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PUERTO RICO NUCLEAR CENTER

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* Submitted to the University of Puerto Rico at Mayaguez in partial fulfillment of the requirements for the degree of Master in Science (Nuclear Engineering)
Work performed at the Puerto Rico Nuclear Center, Mayaguez

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UNIVERSITY OF PUERTO RICO
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Mayaguez, Puerto Rico

THE PROBLEM OF XENON BUILDUP IN OPERATING REACTORS

by

ANGEL SANCHEZ DEL RIO

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partial fulfillment of the
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ABSTRACT

A computer PREX-program was written on the IBM-1620 to determine I-135 and Xe-135 concentrations and negative reactivities associated with the buildup of Xe-135 under various operating conditions of a nuclear reactor. The one velocity point reactor model was used. The program provides operating options for: (a) continuous operation, (b) eight hours a day and (c) 16 hours a day. The results are presented graphically in such a way that negative reactivities due to Xe-135 buildup in operations of the same time-pattern but various power levels can be compared. Negative reactivity values due to xenon buildup computed by the program for the PRNC research reactor agree with measured values within .1% of $\frac{\Delta K}{K}$.

The problem of minimizing the after shutdown xenon peak with respect to the pattern of shutdown is treated using a method described by Ash. In this method a finite number of flux changes are allowed prior to complete shutdown. The sequence of flux steps within a certain "control period" is determined in such a way that the resulting after shutdown xenon peak should be minimum. A computer program -- MINEX -- has been written on the IBM-1620 computer to perform this optimization.

Minimizing the after shutdown xenon peak, with the aid of the MINEX code has been carried out for a number of operating fluxes, control times and stepsizes. The results are presented in tabular and graphical form.

MINEX-computed flux values seem to be corroborated by results obtained by

other investigators using the Pontryagin Maximum Principle.

An important advantage of the MINEX method is its versatility, which permits extension of its use to a rather broad class of optimization problems with only minor modifications.

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1. INTRODUCTION

1-a. Basic Equations of Xenon Buildup

The operation of thermal reactors is unavoidably accompanied by the production of various fission fragments. Among these fission fragments xenon-135 has a special significance, because of its enormous thermal absorption cross section (about 3×10^6 barns). Due to this huge thermal absorption cross section, xenon-135 unavoidably produced during operation, tends to shut down the reactor and, as will be seen later, leads to a number of problems closely related to the operability of the system.

In order to gain some insight into these problems one has to consider the mechanisms by which xenon-135 is produced in the operating core, as well as those by which it is removed from there.

Some of the xenon-135 is produced directly in fission but the major part of it, some 95%, is created as a decay product in the following radioactive chain:

$$Te^{135} \rightarrow I^{135} \rightarrow Xe^{135} \rightarrow Cs^{135} \rightarrow Ba^{135}$$

The mechanisms of removal are: radioactive decay and formation of Xe^{136} by neutron absorption (xenon burn out).

Using the one velocity, point reactor model, the dynamic equations describing the time behavior of xenon-135 and iodine-135 concentration are given as:

$$\frac{dx}{dt} = \gamma_X \Sigma_f \phi + \lambda_I I - \sigma_a^X X \phi - \lambda_X X \qquad (1)$$

$$\frac{dI}{dt} = \gamma_I \Sigma_f \phi - \lambda_I I - \sigma_a^I I \phi \qquad (2)$$

where

X	is the number density of xenon-135	
I	is the number density of iodine-135	
Σ_f	is the macroscopic fission cross section of the reactor under consideration	
γ_X	is the fractional yield of xenon-135	
γ_I	is the fractional yield of iodine-135	
λ_X	is the decay constant of xenon-135	(3)
λ_I	is the decay constant of iodine-135	
σ_a^X	is the microscopic absorption cross section of xenon-135	
σ_a^I	is the microscopic cross section of iodine-135	
ϕ	is the neutron flux which, in the case of the one velocity point reactor model, is given as the function of time.	

The above system of differential equations determines X(t) and I(t) i. e. the xenon and iodine number density as a function of time, provided that the time pattern of the flux, $\phi(t)$ and a set of initial conditions X(o) and I(o) are given.

The analytic expression of the general solution is given by: (See Ref. 11)

$$I(t) = e^{-\int_0^t L(\theta)d\theta}\left[Y \int_0^t \Sigma_f(\theta)\phi(\theta)\, e^{\int_0^\theta L(\theta')d\theta'} d\theta + I(0)\right] \qquad (4)$$

$$X(t) = e^{-\int_0^t M(\theta)d\theta}\left\{\int_0^t \left[\lambda_I I(\theta) + Y_X \Sigma_f(\theta)\,\phi(\theta)\right] e^{\int_0^\theta M(\theta')d\theta'} d\theta + X(0)\right\} \qquad (5)$$

where

$$L(t) = \lambda_I + \sigma_a^I\,\phi(t) \qquad (6)$$

$$M(t) = \lambda_X + \sigma_a^X\phi(t) \qquad (7)$$

The negative reactivity associated with the presence of the xenon-135 is given by

$$\rho = \frac{-\psi Z}{1+Z} \qquad (8)$$

where

$$\psi = \frac{\Sigma_a^P}{\Sigma_a^f} = \frac{X(t)\sigma_a^X}{\Sigma_a^f} \qquad (9)$$

is called "the poisoning" and Z is a parameter given by

$$Z = \Sigma_a^f/\Sigma_a^M \qquad (10)$$

Σ_a^P, Σ_a^f and Σ_a^M being the macroscopic absorption cross sections of the poison, fuel and moderator respectively. The value of negative reactivity due to the presence of xenon-135 is an important piece of information for the reactor operator, since adequate amounts of excess reactivity to compensate for xenon poisoning have to be included in the reactivity inventory -- if the reactor is to be operated for any appreciable length of time.

1-b. Equilibrium Xenon Poisoning

If a reactor is operated for a long enough time at a constant power level (as is normally the case with power reactors), the xenon buildup reaches equilibrium i. e. a point when the rate of xenon-production from direct fissioning and from the decay of iodine exactly matches the rate of destruction by decay and by neutron capture. This value, the equilibrium xenon concentration, can be computed at once from equations (1) and (2) by setting

$$\frac{dX}{dt} = 0 \text{ and } \frac{dI}{dt} = 0$$

resulting in

$$I_e = \frac{Y_I \Sigma_f \phi_o}{\lambda_I + \sigma_a^I \phi_o} \qquad (11)$$

and

$$X_e = \frac{\lambda_I I_o + Y_X \Sigma_f \phi_o}{\lambda_X + \sigma_a^X \phi_o} \qquad (12)$$

This "equilibrium xenon poisoning" is a significant figure that has to be included into the inventory of the excess reactivity required for the continuous operation of the reactor. As can be seen from equation (12) the equilibrium xenon poisoning depends upon the value of the constant operating flux; it increases as flux increases to a limiting value of

$$P_{lim} = 5\% \qquad (13)$$

If the reactor has to be operated on a continuous time schedule appropriate compensation in terms of excess reactivity has to be made in order to overcome equilibrium poisoning.

1-c. After Shutdown Xenon Buildup

While the value of the equilibrium xenon poisoning is limited to 5% $\frac{\Delta K}{K}$, the xenon buildup after shutdown may be one or more orders of magnitude greater -- and the problems associated with overriding it may become very severe, if not unsurmountable.

Shutting down the reactor i.e. dropping its operating flux instantly from the constant operating value to essentially zero, causes a significant acceleration in xenon production due to the vanishing of the large flux dependent negative term $\sigma_a^x X\phi$ in equation 1. Thus the xenon concentration begins to build up swiftly after shutdown, and it comes to a peak value where xenon production is exactly compensated by xenon decay. Since in the shutdown condition the iodine supply is not replenished, further decay of iodine into xenon reduces xenon production below xenon destruction and a slow decay of xenon sets in that is completed within 40-50 hours after shutdown. The value of the after shutdown xenon peak is sensitively dependent upon the operating flux prior to shutdown. Its value may be computed from equations (1) and (2) as:

$$X_{max} = \left\{ I_0 + \left(1 - \frac{\lambda_X}{\lambda_I}\right) X_0 \right\} \left\{ \frac{\lambda_X}{\lambda_I} + \left(1 - \frac{\lambda_X}{\lambda_I}\right) \frac{\lambda_X}{\lambda_I} \frac{X_0}{I_0} \right\}^{\frac{\lambda_X}{\lambda_I - \lambda_X}} \qquad (14)$$

where I_0 and X_0 are the terminal iodine and xenon number density, which are dependent upon the operating flux ϕ as can be seen from equations (11) and (12); so that X_{max} is also dependent upon the operating flux, prior to shutdown. A family of curves representing after shutdown xenon poisoning as a function of time for various operating fluxes (Fig. 1) gives an idea about the magnitude of negative reactivities involved. The fact that there are a number of high flux reactors operating at a flux level $\Phi = 10^{14}$ nv and higher makes the optimization of the after shutdown xenon peak an actual problem.

1-d. Scope

The numerical value of the negative reactivity due to the presence of xenon-135 in the core is an important piece of data. It indicates the amount of excess reactivity that has to be included into the reactivity inventory in order to compensate for xenon buildup. For equilibrium conditions this value can be computed simply from equations (8) and (12); for time variable flux patterns one has to integrate equations (4) and (5). A computer program, PREX, to perform this integration has been written for the IBM-1620 computer, using the FORTRAN computer-language.

In an attempt to test the validity of these computations, a 52 hour long xenon buildup experiment was performed on the PRNC research reactor, and the measured negative reactivities due to xenon buildup were compared with the values computed with the aid of the PREX program. The agreement is very satisfactory, the deviation being within .1% $\frac{\Delta K}{K}$. (Fig. 2)

After the validity of the PREX program was thus tested, PREX was used to compute negative reactivities due to xenon buildup during operation and after shutdown, for a variety of operating schedules and power levels of practical interest.

The second part of the work is devoted to the optimization of the after shutdown xenon peak. As stated in Section 1-c the after shutdown xenon poisoning may reach several hundred dollars.

Restarting such a reactor any time after shutdown may be very difficult -- if not impossible. Loading the required amounts of excess reactivity in the form of additional fuel may be unsafe or at least very disadvantageous from the point of view of neutron economy, cost, etc.

In order to overcome the above described difficulties it has been proposed by several authors to minimize the after shutdown xenon peak, by allowing a certain time interval, called "control period", between the termination of full power operation and the time of complete shutdown. During this control period the flux should be varied in such a way that it should result in a minimized peak after complete shutdown. The problem then consists in optimizing the flux in the control period with the minimal after shutdown peak as a performance index i. e. determining the flux pattern during the prescribed control period in such a fashion that it should lead to a minimized xenon peak after complete shutdown.

In an attempt to solve this problem a FORTRAN-program MINEX was written (Appendix 2) on the IBM-1620, using the basic principles described in a paper of Ash, Bellmann and Kalaba (Ref. 9). As will be seen, further, MINEX not only furnishes a numerical solution to the minimizing of the after shutdown xenon peak, but with very slight modifications can also be used to solve a number of related problems such as minimizing the xenon poisoning at a given time after complete shutdown or minimizing the control period necessary to reach a certain given minimum peak, etc. Besides its flexibility and versatility this solution has the advantage of supplying an actual optimal shutdown program, using not all too long computing times on the IBM-1620 -- which is the only readily available computing facility for students or for PRNC staff. It is estimated that the running time of this program on an IBM-7090, or a similar size computer, would not exceed a few minutes.

2. SURVEY OF THE RELEVANT LITERATURE

The problem of optimizing or at least reducing the after shutdown xenon peak by means of varying the preshutdown operating flux in a suitable manner has been the object of many investigations. In order to gain a better understanding of the background of our optimization solution, a brief survey of the relevant literature is included herewith:

Fresdall and Babb (See Ref. 4) proposed various time varying shutdown methods to improve the after shutdown xenon situation -- without obtaining an optimum solution.

Rosztóczy and Weaver (See Ref. 1) optimized the after shutdown xenon peak using the Pontryagin maximum principle. The Pontryagin maximum principle is outlined in Appendix 3 of this report. Since the Hamiltonian of the system contains the control flux as a linear variable, it follows that optimum control leading to the minimization of the after shutdown xenon peak consists of a number of switchings of the flux between zero and its maximum value, Φ_o, i. e. the type of control referred to as a pulsed control or "bang-bang" control. To determine the optimum number switchings the authors used a trial and error method.

Kohei Sato (See Ref. 3) considered the problem of optimization xenon buildup after shutdown as well as after power reduction, assuming that the power level after reduction will remain constant. His treatment is also based on the Pontryagin maximum principle. He obtained solutions for six problems; using the fluxrate and the inverse period as control variables and the after shutdown xenon peak and a minimum xenon value at a given time as performance indices. The flux after reduction was kept steady in four cases, in the remaining two cases flux reduction amounted to complete shutdown.

In a later paper Ash (See Ref. 12) presented a method to solve the minimization of xenon poisoning at a given time using the methods of dynamic programming. The results of his computations -- carried out on a Philco-2000 computer with an ALTAC-code called DYNPROG -- verify the results obtained with the Pontryagin maximum principle, namely, that the optimal flux pattern for a minimum after shutdown xenon peak consists of pulse or "bang-bang" control. An empirical formula correlating the magnitude of the control period to the magnitude of the after shutdown xenon peak is given. In this paper (See Ref. 12) Ash points out that dynamic programming and the Pontryagin maximum principle are complementary methods of investigating optimally controlled processes. The DYNPROG program is described in detail in a report of Ash (See Ref. 16).

3. PREX, A DIGITAL METHOD TO COMPUTE NEGATIVE REACTIVITIES DUE TO XENON BUILDUP UNDER GIVEN OPERATING CONDITIONS

3-a. Mathematical Model of the PREX Code

Numerical integration of equations (1) and (2), furnishing the iodine and xenon concentration as functions of time, were performed with the aid of the PREX code, written in the FORTRAN language for the IBM-1620 computer. In order to make the problem amenable to digital solution, a suitably small time interval Δt is chosen and the differential equations (1) and (2) are converted into difference equations as follows:

$$\Delta I = \left[Y_I \Sigma_f \phi - \lambda_I I - \sigma_a^I I \phi \right] \Delta t \qquad (15)$$

$$\Delta X = \left[Y_X \Sigma_f \phi + \lambda_I I - \lambda_X X - \sigma_a^{Xe} X \phi \right] \Delta t \qquad (16)$$

The numberdensities at time $t + \Delta t$ are determined as:

$$I(t + \Delta t) = I(t) + \Delta I \qquad (17)$$

$$X(t + \Delta t) = X(t) + \Delta X \qquad (18)$$

Using this step by step approximation PREX permits evaluating the values of the iodine and xenon numberdensities as well as the negative reactivities associated with xenon-135 as functions of time, for any given $\phi = \phi(t)$ fluxpattern and for a given set of initial conditions $Xo = X(0)$ — $Io = I(0)$. The flow diagram of PREX as well as a listing of the program are given in Appendix 1 of this paper. (See also Ref. 10.)

3-b. Comparison with the Experiment

As mentioned before, the validity and the accuracy of calculations, performed with the aid of PREX, were tested against experimental data. The testing experiment was performed at the Puerto Rico Nuclear Center Research Reactor with the participation of the 1964 Advanced Reactor Laboratory Class under the supervision of Dr. A. Gileadi. Reactivities in this experiment were measured with the aid of a calibrated regulating rod. The regulating rod was calibrated with the stable period method immediately before the performance of the 52 hour long experiment. No changes were made in the core configuration after the calibration was completed. At the beginning of the experiment the core was xenon-free.

After the control rod had been calibrated, the reactor was brought to high power, about 1 MW, and was put in automatic mode. The rod positions were recorded at regular time intervals and with the aid of the calibration curve the reactivity changes were evaluated and plotted. After 42 hours of high power operation the reactor was shut down and immediately after that brought to a very low power level of about 30 watts. This power level, being several orders of magnitude smaller than the operating power, corresponds to zero power from the point of view of xenon-135 production or burn out. The buildup of the after shutdown xenon peak was observed and followed through several hours after the peak was reached. Simultaneously the xenon-135-caused negative reactivities were computed with the aid of the PREX code using parameters appropriate to the materials' composition of the Puerto Rico Nuclear Center Research Reactor. Measured and PREX-computed values are compared in Table 1 and represented graphically in Figure 2. As can be seen from the table, as well as from the diagram, the agreement is within .1% of $\frac{\Delta K}{K}$.

It may be concluded from here, then, that the PREX-computed values of the negative reactivities due to xenon buildup can be reasonably trusted, and that PREX-computed values have a good enough accuracy to determine xenon-caused reactivity requirements to be included into the reactivity inventory of a reactor. This establishes the value of PREX as a design tool.

3-c. Xenon Associated Reactivity Requirements in Various Operating Modes Computed with the Aid of PREX

PREX was used to determine xenon associated reactivity requirements under various operating modes. The operating modes considered were chosen with actual operating schedules and power levels in mind, including:

1. Steady-state operation, at 1 MW
2. Steady-state operation, at 2 MW
3. Steady-state operation, at 5 MW
4. One-shift operation, at 1 MW
5. One-shift operation, at 2 MW
6. One-shift operation, at 5 MW
7. Two-shift operation, at 1 MW

8. Two-shift operation, at 2 MW

9. Two-shift operation, at 5 MW

Negative reactivity due to X_e-135 buildup, as a function of operating time, under the above mentioned operating conditions, is presented graphically in such a way that negative reactivities due to xenon buildup in operations of the same type, but at various power levels, can be compared. (See Figures 3 through 5). Tables 2 through 10 contain the computed concentrations of I-135 and X_e-135, as well as the negative reactivity due to the buildup of X_e-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 $3\% \Delta K/_K$ only if the power level does not exceed two megawatts. For five-megawatt operation a reactivity allowance of about $5\% \Delta K/_K$ has to be made.

4. THE SOLUTION OF THE OPTIMAL SHUTDOWN PROBLEM

4-a. Method of Solution

The problem of minimizing the after shutdown xenon peak is treated in this report with the aid of the concepts developed by Ash, Bellmann and Kalaba. (See Ref. 9) First, the problem is reformulated in a somewhat more explicit manner, as follows:

It is assumed that a high flux reactor is operated for a long enough time, so that xenon and iodine are present in equilibrium concentration (given by equations 4 and 5). At a certain time it is decided to shut down the reactor. However, instead of shutting it down by reducing the value of flux from Φ to zero in one step, a certain time interval, the control period b, is allowed between termination of the operation and complete shutdown and in this control period the flux will be varied in such a way as to result in a minimum xenon peak, after complete shutdown. The problem is to determine the flux as a function of time in the control period in such a way, that the after shutdown xenon peak -- which is obviously dependent upon the operating history in the control period -- should be minimum with respect to the choice of $\Phi(t)$ in b. In order to determine the optimal flux pattern in the control period, let us note that the magnitude (and also time of occurrence) of the after shutdown xenon peak is determined by X_f, I_f, the terminal values of xenon and iodine numberdensities at the moment of complete shutdown. Further, the values of X_f and I_f are determined by the flux pattern in the control period, b, and by the initial values Xo, Io and Φo; in other words

$$X_{max} = X_{max}(X_f, I_f)$$

$$X_{max} = X_{max}^{*}\left\{Xf(Xo, Io, \Phi o); \quad If(Xo, Io, \Phi o)\right\}$$

The after shutdown xenon peak value X_{max} is a functional of the flux pattern in the control period, b. Our purpose is to determine $\Phi(t)$ in b in such a way that it should minimize X_{max}^{*}. This we shall do by using an approximation that makes our method amenable for digital computation. To achieve this we shall divide the time interval b into n subintervals each Δt long, so that

$$n \times \Delta t = b$$

and then we shall determine the value of $\Phi(t)$ in each of these subintervals, considering $\Phi(t)$ constant in each subinterval. This step digitalizes the problem: instead of having to determine $\Phi(t)$ in b, it is sufficient to determine $\Phi_1, \Phi_2 \ldots \Phi n$ a set of constant flux values in each Δt times interval. By making Δt small enough the $\Phi_1, \Phi_2 \ldots \Phi n$ sequence thus determined will approximate the optimal $\Phi(t)$ in b. Beside the parameters b, Δt, Φ, X_o and I_o the value of X_{max} is dependent upon the choice of the $\Phi_1, \Phi_2 \ldots \Phi n$ sequence; therefore, to each choice of the set $\Phi_1, \Phi_2 \ldots \Phi n$, one can calculate the suitable X_{max} value e. g. by making use of the PREX computer code described in Chapter 3 of this paper.

