PRNC083

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 RIGO UNDER CONTRACT

NO. AT (40-1)-1832 FOR U. 5. ATQWIC ENERGY COMMISSION

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PRC Report

Xenon Bufldup Under Various Operating Conditions in

?The Puerto Rico Nuclear Center Zesearch Reactor

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XENON BUILDUP UNDER VARIOUS OPERATING CONDITIONS. 1

?DAE PUERTO RIC NUCLEAR CEKTER RESEARCH REACTOR

ALE. Cileadi, PREC A. S

Scope

Concentrations of 1-135 and Yen135, as vell as the uepative reactivities associated with buildep of Xe~135, under various operating conditions Were conputed, using the one-velocity, point reactor node!.

?The computations were done on the T5H-1620 computer at the College of Agriculture and Mechanic Arte. The flow diaeran of the prograr and its Listing are part of this report.

The value of the macroscopic fission cross section for the Puerto Rico Nuclear Center Research Seactor, was taken from the ?Wazards Summary Report, PRNC Report Ke. 37.? For other deta Ftherington's "Nuclear Unpinesring Handbook? was used.

The cross sections have been converted for temperature using 90°F as the

operating texperature of the reactor

?As can be seen from the Hlox diarran ond the Listing, the prograa has

various operating snd shutdown options. These were chosen with the actual

operating problers in mind, ineludine

Steady-state operation, at

Steady-state operation, at 2 Me

3. Steady-state operation, at 5 8

One-shift operation, at 128

One-shift operation, et 2 in

6. Overshite operation,

7. Tworsbift operation, at LF

B, TMo-slift operation, at 2°

Tworshife operation, at 5

Negative reactivity due to ¥e-135 buildup, a6 » funceten of operating under the above nenticned operating conditions, ia presented graphic Such a vay that negative reactivities cue to xenon buiidea ia opercticns « the same type, bet at various power levels, can he compared. (See Piguxes throvgh 4.)

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Tables 1 through 9 contain the computed concentrations of 1-135 and Ke-135,

45 well as the negative reactivity due to the buildup of Xe135.

?The xenon concentrations are given at each hour, but the computation is

carried out with at = 5 min., in order to mininize the error due to

replacing differential equations with difference equations

From the sbove diagrans and data one can see that the negative reactivity

due to the xenon buildup will remain well under 3% K/, if only the

Power level does not exceed two megawatts. is

For five-megawatt operation a reactivity allovance of about 52 2'V/has to

Tr %

Xenon buildup data collected by the re

supervision of one of the authors of thi

agreenent with the conputed values.

?of laboratory class, under the

report, seems to be in good

Reactivities in this experiment were measured with the aid of a calibrated Fegulating rod, that was operated in the automatic mode. The control rod was calibrated with the stable period method at the beginning of tne e periment.

Computed and measured negative reactivities due to xenon buildup are compared in Table 10. A diagram presenting measured and cooputed negative Feactivities is given in Figure 5. In apite of a spurious scran during the experiment, the agreenent is reasonable, ?The aaximu deviation between measured and cosputed values is leas than 0.1 percent ?MY. Considering the simplicity of the point reactor model used for these computations, this agreenent is very satisfactory.

If the reactor is operated at a constant flux level, long enough tine to permit the development of xenon equilibrium, and the reactor is shut dom from this state by scran; thea the magnitude of the xenon peak and the tine of its occurrence are rather characteristic of the flux value at which the Feactor was operated prior to shutdvon,

In Table 11, the sagnitude of the xenon peakand ite time of occurrence are given as a function of operating flux for the PENC research reactor. Ax can be seen fron the diagram in Figure 6, the dependence is sensitive enough te eetimate operating fluxes prior to shutdown from observed xenon peaks after ?shutdown,

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MAGNITUDE OF XENON PEAK- OK 4

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MAGNITUDE OF THE AFTER-SHUTDOWN XENON PEAK

VERSUS STEADY STATE OPERATING FLUX IN THE PRNC

RESEARCH REACTOR.

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OPERATING FLUX~ NEUTRONS /cM? sec

Figure 6. Magnitude of the after shutdown xenon peak versus steady

state operating flux in the PRNC Research Reactor

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TABLE |

?THERMAL FLUX (@), LODINE NUMBER DENSITY (2), XENON NUMBER OENSITY () AND NEGATIVE

eacrivity OUE TO XENON BUILDUP VS. TIME UNDER | MEGAWATT STEADY STATE OPERATION,

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TABLE 2

THERMAL FLUX (@), IODINE NUMBER DENSITY (Z), XENON NUMBER DENSITY (x) AND NEGATIVE

REACTIVITY OUE TO XENON QUILOUP VS TIME UNDER 2 MEGAWATT STEADY STATE OPERATION,

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TABLE 3

THERMAL FLUX (@), 1001ME

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TABLE 4

THERMAL FLUK(@), IODINE NUMBER OENSITY (2), KENON NUMBER DENSITY (x) AND. NEGATIVE

REACTIVITY DUE TO XENON BUILDUP VS. TIME UNDER | MEGAWATT 8 HOURS ON-I6 HOURS OFF

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TABLE 5.

THERMAL FLUX (0)

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REACTIVITY OUE TO XENON QUILDUP VS. TIME UNOER 2 MEGAWATT ® HOURS ON-16 HOURS OFF

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TABLE 6

THERMAL FLUX (@), IODINE NUMBER OENSITY(Z), XENON NUMBER DENSHTY (0) AND. NEGATIVE

REACTIVITY OUE TO XENON BUILDUP VS. TIME UNDER 5 MEGAMATT 8 HOURS ON-I6 HOURS OFF

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TABLE T

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TABLE 8

THERMAL FLUX (@), (O0INE NUMBER OENSITY(L), XENON NUMBER DENSITY (X1 AND NEGATIVE

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TABLE 9

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TABLE 10

?COMPARISON OF COMPUTED ANO MEASURED REACTIVITY VALUES IN THE PUERTO RICO NUCLEAR CENTER RESEARCH REACTOR.

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TABLE II

MAGNITUDE OF THE AFTER SHUTOOWN XENON PEAK VERSUS STEADY STATE OPERATING FLUX

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