in note 3 below.

3. The first trip parameter may be credited if it is high pressure in the system under consideration.

4. The "first shutdown system" is first to trip (it may be either SDS1 or SDS2).

*Level B, C and D Service Limits are those defined in the General Requirements under Section III of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code).

3.5 In a case where only one trip parameter is installed in the first shutdown system and where this parameter is not high pressure in the system under consideration, the service limits given for the first shutdown system in Table I must be met by the first parameter of the second shutdown system.

3.6 In a case where only one trip parameter is installed in the second shutdown system, this trip parameter may be credited.

4. CONNECTIONS BETWEEN POWER-ACTUATED RELIEF VALVES AND SHUTDOWN SYSTEMS

4.1 In reactor plants where power-actuated relief valves are installed and are connected to the instrumentation associated with one of the shutdown systems, these relief valves should be considered as part of the shutdown system in question. Consequently, such relief valves should only be credited in analyses in which it is assumed that the shutdown system in question trips.

NOTE: Where power-actuated relief valves are connected to the first shutdown system's instrumentation, it is conceivable that operation of these valves without a successful reactor trip could occur. It can be argued that such operation could lead to more severe overpressure conditions by delaying a trip of the second shutdown system. In this case, analyses both with and without relief valve operation are required.

4.2 Where power-actuated relief valves are installed but are not connected to the instrumentation associated with either shutdown system, these relief valves may be credited in all overpressure protection analyses, providing that:

(a) each relief valve is equipped with its own instrumentation (and power supplies, etc.) so that no single failure would result in the disablement of more than one relief valve; and

(b) this instrumentation is designed to the same standards as equivalent instrumentation in the shutdown systems.

These requirements are consistent with those of:

(a) paragraph NB-7532 of the ASME code;

(b) paragraph 7.2.4.2 of CSA Standard N285.1 [Ref. 1].

REFERENCES

1. CAN3-N285.1-M81, Requirements for Class 1, 2 and 3 Pressure-Retaining Systems and Components in CANDU Nuclear Power Plants.

2. AECB Regulatory Document R-10, The Use of Two Shutdown Systems in Reactors. January 1977.