With this in mind, our problem of finding the optimal $\Phi_1, \Phi_2 \ldots \Phi n$ sequence is reduced to the following steps:

a. Enumerate all the possible choices of set Φ_1, $\Phi_2 \ldots$ Φn under a given b, Δt, Φo.

b. To each admissible set of Φ_1, $\Phi_2 \ldots \Phi n$ calculate X_{max} (Φ_1, $\Phi_2 \ldots$ Φn) using the PREX code.

c. Among all X_{max}-es thus calculated, choose the smallest. The Φ_1, Φ_2, Φn set leading to this minimal X_{max} value is the optimal flux pattern we were seeking.

Step (a), the process of enumerating all the admissible sets of Φ_1, Φ_2 .... Φn can be significantly simplified by observing that since the Hamiltonian of the system contains the control flux at the first degree only, the optimal flux pattern -- according to the Pontryagin Maximum Principle -- can only take on one of two values: zero and Φ_{max} -- a maximum value; i. e. the optimizing flux pattern consists of a switching back and forth between 0 and Φ_{max}. The value of Φ_{max} may be equal to the operating flux Φo or, in certain cases, may be greater than Φo. This type of control is referred to as pulse control, or "bang-bang" control. Since in each subinterval there are only two admissible choices of the flux value, namely, 0 and Φ_{max}, the total number of admissible sets is 2^n, n being the number of subintervals. Thus our method of optimization can be further reduced to the following steps:

a. Enumerate all admissible choices of the set Φ_1, $\Phi_2 \ldots$ Φn - 2^n in number.

b. Using the PREX code compute X_{max}, pertaining to the first admissible choice of $\Phi_1 \ldots$ Φn and store.

c. Repeat step (b), with the next admissible choice, compare the two values of X_{max}, discard the bigger, store the smaller of the two, also store the pertaining Φ_1, Φ_2 .... Φn set.

d. Repeat step (c) -- until all the admissible choices are used up and the last set of Φ_1.... Φn stored is the required optimizing flux pattern, with a given b, Δt and Φo.

A computer code -- MINEX -- that will execute the above outlined optimization has been written in FORTRAN on the IBM-1620. The program listing and the flow chart are given in Appendix 2.

4-b. Numerical Results Obtained with the Aid of the MINEX Code

Optimization calculations using the MINEX code were performed on the IBM-1620 computer at the Mayaguez campus of the University of Puerto Rico for a large number of cases. The operating fluxes used varied from 3×10^{13} nv to 10^{16} nv, control periods ran from .5 hour to 8 hours, sizes of the subintervals varied between .5 hour and 1 hour. In certain problems the control flux was raised to twice as high as the steady operating flux, under the assumption that operating the reactor at this higher power-level will not be a safety hazard if continued for a short time-interval only. Our results indicate that using $2 \Phi o$ instead of Φo (for Φ_{max}) does not improve optimization results significantly. Characteristics of the problems solved with the aid of the MINEX code, together with the resulting control flux sequences, are presented in Table 11.

Figure 6 shows the ratio of the optimized after shutdown xenon peak to the untreated xenon peak vs. the magnitude of the control interval b for various fluxes. As can be seen, the results improve as the operating flux increases; with an 8 hour control interval we get a peak reduction to 80% at 3×10^{13} flux but 54% with a 10^{15} flux. The subinterval $\Delta t = 1$ hour.

Figure 7 shows the same values for $\Delta t = .5$ hour.

Figure 8 shows $\rho(b)/\rho(o)$ vs. steady state operating flux, for various control periods -- this family of curves also shows a very definite improvement in optimization with the increase of the operating flux as well as with the increase of control time.

Figures 9 through 22 show the diagrams of MINEX optimized after shutdown xenon buildups compared to the xenon buildup for the same operating flux following a shutdown in a single step. The optimizing control flux pattern is also included.

4-c. Application of the MINEX Method to other Optimization Problems

It can be shown that with very slight modifications the MINEX method can be applied to perform other optimizations besides the minimization of the after shutdown xenon peak, described in the previous sections. Optimization problems that can be solved with the MINEX method include the so-called xenon minimum and the xenon time optimal problem. The xenon minimum problem can be formulated as follows:

A reactor is operated at rated power level for a long enough time to permit the development of equilibrium xenon concentration. It is decided to shut down the reactor, allowing a certain given control period b. The xenon minimum problem consists in determining the control flux pattern in the control period that will lead to a minimum xenon concentration at a given time $T > b$. Using the same argument as in Section 4-a, page 17, the optimal control pattern will be of the "bang-bang" type and the steps of optimization will be the following:

a. Enumerate all admissible choices of the control flux set $\phi_1, \phi_2 \ldots \phi_n$, all together 2^n in number.

b. Using the PREX code compute X(T) pertaining to the first admissible set and store.

c. Repeat step (b) with the next admissible choice, compare the two values of X(T), discard the bigger, store the smaller of the two and also store the pertaining $\phi_1, \phi_2 \ldots \phi_n$ set.

d. Repeat step (c) — until all the admissible choices are used up and the last set of $\phi_1, \phi_2 \ldots \phi_n$ stored is the required optimizing flux pattern for a given b, Δt and ϕ_o.

As can be seen, the only modification consists in using X(T) instead of X_{max} as a performance index. A sample problem for minimizing X(T) with the above described modification of MINEX has been run for an operating flux of $\phi_o = 10^{14}$ nv, b = 4 hours and T = 6 hours, and the optimization results in a reduction of xenon-caused negative reactivity to 52% of its unoptimized value. The detailed results of this run are included in Table 11 and represented in graphical form in Figure 23.

The time optimal xenon problem consists in determining the minimal control time necessary to reduce the after shutdown xenon peak below a given value. The solution of this problem requires the following modification:

a. Run a MINEX problem with b = o and compare the resulting after shutdown xenon peak X_{max} with the given value of the problem. If its X_{max} is smaller than the given value, we have the solution; if not, go to step b.

b. Increase b by Δt and repeat step a.

The required minimal b is the first b which will lead to a smaller after shutdown xenon peak than the value specified in the problem.

This problem has not been run on the IBM-1620 because it would require too much time; however, it can be run with no difficulty on a bigger and quicker computer e. g. the IBM-7090 or IBM-7094.

5. SUMMARY AND CONCLUSIONS

5-a. A computer code -- PREX -- has been written for the IBM-1620 in the FORTRAN language that will furnish numerical values of xenon-135 and iodine-135 numberdensities, and of negative reactivities tied up in xenon-135 for any given operating flux and schedule.

5-b. PREX has been used to compute xenon-135 associated reactivities in the Puerto Rico Nuclear Center Research Reactor for several actual operating modes and power levels, thus determining reactivity requirements for 1, 2 and 5 megawatt operations in 1, 2 and 3 shifts. Among other things, it has been determined that the present fuel loading in the PRNC Research Reactor is insufficient for 5 megawatt operation.

5-c. The validity and accuracy of PREX has been checked against measured values in the PRNC Research Reactor, and the agreement has been found to be within .1% of $\Delta K/_K$ for the case considered.

5-d. A computer code MINEX has been written for the IBM-1620 in the FORTRAN language to perform the optimization of the after shutdown xenon peak. This computer code is very versatile and flexible and with minor modifications it can also solve the xenon minimum and the time optimal xenon problem. A further advantage of this method consists in the fact that its output supplies the actual operating data for the control flux program leading to the prescribed value of the performance index.

5-e. After running a large number of MINEX problems, it can be concluded that the optimization of the after shutdown xenon peak leads to increasingly better results as the operating flux and the control period increase (See Figures 6, 7 and 8). However, the increase of the control flux from Φo to 2 Φo does not seem to affect the X_{max} values significantly (See Figure 22).

TABLE 1. COMPARISON OF PREX COMPUTED AND MEASURED REACTIVITY VALUES IN THE PUERTO RICO NUCLEAR CENTER RESEARCH REACTOR

t	ϕ	X	$\frac{\Delta K}{K}$ % COMPUTED	$\frac{\Delta K}{K}$ % MEASURED
1.00	.38455746E+13	.39107503E+13	.014	.006
2.00	.38455746E+13	.10723605E+14	.040	.040
3.00	.38455746E+13	.19763787E+14	.075	.068
4.00	.38455746E+13	.30468938E+14	.116	.114
5.00	.38455746E+13	.42372607E+14	.161	.171
6.00	.38455746E+13	.55090038E+14	.210	.206
7.00	.38455746E+13	.68305897E+14	.260	.264
8.00	.38455746E+13	.81763714E+14	.311	.327
9.00	.38455746E+13	.95256795E+14	.363	.379
10.00	.38455746E+13	.10862040E+15	.414	.429
11.00	.38455746E+13	.12172515E+15	.464	.482
12.00	.38455746E+13	.13447119E+15	.512	.547
13.00	.38455746E+13	.14678334E+15	.559	.592
14.00	.38455746E+13	.15860693E+15	.605	.634
15.00	.38455746E+13	.16990417E+15	.648	.680
16.00	.38455746E+13	.18065119E+15	.689	.728
17.00	.38455746E+13	.19083539E+15	.727	.770
18.00	.38455746E+13	.20045339E+15	.764	.807
19.00	.38455746E+13	.20950906E+15	.799	.837
20.00	.38455746E+13	.21801206E+15	.831	.882
21.00	.38455746E+13	.22597651E+15	.862	.929
22.00	.38455746E+13	.23341993E+15	.890	.953
23.00	.38455746E+13	.24036231E+15	.916	.986
24.00	.38455746E+13	.24682541E+15	.941	1.000
25.00	.38455746E+13	.25283211E+15	.964	1.000
26.00	.38455746E+13	.25840591E+15	.985	1.018
27.00	.38455746E+13	.26357057E+15	1.005	1.034
28.00	.38455746E+13	.26834972E+15	1.023	1.034
29.00	.47921776E+13	.27069288E+15	1.032	1.070
30.00	.47921776E+13	.27373663E+15	1.044	1.080
31.00	.47921776E+13	.27729185E+15	1.057	1.095
32.00	.47921776E+13	.28120355E+15	1.072	1.108
33.00	.47921776E+13	.28534540E+15	1.088	1.123
34.00	.47921776E+13	.28961532E+15	1.104	1.135
35.00	.47921776E+13	.29393148E+15	1.121	1.145
36.00	.47921776E+13	.29822907E+15	1.137	1.161
37.00	.47921776E+13	.30245735E+15	1.153	1.175
38.00	.47921776E+13	.30657744E+15	1.169	1.183
39.00	.47921776E+13	.31056012E+15	1.184	1.192
40.00	.47921776E+13	.31438419E+15	1.199	1.200
41.00	.47921776E+13	.31803505E+15	1.213	1.215
42.00	.47921776E+13	.32150344E+15	1.226	1.226
43.00	.47921776E+13	.32478438E+15	1.238	1.240

TABLE 1 (Continued)

t	ϕ	X	$\frac{\Delta K}{K}$ % COMPUTED	$\frac{\Delta K}{K}$ % MEASURED
44.00	.47921776E+10	.34192859E+15	1.304	1.316
45.00	.47921776E+10	.35375471E+15	1.349	1.372
46.00	.47921776E+10	.36105615E+15	1.377	1.424
47.00	.47921776E+10	.36452794E+15	1.390	1.468
48.00	.47921776E+10	.36477817E+15	1.391	1.469
49.00	.47921776E+10	.36233775E+15	1.382	1.462
50.00	.47921776E+10	.35766933E+15	1.364	1.452
51.00	.47921776E+10	.35117530E+15	1.339	1.420
52.00	.47921776E+10	.34320476E+15	1.309	1.397

TABLE 2. THERMAL FLUX (ϕ), IODINE NUMBER DENSITY (I), XENON NUMBER DENSITY (X) AND NEGATIVE REACTIVITY DUE TO XENON BUILDUP VS. TIME UNDER 1 MEGAWATT STEADY STATE OPERATION, AND AFTER SHUT-DOWN

t	ϕ	I	X	ΔK/K	
R1.00	R.59100000ER13	R.58473159ER14	R.62737891ER13	R.21706040E-C1	005
R2.00	R.59100000ER13	R.11112550ER15	R.17C39013ER14	R.58951534E-01	006
R3.00	R.59100000ER13	R.15853644ER15	R.31125032ER14	R.10768630E-00	007
R4.00	R.59100000ER13	R.20122779ER15	R.47580063ER14	R.16461738E-00	C08
R5.00	R.59100000ER13	R.23966935ER15	R.65634929ER14	R.22708357E-C0	009
R6.00	R.59100000ER13	R.27428417ER15	R.84672447ER14	R.29294953E-C0	010
R7.00	R.59100000ER13	R.30545322ER15	R.10420162ER15	R.36051650E-00	011
R8.00	R.59100000ER13	R.33351949ER15	R.12383594ER15	R.42844727E-C0	012
R9.00	R.59100000ER13	R.35879184ER15	R.14327516ER15	R.49570305E-00	013
R10.00	R.59100000ER13	R.38154844ER15	R.16228985ER15	R.56149003E-00	014
R11.00	R.59100000ER13	R.40203968ER15	R.18C70866ER15	R.62521537E-00	015
R12.00	R.59100000ER13	R.42049108ER15	R.19840746ER15	R.68644965E-00	016
R13.00	R.59100000ER13	R.43710570ER15	R.21530046ER15	R.74489601E-00	C17
R14.00	R.59100000ER13	R.45206639ER15	R.23133265ER15	R.80036419E-00	C18
R15.00	R.59100000ER13	R.46553780ER15	R.24647363ER15	R.85274887E-00	C19
R16.00	R.59100000ER13	R.47766818ER15	R.26071246ER15	R.90201233E-00	020
R17.00	R.59100000ER13	R.48859103ER15	R.27405338ER15	R.94816921E-00	021
R18.00	R.59100000ER13	R.49842653ER15	R.28651229ER15	R.99127454E-00	022
R19.00	R.59100000ER13	R.50728293ER15	R.29811389ER15	R.10314136ER01	023
R20.00	R.59100000ER13	R.51525771ER15	R.30888941ER15	R.10686948ER01	024
R21.00	R.59100000ER13	R.52243863ER15	R.31887454ER15	R.11032412ER01	025
R22.00	R.59100000ER13	R.52890471ER15	R.32810806ER15	R.11351874ER01	026
R23.00	R.59100000ER13	R.53472711ER15	R.33663051ER15	R.11646733ER01	027
R24.00	R.59100000ER13	R.53996992ER15	R.34448323ER15	R.11918422ER01	028
R25.00	R.59100000ER13	R.54469083ER15	R.35170765ER15	R.12168372ER01	029
R26.00	R.59100000ER13	R.54894179ER15	R.35834458ER15	R.12397994ERC1	030
R27.00	R.59100000ER13	R.55276957ER15	R.36443391ER15	R.12608675ERC1	C31
R28.00	R.59100000ER13	R.55621632ER15	R.37C01415ER15	R.12801740ER01	C32
R29.00	R.59100000ER13	R.55931996ER15	R.37512225ER15	R.12978469ER01	033
R30.00	R.59100000ER13	R.56211461ER15	R.37979341ER15	R.13140083ER01	034
R31.00	R.59100000ER13	R.56463110ER15	R.38406101ER15	R.13287733ER01	035
R32.00	R.59100000ER13	R.56689707ER15	R.38795656ER15	R.13422511ERC1	C36
R33.00	R.59100000ER13	R.56893745ER15	R.39150958ER15	R.13545438ERC1	C37
R34.00	R.59100000ER13	R.57077475ER15	R.39474782ER15	R.13657475ER01	038
R35.00	R.59100000ER13	R.57242915ER15	R.39769710ER15	R.13759514ERC1	039
R36.00	R.59100000ER13	R.57391884ER15	R.40038145ER15	R.13852387ER01	C40
R37.00	R.59100000ER13	R.57526024ER15	R.40282319ER15	R.13936867ERC1	041
R38.00	R.59100000ER13	R.57646811ER15	R.40504299ER15	R.14C13667ER01	042
R39.00	R.59100000ER13	R.57755576ER15	R.40705996ER15	R.14083450ER01	C43
R40.00	R.59100000ER13	R.57853511ER15	R.40889173ER15	R.14146826ERC1	044
R41.00	R.59100000ER13	R.57941698ER15	R.41055453ER15	R.14204355ERC1	C45
R42.00	R.59100000ER13	R.58021106ER15	R.41206329ER15	R.14256555ER01	C46
R43.00	R.59100000ER13	R.58092609ER15	R.41343171ER15	R.14303899ERC1	047
R44.00	R.59100000ER13	R.58156994ER15	R.41467237ER15	R.14346824ERC1	C48
R45.00	R.59100000ER13	R.58214971ER15	R.41579680ER15	R.14385727ERC1	C49
R46.00	R.59100000ER13	R.58267174ER15	R.41681553ER15	R.14420973ERC1	C50
R47.00	R.59100000ER13	R.58314183ER15	R.41773820ER15	R.14452895ER01	051
R48.00	R.59100000ER13	R.58356511ER15	R.41857362ER15	R.14481799ER01	052
R49.00	R.59100000ER13	R.58394625ER15	R.41932983ER15	R.14507963ER01	053
R50.00	R.59100000ER13	R.58428947ER15	R.42001415ER15	R.14531639ER01	054

NOTE: The R sign in the above data should be read as a + sign

XENON BUILDUP, I MW, STEADY OPERATION.

