PRNC 64 PUERTO RICO NUCLEAR CENTER OPERATING LIMITS FOR THE PRNC POOL-TYPE RESEARCH REACTOR. OPERATED BY UNIVERSITY OF PUERTO RICO UNDER CONTRACT NO. AT (40-11-1839) FOR U.S. ATOMIC ENERGY COMMISSION ---Page Break--- OPERATING LIMITS FOR THE PRNC POOL-TYPE RESEARCH REACTOR Prepared for The United States Atomic Energy Commission by The Puerto Rico Nuclear Center Operated by The University of Puerto Rico Under Contract No. AT (40-1)1833. August 1965 ---Page Break--- OPERATING LIMITS FOR PRNC POOL-TYPE RESEARCH REACTOR 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. Reactor Building Openings The personnel access doors and the truck door are of steel construction, airtight, and have spring-type closures to ensure fire closing and latching. All other openings, such as drain lines, sewer lines, hood ventilation lines, etc., are provided with electrically operated, solenoid-controlled sealing closures. These provide containment in the event of an accident. Ventilation Toleskage 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. ---Page Break--- The emergency system will automatically start upon the actuation of any one of the following signals: 1. 130% Flux. 2. A radiation level of 10 R 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 HEPA 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. Leakage Under the design pressure limit of 0.5 psig, the building leakage rate will not exceed 360 cfm. Fuel Elements Three distinct types of HTR-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. 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. ---Page Break--- ©. 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. Maximum Flow Rate The maximum flow rate is 1000 gpm. Maximum Activity of Coolant Water The radioactivity concentration in the coolant water shall not exceed 3 x 10^-5 µCi per cc. E. Maximum Core Differential Pressure The maximum core pressure differential will be 1 psi. ---Page Break--- " Vs Secondary Cooling System: A Purification System A portion of the pool water will be continuously filtered and demineralized for purity.

and clarity of the pools Reactor Pool ‘The pool water height will be maintained at not less than 22

feet, 6 inches above the reactor core. Minima Flow Requirement. ‘The minimum flow rate in the secondary cooling system for 1 Mw operations will be 700 gpm. VL. 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% Alfk. The maximum rate of reactivity change due to simultaneous operation of all shim safety rods will be 0.045% Ak/k per second and, for the regulating rod, it will be 0.0222 Ak/k per second ‘The reactor core will be arranged that criticality cannot be achieved by complete withdrawal of any one of the safety rods while the others are completely inserted, The shim safety rods must have an insertion time (including magnet release time) of 1 ‘The amount of positive reactivity that the servo system is to control will be no greater than 0.7% Ak/k. ---Page Break--- ©, 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. 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 position. 5. Primary coolant flow less than 800 gpm. 6. Primary pump failure of shutdown. 7. Safety clapper 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. 12. Start-up interlock and inhibit circuit prevents the withdrawal of shim safety rods if the count rate channel indicates less than 2 or more than 9800 counts per VIX. Monitoring System ‘A minimum of three radiation

Detectors will be located in the beam hole cond. ---Page Break--- vir. rea 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 ar/hr. An independent radiation sensor under the bridge actuates the building evacuation alarm at a level of 100 ar/hr. A detector will be located in the pump room adjacent to the primary coolant piping for detection of fission product activity of 40 mx/hr. An off-gas radiation detector will actuate an alarm upon detecting a radiation level of 5.5 mr per hour. Experiments as 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 systems, and operational policy changes. Reactor supervisors are responsible for fuel handling. Appropriate limits are placed on 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 ---Page Break--- 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 experiment may cause changes from 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. TX Administrative and Procedural Safeguards A. Personnel Qualifications The Reactor Division Head will have at least: + Engineering degree. + Extensive nuclear science

background. The Reactor Supervisor will have at least an Engineering degree: 2, background in nuclear science and engineering. 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. 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 ---Page Break--- 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 PENC compound during all reactor operations. Procedures: The reactor will be operated in accordance 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. ---Page Break---