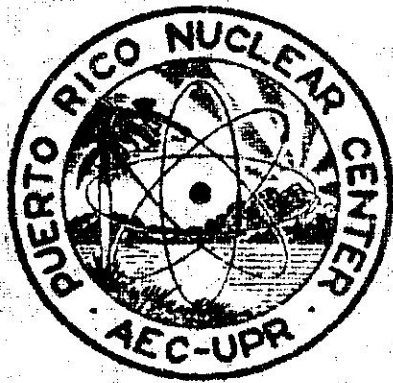


PUERTO RICO NUCLEAR CENTER

OPERATING LIMITS FOR THE PRNC POOL-TYPE
RESEARCH REACTOR.



OPERATED BY UNIVERSITY OF PUERTO RICO UNDER CONTRACT
NO. AT (40-1)-1833 FOR U. S. ATOMIC ENERGY COMMISSION

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Prepared for The United States Atomic Energy
Commission by The Puerto Rico Nuclear Center
Operated by The University of Puerto Rico
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August 1965

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I. Introduction

The intention of this document is to establish a limit for each operating variable which has direct reactor safety significance. Each limit designates a realistic boundary to the operating range of the variable; therefore, each limit can be approached with confidence that the safety of the reactor will not be compromised. The Operating Procedures will provide reasonable assurance that the reactor will be operated within the stated Operating Limits. The approval of AEC is required for changes to these Operating Limits.

II. Reactor Building

A. Openings

The personnel access doors and the truck door are of steel construction, air tight, and have spring-type closures to insure firm closing and latching.

All other openings, such as drain lines, sewer lines, hood ventilation lines, etc., are provided with air operated, solenoid controlled, sealing closures. These provide containment in event of an accident.

B. Ventilation

Inleakage to the building during normal operation is provided by a fan and ductwork. A negative pressure is normally maintained in the reactor building. The bulk of the exhaust air is collected at ceiling exhaust registers above the pool and ducted to the outside discharge stack.

The emergency system will automatically start upon the actuation of any one of the following signals:

1. 150% flux.
2. A radiation level of 10 mr per hour at the reactor bridge or reactor basement.
3. A manual pushbutton in the control room.

The normal supply and exhaust systems are stopped and sealed whenever the emergency system is started.

The emergency system exhausts through CWS filters with an efficiency of not less than 99.95% for particles greater than 0.3 microns in diameter. In addition, an activated carbon filter in the system has an efficiency of not less than 95% for iodine vapor removal.

C. Leakage

Under the design pressure limit of 0.5 psi, the building leakage rate will not exceed 360 cfm.

III. Reactor Core

A. Fuel Elements

Three distinct types of MTR-type fuel elements may be used in the core. These are (1) the standard assembly, (2) the partial assembly, and (3) the control rod assembly.

B. Maximum Fuel Loading

The maximum amount of fuel in the core will be such that the excess reactivity will never exceed 50% of the reactivity worth of all control rods.

C. Maximum Power Level

The maximum power level will be 1 Mw (administrative limit).

D. Maximum Fuel and Moderator Temperatures

The maximum fuel temperature shall be 150°F and the maximum moderator temperature shall be 108°F.

IV. Primary Cooling System

A. Flow Pattern

The core may be positioned over either one of two pool outlet connections. Water flows downward through the core into the lower plenum. A safety flapper valve is closed during normal reactor operation, but will drop open whenever the cooling water flow is stopped, to provide a path for natural circulation.

Butterfly valves are provided in the connections from the reactor to adjust the flow rate through the core, and to close off the coolant flow from the pool section not in use.

B. Minimum Flow for 1 Mw Operations

The minimum flow for 1 Mw operations is 900 gpm.

C. Maximum Flow Rate

The maximum flow rate is 1000 gpm.

D. Maximum Activity of Coolant Water

The radioactivity concentration in the coolant water shall not exceed 3×10^{-4} μc per cc.

E. Maximum Core Differential Pressure

The maximum core pressure differential will be 1 psi.

F. Purification System

A portion of the pool water will be continuously filtered and demineralized for purity and clarity of the pool.

G. Reactor Pool

The pool water height will be maintained at not less than 22 feet, 6 inches above the reactor core.

V. Secondary Cooling System

A. Minimum Flow Requirement

The minimum flow rate in the secondary cooling system for 1 Mw operations will be 700 gpm.