t	ϕ	I	X	$\Delta K/K$
R51.00	R.59100000ER13	R.58459851ER15	R.42063327ER15	R.14553059ER01
R52.00	R.59100000ER13	R.58487680ER15	R.42119325ER15	R.14572433ER01
R53.00	R.59100000ER13	R.58512737ER15	R.42169964ER15	R.14589953ER01
R54.00	R.59100000ER13	R.58535301ER15	R.42215747ER15	R.14605793ER01
R55.00	R.59100000ER13	R.58555619ER15	R.42257130ER15	R.14620111ER01
R1.00	R.00000000E-99	R.52726616ER15	R.44749440ER15	R.15482399ER01
R2.00	R.00000000E-99	R.47477870ER15	R.46504400ER15	R.16089580ER01
R3.00	R.00000000E-99	R.42751617ER15	R.47631143ER15	R.16479411ER01
R4.00	R.00000000E-99	R.38495847ER15	R.48225326ER15	R.16684986ER01
R5.00	R.00000000E-99	R.34663723ER15	R.48370672ER15	R.16735273ER01
R6.00	R.00000000E-99	R.31213075ER15	R.48140329ER15	R.16655579ER01
R1.00	R.00000000E-99	R.28105927ER15	R.47598068ER15	R.16467968ER01
R2.00	R.00000000E-99	R.25308085ER15	R.46799395ER15	R.16191642ER01
R3.00	R.00000000E-99	R.22788758ER15	R.45792506ER15	R.15843280ER01
R4.00	R.00000000E-99	R.20520221ER15	R.44619140ER15	R.15437319ER01
R5.00	R.00000000E-99	R.18477509ER15	R.43315347ER15	R.14986232ER01
R6.00	R.00000000E-99	R.16638142ER15	R.41912170ER15	R.14500762ER01
R7.00	R.00000000E-99	R.14981878ER15	R.40436235ER15	R.13990118ER01
R8.00	R.00000000E-99	R.13490489ER15	R.38910305ER15	R.13462177ER01
R9.00	R.00000000E-99	R.12147565ER15	R.37353738ER15	R.12923636ER01
R10.00	R.00000000E-99	R.10938323ER15	R.35782915ER15	R.12380163ER01
R11.00	R.00000000E-99	R.98494557ER14	R.34211613ER15	R.11836524ER01
R12.00	R.00000000E-99	R.88689770ER14	R.32651336ER15	R.11296701ER01
R13.00	R.00000000E-99	R.79861017ER14	R.31111602ER15	R.10763984ER01
R14.00	R.00000000E-99	R.71911135ER14	R.29600210ER15	R.10241073ER01
R15.00	R.00000000E-99	R.64752637ER14	R.28123466ER15	R.97301498E-00
R16.00	R.00000000E-99	R.58306742ER14	R.26686376ER15	R.92329458E-00
R17.00	R.00000000E-99	R.52502514ER14	R.25292835ER15	R.87508088E-00
R18.00	R.00000000E-99	R.47276077ER14	R.23945773ER15	R.82847527E-00
R19.00	R.00000000E-99	R.42569914ER14	R.22647302ER15	R.78355080E-00
R20.00	R.00000000E-99	R.38332232ER14	R.21398829ER15	R.74035615E-00
R21.00	R.00000000E-99	R.34516397ER14	R.20201167ER15	R.69891947E-00
R22.00	R.00000000E-99	R.31080414ER14	R.19054622ER15	R.65925134E-00
R23.00	R.00000000E-99	R.27986471ER14	R.17959080ER15	R.62134782E-00
R24.00	R.00000000E-99	R.25200520ER14	R.16914074ER15	R.58519270E-00
R25.00	R.00000000E-99	R.22691901ER14	R.15918851ER15	R.55076002E-00
R26.00	R.00000000E-99	R.20433007ER14	R.14972413ER15	R.51801517E-00
R27.00	R.00000000E-99	R.18398978ER14	R.14073576ER15	R.48691724E-00
R28.00	R.00000000E-99	R.16567429ER14	R.13221007ER15	R.45742008E-00
R29.00	R.00000000E-99	R.14918206ER14	R.12413257ER15	R.42947355E-00
R30.00	R.00000000E-99	R.13433155ER14	R.11648788ER15	R.40302448E-00
R31.00	R.00000000E-99	R.12095937ER14	R.10926003ER15	R.37801757E-00
R32.00	R.00000000E-99	R.10891835ER14	R.10243270ER15	R.35439639E-00
R33.00	R.00000000E-99	R.98075948ER13	R.95989237ER14	R.33210331E-00
R34.00	R.00000000E-99	R.88312834ER13	R.89913060ER14	R.31108098E-00
R35.00	R.00000000E-99	R.79521604ER13	R.84187644ER14	R.29127219E-00
R36.00	R.00000000E-99	R.71605510ER13	R.78796628ER14	R.27262037E-00
R37.00	R.00000000E-99	R.64477435ER13	R.73723927ER14	R.25506985E-00
R38.00	R.00000000E-99	R.58058937ER13	R.68953800ER14	R.23856618E-00
R39.00	R.00000000E-99	R.52279376ER13	R.64470909ER14	R.22305629E-00
R40.00	R.00000000E-99	R.47075153ER13	R.60260363ER14	R.20848866E-00

TABLE 3. THERMAL FLUX (ϕ), IODINE NUMBER DENSITY (I), XENON NUMBER DENSITY (X) AND NEGATIVE REACTIVITY DUE TO XENON BUILDUP VS. TIME UNDER 2 MEGAWATT STEADY STATE OPERATION, AND AFTER SHUTDOWN

t	ϕ	I	X	$\Delta K/K$	
R1.00	R.1180C000ER14	R.11674843ER15	F.12176825ER14	R.42129349F-C1	554
R2.00	R.1180C000ER14	R.22187489ER15	K.32231044ER14	K.11151288E-CO	555
R3.00	R.11800000ER14	F.31653635ER15	K.57515532ER14	R.19899209E-CO	556
R4.00	R.11800000ER14	R.40177457ER15	R.86C28497ER14	R.29764117E-CO	557
R5.00	R.11800000ER14	F.47852759ER15	F.11627096ER15	R.40227398E-00	558
R6.00	R.11800000ER14	K.54764010ER15	K.14713454ER15	R.50905572E-CO	559
R7.00	R.11800000ER14	F.60987268ER15	F.17781310ER15	R.61519733F-CO	560
R8.00	R.1180C000ER14	F.66591021ER15	K.20773327ER15	R.71871505F-CO	561
R9.00	R.1180C000ER14	F.71636939ER15	K.23650009ER15	R.81624244E-CO	562
R10.00	R.118000C0ER14	K.76180551ER15	K.26385430ER15	R.91288248E-CO	563
R11.00	R.11800000ER14	R.80271863ER15	F.28963908ER15	R.10020975ERC1	564
R12.00	R.1180C000ER14	R.83955895ER15	K.31377425ER15	R.10855953ERC1	565
K13.00	R.11800000ER14	R.87273194ER15	R.33623604ER15	R.11633085FRC1	566
R14.00	R.11800000ER14	R.90260268ER15	R.35704158ER15	R.12352916ERC1	567
K15.00	R.11800000ER14	R.92949987ER15	K.37623692ER15	R.13C17C35ERC1	568
R16.00	R.11800000ER14	F.95371953ER15	K.39388787ER15	R.13627722ERC1	569
R17.00	R.11800000ER14	R.97552821ER15	K.41C07309ER15	R.14187698ERC1	570
R18.00	R.11800000ER14	K.99516590ER15	K.42487876ER15	R.14699944ERC1	571
K19.00	R.11800000ER14	R.10128483ER16	K.43839469ER15	R.15167568ERC1	572
R20.00	R.11800000ER14	F.10287703ER16	K.45C71152ER15	R.15593706ERC1	573
R21.00	R.11800000ER14	R.10431074ER16	K.46191864ER15	R.15981449ERC1	574
R22.00	R.1180C000ER14	R.10560172ER16	K.47210263ER15	R.16333795ERC1	575
K23.00	R.1180C000ER14	R.10676422ER16	K.48134641ER15	R.16653611ERC1	576
K24.00	R.1180C000ER14	R.10781098ER16	K.48972850ER15	R.16943614FRC1	577
R25.00	R.1180C000ER14	R.10875354ER16	K.49732268ER15	R.17206357ERC1	578
R26.00	R.1180C000ER14	F.10960228ER16	F.50419786ER15	R.17444225FRC1	579
K27.00	R.118000C0ER14	K.11036651ER16	K.51C41803ER15	K.1765943CERC1	580
R28.00	R.11800000ER14	R.11105466ER16	K.516C4236ER15	R.17854020ERC1	581
R29.00	R.11800000ER14	K.11167431ER16	R.52112537ER15	R.18029883ERC1	582
R30.00	F.1180C000ER14	R.11223227ER16	R.52571715ER15	R.18188748ERC1	583
R31.00	R.11800000ER14	R.11273470ER16	R.52986355ER15	K.183322C6FRC1	584
R32.00	R.1180C000ER14	K.11318712ER16	K.53360654ER15	K.184617C5ERC1	585
R33.00	R.1180C000ER14	K.11359448ER16	R.53698434ER15	R.18578570ERC1	586
R34.00	R.118000C0ER14	K.11396130ER16	K.54CC3181ER15	K.18684CC7ERC1	587
R35.00	R.11800000ER14	R.11429160ER16	K.54278059ER15	R.187791C9FRC1	588
R36.00	R.11800000ER14	R.11458902ER16	K.54525945ER15	R.18864873ERC1	589
R37.00	R.118000C0ER14	R.11485685ER16	K.54749454ER15	R.189422C2ERC1	590
R38.00	R.1180C0C0ER14	R.115098CCER16	K.54950949ER15	R.19C11915ERC1	591
R39.00	R.1180C000ER14	K.11531516ER16	F.55132571ER15	K.19C74753ERC1	592
R40.00	R.11800000ER14	K.11551071ER16	F.55296265ER15	K.19131387FRC1	593
R41.00	R.11800000ER14	K.11568677ER16	F.55443782ER15	R.19182425ERC1	594
R42.00	R.11800000ER14	R.11584533ER16	K.55576710ER15	R.19228416ERC1	595
R43.00	R.11800000ER14	R.11598808ER16	K.55696481ER15	K.19269855FRC1	596
R44.00	R.11800000ER14	R.11611662ER16	K.55804387ER15	R.19307168ERC1	597
R45.00	R.1180C000ER14	F.11623237ER16	K.559C1597ER15	K.1934C821ERC1	598
R46.00	R.11800000ER14	F.11633659ER16	K.55989168ER15	R.19371118ERC1	599
R47.00	R.11800000ER14	R.11643044ER16	K.56C68049ER15	K.193984C9ERC1	60C
R48.00	R.1180C000ER14	R.11651496ER16	K.56139104ER15	R.19422993FRC1	6C1
R49.00	R.1180C000ER14	K.11659106ER16	F.562031C5ER15	R.19445136ERC1	6C2
R50.00	R.11800000ER14	R.11665957ER16	F.56260749ER15	R.1946507?FRC1	603

XENON BUILDUP, 2 MW, STEADY OPERATION.

t	ϕ	I	X	$\Delta K/K$
R51.00	R.11800000ER14	R.11672127ER16	R.56312666ER15	R.19483042ER01
R1.00	R.00000000E-99	R.10510212ER16	R.63319836ER15	R.21907381ER01
R2.00	R.00000000E-99	R.94639599ER15	R.68708292ER15	R.23771677ER01
R3.00	R.00000000E-99	R.85218560ER15	R.72706446ER15	R.25154957ER01
R4.00	R.00000000E-99	R.76735353ER15	R.75515059ER15	R.26126681ER01
R5.00	R.00000000E-99	R.69096620ER15	R.77310355ER15	R.26747815ER01
R6.00	R.00000000E-99	R.62218297ER15	R.78246798ER15	R.27071806ER01
R7.00	R.00000000E-99	R.56024688ER15	R.78459555ER15	R.27145416ER01
R8.00	R.00000000E-99	R.50447633ER15	R.78066724ER15	R.27009504ER01
R1.00	R.00000000E-99	R.45425752ER15	R.77171262ER15	R.26699694ER01
R2.00	R.00000000E-99	R.40903781ER15	R.75862768ER15	R.26246982ER01
R3.00	R.00000000E-99	R.36831957ER15	R.74219033ER15	R.25678280ER01
R4.00	R.00000000E-99	R.33165469ER15	R.72307429ER15	R.25016905ER01
R5.00	R.00000000E-99	R.29863967ER15	R.70186132ER15	R.24282978ER01
R6.00	R.00000000E-99	R.26891118ER15	R.67905235ER15	R.23493837ER01
R7.00	R.00000000E-99	R.24214208ER15	R.65507701ER15	R.22664338ER01
R8.00	R.00000000E-99	R.21803773ER15	R.63030242ER15	R.21807187ER01
R9.00	R.00000000E-99	R.19633290ER15	R.60504084ER15	R.20933188ER01
R10.00	R.00000000E-99	R.17678869ER15	R.57955642ER15	R.20051479ER01
R11.00	R.00000000E-99	R.15919004ER15	R.55407128ER15	R.19169744ER01
R12.00	R.00000000E-99	R.14334327ER15	R.52877084ER15	R.18294400ER01
R13.00	R.00000000E-99	R.12907400ER15	R.50380849ER15	R.17430753ER01
R14.00	R.00000000E-99	R.11622520ER15	R.47930984ER15	R.16583150ER01
R15.00	R.00000000E-99	R.10465544ER15	R.45537635ER15	R.15755099ER01
R16.00	R.00000000E-99	R.94237387ER14	R.43208859ER15	R.14949390ER01
R17.00	R.00000000E-99	R.84856387ER14	R.40950913ER15	R.14168186ER01
R18.00	R.00000000E-99	R.76409235ER14	R.38768503ER15	R.13413116ER01
R19.00	R.00000000E-99	R.68802968ER14	R.36665010ER15	R.12685351ER01
R20.00	R.00000000E-99	R.61953876ER14	R.34642680ER15	R.11985665ER01
R21.00	R.00000000E-99	R.55786590ER14	R.32702799ER15	R.11314506ER01
R22.00	R.00000000E-99	R.50233234ER14	R.30845841ER15	R.10672036ER01
R23.00	R.00000000E-99	R.45232696ER14	R.29071598ER15	R.10058183ER01
R24.00	R.00000000E-99	R.40729944ER14	R.27379296ER15	R.94726821E-00
R25.00	R.00000000E-99	R.36675424ER14	R.25767694ER15	R.89151005E-00
R26.00	R.00000000E-99	R.33024510ER14	R.24235168ER15	R.83848775E-00
R27.00	R.00000000E-99	R.29737048ER14	R.22779787ER15	R.78813453E-00
R28.00	R.00000000E-99	R.26776834ER14	R.21399380ER15	R.74037523E-00
R29.00	R.00000000E-99	R.24111300ER14	R.20091590ER15	R.69512835E-00
R30.00	R.00000000E-99	R.21711109ER14	R.18853920ER15	R.65230746E-00
R31.00	R.00000000E-99	R.19549849ER14	R.17683777ER15	R.61182287E-00
R32.00	R.00000000E-99	R.17603734ER14	R.16578503ER15	R.57358263E-00
R33.00	R.00000000E-99	R.15851349ER14	R.15535412ER15	R.53749379E-00
R34.00	R.00000000E-99	R.14273410ER14	R.14551808ER15	R.50346308E-00
R35.00	R.00000000E-99	R.12852547ER14	R.13625008ER15	R.47139768E-00
R36.00	R.00000000E-99	R.11573125ER14	R.12752360ER15	R.44120584E-00
R37.00	R.00000000E-99	R.10421066ER14	R.11931256ER15	R.41279730E-00
R38.00	R.00000000E-99	R.93836872ER13	R.11159147ER15	R.38608389E-00
R39.00	R.00000000E-99	R.84495742ER13	R.10433546ER15	R.36097956E-00
R40.00	R.00000000E-99	R.76084490ER13	R.97520379ER14	R.33740076E-00
R1.00	R.59000000ER13	R.11093953ER16	R.59718569ER15	R.20661415ER01

TABLE 4. THERMAL FLUX (ϕ), IODINE NUMBER DENSITY (I), XENON NUMBER DENSITY (X) AND NEGATIVE REACTIVITY DUE TO XENON BUILDUP VS. TIME UNDER 5 MEGAWATT STEADY STATE OPERATION, AND AFTER SHUTDOWN

t	ϕ	I	X	$\Delta K/K$
R1.00	R.29600000ER14	R.29286039ER15	R.28087073ER14	R.97175585E-01
R2.00	R.29600000ER14	R.55656735ER15	R.69204690ER14	R.23943421E-00
R3.00	R.29600000ER14	R.79402305ER15	R.11617316ER15	R.40193561E-00
R4.00	R.29600000ER14	R.10078407ER16	R.16471397ER15	R.56987690E-00
R5.00	R.29600000ER14	R.12003727ER16	R.21234832ER15	R.73468221E-00
R6.00	R.29600000ER14	R.13737390ER16	R.25770734ER15	R.89161523E-00
R7.00	R.29600000ER14	R.15298470ER16	R.30010074ER15	R.10382877ER01
R8.00	R.29600000ER14	R.16704149ER16	R.33924771ER15	R.11737284ER01
R9.00	R.29600000ER14	R.17969897ER16	R.37510951ER15	R.12978029ER01
R10.00	R.29600000ER14	R.19109642ER16	R.40778579ER15	R.14108562ER01
R11.00	R.29600000ER14	R.20135930ER16	R.43745076ER15	R.15134910ER01
R12.00	R.29600000ER14	R.21060053ER16	R.46431441ER15	R.16064338ER01
R13.00	R.29600000ER14	R.21892183ER16	R.48859921ER15	R.16904543ER01
R14.00	R.29600000ER14	R.22641477ER16	R.51052643ER15	R.17663181ER01
R15.00	R.29600000ER14	R.23316182ER16	R.53030850ER15	R.18347600ER01
R16.00	R.29600000ER14	R.23923723ER16	R.54814501ER15	R.18964707ER01
R17.00	R.29600000ER14	R.24470783ER16	R.56422080ER15	R.19520897ER01
R18.00	R.29600000ER14	R.24963386ER16	R.57870563ER15	R.20022042ER01
R19.00	R.29600000ER14	R.25406951ER16	R.59175440ER15	R.20473504ER01
R20.00	R.29600000ER14	R.25806361ER16	R.60350787ER15	R.20880150ER01
R21.00	R.29600000ER14	R.26166010ER16	R.61409366ER15	R.21246397ER01
R22.00	R.29600000ER14	R.26489857ER16	R.62362712ER15	R.21576236ER01
R23.00	R.29600000ER14	R.26781466ER16	R.63221246ER15	R.21873270ER01
R24.00	R.29600000ER14	R.27044046ER16	R.63994371ER15	R.22140757ER01
R25.00	R.29600000ER14	R.27280486ER16	R.64690569ER15	R.22381626ER01
R26.00	R.29600000ER14	R.27493392ER16	R.65317486ER15	R.22598520ER01
R27.00	R.29600000ER14	R.27685104ER16	R.65882011ER15	R.22793842ER01
R28.00	R.29600000ER14	R.27857731ER16	R.66390350ER15	R.22969717ER01
R29.00	R.29600000ER14	R.28013173ER16	R.66848092ER15	R.23128086ER01
R30.00	R.29600000ER14	R.28153141ER16	R.67260269ER15	R.23270691ER01
R31.00	R.29600000ER14	R.28279174ER16	R.67631417ER15	R.23399101ER01
R32.00	R.29600000ER14	R.28392662ER16	R.67965618ER15	R.23514728ER01
R33.00	R.29600000ER14	R.28494852ER16	R.68266551ER15	R.23618845ER01
R34.00	R.29600000ER14	R.28586870ER16	R.68537527ER15	R.23712597ER01
R35.00	R.29600000ER14	R.28669729ER16	R.68781529ER15	R.23797018ER01
R36.00	R.29600000ER14	R.28744340ER16	R.69001244ER15	R.23873035ER01
R37.00	R.29600000ER14	R.28811521ER16	R.69199086ER15	R.23941482ER01
R38.00	R.29600000ER14	R.28872014ER16	R.69377232ER15	R.24003118ER01
R39.00	R.29600000ER14	R.28926486ER16	R.69537643ER15	R.24058616ER01
R40.00	R.29600000ER14	R.28975537ER16	R.69682087ER15	R.24108591ER01
R41.00	R.29600000ER14	R.29019702ER16	R.69812151ER15	R.24153590ER01
R42.00	R.29600000ER14	R.29059473ER16	R.69929268ER15	R.24194111ER01
R43.00	R.29600000ER14	R.29095285ER16	R.70034728ER15	R.24230597ER01
R44.00	R.29600000ER14	R.29127530ER16	R.70129687ER15	R.24263458ER01
R45.00	R.29600000ER14	R.29156567ER16	R.70215195ER15	R.24293036ER01
R46.00	R.29600000ER14	R.29182712ER16	R.70292188ER15	R.24319673ER01
R47.00	R.29600000ER14	R.29206256ER16	R.70361519ER15	R.24343661ER01
R1.00	R.00000000E-99	R.26298881ER16	R.93047276ER15	R.32192473ER01
R2.00	R.00000000E-99	R.23680923ER16	R.11130631ER16	R.38509729ER01

XENON BUILDUP, 5 MW, STEADY OPERATION.

