PRNC - 83 PUERTO RICO NUCLEAR CENTER XENON BUILD UP UNDER VARIOUS OPERATING CONDITIONS IN THE PUERTO RICO NUCLEAR CENTER RESEARCH REACTOR ‘OPERATED BY UNIVERSITY OF PUERTO RICO UNDER CONTRACT NO. AT (40-1)-1832 FOR U.S. ATOMIC ENERGY COMMISSION ---Page Break--- PRC Report Xenon Buildup Under Various Operating Conditions in ‘The Puerto Rico Nuclear Center Research Reactor ALE, Gilead A. Sanchez ---Page Break--- XENON BUILDUP UNDER VARIOUS OPERATING CONDITIONS. 1 ‘THE PUERTO RICO NUCLEAR CENTER RESEARCH REACTOR ALE. Gilead, PREC A. S Scope Concentrations of I-135 and Xe-135, as well as the reactivity reactivities associated with buildup of Xe-135, under various operating conditions were computed, using the one-velocity, point reactor model. ‘The computations were done on the T5H-1620 computer at the College of Agriculture and Mechanic Arts. The flow diagram of the program and its listing are part of this report. The value of the macroscopic fission cross section for the Puerto Rico Nuclear Center Research Reactor was taken from the “Hazards Summary Report, PRNC Report No. 37.” For other details, Fetherington's "Nuclear Engineering Handbook” was used. The cross sections have been converted for temperature using 90°F as the operating temperature of the reactor. ‘As can be seen from the flow diagram and the listing, the program has various operating and shutdown options. These were chosen with the actual operating problems in mind, including steady-state operation, at 2 MeV. Steady-state operation, at 5 MeV. One-shift operation, at 128 One-shift operation, at 2 in 6. Overshift operation, 7. Two-shift operation, at LF B, Two-shift operation, at 2° Two-shift operation, at 5 Negative reactivity due to Xe-135 buildup, as a function of operating under the above mentioned operating conditions, is presented graphically such that negative reactivities due to xenon buildup in operations of the same type, but at various power levels, can be compared. (See Figures through 4.) ---Page Break--- Tables 1

Through 9 contain the computed concentrations of I-135 and Ke-135, as well as the negative reactivity due to the buildup of Xe-135. The xenon concentrations are given at each hour, but the computation is carried out with $\Delta t = 5$ min., in order to minimize the error due to replacing differential equations with difference equations. From the above diagrams and data, one can see that the negative reactivity due to the xenon buildup will remain well under 3% K/k if only the power level does not exceed two megawatts. For five-megawatt operation, a reactivity allowance of about 52 2'V/has to be considered. Xenon buildup data collected by the supervision of one of the authors of this agreement with the computed values of laboratory class, under the report, seems to be in good agreement. Reactivities in this experiment were measured with the aid of a calibrated regulating rod, which was operated in automatic mode. The control rod was calibrated with the stable period method at the beginning of the experiment. Computed and measured negative reactivities due to xenon buildup are compared in Table 10. A diagram presenting measured and computed negative reactivities is given in Figure 5. In spite of a spurious scram during the experiment, the agreement is reasonable. The maximum deviation between measured and computed values is less than 0.1 percent “MY. Considering the simplicity of the point reactor model used for these computations, this agreement is very satisfactory. If the reactor is operated at a constant flux level long enough to permit the development of xenon equilibrium, and the reactor is shut down from this state by scram, then the magnitude of the xenon peak and the time of its occurrence are rather characteristic of the flux value at which the reactor was operated prior to shutdown. In Table 11, the magnitude of the xenon peak and its time of occurrence are given as a function of operating flux for the PENC research reactor. As can be seen from the diagram in Figure 6, the dependence is sensitive enough to estimate.

operating fluxes prior to shutdown from observed xenon peaks after shutdown, ---Page Break---

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REACTIVITY DUE TO XENON Buildup VS. TIME UNDER 5 MEGAWATT STEADY STATE OPERATION, AND AFTER “SHUT DOWN,” -00000000e-99 ky Kk x ---Page Break--- XENON BUILDUP, 5 MW, STEADY OPERATION on to 1 x A ---Page Break--- a TABLE 4 THERMAL FLUX (@), IODINE NUMBER DENSITY (2), XENON NUMBER DENSITY (x) AND NEGATIVE REACTIVITY DUE TO XENON BUILDUP VS. TIME UNDER 5 MEGAWATT 8 HOURS ON-16 HOURS OFF OPERATION DURING A 5 DAY WEEK AND AFTER TERMINAL SHUT DOWN a 1 x “the Systems Accessibility Resources 39 aise Aiiertssecenis lioessteeems ectsesnocmoce Tem ---Page Break--- XENON BUILDUP, 1 MW, 8 HRS. ON-16 HRS. OFF x oe t o ---Page Break--- XENON BUILDUP, 1 MW, 8 HRS. ON-16 HRS. OFF 1 x ON mirckosasems Siassriotents ---Page Break--- XENON BUILDUP, 1 MW, 8 HRS. ON-16 HRS. OFF 1 aK, % ---Page Break--- TABLE 5. THERMAL FLUX (@), IODINE NUMBER DENSITY (Z1), XENON NUMBER DENSITY (x) AND NEGATIVE REACTIVITY DUE TO XENON BUILDUP VS. TIME UNDER 2 MEGAWATT 8 HOURS ON-16 HOURS OFF OPERATION DURING A 5 DAY WEEK AND AFTER TERMINAL SHUT DOWN, $ L x unt Bistsisssaeals, ERR: Sse Rersteraar=o0 ies EERRES! iad Eee Blis3e939ecR01 Bri3pezeete wot Acise329secnot S1GzRaoo0c cot ---Page Break--- t > I x aK, CURRANTS unmeracs Wun, ENsGeree? ies stoegot Auasoa Tenens ci35030300N0L ---Page Break--- XENON BUILDUP, 2 MW, 8 HRS. ON-16 HRS. OFF t 9 1 x OK s:ooccocaae= 93 Eeniniernn? Riszrrtearais Razwsansnces Sh EAAR329960816 MLLoTII¥>3ER15 Al3TORI 89 ~O0 ir Bas00 Researesiseel? AlseiSesicenis Ropssreste oo Ase ---Page Break--- XENON BUILDUP, 2 MW, 8 HRS. ON-16 HRS. OFF. ---Page Break--- TABLE 6 THERMAL FLUX (@), IODINE NUMBER DENSITY (Z), XENON NUMBER DENSITY (0) AND NEGATIVE REACTIVITY DUE TO XENON BUILDUP VS. TIME UNDER 5 MEGAWATT 8 HOURS ON-16 HOURS OFF OPERATION DURING A 5 DAY WEEK AND AFTER TERMINAL SHUT DOWN, t 6 1 x Om iso0 nuaeeooooorniy sazsznconacms a. 20087072816. .971755856-01 20099T20ehOL RraeeLecorenot Rivets: HERES! ESRRR CEuat MORNE SSUSIER RIsLzDSUTSERLS Reg24Bo4NOERIS .32088323<ROL Ao;00D000E-99 AIAISSLIEVEML ReBsST4999ER19 Nz

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