VI. Control and Safety System

A. Control Rods

The 4 shim-safety rods may be operated in any combination simultaneously. Total worth of the 4 shim-safety rods will be at least 8.75% $\Delta k/k$. The maximum rate of reactivity change due to simultaneous operation of all shim-safety rods will be 0.045% $\Delta k/k$ per second and, for the regulating rod, it will be 0.022% $\Delta k/k$ per second.

The reactor core will be so arranged that criticality cannot be achieved by complete withdrawal of any one of the shim-safety rods while the others are completely inserted. The shim-safety rods must have an insertion time (including magnet release time) of less than 500 milliseconds.

B. Servo System

The amount of positive reactivity that the servo system is permitted to control will be no greater than 0.7% $\Delta k/k$.

C. Nuclear Instrumentation

Four channels of instrumentation are required from startup to full power operations. These are: the count rate channel, the log N and period channel, the linear power level and automatic control channel, and the safety channel.

D. Conditions That Cause Reactor Scram

The conditions that will cause the reactor to scram are:

1. Flux level greater than 150% of full power.
2. Reactor period of 1 second or less.
3. Pool water level less than 22 feet, 6 inches above the core.
4. Core support bridge unlocked from its normal positions.
5. Primary coolant flow less than 800 gpm.
6. Primary pump failure or shutdown.
7. Safety flapper valve not closed.
8. Reactor key switch off.
9. Any of the manual scram buttons depressed.
10. Any of the scram facility outlets open.
11. Loss of AC power to the console.

E. Start-up Interlock

An inhibit circuit prevents the withdrawal of shim safety rods if the count rate channel indicates less than 2 or more than 9800 counts per second.

VII. Monitoring System

A minimum of three radiation detectors will be located in the beam hole

area and at least one radiation detector will be located on the bridge over the pool surface. These will actuate a local alarm upon detecting a radiation level of 10 mr/hr. An independent radiation monitor under the bridge actuates a building evacuation alarm at a level of 100 mr/hr. A detector will be located in the pump room adjacent to the primary coolant piping for detection of fission product activity of 40 mr/hr.

An off-gas radiation detector will actuate an alarm upon detecting a radiation level of 5.5 mr per hour.

VIII. Experiments

A. Review

Each reactor experiment is subjected to comprehensive reviews and hazards evaluations by the Reactor Division Head and the PRNC Technical Committee. The Reactor Division Head will have authority to consult with the Technical Committee in the case of new experiments or changes that affect reactivity levels, fuel loadings, safety system, and operational policy changes. Reactor supervisors are responsible for fuel handling.

Appropriate limits are placed on any materials, systems, or components that may (for any credible reason) affect the reactivity in such a manner, or to such a degree, that unsafe conditions could result.

B. Reactivity Limitations

An experiment is approved more or less routinely if the maximum change in reactivity that can be caused by the experiment is conservatively less than the total amount of reactivity controlled by the servo system.

New experiments or experiments having reactivity worths greater than the worth of the servo system are considered in more detail, in particular, if failure or malfunction of the experiments may cause changes in these values. No experiment is approved if, for any credible reason, it can cause changes in reactivity that cannot be safely handled by the reactor control system.

IX. Administrative and Procedural Safeguards

A. Personnel Qualifications

The Reactor Division Head will have at least:

1. Engineering degree.
2. Extensive nuclear science background.

The Reactor Supervisor will have at least:

1. Engineering degree.
2. Background in nuclear science and engineering.
3. Adequate experience in reactor operations.

The Reactor Operators will have at least:

1. High school diploma.
2. Successful completion of a four-month theoretical and practical course in reactor operation.

B. Operating Personnel Requirements

There will always be at least one operator in the control room while the reactor is in operation. One standby operator will be in the reactor building or the pump room in order to assist or relieve the reactor operator.

The reactor supervisor will be in the control room during the first startup of the week or during the first startup after any repairs have been performed in the control or safety systems. A supervisor will also be present to oversee core loading and unloading operations, and will be within easy telephone or intercom reach within the PRNC compound during all reactor operations.

C. Procedures

The reactor will be operated in conformance with documented operating procedures. In no instance will the operating procedures authorize operation of the reactor in excess of any operating safety limits listed above.