t	φ	I	X	ΔK/K
+3.00	+0.00000000E-99	+.21323576E+16	+.12573767E+16	+.43502688E+01
+4.00	+0.00000000E-99	+.19200894E+16	+.13686923E+16	+.47353982E+01
+5.00	+0.00000000E-99	+.17289518E+16	+.14516553E+16	+.50224334E+01
+6.00	+0.00000000E-99	+.15568414E+16	+.15103494E+16	+.52255032E+01
+7.00	+0.00000000E-99	+.14018639E+16	+.15483602E+16	+.53570128E+01
+8.00	+0.00000000E-99	+.12623137E+16	+.15688303E+16	+.54278353E+01
+9.00	+0.00000000E-99	+.11366554E+16	+.15745105E+16	+.54474875E+01
+10.00	+0.00000000E-99	+.10235058E+16	+.15678056E+16	+.54242900E+01
+1.00	+0.00000000E-99	+.92161947E+15	+.15508106E+16	+.53654906E+02
+2.00	+0.00000000E-99	+.82987549E+15	+.15253501E+16	+.52774024E+01
+3.00	+0.00000000E-99	+.74726433E+15	+.14930089E+16	+.51655085E+01
+4.00	+0.00000000E-99	+.67287681E+15	+.14551592E+16	+.50345561E+01
+5.00	+0.00000000E-99	+.60589431E+15	+.14129871E+16	+.48886493E+01
+6.00	+0.00000000E-99	+.54557968E+15	+.13675139E+16	+.47313210E+01
+7.00	+0.00000000E-99	+.49126915E+15	+.13196157E+16	+.45656038E+01
+8.00	+0.00000000E-99	+.44236507E+15	+.12700414E+16	+.43940861E+01
+9.00	+0.00000000E-99	+.39832923E+15	+.12194290E+16	+.42189775E+02
+10.00	+0.00000000E-99	+.35867699E+15	+.11683176E+16	+.40421423E+02
+11.00	+0.00000000E-99	+.32297199E+15	+.11171615E+16	+.38651524E+02
+12.00	+0.00000000E-99	+.29082130E+15	+.10663398E+16	+.36893198E+02
+13.00	+0.00000000E-99	+.26187109E+15	+.10161667E+16	+.35157310E+01
+14.00	+0.00000000E-99	+.23580279E+15	+.96689979E+15	+.33452775E+01
+15.00	+0.00000000E-99	+.21232950E+15	+.91874738E+15	+.31786798E+01
+16.00	+0.00000000E-99	+.19119289E+15	+.87187549E+15	+.30165125E+01
+17.00	+0.00000000E-99	+.17216035E+15	+.82641320E+15	+.28592229E+01
+18.00	+0.00000000E-99	+.15502244E+15	+.78245802E+15	+.27071462E+02
+19.00	+0.00000000E-99	+.13959056E+15	+.74008038E+15	+.25605281E+01
+20.00	+0.00000000E-99	+.12569485E+15	+.69932759E+15	+.24195318E+01
+21.00	+0.00000000E-99	+.11318241E+15	+.66022733E+15	+.22042528E+01
+22.00	+0.00000000E-99	+.10191555E+15	+.62279069E+15	+.21547297E+01
+23.00	+0.00000000E-99	+.91770225E+14	+.58701485E+15	+.20309525E+01
+24.00	+0.00000000E-99	+.82634822E+14	+.55288534E+15	+.19128713E+01
+25.00	+0.00000000E-99	+.74408816E+14	+.52037815E+15	+.18004030E+01
+26.00	+0.00000000E-99	+.67001682E+14	+.48946142E+15	+.16934374E+01
+27.00	+0.00000000E-99	+.60331902E+14	+.46009701E+15	+.15918426E+01
+28.00	+0.00000000E-99	+.54326076E+14	+.43224178E+15	+.14954690E+01
+29.00	+0.00000000E-99	+.48918111E+14	+.40584879E+15	+.14041546E+01
+30.00	+0.00000000E-99	+.44048488E+14	+.38086819E+15	+.13177268E+01
+31.00	+0.00000000E-99	+.39663621E+14	+.35724811E+15	+.12360061E+01
+32.00	+0.00000000E-99	+.35715251E+14	+.33493538E+15	+.11588086E+01
+33.00	+0.00000000E-99	+.32159928E+14	+.31387609E+15	+.10859477E+01
+34.00	+0.00000000E-99	+.28958524E+14	+.29401616E+15	+.10172369E+02
+35.00	+0.00000000E-99	+.26075809E+14	+.27530171E+15	+.95248810E-00
+36.00	+0.00000000E-99	+.23400058E+14	+.25767939E+15	+.89151854E-00
+37.00	+0.00000000E-99	+.21142705E+14	+.24109682E+15	+.83414619E-00
+38.00	+0.00000000E-99	+.19038027E+14	+.22550268E+15	+.78019362E-00
+39.00	+0.00000000E-99	+.17142864E+14	+.21084896E+15	+.72948780E-00
+40.00	+0.00000000E-99	+.15436356E+14	+.19708105E+15	+.68186054E-00

TABLE 5. THERMAL FLUX (ϕ), IODINE NUMBER DENSITY (I), XENON NUMBER DENSITY (X) AND NEGATIVE REACTIVITY DUE TO XENON BUILDUP VS. TIME UNDER 1 MEGAWATT 8 HOURS ON — 16 HOURS OFF OPERATION DURING A 5 DAY WEEK AND AFTER TERMINAL SHUTDOWN

t	ϕ	I	X	ΔK/K
R1.00	R.59100000ER13	R.58473159ER14	R.62737891ER13	R.21706040E-01
R2.00	R.59100000ER13	R.11112550ER15	R.17039013ER14	R.58951534E-01
R3.00	R.59100000ER13	R.15853644ER15	R.31125032ER14	R.10768630E-00
R4.00	R.59100000ER13	R.20172779ER15	R.47580063ER14	R.16461738E-00
R5.00	R.59100000ER13	R.23966935ER15	R.65634929ER14	R.22708357E-00
R6.00	R.59100000ER13	R.27428417ER15	R.84672447ER14	R.29294953E-00
R7.00	R.59100000ER13	R.30545322ER15	R.10420162ER15	R.36051650E-00
R8.00	R.59100000ER13	R.33351949ER15	R.12383594ER15	R.42844727E-00
R1.00	R.00000000E-99	R.30031883ER15	R.14656571ER15	R.50708767E-00
R2.00	R.00000000E-99	R.27042321ER15	R.16447244ER15	R.56904135E-00
R3.00	R.00000000E-99	R.24350358ER15	R.17822322ER15	R.61661625E-00
R4.00	R.00000000E-99	R.21926370ER15	R.18840509ER15	R.65184345E-00
R5.00	R.00000000E-99	R.19743682ER15	R.19553401ER15	R.67650809E-00
R6.00	R.00000000E-99	R.17778272ER15	R.20006286ER15	R.69217700E-00
R7.00	R.00000000E-99	R.16008512ER15	R.20238851ER15	R.70022327E-00
R8.00	R.00000000E-99	R.14414925ER15	R.20285829ER15	R.70184862E-00
R9.00	R.00000000E-99	R.12979975ER15	R.20177566ER15	R.69810294E-00
R10.00	R.00000000E-99	R.11687869ER15	R.19940502ER15	R.68990100E-00
R11.00	R.00000000E-99	R.10524388ER15	R.19597655ER15	R.67803919E-00
R12.00	R.00000000E-99	R.94767247ER14	R.19169002ER15	R.66320865E-00
R13.00	R.00000000E-99	R.85333501ER14	R.18671848ER15	R.64600814E-00
R14.00	R.00000000E-99	R.76838853ER14	R.18121127ER15	R.62695430E-00
R15.00	R.00000000E-99	R.69189818ER14	R.17529700ER15	R.60649212E-00
R16.00	R.00000000E-99	R.62302216ER14	R.16908596ER15	R.58500319E-00
R1.00	R.59100000ER13	R.11457338ER15	R.15717748ER15	R.54380224E-00
R2.00	R.59100000ER13	R.16164108ER15	R.15176140ER15	R.52506372E-00
R3.00	R.59100000ER13	R.20402337ER15	R.15144085ER15	R.52395467E-00
R4.00	R.59100000ER13	R.24218665ER15	R.15506414ER15	R.53649052E-00
R5.00	R.59100000ER13	R.27655090ER15	R.16168550ER15	R.55939908E-00
R6.00	R.59100000ER13	R.30749430ER15	R.17053146ER15	R.59000431E-00
R7.00	R.59100000ER13	R.33535738ER15	R.18097272ER15	R.62612898E-00
R8.00	R.59100000ER13	R.36044676ER15	R.19250033ER15	R.66601216E-00
R1.00	R.00000000E-99	R.32456558ER15	R.21278057ER15	R.73617770E-00
R2.00	R.00000000E-99	R.29225624ER15	R.22816128ER15	R.78939184E-00
R3.00	R.00000000E-99	R.26316320ER15	R.23934059ER15	R.82807000E-00
R4.00	R.00000000E-99	R.23696628ER15	R.24693176ER15	R.85433390E-00
R5.00	R.00000000E-99	R.21337716ER15	R.25147272ER15	R.87004469E-00
R6.00	R.00000000E-99	R.19213624ER15	R.25343473ER15	R.87683286E-00
R7.00	R.00000000E-99	R.17300980ER15	R.25322989ER15	R.87612415E-00
R8.00	R.00000000E-99	R.15578734ER15	R.25121791ER15	R.86916311E-00
R9.00	R.00000000E-99	R.14027931ER15	R.24771210ER15	R.85709371E-00
R10.00	R.00000000E-99	R.12631505ER15	R.24298488ER15	R.84067850E-00
R11.00	R.00000000E-99	R.11374087ER15	R.23727255ER15	R.82091499E-00
R12.00	R.00000000E-99	R.10241841ER15	R.23077949ER15	R.79845033E-00
R13.00	R.00000000E-99	R.92223029ER14	R.22368196ER15	R.77389431E-00
R14.00	R.00000000E-99	R.83042553ER14	R.21613149ER15	R.74777119E-00
R15.00	R.00000000E-99	R.74775960ER14	R.20825786ER15	R.72053003E-00

XENON BUILDUP, 1 MW, 8 HRS. ON-16 HRS. OFF.

t	φ	I	X	ΔK/K
R16.00	R.00000000E-99	R.67332278ER14	R.20017170ER15	R.69255357E-00
R1.00	R.59100000ER13	R.11910272ER15	R.18432959ER15	R.63774305E-00
R2.00	R.59100000ER13	R.16571955ER15	R.17549014ER15	R.60716037E-00
R3.00	R.59100000ER13	R.20769583ER15	R.17218891ER15	R.59573876E-00
R4.00	R.59100000ER13	R.24549351ER15	R.17321571ER15	R.59929129E-00
R5.00	R.59100000ER13	R.27952857ER15	R.17757413ER15	R.61437053E-00
R6.00	R.59100000ER13	R.31017552ER15	R.18444692ER15	R.63814900E-00
R7.00	R.59100000ER13	R.33777168ER15	R.19316681ER15	R.66831805E-00
R8.00	R.59100000ER13	R.36262075ER15	R.20319192ER15	R.70300290E-00
R1.00	R.00000000E-99	R.32652316ER15	R.22289842ER15	R.77118340E-00
R2.00	R.00000000E-99	R.29401895ER15	R.23772666ER15	R.82248611E-00
R3.00	R.00000000E-99	R.26475044ER15	R.24837529ER15	R.85932823E-00
R4.00	R.00000000E-99	R.23839551ER15	R.25545780ER15	R.88383228E-00
R5.00	R.00000000E-99	R.21466412ER15	R.25951224ER15	R.89785981E-00
R6.00	R.00000000E-99	R.19329513ER15	R.26100970ER15	R.90304072E-00
R7.00	R.00000000E-99	R.17405334ER15	R.26036208ER15	R.90080009E-00
R8.00	R.00000000E-99	R.15672699ER15	R.25792861ER15	R.89238078E-00
R9.00	R.00000000E-99	R.14112542ER15	R.25402220ER15	R.87886539E-00
R10.00	R.00000000E-99	R.12707692ER15	R.24891474ER15	R.86119462E-00
R11.00	R.00000000E-99	R.11442691ER15	R.24284190ER15	R.84018381E-00
R12.00	R.00000000E-99	R.10303617ER15	R.23600744ER15	R.81653798E-00
R13.00	R.00000000E-99	R.92779296ER14	R.22858693ER15	R.79086449E-00
R14.00	R.00000000E-99	R.83543444ER14	R.22073123ER15	R.76368536E-00
R15.00	R.00000000E-99	R.75226990ER14	R.21256937ER15	R.73544698E-00
R16.00	R.00000000E-99	R.67738410ER14	R.20421131ER15	R.70652979E-00
R1.00	R.59100000ER13	R.11946842ER15	R.18783525ER15	R.64987193E-00
R2.00	R.59100000ER13	R.16604885ER15	R.17853365ER15	R.61769028E-00
R3.00	R.59100000ER13	R.20799236ER15	R.17483228ER15	R.60488430E-00
R4.00	R.59100000ER13	R.24576052ER15	R.17551255ER15	R.60723789E-00
R5.00	R.59100000ER13	R.27976897ER15	R.17957071ER15	R.62127830E-00
R6.00	R.59100000ER13	R.31039201ER15	R.18618325ER15	R.64415634E-00
R7.00	R.59100000ER13	R.33796664ER15	R.19467748ER15	R.67354467E-00
R8.00	R.59100000ER13	R.36279629ER15	R.20450687ER15	R.70755238E-00
R1.00	R.00000000E-99	R.32668123ER15	R.22413405ER15	R.77545845E-00
R2.00	R.00000000E-99	R.29416130ER15	R.23888711ER15	R.82650104E-00
R3.00	R.00000000E-99	R.26487863ER15	R.24946454ER15	R.86309681E-00
R4.00	R.00000000E-99	R.23851094ER15	R.25647972ER15	R.88736791E-00
R5.00	R.00000000E-99	R.21476805ER15	R.26047052ER15	R.90117527E-00
R6.00	R.00000000E-99	R.19338870ER15	R.26190788ER15	R.90614825E-00
R7.00	R.00000000E-99	R.17413758ER15	R.26120356ER15	R.90371144E-00
R8.00	R.00000000E-99	R.15680286ER15	R.25871667ER15	R.89510731E-00
R9.00	R.00000000E-99	R.14119374ER15	R.25475994ER15	R.88141782E-00
R10.00	R.00000000E-99	R.12713844ER15	R.24960510ER15	R.86358311E-00
R11.00	R.00000000E-99	R.11448230ER15	R.24348772ER15	R.84241873E-00
R12.00	R.00000000E-99	R.10308605ER15	R.23661139ER15	R.81862752E-00
R13.00	R.00000000E-99	R.92824214ER14	R.22915154ER15	R.79281795E-00
R14.00	R.00000000E-99	R.83583893ER14	R.22125889ER15	R.76551098E-00
R15.00	R.00000000E-99	R.75263412ER14	R.21306236ER15	R.73715263E-00
R16.00	R.00000000E-99	R.67771206ER14	R.20467177ER15	R.70812289E-00

XENON BUILDUP, 1 MW, 8 HRS. ON – 16 HRS. OFF.

t	ϕ	I	X	ΔK/K	
R1.00	R.59100000ER13	R.11549795ER15	R.18823359ER15	R.65125010E-00	823
R2.00	R.59100000ER13	R.16607545ER15	R.17887836ER15	R.61888292E-00	824
R3.00	R.59100000ER13	R.20801631ER15	R.17513070ER15	R.60591675E-00	825
R4.00	R.59100000ER13	R.24578207ER15	R.17577095ER15	R.60813191E-00	826
R5.00	R.59100000ER13	R.27978838ER15	R.17979455ER15	R.62205274E-00	827
R6.00	R.59100000ER13	R.31040949ER15	R.18637721ER15	R.64482741E-00	828
R7.00	R.59100000ER13	R.33798238ER15	R.19484564ER15	R.67412648E-00	829
R8.00	R.59100000ER13	R.36281048ER15	R.20465272ER15	R.70805698E-00	830
					831
R1.00	R.00000000E-99	R.32669402ER15	R.22427061ER15	R.77593091E-00	832
R2.00	R.00000000E-99	R.29417282ER15	R.23901492ER15	R.82694322E-00	833
R3.00	R.00000000E-99	R.26488899ER15	R.249[illegible]0412ER15	R.86351054E-00	834
R4.00	R.00000000E-99	R.23852028ER15	R.25659154ER15	R.88775478E-00	835
R5.00	R.00000000E-99	R.21477647ER15	R.26057507ER15	R.90153699E-00	836
R6.00	R.00000000E-99	R.19339628ER15	R.26200558ER15	R.90648628E-00	837
R7.00	R.00000000E-99	R.17414443ER15	R.26129485ER15	R.90402729E-00	838
R8.00	R.00000000E-99	R.15680902ER15	R.25880194ER15	R.89540233E-00	839
R9.00	R.00000000E-99	R.14119929ER15	R.25483956ER15	R.88169329E-00	840
R10.00	R.00000000E-99	R.12714347ER15	R.24967943ER15	R.86384028E-00	841
R11.00	R.00000000E-99	R.11448684ER15	R.24355711ER15	R.84265831E-00	842
R12.00	R.00000000E-99	R.10309013ER15	R.23667611ER15	R.81885143E-00	843
R13.00	R.00000000E-99	R.92827887ER14	R.22921190ER15	R.79302678E-00	844
R14.00	R.00000000E-99	R.83587199ER14	R.22131519ER15	R.76570574E-00	845
R15.00	R.00000000E-99	R.75266389ER14	R.21311484ER15	R.73733419E-00	846
R16.00	R.00000000E-99	R.67773887ER14	R.20472068ER15	R.70829211E-00	847
					848
R1.00	R.00000000E-99	R.61027239ER14	R.19622581ER15	R.67890158E-00	849
R2.00	R.00000000E-99	R.54952197ER14	R.18770860ER15	R.64943375E-00	850
R3.00	R.00000000E-99	R.49481903ER14	R.17923467ER15	R.62011567E-00	851
R4.00	R.00000000E-99	R.44556158ER14	R.17085849ER15	R.59113579E-00	852
R5.00	R.00000000E-99	R.40170754ER14	R.16262478ER15	R.56264880E-00	853
R6.00	R.00000000E-99	R.36126879ER14	R.15456987ER15	R.53478045E-00	854
R7.00	R.00000000E-99	R.32530581ER14	R.14672274ER15	R.50763096E-00	855
R8.00	R.00000000E-99	R.29292280ER14	R.13910611ER15	R.48127897E-00	856
R9.00	R.00000000E-99	R.26376340ER14	R.13173724ER15	R.45578416E-00	857
R10.00	R.00000000E-99	R.23750672ER14	R.12462877ER15	R.43119030E-00	858
R11.00	R.00000000E-99	R.21386381ER14	R.11778930ER15	R.40752712E-00	859
R12.00	R.00000000E-99	R.19257447ER14	R.11122412ER15	R.38481293E-00	860
R13.00	R.00000000E-99	R.17340440ER14	R.10493560ER15	R.36305592E-00	861
R14.00	R.00000000E-99	R.15614265ER14	R.98923720ER14	R.34225604E-00	862
R15.00	R.00000000E-99	R.14059924ER14	R.93186422ER14	R.32240614E-00	863
R16.00	R.00000000E-99	R.12660312ER14	R.87720064ER14	R.30349364E-00	864
R17.00	R.00000000E-99	R.11400028ER14	R.82519600ER14	R.28550109E-00	865
R18.00	R.00000000E-99	R.10265199ER14	R.77578885ER14	R.26840723E-00	866
R19.00	R.00000000E-99	R.92433350ER13	R.72890899ER14	R.25218773E-00	867
R20.00	R.00000000E-99	R.83231937ER13	R.68447946ER14	R.23681603E-00	868
R21.00	R.00000000E-99	R.74946491ER13	R.64241821ER14	R.22226369E-00	869
R22.00	R.00000000E-99	R.67485833ER13	R.60263955ER14	R.20850108E-00	870
R23.00	R.00000000E-99	R.60767859ER13	R.56505533ER14	R.19549770E-00	871
R24.00	R.00000000E-99	R.54718634ER13	R.52957605ER14	R.18322259E-00	872
R25.00	R.00000000E-99	R.49271589ER13	R.49611169ER14	R.17164460E-00	873
R26.00	R.00000000E-99	R.44366781ER13	R.46457245ER14	R.16073266E-00	874
R27.00	R.00000000E-99	R.39950228ER13	R.43486939ER14	R.15045600E-00	875
R28.00	R.00000000E-99	R.35973327ER13	R.40691492ER14	R.14078432E-00	876

XENON BUILDUP, I MW, 8 HRS. ON- 16 HRS. OFF.

t	ϕ	I	X	$\Delta K/K$	
R29.00	R.00000000E-99	R.32392313ER13	R.38C62322ER14	R.13168792t-C0	877
R30.00	R.0000C000E-99	R.29167777ER13	R.35591058ER14	R.12313785E-C0	87R
R31.00	R.00000000E-99	R.26264231EK13	K.33269560ER14	R.1151C593t-C0	879
R32.00	R.00000000E-99	K.23649724ER13	F.31C89950ER14	K.10756492E-C0	880
R33.00	R.00000000E-99	K.21295482ER13	R.29C44618ER14	R.10C48849E-C0	881
R34.00	R.00000000E-99	R.19175598EK13	R.27126241ER14	K.93851304E-C1	882
R35.00	R.00000000E-99	R.17266739ER13	K.25327774ER14	R.87628971t-C1	883
R36.00	R.00000000E-99	R.15547902ER13	R.23642473ER14	R.81798172E-C1	8R4
R37.00	R.00000000E-99	R.14000170ER13	R.22C63883ER14	R.76336568E-C1	885
R38.00	R.00000000E-99	K.12606507ER13	R.20585839ER14	R.71222836E-01	886
R39.00	R.00000000E-99	R.11351580ER13	R.19202466ER14	R.66436646E-C1	887
R40.00	R.00000000E-99	R.10221576ER13	K.17908170ER14	K.61958641E-C1	888
R41.00	R.00000000E-99	R.92040549ER12	F.16697637ER14	R.5777C444E-C1	889
R42.00	R.00000000E-99	R.82878236ER12	R.15565822ER14	R.53854593E-C1	890
R43.00	R.00000000E-99	R.74628002ER12	R.14507939ER14	R.50194531E-01	891
R44.00	R.00000000E-99	R.67199050ER12	R.13519462ER14	R.46774601E-C1	892
R45.00	R.00000000E-99	R.60509623ER12	K.12596098ER14	R.43579948E-C1	893
R46.00	R.C0000000E-99	R.54486107ER12	K.11733799ER14	R.40596567E-C1	894
R47.00	R.00000000E-99	K.49062209ER12	R.10928739ER14	R.37811223E-C1	895
R48.00	R.00000000E-99	R.44178242ER12	R.10177309ER14	R.35211429E-C1	896

TABLE 6. THERMAL FLUX (ϕ), IODINE NUMBER DENSITY (I), 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 SHUTDOWN

t	ϕ	I	X	$\Delta K/K$
R1.00	R.11800000ER14	R.11674843ER15	R.12176825ER14	R.42129349E-01
R2.00	R.11800000ER14	R.22187489ER15	R.32231044ER14	R.11151288E-00
R3.00	R.11800000ER14	R.31653635ER15	R.57515532ER14	R.19899209E-00
R4.00	R.11800000ER14	R.40177457ER15	R.86028497ER14	R.29764117E-00
R5.00	R.11800000ER14	R.47852759ER15	R.11627096ER15	R.40227398E-00
R6.00	R.11800000ER14	R.54764010ER15	R.14713454ER15	R.50905572E-00
R7.00	R.11800000ER14	R.60987268ER15	R.17781310ER15	R.61519733E-00
R8.00	R.11800000ER14	R.66591021ER15	R.20773327ER15	R.71871505E-00
R1.00	R.00000000E-99	R.59962121ER15	R.25600227ER15	R.88571602E-00
R2.00	R.00000000E-99	R.53993107ER15	R.29443066ER15	R.10186704ER01
R3.00	R.00000000E-99	R.48618285ER15	R.32436580ER15	R.11222399ER01
R4.00	R.00000000E-99	R.43778508ER15	R.34699408ER15	R.12005292ER01
R5.00	R.00000000E-99	R.39420516ER15	R.36335890ER15	R.12571482ER01
R6.00	R.00000000E-99	R.35496348ER15	R.37437669ER15	R.12952675ER01
R7.00	R.00000000E-99	R.31962816ER15	R.38085127ER15	R.13176682ER01
R8.00	R.00000000E-99	R.28781033ER15	R.38348659ER15	R.13267859ER01
R9.00	R.00000000E-99	R.25915986ER15	R.38289828ER15	R.13247504ER01
R10.00	R.00000000E-99	R.23336145ER15	R.37962345ER15	R.13134202ER01
R11.00	R.00000000E-99	R.21013118ER15	R.37413001ER15	R.12944141ER01
R12.00	R.00000000E-99	R.18921340ER15	R.36682464ER15	R.12691389ER01
R13.00	R.00000000E-99	R.17037792ER15	R.35806000ER15	R.12388150ER01
R14.00	R.00000000E-99	R.15341745ER15	R.34814105ER15	R.12044975ER01
R15.00	R.00000000E-99	R.13814534ER15	R.33733071ER15	R.11670959ER01
R16.00	R.00000000E-99	R.12439351ER15	R.32585493ER15	R.11273920ER01
R1.00	R.11800000ER14	R.22875891ER15	R.28229828ER15	R.97669491E-00
R2.00	R.11800000ER14	R.32273508ER15	R.25694170ER15	R.88896628E-00
R3.00	R.11800000ER14	R.40735624ER15	R.24513190ER15	R.84810675E-00
R4.00	R.11800000ER14	R.48355361ER15	R.24326117ER15	R.84163441E-00
R5.00	R.11800000ER14	R.55216579ER15	R.24854393ER15	R.85991169E-00
R6.00	R.11800000ER14	R.61394785ER15	R.25884014ER15	R.89553449E-00
R7.00	R.11800000ER14	R.66957970ER15	R.27251543ER15	R.94284823E-00
R8.00	R.11800000ER14	R.71967358ER15	R.28833078ER15	R.99756610E-00
R1.00	R.00000000E-99	R.64803264ER15	R.33583537ER15	R.11619223ER01
R2.00	R.00000000E-99	R.58352328ER15	R.37304529ER15	R.12906611ER01
R3.00	R.00000000E-99	R.52543562ER15	R.40139184ER15	R.13887344ER01
R4.00	R.00000000E-99	R.47313040ER15	R.42213414ER15	R.14604986ER01
R5.00	R.00000000E-99	R.42603197ER15	R.43637844ER15	R.15097810ER01
R6.00	R.00000000E-99	R.38362203ER15	R.44509538ER15	R.15399398ER01
R7.00	R.00000000E-99	R.34543385ER15	R.44913532ER15	R.15539172ER01
R8.00	R.00000000E-99	R.31104716ER15	R.44924209ER15	R.15542867ER01
R9.00	R.00000000E-99	R.28008356ER15	R.44606512ER15	R.15432950ER01
R10.00	R.00000000E-99	R.25220228ER15	R.44017030ER15	R.15229000ER01
R11.00	R.00000000E-99	R.22709648ER15	R.43204978ER15	R.14948047ER01
R12.00	R.00000000E-99	R.20448986ER15	R.42213054ER15	R.14604861ER01
R13.00	R.00000000E-99	R.18413364ER15	R.41078203ER15	R.14212226ER01
R14.00	R.00000000E-99	R.16580384ER15	R.39832304ER15	R.13781170ER01

XENON BUILDUP, 2 MW, 8 HRS. ON-16 HRS. OFF.

t	ϕ	I	X	$\Delta K/K$
Ø15.00	Ø.00000000E-99	Ø.14929870EØ15	Ø.38502771EØ15	Ø.13321179EØ01
Ø16.00	Ø.00000000E-99	Ø.13443658EØ15	Ø.37113098EØ15	Ø.12840380EØ01
Ø1.00	Ø.11800000EØ14	Ø.23780222EØ15	Ø.31918707EØ15	Ø.11043225EØ01
Ø2.00	Ø.11800000EØ14	Ø.33087817EØ15	Ø.28707341EØ15	Ø.99321588E-00
Ø3.00	Ø.11800000EØ14	Ø.41468870EØ15	Ø.26981145EØ15	Ø.93349299E-00
Ø4.00	Ø.11800000EØ14	Ø.49015616EØ15	Ø.26353401EØ15	Ø.91177432E-00
Ø5.00	Ø.11800000EØ14	Ø.55811108EØ15	Ø.26524838EØ15	Ø.91770570E-00
Ø6.00	Ø.11800000EØ14	Ø.61930130EØ15	Ø.27264915EØ15	Ø.94331087E-00
Ø7.00	Ø.11800000EØ14	Ø.67440024EØ15	Ø.28396986EØ15	Ø.98247820E-00
Ø8.00	Ø.11800000EØ14	Ø.72401424EØ15	Ø.29786587EØ15	Ø.10305555EØ01
Ø1.00	Ø.00000000E-99	Ø.65194121EØ15	Ø.34508759EØ15	Ø.11939331EØ01
Ø2.00	Ø.00000000E-99	Ø.58704279EØ15	Ø.38199412EØ15	Ø.13216223EØ01
Ø3.00	Ø.00000000E-99	Ø.52860477EØ15	Ø.41002240EØ15	Ø.14185944EØ01
Ø4.00	Ø.00000000E-99	Ø.47598405EØ15	Ø.43043629EØ15	Ø.14892223EØ01
Ø5.00	Ø.00000000E-99	Ø.42860154EØ15	Ø.44434611EØ15	Ø.15373475EØ01
Ø6.00	Ø.00000000E-99	Ø.38593580EØ15	Ø.45272596EØ15	Ø.15663401EØ01
Ø7.00	Ø.00000000E-99	Ø.34751727EØ15	Ø.45642902EØ15	Ø.15791519EØ01
Ø8.00	Ø.00000000E-99	Ø.31292317EØ15	Ø.45620159EØ15	Ø.15783651EØ01
Ø9.00	Ø.00000000E-99	Ø.28177280EØ15	Ø.45269507EØ15	Ø.15662332EØ01
Ø10.00	Ø.00000000E-99	Ø.25372334EØ15	Ø.44647696EØ15	Ø.15447199EØ01
Ø11.00	Ø.00000000E-99	Ø.22846613EØ15	Ø.43804076EØ15	Ø.15155323EØ01
Ø12.00	Ø.00000000E-99	Ø.20572317EØ15	Ø.42781447EØ15	Ø.14801514EØ01
Ø13.00	Ø.00000000E-99	Ø.18524419EØ15	Ø.41616831EØ15	Ø.14398580EØ01
Ø14.00	Ø.00000000E-99	Ø.16680384EØ15	Ø.40342173EØ15	Ø.13957575EØ01
Ø15.00	Ø.00000000E-99	Ø.15019916EØ15	Ø.38984930EØ15	Ø.13487996EØ01
Ø16.00	Ø.00000000E-99	Ø.13524741EØ15	Ø.37568621EØ15	Ø.12997982EØ01
Ø1.00	Ø.11800000EØ14	Ø.23853234EØ15	Ø.32288072EØ15	Ø.11171019EØ01
Ø2.00	Ø.11800000EØ14	Ø.33153559EØ15	Ø.29007489EØ15	Ø.10036003EØ01
Ø3.00	Ø.11800000EØ14	Ø.41528068EØ15	Ø.27225618EØ15	Ø.94195127E-00
Ø4.00	Ø.11800000EØ14	Ø.49068920EØ15	Ø.26553028EØ15	Ø.91868102E-00
Ø5.00	Ø.11800000EØ14	Ø.55859106EØ15	Ø.26688287EØ15	Ø.92336071E-00
Ø6.00	Ø.11800000EØ14	Ø.61973351EØ15	Ø.27399129EØ15	Ø.94795440E-00
Ø7.00	Ø.11800000EØ14	Ø.67478941EØ15	Ø.28507534EØ15	Ø.98630290E-00
Ø8.00	Ø.11800000EØ14	Ø.72436467EØ15	Ø.29877937EØ15	Ø.10337161EØ01
Ø1.00	Ø.00000000E-99	Ø.65225674EØ15	Ø.34596776EØ15	Ø.11969784EØ01
Ø2.00	Ø.00000000E-99	Ø.58732691EØ15	Ø.38284009EØ15	Ø.13245491EØ01
Ø3.00	Ø.00000000E-99	Ø.52886061EØ15	Ø.41083363EØ15	Ø.14214011EØ01
Ø4.00	Ø.00000000E-99	Ø.47621444EØ15	Ø.43121264EØ15	Ø.14919084EØ01
Ø5.00	Ø.00000000E-99	Ø.42880902EØ15	Ø.44508772EØ15	Ø.15399134EØ01
Ø6.00	Ø.00000000E-99	Ø.38612264EØ15	Ø.45343315EØ15	Ø.15687869EØ01
Ø7.00	Ø.00000000E-99	Ø.34768552EØ15	Ø.45710237EØ15	Ø.15814816EØ01
Ø8.00	Ø.00000000E-99	Ø.31307468EØ15	Ø.45684177EØ15	Ø.15805800EØ01
Ø9.00	Ø.00000000E-99	Ø.28190923EØ15	Ø.45330293EØ15	Ø.15683363EØ01
Ø10.00	Ø.00000000E-99	Ø.25384619EØ15	Ø.44705343EØ15	Ø.15467144EØ01
Ø11.00	Ø.00000000E-99	Ø.22857673EØ15	Ø.43858684EØ15	Ø.15174216EØ01
Ø12.00	Ø.00000000E-99	Ø.20582277EØ15	Ø.42833117EØ15	Ø.14819391EØ01
Ø13.00	Ø.00000000E-99	Ø.18533389EØ15	Ø.41665678EØ15	Ø.14415480EØ01
Ø14.00	Ø.00000000E-99	Ø.16688460EØ15	Ø.40388307EØ15	Ø.13973536EØ01
Ø15.00	Ø.00000000E-99	Ø.15027188EØ15	Ø.39028464EØ15	Ø.13503058EØ01

XENON BUILDUP, 2 MW, 8 HRS. ON–16 HRS. OFF

t	ϕ	I	X	$\Delta K/K$
A16.00	A.00000000E-99	A.13531290EA15	A.37609667EA15	A.13012183EA01
A1.00	A.11800000EA14	A.23859132EA15	A.32321287EA15	A.11182510EA01
A2.00	A.11800000EA14	A.33158871EA15	A.29034423EA15	A.10045322EA01
A3.00	A.11800000EA14	A.41532850EA15	A.27247501EA15	A.94270839E-00
A4.00	A.11800000EA14	A.49073225EA15	A.26570849EA15	A.91929759E-00
A5.00	A.11800000EA14	A.55862981EA15	A.26702838EA15	A.92386415E-00
A6.00	A.11800000EA14	A.61976839EA15	A.27411043EA15	A.94836660E-00
A7.00	A.11800000EA14	A.67482084EA15	A.28517314EA15	A.98664129E-00
A8.00	A.11800000EA14	A.72439298EA15	A.29885989EA15	A.10339946EA01
A1.00	A.00000000E-99	A.65228224EA15	A.34604510EA15	A.11972459EA01
A2.00	A.00000000E-99	A.58734986EA15	A.38291421EA15	A.13248056EA01
A3.00	A.00000000E-99	A.52888128EA15	A.41090452EA15	A.14216464EA01
A4.00	A.00000000E-99	A.47623304EA15	A.43128032EA15	A.14921426EA01
A5.00	A.00000000E-99	A.42882576EA15	A.44515222EA15	A.15401365EA01
A6.00	A.00000000E-99	A.38613769EA15	A.45349453EA15	A.15689992EA01
A7.00	A.00000000E-99	A.34769908EA15	A.45716070EA15	A.15816834EA01
A8.00	A.00000000E-99	A.31308690EA15	A.45689717EA15	A.15807717EA01
A9.00	A.00000000E-99	A.28192024EA15	A.45335543EA15	A.15685179EA01
A10.00	A.00000000E-99	A.25385613EA15	A.44710315EA15	A.15468864EA01
A11.00	A.00000000E-99	A.22858570EA15	A.43863386EA15	A.15175843EA01
A12.00	A.00000000E-99	A.20583085EA15	A.42837563EA15	A.14820929EA01
A13.00	A.00000000E-99	A.18534118EA15	A.41669877EA15	A.14416934EA01
A14.00	A.00000000E-99	A.16689118EA15	A.40392267EA15	A.13974906EA01
A15.00	A.00000000E-99	A.15027778EA15	A.39032197EA15	A.13504349EA01
A16.00	A.00000000E-99	A.13531821EA15	A.37613183EA15	A.13013399EA01
A1.00	A.00000000E-99	A.12184781EA15	A.36155289EA15	A.12508997EA01
A2.00	A.00000000E-99	A.10971835EA15	A.34675540EA15	A.11997034EA01
A3.00	A.00000000E-99	A.98796309EA14	A.33188307EA15	A.11482482EA01
A4.00	A.00000000E-99	A.88961484EA14	A.31705640EA15	A.10969508EA01
A5.00	A.00000000E-99	A.80105682EA14	A.30237565EA15	A.10461585EA01
A6.00	A.00000000E-99	A.72131445EA14	A.28792340EA15	A.99615668E-00
A7.00	A.00000000E-99	A.64951016EA14	A.27376699EA15	A.94717835E-00
A8.00	A.00000000E-99	A.58485372EA14	A.25996037EA15	A.89941026E-00
A9.00	A.00000000E-99	A.52663363EA14	A.24654616EA15	A.85299980E-00
A10.00	A.00000000E-99	A.47420915EA14	A.23355698EA15	A.80805987E-00
A11.00	A.00000000E-99	A.42700332EA14	A.22101704EA15	A.76467421E-00
A12.00	A.00000000E-99	A.38449669EA14	A.20894322EA15	A.72290124E-00
A13.00	A.00000000E-99	A.34622143EA14	A.19734624EA15	A.68277803E-00
A14.00	A.00000000E-99	A.31175634EA14	A.18623162EA15	A.64432370E-00
A15.00	A.00000000E-99	A.28072212EA14	A.17560039EA15	A.60754181E-00
A16.00	A.00000000E-99	A.25277725EA14	A.16544995EA15	A.57242332E-00
A17.00	A.00000000E-99	A.22761420EA14	A.15577460EA15	A.53894858E-00
A18.00	A.00000000E-99	A.20495607EA14	A.14656617EA15	A.50708927E-00
A19.00	A.00000000E-99	A.18455345EA14	A.13781441EA15	A.47680995E-00
A20.00	A.00000000E-99	A.16618165EA14	A.12950746EA15	A.44806959E-00
A21.00	A.00000000E-99	A.14963908EA14	A.12163219EA15	A.42082275E-00
A22.00	A.00000000E-99	A.13474308EA14	A.11417449EA15	A.39502060E-00
A23.00	A.00000000E-99	A.12132994EA14	A.10711953EA15	A.37061189E-00
A24.00	A.00000000E-99	A.10925202EA14	A.10045205EA15	A.34754375E-00
A25.00	A.00000000E-99	A.98376414EA13	A.94156410EA14	A.32576210E-00

XENON BUILDUP, 2 MW, 8 HRS. ON-16 HRS. OFF.

t	ϕ	I	X	$\Delta K/K$	
R26.00	R.00000000E-99	R.88583389ER13	R.88216956ER14	R.30521280E-00	160
R27.00	R.00000000E-99	R.79765226ER13	R.82617991ER14	R.28584151E-00	161
R28.00	R.00000000E-99	R.71824879ER13	R.77343933ER14	R.26759434E-00	162
R29.00	R.00000000E-99	R.64674967ER13	R.72379418ER14	R.25041811E-00	163
R30.00	R.00000000E-99	R.58236803ER13	R.67709367ER14	R.23426070E-00	164
R31.00	R.00000000E-99	R.52439536ER13	R.63319057ER14	R.21907112E-00	165
R32.00	R.00000000E-99	R.47219369ER13	R.59194163ER14	R.20479967E-00	166
R33.00	R.00000000E-99	R.42518851ER13	R.55320796ER14	R.19139875E-00	167
R34.00	R.00000000E-99	R.38286253ER13	R.51685538ER14	R.17882149E-00	168
R35.00	R.00000000E-99	R.34474995ER13	R.48275457ER14	R.16702330E-00	169
R36.00	R.00000000E-99	R.31043134ER13	R.45078122ER14	R.15596117E-00	170
R37.00	R.00000000E-99	R.27952904ER13	R.42081606ER14	R.14559381E-00	171
R38.00	R.00000000E-99	R.25176295ER13	R.39274499ER14	R.13588181E-00	172
R39.00	R.00000000E-99	R.22664685ER13	R.36645900ER14	R.12678739E-00	173
R40.00	R.00000000E-99	R.20408500ER13	R.34185407ER14	R.11827458E-00	174
R41.00	R.00000000E-99	R.18376910ER13	R.31883121ER14	R.11030913E-00	175
R42.00	R.00000000E-99	R.16547558ER13	R.29729629ER14	R.10285849E-00	176
R43.00	R.00000000E-99	R.14900313ER13	R.27715989ER14	R.95891712E-01	177
R44.00	R.00000000E-99	R.13417045ER13	R.25833719ER14	R.89379439E-01	178
R45.00	R.00000000E-99	R.12081429ER13	R.24074788ER14	R.83293893E-01	179
R46.00	R.00000000E-99	R.10878771ER13	R.22431599ER14	R.77608791E-01	180
R47.00	R.00000000E-99	R.97958312ER12	R.20896961ER14	R.72299255E-01	181

TABLE 7. THERMAL FLUX (ϕ), IODINE NUMBER DENSITY (I), 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 SHUTDOWN

t	ϕ	I	X	ΔK/K
A1.00	A.29600000EA14	A.29286039EA15	A.28087073EA14	A.97175585E-01
A2.00	A.29600000EA14	A.55656735EA15	A.69204690EA14	A.23943421E-00
A3.00	A.29600000EA14	A.79402305EA15	A.11617316EA15	A.40193561E-00
A4.00	A.29600000EA14	A.10078407EA16	A.16471397EA15	A.56987698E-00
A5.00	A.29600000EA14	A.12003727EA16	A.21234832EA15	A.73468221E-00
A6.00	A.29600000EA14	A.13737390EA16	A.25770734EA15	A.89161523E-00
A7.00	A.29600000EA14	A.15298470EA16	A.30010074EA15	A.10382877EA01
A8.00	A.29600000EA14	A.16704149EA16	A.33924771EA15	A.11737284EA01
A1.00	A.00000000E-99	A.15041314EA16	A.47361007EA15	A.16385949EA01
A2.00	A.00000000E-99	A.13544008EA16	A.58231760EA15	A.20147010EA01
A3.00	A.00000000E-99	A.12195754EA16	A.66882098EA15	A.23139851EA01
A4.00	A.00000000E-99	A.10981715EA16	A.73616191EA15	A.25469709EA01
A5.00	A.00000000E-99	A.98885298EA15	A.78701854EA15	A.27229248EA01
A6.00	A.00000000E-99	A.89041616EA15	A.82374616EA15	A.28499949EA01
A7.00	A.00000000E-99	A.80177837EA15	A.84841337EA15	A.29353383EA01
A8.00	A.00000000E-99	A.72196416EA15	A.86283455EA15	A.29852327EA01
A9.00	A.00000000E-99	A.65009518EA15	A.86859864EA15	A.30051752EA01
A10.00	A.00000000E-99	A.58538052EA15	A.86709493EA15	A.29999728EA01
A11.00	A.00000000E-99	A.52710796EA15	A.85953575EA15	A.29738197EA01
A12.00	A.00000000E-99	A.47463625EA15	A.84697707EA15	A.29303691EA01
A13.00	A.00000000E-99	A.42738793EA15	A.83033668EA15	A.28727968EA01
A14.00	A.00000000E-99	A.38484301EA15	A.81041030EA15	A.28038556EA01
A15.00	A.00000000E-99	A.34653328EA15	A.78788602EA15	A.27259259EA01
A16.00	A.00000000E-99	A.31203717EA15	A.76335705EA15	A.26410607EA01
A1.00	A.29600000EA14	A.57383515EA15	A.53272102EA15	A.18431068EA01
A2.00	A.29600000EA14	A.80957187EA15	A.40879027EA15	A.14143316EA01
A3.00	A.29600000EA14	A.10218416EA16	A.34981519EA15	A.12102897EA01
A4.00	A.29600000EA14	A.12129801EA16	A.32977193EA15	A.11409441EA01
A5.00	A.29600000EA14	A.13850913EA16	A.33249647EA15	A.11503704EA01
A6.00	A.29600000EA14	A.15400694EA16	A.34800149EA15	A.12040146EA01
A7.00	A.29600000EA14	A.16796197EA16	A.37016360EA15	A.12806911EA01
A8.00	A.29600000EA14	A.18052782EA16	A.39527205EA15	A.13675612EA01
A1.00	A.00000000E-99	A.16255696EA16	A.53839103EA15	A.18627240EA01
A2.00	A.00000000E-99	A.14637504EA16	A.65393664EA15	A.22624883EA01
A3.00	A.00000000E-99	A.13180395EA16	A.74562700EA15	A.25797183EA01
A4.00	A.00000000E-99	A.11868339EA16	A.81673903EA15	A.28257516EA01
A5.00	A.00000000E-99	A.10686893EA16	A.87015754EA15	A.30105689EA01
A6.00	A.00000000E-99	A.96230535EA15	A.90841908EA15	A.31429461EA01
A7.00	A.00000000E-99	A.86651125EA15	A.93375105EA15	A.32305895EA01
A8.00	A.00000000E-99	A.78025311EA15	A.94810667EA15	A.32802569EA01
A9.00	A.00000000E-99	A.70258167EA15	A.95319608EA15	A.32978654EA01
A10.00	A.00000000E-99	A.63264215EA15	A.95051418EA15	A.32885865EA01
A11.00	A.00000000E-99	A.56966487EA15	A.94136510EA15	A.32569326EA01
A12.00	A.00000000E-99	A.51295675EA15	A.92688440EA15	A.32068329EA01
A13.00	A.00000000E-99	A.46189374EA15	A.90805877EA15	A.31416994EA01
A14.00	A.00000000E-99	A.41591389EA15	A.88574333EA15	A.30644926EA01

XENON BUILDUP, 5 MW, 8 HRS. ON-16 HRS. OFF.

t	Φ	I	X	ΔK/K
A15.00	A.00000000E-99	A.37451116EA15	A.86067722EA15	A.29777689EA01
A16.00	A.00000000E-99	A.33722993EA15	A.83349739EA15	A.28837322EA01
A1.00	A.29600000EA14	A.59652004EA15	A.57881005EA15	A.20025655EA01
A2.00	A.29600000EA14	A.82999856EA15	A.43956656EA15	A.15208112EA01
A3.00	A.29600000EA14	A.10402349EA16	A.37078936EA15	A.12828560EA01
A4.00	A.29600000EA14	A.12295423EA16	A.34442432EA15	A.11916384EA01
A5.00	A.29600000EA14	A.14000048EA16	A.34303010EA15	A.11868146EA01
A6.00	A.29600000EA14	A.15534984EA16	A.35581510EA15	A.12310482EA01
A7.00	A.29600000EA14	A.16917121EA16	A.37614921EA15	A.13014001EA01
A8.00	A.29600000EA14	A.18161670EA16	A.40000199EA15	A.13839259EA01
A1.00	A.00000000E-99	A.16353745EA16	A.54381286EA15	A.18814824EA01
A2.00	A.00000000E-99	A.14725792EA16	A.65989660EA15	A.22831086EA01
A3.00	A.00000000E-99	A.13259898EA16	A.75199281EA15	A.26017428EA01
A4.00	A.00000000E-99	A.11939926EA16	A.82339733EA15	A.28487879EA01
A5.00	A.00000000E-99	A.10751355EA16	A.87701155EA15	A.30342822EA01
A6.00	A.00000000E-99	A.96810993EA15	A.91538663EA15	A.31670524EA01
A7.00	A.00000000E-99	A.87173799EA15	A.94076273EA15	A.32548484EA01
A8.00	A.00000000E-99	A.78495954EA15	A.95510422EA15	A.33044672EA01
A9.00	A.00000000E-99	A.70681959EA15	A.96013096EA15	A.33218587EA01
A10.00	A.00000000E-99	A.63645820EA15	A.95734633EA15	A.33122245EA01
A11.00	A.00000000E-99	A.57310105EA15	A.94806180EA15	A.32801018EA01
A12.00	A.00000000E-99	A.51605087EA15	A.93341941EA15	A.32294419EA01
A13.00	A.00000000E-99	A.46467984EA15	A.91441127EA15	A.31636777EA01
A14.00	A.00000000E-99	A.41842263EA15	A.89189730EA15	A.30857841EA01
A15.00	A.00000000E-99	A.37677018EA15	A.86662074EA15	A.29983322EA01
A16.00	A.00000000E-99	A.33926406EA15	A.83922204EA15	A.29035383EA01
A1.00	A.29600000EA14	A.59835168EA15	A.58256994EA15	A.20155740EA01
A2.00	A.29600000EA14	A.83164785EA15	A.44207574EA15	A.15294925EA01
A3.00	A.29600000EA14	A.10417199EA16	A.37249808EA15	A.12887679EA01
A4.00	A.29600000EA14	A.12308796EA16	A.34561694EA15	A.11957645EA01
A5.00	A.29600000EA14	A.14012089EA16	A.34388660EA15	A.11897779EA01
A6.00	A.29600000EA14	A.15545827EA16	A.35644974EA15	A.12332439EA01
A7.00	A.29600000EA14	A.16926882EA16	A.37663484EA15	A.13030803EA01
A8.00	A.29600000EA14	A.18170458EA16	A.40038536EA15	A.13852522EA01
A1.00	A.00000000E-99	A.16361658EA16	A.54425195EA15	A.18830015EA01
A2.00	A.00000000E-99	A.14732916EA16	A.66037898EA15	A.22847776EA01
A3.00	A.00000000E-99	A.13266312EA16	A.75250781EA15	A.26035245EA01
A4.00	A.00000000E-99	A.11945704EA16	A.82393582EA15	A.28506510EA01
A5.00	A.00000000E-99	A.10756557EA16	A.87756576EA15	A.30361998EA01
A6.00	A.00000000E-99	A.96857839EA15	A.91594992EA15	A.31690013EA01
A7.00	A.00000000E-99	A.87215982EA15	A.94132953EA15	A.32568095EA01
A8.00	A.00000000E-99	A.78533939EA15	A.95566981EA15	A.33064241EA01
A9.00	A.00000000E-99	A.70716163EA15	A.96069142EA15	A.33237976EA01
A10.00	A.00000000E-99	A.63676619EA15	A.95789844EA15	A.33141346EA01
A11.00	A.00000000E-99	A.57337839EA15	A.94860295EA15	A.32819741EA01
A12.00	A.00000000E-99	A.51630061EA15	A.93394743EA15	A.32312689EA01
A13.00	A.00000000E-99	A.46490473EA15	A.91492451EA15	A.31654535EA01
A14.00	A.00000000E-99	A.41862513EA15	A.89239447EA15	A.30875042EA01
A15.00	A.00000000E-99	A.37695250EA15	A.86710088EA15	A.29999934EA01

XENON BUILDUP, 5 MW, 8 HRS. ON – 16 HRS. OFF.

t	φ	I	X	ΔK/K	
A16.00	A.00000000E-99	A.33942824EA15	A.83968447EA15	A.29051381EA01	471
					472
A1.00	A.29600000EA14	A.59849950EA15	A.58287366EA15	A.20166249EA01	473
A2.00	A.29600000EA14	A.83178097EA15	A.44227842EA15	A.15301938EA01	474
A3.00	A.29600000EA14	A.10418399EA16	A.37263611EA15	A.12892454EA01	475
A4.00	A.29600000EA14	A.12309876EA16	A.34571328EA15	A.11960979EA01	476
A5.00	A.29600000EA14	A.14013060EA16	A.34395576EA15	A.11900172EA01	477
A6.00	A.29600000EA14	A.15546697EA16	A.35650095EA15	A.12334210EA01	478
A7.00	A.29600000EA14	A.16927668EA16	A.37667401EA15	A.13032157EA01	479
A8.00	A.29600000EA14	A.18171166EA16	A.40041625EA15	A.13853591EA01	480
					481
A1.00	A.00000000E-99	A.16362295EA16	A.54428734EA15	A.18831239EA01	482
A2.00	A.00000000E-99	A.14733493EA16	A.66041789EA15	A.22849122EA01	483
A3.00	A.00000000E-99	A.13266831EA16	A.75254940EA15	A.26036684EA01	484
A4.00	A.00000000E-99	A.11946170EA16	A.82397931EA15	A.28508016EA01	485
A5.00	A.00000000E-99	A.10756975EA16	A.87761052EA15	A.30363547EA01	486
A6.00	A.00000000E-99	A.96861599EA15	A.91599541EA15	A.31691586EA01	487
A7.00	A.00000000E-99	A.87219369EA15	A.94137526EA15	A.32549678EA01	488
A8.00	A.00000000E-99	A.78536990EA15	A.95571542EA15	A.33065819EA01	489
A9.00	A.00000000E-99	A.70718909EA15	A.96073659EA15	A.33239540EA01	490
A10.00	A.00000000E-99	A.63679093EA15	A.95794294EA15	A.33142885EA01	491
A11.00	A.00000000E-99	A.57340066EA15	A.94864655EA15	A.32821248EA01	492
A12.00	A.00000000E-99	A.51632065EA15	A.93398996EA15	A.32314161EA01	493
A13.00	A.00000000E-99	A.46492280EA15	A.91496583EA15	A.31655965EA01	494
A14.00	A.00000000E-99	A.41864141EA15	A.89243451EA15	A.30876426EA01	495
A15.00	A.00000000E-99	A.37696716EA15	A.86713954EA15	A.30001272EA01	496
A16.00	A.00000000E-99	A.33944145EA15	A.83972171EA15	A.29052671EA01	497
					498
A1.00	A.00000000E-99	A.30565128EA15	A.81073132EA15	A.28049663EA01	499
A2.00	A.00000000E-99	A.27522482EA15	A.78063905EA15	A.27008530EA01	500
A3.00	A.00000000E-99	A.24782720EA15	A.74984582EA15	A.25943147EA01	501
A4.00	A.00000000E-99	A.22315692EA15	A.71869144EA15	A.24865268EA01	502
A5.00	A.00000000E-99	A.20094248EA15	A.68746208EA15	A.23784796EA01	503
A6.00	A.00000000E-99	A.18093941EA15	A.65639720EA15	A.22710014EA01	504
A7.00	A.00000000E-99	A.16292758EA15	A.62569545EA15	A.21647795EA01	505
A8.00	A.00000000E-99	A.14670878EA15	A.59552003EA15	A.20603787EA01	506
A9.00	A.00000000E-99	A.13210447EA15	A.56600330EA15	A.19582568EA01	507
A10.00	A.00000000E-99	A.11895399EA15	A.53725098EA15	A.18587796EA01	508
A11.00	A.00000000E-99	A.10711260EA15	A.50934575EA15	A.17622331EA01	509
A12.00	A.00000000E-99	A.96449951EA14	A.48235045EA15	A.16688349EA01	510
A13.00	A.00000000E-99	A.86848699EA14	A.45631092EA15	A.15787433EA01	511
A14.00	A.00000000E-99	A.78203217EA14	A.43125846EA15	A.14920669EA01	512
A15.00	A.00000000E-99	A.70418364EA14	A.40721205EA15	A.14088712EA01	513
A16.00	A.00000000E-99	A.63408465EA14	A.38418022EA15	A.13291857EA01	514
A17.00	A.00000000E-99	A.57096377EA14	A.36216267EA15	A.12530095EA01	515
A18.00	A.00000000E-99	A.51412635EA14	A.34115183EA15	A.11803162EA01	516
A19.00	A.00000000E-99	A.46294692EA14	A.32113402EA15	A.11110587EA01	517
A20.00	A.00000000E-99	A.41686223EA14	A.30209060EA15	A.10451722EA01	518
A21.00	A.00000000E-99	A.37536511EA14	A.28399899EA15	A.98257894E-00	519
A22.00	A.00000000E-99	A.33799887EA14	A.26683334EA15	A.92318933E-00	520
A23.00	A.00000000E-99	A.30435230EA14	A.25056540EA15	A.86690556E-00	521
A24.00	A.00000000E-99	A.27405516EA14	A.23516502EA15	A.81362335E-00	522
A25.00	A.00000000E-99	A.24677397EA14	A.22060077EA15	A.76323401E-00	523

XENON BUILDUP, 5 MW, 8 HRS. ON-16 HRS. OFF.

t	φ	I	X	ΔK/K	
R26.00	R.00000000E-99	R.22220854ER14	R.20684031ER15	R.71562561E-00	524
R27.00	R.00000000E-99	R.20008850ER14	R.19385081ER15	R.67068456E-00	525
R28.00	R.00000000E-99	R.18017045ER14	R.18159925ER15	R.62829665E-00	526
R29.00	R.00000000E-99	R.16223517ER14	R.17005273ER15	R.58834801E-00	527
R30.00	R.00000000E-99	R.14608529ER14	R.15917864ER15	R.55072586E-00	528
R31.00	R.00000000E-99	R.13154306ER14	R.14894489ER15	R.51531916E-00	529
R32.00	R.00000000E-99	R.11844846ER14	R.13932001ER15	R.48201902E-00	530
R33.00	R.00000000E-99	R.10665740ER14	R.13027332ER15	R.45071929E-00	531
R34.00	R.00000000E-99	R.96040061ER13	R.12177502ER15	R.42131691E-00	532
R35.00	R.00000000E-99	R.86479612ER13	R.11379624ER15	R.39371195E-00	533
R36.00	R.00000000E-99	R.77870873ER13	R.10630912ER15	R.36780801E-00	534
R37.00	R.00000000E-99	R.70119104ER13	R.99286779ER14	R.34351214E-00	535
R38.00	R.00000000E-99	R.63138996ER13	R.92703423ER14	R.32073505E-00	536
R39.00	R.00000000E-99	R.56853734ER13	R.86534383ER14	R.29939142E-00	537
R40.00	R.00000000E-99	R.51194148ER13	R.80756016ER14	R.27939945E-00	538
R41.00	R.00000000E-99	R.46097954ER13	R.75345752ER14	R.26068104E-00	539
R42.00	R.00000000E-99	R.41509067ER13	R.70282076ER14	R.24316175E-00	540
R43.00	R.00000000E-99	R.37376990ER13	R.65544504ER14	R.22677071E-00	541
R44.00	R.00000000E-99	R.33656246ER13	R.61113574ER14	R.21144059E-00	542
R45.00	R.00000000E-99	R.30305889ER13	R.56970808ER14	R.19710746E-00	543
R46.00	R.00000000E-99	R.27289048ER13	R.53098690ER14	R.18371071E-00	544
R47.00	R.00000000E-99	R.24572523ER13	R.49480630ER14	R.17119296E-00	545
R48.00	R.00000000E-99	R.22126420ER13	R.46100934ER14	R.15949989E-00	546

TABLE 8. THERMAL FLUX (ϕ), IODINE NUMBER DENSITY (I), XENON NUMBER DENSITY (X) AND NEGATIVE REACTIVITY DUE TO XENON BUILDUP VS. TIME UNDER 1 MEGAWATT 16 HOURS ON -- 8 HOURS OFF OPERATION DURING A 5 DAY WEEK AND AFTER TERMINAL SHUTDOWN

t	ϕ	I	X	$\Delta K/K$	
R1.00	R.59100000ER13	R.50473159ER14	R.62737891ER13	R.21706040E-01	901
R2.00	R.59100000ER13	R.11112550ER15	R.17039013ER14	R.58951534E-01	902
R3.00	R.59100000ER13	R.15853644ER15	R.31125032ER14	R.10768630E-00	903
R4.00	R.59100000ER13	R.20122779ER15	R.47580063ER14	R.16461738E-00	904
R5.00	R.59100000ER13	R.23966935ER15	R.65634929ER14	R.22708357E-00	905
R6.00	R.59100000ER13	R.27428417ER15	R.84672447ER14	R.29294953E-00	906
R7.00	R.59100000ER13	R.30545322ER15	R.10420162ER15	R.36051650E-00	907
R8.00	R.59100000ER13	R.33351949ER15	R.12383594ER15	R.42844727E-00	908
R9.00	R.59100000ER13	R.35879184ER15	R.14327516ER15	R.49570305E-00	909
R10.00	R.59100000ER13	R.38154844ER15	R.16228985ER15	R.56149003E-00	910
R11.00	R.59100000ER13	R.40203968ER15	R.18070866ER15	R.62521537E-00	911
R12.00	R.59100000ER13	R.42049108ER15	R.19840746ER15	R.68644966E-00	912
R13.00	R.59100000ER13	R.43710570ER15	R.21530046ER15	R.74489601E-00	913
R14.00	R.59100000ER13	R.45206639ER15	R.23133265ER15	R.80036413E-00	914
R15.00	R.59100000ER13	R.46553780ER15	R.24647363ER15	R.85274887E-00	915
R16.00	R.59100000ER13	R.47766818ER15	R.26071246ER15	R.90201235E-00	916
					917
R1.00	R.00000000E-99	R.43011803ER15	R.28717846ER15	R.99357928E-00	918
R2.00	R.00000000E-99	R.38730134ER15	R.30718146ER15	R.10627856ER01	919
R3.00	R.00000000E-99	R.34874690ER15	R.32164442ER15	R.11128245ER01	920
R4.00	R.00000000E-99	R.31403040ER15	R.33137804ER15	R.11465008ER01	921
R5.00	R.00000000E-99	R.28276983ER15	R.33709335ER15	R.11662748ER01	922
R6.00	R.00000000E-99	R.25462114ER15	R.33941306ER15	R.11743004ER01	923
R7.00	R.00000000E-99	R.22927455ER15	R.33888171ER15	R.11724621ER01	924
R8.00	R.00000000E-99	R.20645113ER15	R.33597450ER15	R.11624037ER01	925
					926
R1.00	R.59100000ER13	R.24437271ER15	R.31372325ER15	R.10854189ER01	927
R2.00	R.59100000ER13	R.27851934ER15	R.29810720ER15	R.10313905ER01	928
R3.00	R.59100000ER13	R.30926678ER15	R.28784070ER15	R.99587056E-00	929
R4.00	R.59100000ER13	R.33695343ER15	R.28185448ER15	R.97515945E-00	930
R5.00	R.59100000ER13	R.36188397ER15	R.27926167ER15	R.96618885E-00	931
R6.00	R.59100000ER13	R.38433274ER15	R.27932875ER15	R.96642092E-00	932
R7.00	R.59100000ER13	R.40454681ER15	R.28145125ER15	R.97376428E-00	933
R8.00	R.59100000ER13	R.42274863ER15	R.28513300ER15	R.98650244E-00	934
R9.00	R.59100000ER13	R.43913850ER15	R.28996836ER15	R.10032317ER01	935
R10.00	R.59100000ER13	R.45389682ER15	R.29562752ER15	R.10228113ER01	936
R11.00	R.59100000ER13	R.46718603ER15	R.30184388ER15	R.10443187ER01	937
R12.00	R.59100000ER13	R.47915233ER15	R.30840352ER15	R.10670137ER01	938
R13.00	R.59100000ER13	R.48992742ER15	R.31513618ER15	R.10903079ER01	939
R14.00	R.59100000ER13	R.49962989ER15	R.32190783ER15	R.11137358ER01	940
R15.00	R.59100000ER13	R.50836651ER15	R.32861428ER15	R.11369388ER01	941
R16.00	R.59100000ER13	R.51623343ER15	R.33517589ER15	R.11596406ER01	942
					943
R1.00	R.00000000E-99	R.46484423ER15	R.35987755ER15	R.12451034ER01	944
R2.00	R.00000000E-99	R.41857066ER15	R.37787933ER15	R.13073859ER01	945
R3.00	R.00000000E-99	R.37690347ER15	R.39015790ER15	R.13498673ER01	946
R4.00	R.00000000E-99	R.33938409ER15	R.39757010ER15	R.13755119ER01	947
R5.00	R.00000000E-99	R.30559964ER15	R.40086651ER15	R.13869169ER01	948
R6.00	R.00000000E-99	R.27517833ER15	R.40070362ER15	R.13863534ER01	949

XENON BUILDUP, 1 MW, 16 HRS. ON-8 HRS. OFF

t	ϕ	I	X	ΔK/K	
R7.00	R.00000000E-99	R.24778534ER15	R.39765447ER15	R.13758039ER01	950
R8.00	R.00000000E-99	R.22311923ER15	R.39221828ER15	R.13569558ER01	951
					952
R1.00	R.59100000ER13	R.25938157ER15	R.36354594ER15	R.12577953ER01	953
R2.00	R.59100000ER13	R.29203472ER15	R.34226424ER15	R.11841649ER01	954
R3.00	R.59100000ER13	R.32243620ER15	R.32699596ER15	R.11313397ER01	955
R4.00	R.59100000ER13	R.34791142ER15	R.31659154ER15	R.10953426ER01	956
R5.00	R.59100000ER13	R.37175111ER15	R.31009397ER15	R.10728623ER01	957
R6.00	R.59100000ER13	R.39321763ER15	R.30670825ER15	R.10611483ER01	958
R7.00	R.59100000ER13	R.41254725ER15	R.30577597ER15	R.10579229ER01	959
R8.00	R.59100000ER13	R.42995265ER15	R.30675349ER15	R.10613049ER01	960
R9.00	R.59100000ER13	R.44562540ER15	R.30919382ER15	R.10697480ER01	961
R10.00	R.59100000ER13	R.45973800ER15	R.31273071ER15	R.10819849ER01	962
R11.00	R.59100000ER13	R.47244572ER15	R.31706553ER15	R.10969824ER01	963
R12.00	R.59100000ER13	R.48388843ER15	R.32195622ER15	R.11139039ER01	964
R13.00	R.59100000ER13	R.49419205ER15	R.32720783ER15	R.11320728ER01	965
R14.00	R.59100000ER13	R.50346999ER15	R.33266451ER15	R.11509518ER01	966
R15.00	R.59100000ER13	R.51182436ER15	R.33820291ER15	R.11701135ER01	967
R16.00	R.59100000ER13	R.51934708ER15	R.34372652ER15	R.11892241ER01	968
					969
R1.00	R.00000000E-99	R.46764792ER15	R.36810034ER15	R.12735526ER01	970
R2.00	R.00000000E-99	R.42109525ER15	R.38576867ER15	R.13346815ER01	971
R3.00	R.00000000E-99	R.37917674ER15	R.39771156ER15	R.13760014ER01	972
R4.00	R.00000000E-99	R.34143108ER15	R.40478868ER15	R.14004868ER01	973
R5.00	R.00000000E-99	R.30744286ER15	R.40775291ER15	R.14107475ER01	974
R6.00	R.00000000E-99	R.27683804ER15	R.40726268ER15	R.14090469ER01	975
R7.00	R.00000000E-99	R.24927984ER15	R.40389259ER15	R.13973866ER01	976
R8.00	R.00000000E-99	R.22446494ER15	R.39814320ER15	R.13774948ER01	977
					978
R1.00	R.59100000ER13	R.26059332ER15	R.36875669ER15	R.12758234ER01	979
R2.00	R.59100000ER13	R.29312523ER15	R.34684951ER15	R.12000790ER01	980
R3.00	R.59100000ER13	R.32241870ER15	R.33103307ER15	R.11453074ER01	981
R4.00	R.59100000ER13	R.34879610ER15	R.32014809ER15	R.11076475ER01	982
R5.00	R.59100000ER13	R.37254771ER15	R.31322891ER15	R.10837086ER01	983
R6.00	R.59100000ER13	R.39393492ER15	R.30947310ER15	R.10707142ER01	984
R7.00	R.59100000ER13	R.41319312ER15	R.30821519ER15	R.10663641ER01	985
R8.00	R.59100000ER13	R.43053423ER15	R.30890768ER15	R.10687580ER01	986
R9.00	R.59100000ER13	R.44614910ER15	R.31109684ER15	R.10763320ER01	987
R10.00	R.59100000ER13	R.46020955ER15	R.31441276ER15	R.10878044ER01	988
R11.00	R.59100000ER13	R.47287634ER15	R.31855308ER15	R.11021291ER01	989
R12.00	R.59100000ER13	R.48427080ER15	R.32327245ER15	R.11184571ER01	990
R13.00	R.59100000ER13	R.49453637ER15	R.32837308ER15	R.11361043ER01	991
R14.00	R.59100000ER13	R.50378004ER15	R.33369663ER15	R.11545228ER01	992
R15.00	R.59100000ER13	R.51210354ER15	R.33911759ER15	R.11732782ER01	993
R16.00	R.59100000ER13	R.51959846ER15	R.34453752ER15	R.11920300ER01	994
					995
R1.00	R.00000000E-99	R.46787429ER15	R.36887606ER15	R.12762364ER01	996
R2.00	R.00000000E-99	R.42129909ER15	R.38650931ER15	R.13372439ER01	997
R3.00	R.00000000E-99	R.37936027ER15	R.39841754ER15	R.13784439ER01	998
R4.00	R.00000000E-99	R.34159632ER15	R.40546056ER15	R.14028114ER01	999
R5.00	R.00000000E-99	R.30759164ER15	R.40839146ER15	R.14129517ER01	C00
R6.00	R.00000000E-99	R.27697204ER15	R.40786877ER15	R.14111433ER01	C01
R7.00	R.00000000E-99	R.24940049ER15	R.40446717ER15	R.13993745ER01	C02
R8.00	R.00000000E-99	R.22457360ER15	R.39868730ER15	R.13793773ER01	C03

XENON BUILDUP, 1 MW, 16 HRS. ON – 8 HRS. OFF.

t	φ	I	X	ΔK/K	
R1.00	R.59100000ER13	R.26069115ER15	R.36923383ER15	R.12774742ER01	005
R2.00	R.59100000ER13	R.29321333ER15	R.34726819ER15	R.12014775ER01	006
R3.00	R.59100000ER13	R.32249802ER15	R.33140066ER15	R.11465791ER01	007
R4.00	R.59100000ER13	R.34886754ER15	R.32047102ER15	R.11087648ER01	008
R5.00	R.59100000ER13	R.37261205ER15	R.31351274ER15	R.10846905ER01	009
R6.00	R.59100000ER13	R.39399287ER15	R.30972270ER15	R.10715778ER01	010
R7.00	R.59100000ER13	R.41324531ER15	R.30843540ER15	R.10671240ER01	011
R8.00	R.59100000ER13	R.43058123ER15	R.30910103ER15	R.10694269ER01	012
R9.00	R.59100000ER13	R.44619141ER15	R.31126719ER15	R.10769214ER01	013
R10.00	R.59100000ER13	R.46024746ER15	R.31456290ER15	R.10883239ER01	014
R11.00	R.59100000ER13	R.47290464ER15	R.31868549ER15	R.11025872ER01	015
R12.00	R.59100000ER13	R.48430169ER15	R.32338932ER15	R.11188615ER01	016
R13.00	R.59100000ER13	R.49456419ER15	R.32847625ER15	R.11364613ER01	017
R14.00	R.59100000ER13	R.50380508ER15	R.33378777ER15	R.11548381ER01	018
R15.00	R.59100000ER13	R.51212609ER15	R.33919812ER15	R.11735567ER01	019
R16.00	R.59100000ER13	R.51961876ER15	R.34460872ER15	R.11922764ER01	020
					021
R1.00	R.00000000E-99	R.46789257ER15	R.36894397ER15	R.12764714ER01	022
R2.00	R.00000000E-99	R.42131554ER15	R.38657398ER15	R.13374676ER01	023
R3.00	R.00000000E-99	R.37937510ER15	R.39847904ER15	R.13786560ER01	024
R4.00	R.00000000E-99	R.34160969ER15	R.40551899ER15	R.14030136ER01	025
R5.00	R.00000000E-99	R.30760368ER15	R.40844689ER15	R.14131435ER01	026
R6.00	R.00000000E-99	R.27698286ER15	R.40792131ER15	R.14113251ER01	027
R7.00	R.00000000E-99	R.24941022ER15	R.40451693ER15	R.13995467ER01	028
R8.00	R.00000000E-99	R.22458236ER15	R.39873436ER15	R.13795401ER01	029
					030
R1.00	R.00000000E-99	R.20222604ER15	R.39100878ER15	R.13528111ER01	031
R2.00	R.00000000E-99	R.18209520ER15	R.38171758ER15	R.13206655ER01	032
R3.00	R.00000000E-99	R.16396831ER15	R.37118709ER15	R.12842321ER01	033
R4.00	R.00000000E-99	R.14764588ER15	R.35969876ER15	R.12444840ER01	034
R5.00	R.00000000E-99	R.13294830ER15	R.34749445ER15	R.12022604ER01	035
R6.00	R.00000000E-99	R.11971379ER15	R.33478122ER15	R.11582752ER01	036
R7.00	R.00000000E-99	R.10779675ER15	R.32173568ER15	R.11131402ER01	037
R8.00	R.00000000E-99	R.97066009ER14	R.30850759ER15	R.10673738ER01	038
R9.09	R.00000000E-99	R.87403431ER14	R.29522330ER15	R.10214128ER01	039
R10.00	R.00000000E-99	R.78702727ER14	R.28198869ER15	R.97562378E-00	040
R11.00	R.00000000E-99	R.70868150ER14	R.26889174ER15	R.93031100E-00	041
R12.00	R.00000000E-99	R.63813478ER14	R.25600494ER15	R.88572526E-00	042
R13.00	R.00000000E-99	R.57461075ER14	R.24338722ER15	R.84207051E-00	043
R14.00	R.00000300E-99	R.51741028ER14	R.23108583ER15	R.79951020E-00	044
R15.00	R.00000000E-99	R.46590393ER14	R.21913793ER15	R.75817288E-00	045
R16.00	R.00000000E-99	R.41952488ER14	R.20757196ER15	R.71815695E-00	046
R17.00	R.00000000E-99	R.37776271ER14	R.19640886ER15	R.67953490E-00	047
R18.00	R.00000000E-99	R.34015781ER14	R.18566317ER15	R.64235698E-00	048
R19.00	R.00000000E-99	R.30629633ER14	R.17534404ER15	R.60665480E-00	049
R20.00	R.00000000E-99	R.27580565ER14	R.16545596ER15	R.57244412E-00	050
R21.00	R.00000000E-99	R.24835023ER14	R.15599956ER15	R.53972688E-00	051
R22.00	R.00000000E-99	R.22362789ER14	R.14697224ER15	R.50849420E-00	052
R23.00	R.00000000E-99	R.20136656ER14	R.13836671ER15	R.47872779E-00	053
R24.00	R.00000000E-99	R.18132129ER14	R.13018146ER15	R.45040148E-00	054
R25.00	R.00000000E-99	R.16327144ER14	R.12240120ER15	R.42348337E-00	055
R26.00	R.00000000E-99	R.14701839ER14	R.11501720ER15	R.39793622E-00	056
R27.00	R.00000000E-99	R.13238328ER14	R.10801764ER15	R.37371915E-00	057

XENON BUILDUP, 1 MW, 16 HRS. ON – 8 HRS. OFF.

t	ϕ	I	X	$\Delta K/K$	
R28.00	R.00000000E-99	R.11920505ER14	R.10138988ER15	R.35078845E-00	058
R29.00	R.00000000E-99	R.10733865ER14	R.95120575ER14	R.32909792E-00	059
R30.00	R.00000000E-99	R.96653505ER13	R.89196086ER14	R.30860040E-00	060
R31.00	R.00000000E-99	R.87031991ER13	R.83602492ER14	R.28924768E-00	061
R32.00	R.00000000E-99	R.78368264ER13	R.78325761ER14	R.27099127E-00	062
R33.00	R.00000000E-99	R.70566980ER13	R.73351876ER14	R.25378263E-00	063
R34.00	R.00000000E-99	R.63542287ER13	R.68666935ER14	R.23757369E-00	064
R35.00	R.00000000E-99	R.57216878ER13	R.64257236ER14	R.22231703E-00	065
R36.00	R.00000000E-99	R.51521141ER13	R.60109334ER14	R.20796613E-00	066
R37.00	R.00000000E-99	R.46392395ER13	R.56210111ER14	R.19447559E-00	067
R38.00	R.00000000E-99	R.41774199ER13	R.52546806ER14	R.18180130E-00	068
R39.00	R.00000000E-99	R.37615727ER13	R.49107051ER14	R.16990046E-00	069
R40.00	R.00000000E-99	R.33871218ER13	R.45878901ER14	R.15873171E-00	070
R41.00	R.00000000E-99	R.30499460ER13	R.42850844ER14	R.14825524E-00	071
R42.00	R.00000000E-99	R.27463350ER13	R.40011819ER14	R.13843279E-00	072
R43.00	R.00000000E-99	R.24729474ER13	R.37351216ER14	R.12922764E-00	073
R44.00	R.00000000E-99	R.22267746ER13	R.34858883ER14	R.12060467E-00	074
R45.00	R.00000000E-99	R.20051075ER13	R.32525123ER14	R.11253034E-00	075
R46.00	R.00000000E-99	R.18055065ER13	R.30340692ER14	R.10497264E-00	076
R47.00	R.00000000E-99	R.16257751ER13	R.28296783ER14	R.97901139E-01	077
R48.00	R.00000000E-99	R.14639354ER13	R.26385029ER14	R.91286859E-01	078

TABLE 9. THERMAL FLUX (ϕ), IODINE NUMBER DENSITY (I), XENON NUMBER DENSITY (X) AND NEGATIVE REACTIVITY DUE TO XENON BUILDUP VS. TIME UNDER 2 MEGAWATT 16 HOURS ON -- 8 HOURS OFF OPERATION DURING A 5 DAY WEEK, AND AFTER TERMINAL SHUTDOWN

t	ϕ	I	X	$\Delta K/K$
R1.00	R.11800000ER14	R.11674843ER15	R.12176825ER14	R.42129349E-01
R2.00	R.11800000ER14	R.22187489ER15	R.32231044ER14	R.11151288E-00
R3.00	R.11800000ER14	R.31653635ER15	R.57515532ER14	R.19899209E-00
R4.00	R.11800000ER14	R.40177457ER15	R.86028497ER14	R.29764117E-00
R5.00	R.11800000ER14	R.47852759ER15	R.11627096ER15	R.40227398E-00
R6.00	R.11800000ER14	R.54764010ER15	R.14713454ER15	R.50905572E-00
R7.00	R.11800000ER14	R.60987268ER15	R.17781310ER15	R.61519733E-00
R8.00	R.11800000ER14	R.66591021ER15	R.20773327ER15	R.71871505E-00
R9.00	R.11800000ER14	R.71636939ER15	R.23650009ER15	R.81824244E-00
R10.00	R.11800000ER14	R.76180551ER15	R.26385430ER15	R.91288248E-00
R11.00	R.11800000ER14	R.80271863ER15	R.28963908ER15	R.10020925ER01
R12.00	R.11800000ER14	R.83955895ER15	R.31377425ER15	R.10855953ER01
R13.00	R.11800000ER14	R.87273194ER15	R.33623604ER15	R.11633085ER01
R14.00	R.11800000ER14	R.90260268ER15	R.35704158ER15	R.12352916ER01
R15.00	R.11800000ER14	R.92949987ER15	R.37623692ER15	R.13017035ER01
R16.00	R.11800000ER14	R.95371953ER15	R.39388787ER15	R.13627722ER01
R1.00	R.00000000E-99	R.85878013ER15	R.45598051ER15	R.15776002ER01
R2.00	R.00000000E-99	R.77329160ER15	R.50449343ER15	R.17454450ER01
R3.00	R.00000000E-99	R.69631316ER15	R.54131878ER15	R.18728533ER01
R4.00	R.00000000E-99	R.62699765ER15	R.56812093ER15	R.19655833ER01
R5.00	R.00000000E-99	R.56458226ER15	R.58636196ER15	R.20286936ER01
R6.00	R.00000000E-99	R.50838010ER15	R.59732447ER15	R.20666217ER01
R7.00	R.00000000E-99	R.45777268ER15	R.60213202ER15	R.20832548ER01
R8.00	R.00000000E-99	R.41220306ER15	R.60176718ER15	R.20819926ER01
R1.00	R.11800000ER14	R.48791795ER15	R.52723259ER15	R.18241180ER01
R2.00	R.11800000ER14	R.55609566ER15	R.47470161ER15	R.16423714ER01
R3.00	R.11800000ER14	R.61748650ER15	R.43899474ER15	R.15188328ER01
R4.00	R.11800000ER14	R.67276609ER15	R.41606080ER15	R.14394861ER01
R5.00	R.11800000ER14	R.72254278ER15	R.40273892ER15	R.13933951ER01
R6.00	R.11800000ER14	R.76736437ER15	R.39657009ER15	R.13720522ER01
R7.00	R.11800000ER14	R.80772411ER15	R.39564797ER15	R.13688618ER01
R8.00	R.11800000ER14	R.84406618ER15	R.39850075ER15	R.13787319ER01
R9.00	R.11800000ER14	R.87679048ER15	R.40399782ER15	R.13977506ER01
R10.00	R.11800000ER14	R.90625719ER15	R.41127577ER15	R.14229309ER01
R11.00	R.11800000ER14	R.93279059ER15	R.41968019ER15	R.14520085ER01
R12.00	R.11800000ER14	R.95668269ER15	R.42871957ER15	R.14832828ER01
R13.00	R.11800000ER14	R.97819641ER15	R.43802909ER15	R.15154919ER01
R14.00	R.11800000ER14	R.99756849ER15	R.44734207ER15	R.15477129ER01
R15.00	R.11800000ER14	R.10150117ER16	R.45646749ER15	R.15792851ER01
R16.00	R.11800000ER14	R.10307185ER16	R.46527243ER15	R.16097483ER01
R1.00	R.00000000E-99	R.92811420ER15	R.52948716ER15	R.18319183ER01
R2.00	R.00000000E-99	R.83572370ER15	R.57923695ER15	R.20040425ER01
R3.00	R.00000000E-99	R.75253035ER15	R.61655130ER15	R.21331426ER01
R4.00	R.00000000E-99	R.67761862ER15	R.64321465ER15	R.22253924ER01
R5.00	R.00000000E-99	R.61016409ER15	R.66079385ER15	R.22862129ER01
R6.00	R.00000000E-99	R.54942442ER15	R.67066282ER15	R.23203575ER01

XENON BUILDUP, 2 MW, 16 HRS. ON-8 HRS. OFF.

t	ϕ	I	X	ΔK/K
A7.00	A.00000000E-99	A.49473118EA15	A.67402438EA15	A.23319878EA01
A8.00	A.00000000E-99	A.44548247EA15	A.67192997EA15	A.23247416EA01
A1.00	A.11800000EA14	A.51788451EA15	A.58597198EA15	A.20273444EA01
A2.00	A.11800000FA14	A.58307914EA15	A.52406453EA15	A.18131572EA01
A3.00	A.11800000EA14	A.64178387EA15	A.48063792EA15	A.16429098EA01
A4.00	A.11800000EA14	A.69464473EA15	A.45132778EA15	A.15615027EA01
A5.00	A.11800000EA14	A.74224347EA15	A.43272162EA15	A.14971291EA01
A6.00	A.11800000EA14	A.78510392EA15	A.42215806EA15	A.14605813FA01
A7.00	A.11800000EA14	A.82369774EA15	A.41756774EA15	A.14446998EA01
A8.00	A.11800000EA14	A.85844967EA15	A.41734723EA15	A.14439368EA01
A9.00	A.11800000EA14	A.88974216EA15	A.42025957EA15	A.14540129EA01
A10.00	A.11800000EA14	A.91791959EA15	A.42535536EA15	A.14716433EA01
A11.00	A.11800000EA14	A.94329203EA15	A.43191029EA15	A.14943221EA01
A12.00	A.11800000EA14	A.96613875EA15	A.43937610EA15	A.15201523EA01
A13.00	A.11800000EA14	A.98671113EA15	A.44734168EA15	A.15477116EA01
A14.00	A.11800000EA14	A.10052355EA16	A.45550251EA15	A.15759464EA01
A15.00	A.11800000EA14	A.10219154EA16	A.46363660EA15	A.16040888EA01
A16.00	A.11800000EA14	A.10369349EA16	A.47158959EA15	A.16315906EA01
A1.00	A.00000000E-99	A.93371186EA15	A.53593149EA15	A.18542144EA01
A2.00	A.00000000E-99	A.84076411EA15	A.58574391EA15	A.20265553EA01
A3.00	A.00000000E-99	A.75706901EA15	A.62306322EA15	A.21556725EA01
A4.00	A.00000000E-99	A.68170548EA15	A.64968336EA15	A.22477729EA01
A5.00	A.00000000E-99	A.61384411EA15	A.66717947EA15	A.23083059EA01
A6.00	A.00000000E-99	A.55273812EA15	A.67693265EA15	A.23420499EA01
A7.00	A.00000000E-99	A.49771501EA15	A.68015200EA15	A.23531882EA01
A8.00	A.00000000E-99	A.44816926EA15	A.67789431EA15	A.23453771EA01
A1.00	A.11800000EA14	A.52030384EA15	A.59095263EA15	A.20445764EA01
A2.00	A.11800000EA14	A.58525766EA15	A.52823933EA15	A.18276011EA01
A3.00	A.11800000EA14	A.64374552EA15	A.48415063EA15	A.16750631EA01
A4.00	A.11800000EA14	A.69641111EA15	A.45429483EA15	A.15717681EA01
A5.00	A.11800000EA14	A.74383402EA15	A.43523750EA15	A.15058336EA01
A6.00	A.11800000EA14	A.78653612EA15	A.42429962EA15	A.14679907EA01
A7.00	A.11800000EA14	A.82498738EA15	A.41939761EA15	A.14510307EA01
A8.00	A.11800000EA14	A.85961093EA15	A.41891664EA15	A.14493667EA01
A9.00	A.11800000EA14	A.89078782EA15	A.42161049EA15	A.14586869EA01
A10.00	A.11800000EA14	A.91886116EA15	A.42652230EA15	A.14756808EA01
A11.00	A.11800000EA14	A.94413987EA15	A.43292173EA15	A.14978214EA01
A12.00	A.11800000EA14	A.96690218EA15	A.44025559EA15	A.15231952EA01
A13.00	A.11800000EA14	A.98739856EA15	A.44810875EA15	A.15503655EA01
A14.00	A.11800000EA14	A.10058545EA16	A.45617345EA15	A.15782678EA01
A15.00	A.11800000EA14	A.10224728EA16	A.46422504EA15	A.16061246EA01
A16.00	A.11800000EA14	A.10374368EA16	A.47210294EA15	A.16333806EA01
A1.00	A.00000000E-99	A.93416384EA15	A.53645886EA15	A.18560390EA01
A2.00	A.00000000E-99	A.84117114EA15	A.58627582EA15	A.20283956EA01
A3.00	A.00000000E-99	A.75743552EA15	A.62359507EA15	A.21575126EA01
A4.00	A.00000000E-99	A.68203549EA15	A.65021129EA15	A.22495994EA01
A5.00	A.00000000E-99	A.61414127EA15	A.66770030EA15	A.23101079EA01
A6.00	A.00000000E-99	A.55300571EA15	A.67744375EA15	A.23438181EA01
A7.00	A.00000000E-99	A.49795598EA15	A.68065126EA15	A.23549155EA01

XENON BUILDUP, 2 MW, 16 HRS. ON-8 HRS. OFF.

t	ϕ	I	X	ΔK/K
A8.00	A.00000000E-99	A.44838625ER15	A.67838007ER15	A.23470577ER01
A1.00	A.11800000ER14	A.52049923ER15	A.59135812ER15	A.20459793ER01
A2.00	A.11800000ER14	A.58543359ER15	A.52857906ER15	A.18287765ER01
A3.00	A.11800000ER14	A.64390394ER15	A.48443637ER15	A.167[illegible]17ER01
A4.00	A.11800000ER14	A.69655376ER15	A.45453608ER15	A.15726028ER01
A5.00	A.11800000ER14	A.74396247ER15	A.43544197ER15	A.15065410ER01
A6.00	A.11800000ER14	A.78665178ER15	A.42447358ER15	A.14685926ER01
A7.00	A.11800000ER14	A.82509151ER15	A.41954620ER15	A.14515448ER01
A8.00	A.11800000ER14	A.85970471ER15	A.41904403ER15	A.14498075ER01
A9.00	A.11800000ER14	A.89087227ER15	A.42172011ER15	A.14590661ER01
A10.00	A.11800000ER14	A.91893720ER15	A.42661697ER15	A.14760083ER01
A11.00	A.11800000ER14	A.94420835ER15	A.43300375ER15	A.14981052ER01
A12.00	A.11800000ER14	A.96696384ER15	A.44032686ER15	A.15234417ER01
A13.00	A.11800000ER14	A.98745409ER15	A.44817089ER15	A.15505805ER01
A14.00	A.11800000ER14	A.10059044ER16	A.45622779ER15	A.15784558ER01
A15.00	A.11800000ER14	A.10225178ER16	A.46427267ER15	A.16062894ER01
A16.00	A.11800000ER14	A.10374772ER16	A.47214481ER15	A.16335254ER01
A1.00	A.00000000E-99	A.93420016ER15	A.53650154ER15	A.18561867ER01
A2.00	A.00000000E-99	A.84120382ER15	A.58631884ER15	A.20285445ER01
A3.00	A.00000000E-99	A.75746494ER15	A.62363806ER15	A.21576614ER01
A4.00	A.00000000E-99	A.68206199ER15	A.65025392ER15	A.22497469ER01
A5.00	A.00000000E-99	A.61416516ER15	A.66774232ER15	A.23102532ER01
A6.00	A.00000000E-99	A.55302722ER15	A.67748498ER15	A.23439609ER01
A7.00	A.00000000E-99	A.49797534ER15	A.68069152ER15	A.23550548ER01
A8.00	A.00000000E-99	A.44840369ER15	A.67841924ER15	A.23471931ER01
A1.00	A.00000000E-99	A.40376671ER15	A.67159026ER15	A.23235663ER01
A2.00	A.00000000E-99	A.36357318ER15	A.66100749ER15	A.22869521ER01
A3.00	A.00000000E-99	A.32738080ER15	A.64736844ER15	A.22397637ER01
A4.00	A.00000000E-99	A.29479123ER15	A.63127749ER15	A.21840923ER01
A5.00	A.00000000E-99	A.26544583ER15	A.61325693ER15	A.21217448ER01
A6.00	A.00000000E-99	A.23902168ER15	A.59375677ER15	A.20542781ER01
A7.00	A.00000000E-99	A.21522796ER15	A.57316341ER15	A.19830293ER01
A8.00	A.00000000E-99	A.19380282ER15	A.55180725ER15	A.19091414ER01
A9.00	A.00000000E-99	A.17451048ER15	A.52996968ER15	A.18335878ER01
A10.00	A.00000000E-99	A.15713863ER15	A.50788904ER15	A.17571932ER01
A11.00	A.00000000E-99	A.14149608ER15	A.48576608ER15	A.16806522ER01
A12.00	A.00000000E-99	A.12741069ER15	A.46376859ER15	A.16045454ER01
A13.00	A.00000000E-99	A.11472747ER15	A.44203577ER15	A.15293542ER01
A14.00	A.00000000E-99	A.10330682ER15	A.42068189ER15	A.14554741ER01
A15.00	A.00000000E-99	A.93023010ER14	A.39979953ER15	A.13832253ER01
A16.00	A.00000000E-99	A.83762899ER14	A.37946259ER15	A.13128637ER01
A17.00	A.00000000E-99	A.75424599ER14	A.35972876ER15	A.12445886ER01
A18.00	A.00000000E-99	A.67916349ER14	A.34064177ER15	A.11785515ER01
A19.00	A.00000000E-99	A.61155519ER14	A.32223350ER15	A.11148626ER01
A20.00	A.00000000E-99	A.55067705ER14	A.30452558ER15	A.10535968ER01
A21.00	A.00000000E-99	A.49585910ER14	A.28753096ER15	A.99479885E-00
A22.00	A.00000000E-99	A.44649811ER14	A.27125529ER15	A.93848838E-00
A23.00	A.00000000E-99	A.40205082ER14	A.25569806ER15	A.88466352E-00
A24.00	A.00000000E-99	A.36202809ER14	A.24085361ER15	A.83330474E-00
A25.00	A.00000000E-99	A.32598953ER14	A.22671201ER15	A.78437766E-00

XENON BUILDUP, 2 MW, 16 HRS. ON – 8 HRS. OFF.

t	Φ	I	X	ΔK/K	
R26.00	R.00000000E-99	R.29353847ER14	R.21325990ER15	R.73783608E-00	342
R27.00	R.00000000E-99	R.26431778ER14	R.20048110ER15	R.69362403E-00	343
R28.00	R.00000000E-99	R.23800594ER14	R.18835721ER15	R.65167782E-00	344
R29.00	R.00000000E-99	R.21431335ER14	R.17686813ER15	R.61192793E-00	345
R30.00	R.00000000E-99	R.19297926ER14	R.16599244ER15	R.57430023E-00	346
R31.00	R.00000000E-99	R.17376889ER14	R.15570779ER15	R.53871743E-00	347
R32.00	R.00000000E-99	R.15647085ER14	R.14599126ER15	R.50510020E-00	348
R33.00	R.00000000E-99	R.14089477ER14	R.13681958ER15	R.47336803E-00	349
R34.00	R.00000000E-99	R.12686924ER14	R.12816936ER15	R.44344003E-00	350
R35.00	R.00000000E-99	R.11423992ER14	R.12001727ER15	R.41523544E-00	351
R36.00	R.00000000E-99	R.10286779ER14	R.11234028ER15	R.38867462E-00	352
R37.00	R.00000000E-99	R.92627604ER13	R.10511562ER15	R.36367877E-00	353
R38.00	R.00000000E-99	R.83406926ER13	R.98321028ER14	R.34017084E-00	354
R39.00	R.00000000E-99	R.75104060ER13	R.91934798ER14	R.31807577E-00	355
R40.00	R.00000000E-99	R.67627718ER13	R.85935884ER14	R.29732074E-00	356
R41.00	R.00000000E-99	R.60895619ER13	R.80303875ER14	R.27783514E-00	357
R42.00	R.00000000E-99	R.54833670ER13	R.75019060ER14	R.25955075E-00	358
R43.00	R.00000000E-99	R.49375182ER13	R.70062469ER14	R.24240194E-00	359
R44.00	R.00000000E-99	R.44460059ER13	R.65415876ER14	R.22632568E-00	360
R45.00	R.00000000E-99	R.40034220ER13	R.61061820ER14	R.21126154E-00	361
R46.00	R.00000000E-99	R.36048957ER13	R.56983596ER14	R.19715170E-00	362
R47.00	R.00000000E-99	R.32460414ER13	R.53165257ER14	R.18394102E-00	363
R48.00	R.00000000E-99	R.29229099ER13	R.49591601ER14	R.17157690E-00	364

TABLE 10. THERMAL FLUX (ϕ), IODINE NUMBER DENSITY (I), XENON NUMBER DENSITY (X) AND NEGATIVE REACTIVITY DUE TO XENON BUILDUP VS. TIME UNDER 5 MEGAWATT 16 HOURS ON -- 8 HOURS OFF OPERATION DURING A 5 DAY WEEK AND AFTER TERMINAL SHUTDOWN

t	ϕ	I	X	$\Delta K/K$
A1.00	A.29600000EA14	A.29286039EA15	A.28087073EA14	A.97175585E-01
A2.00	A.29600000EA14	A.55656735EA15	A.69204690EA14	A.23943421E-00
A3.00	A.29600000EA14	A.79402305EA15	A.11617316EA15	A.40193561E-00
A4.00	A.29600000EA14	A.10078407EA16	A.16471397EA15	A.56987698E-00
A5.00	A.29600000EA14	A.12003727EA16	A.21234832EA15	A.73468221E-00
A6.00	A.29600000EA14	A.13737390EA16	A.25770734EA15	A.89161523E-00
A7.00	A.29600000EA14	A.15298470EA16	A.30010074EA15	A.10382877EA01
A8.00	A.29600000EA14	A.16704149EA16	A.33924771EA15	A.11737284EA01
A9.00	A.29600000EA14	A.17969897EA16	A.37510951EA15	A.12978029EA01
A10.00	A.29600000EA14	A.19109642EA16	A.40778579EA15	A.14108562EA01
A11.00	A.29600000EA14	A.20135930EA16	A.43745076EA15	A.15134910EA01
A12.00	A.29600000EA14	A.21060053EA16	A.46431441EA15	A.16064338EA01
A13.00	A.29600000EA14	A.21892183EA16	A.48859921EA15	A.16904543EA01
A14.00	A.29600000EA14	A.22641477EA16	A.51052643EA15	A.17663181EA01
A15.00	A.29600000EA14	A.23316182EA16	A.53030850EA15	A.18347600EA01
A16.00	A.29600000EA14	A.23923723EA16	A.54814501EA15	A.18964707EA01
A1.00	A.00000000E-99	A.21542204EA16	A.73603097EA15	A.25465181EA01
A2.00	A.00000000E-99	A.19397757EA16	A.88750610EA15	A.30705917EA01
A3.00	A.00000000E-99	A.17466782EA16	A.10074884EA16	A.34857058EA01
A4.00	A.00000000E-99	A.15728029EA16	A.11003111EA16	A.38068536EA01
A5.00	A.00000000E-99	A.14162364EA16	A.11697893EA16	A.40472342EA01
A6.00	A.00000000E-99	A.12752555EA16	A.12192774EA16	A.42184529EA01
A7.00	A.00000000E-99	A.11483087EA16	A.12517199EA16	A.43306973EA01
A8.00	A.00000000E-99	A.10339990EA16	A.12696990EA16	A.43929015EA01
A1.00	A.29600000EA14	A.12239272EA16	A.90872112EA15	A.31439911EA01
A2.00	A.29600000EA14	A.13949485EA16	A.69713494EA15	A.24119457EA01
A3.00	A.29600000EA14	A.15489453EA16	A.57789053EA15	A.19994119EA01
A4.00	A.29600000EA14	A.16876120EA16	A.51532225EA15	A.17829106EA01
A5.00	A.29600000EA14	A.18124750EA16	A.48711769EA15	A.16853285EA01
A6.00	A.29600000EA14	A.19249081EA16	A.47940306EA15	A.16586375EA01
A7.00	A.29600000EA14	A.20261489EA16	A.48356629EA15	A.16730414EA01
A8.00	A.29600000EA14	A.21173113EA16	A.49429563EA15	A.17101627EA01
A9.00	A.29600000EA14	A.21993990EA16	A.50834287EA15	A.17587633EA01
A10.00	A.29600000EA14	A.22733150EA16	A.52374754EA15	A.18120605EA01
A11.00	A.29600000EA14	A.23398728EA16	A.53935018EA15	A.18660424EA01
A12.00	A.29600000EA14	A.23998049EA16	A.55448752EA15	A.19184146EA01
A13.00	A.29600000EA14	A.24537708EA16	A.56880152EA15	A.19679381EA01
A14.00	A.29600000EA14	A.25023649EA16	A.58212008EA15	A.20140176EA01
A15.00	A.29600000EA14	A.25461215EA16	A.59438270EA15	A.20564437EA01
A16.00	A.29600000EA14	A.25855224EA16	A.60559417EA15	A.20952332EA01
A1.00	A.00000000E-99	A.23281430EA16	A.80768563EA15	A.27944286EA01
A2.00	A.00000000E-99	A.20963851EA16	A.97049704EA15	A.33577233EA01
A3.00	A.00000000E-99	A.18876978EA16	A.10993376EA16	A.38034854EA01
A4.00	A.00000000E-99	A.16997846EA16	A.11988869EA16	A.41479059EA01
A5.00	A.00000000E-99	A.15305776EA16	A.12732632EA16	A.44052329EA01
A6.00	A.00000000E-99	A.13782146EA16	A.13260874EA16	A.45879938EA01

XENON BUILDUP, 5 MW, 16 HRS. ON-8 HRS. OFF.

t	ϕ	I	X	$\Delta K/K$
A7.00	A.00000000E-99	A.12410185EA16	A.13605379EA16	A.47071857EA01
A8.00	A.00000000E-99	A.11174800EA16	A.13794017EA16	A.47724506EA01
A1.00	A.29600000EA14	A.12990980EA16	A.98433900EA15	A.34056135EA01
A2.00	A.29600000EA14	A.14626364EA16	A.75067089EA15	A.25971692EA01
A3.00	A.29600000EA14	A.16098950EA16	A.61696042EA15	A.21345582EA01
A4.00	A.29600000EA14	A.17424945EA16	A.54474989EA15	A.18847242EA01
A5.00	A.29600000EA14	A.18618942EA16	A.51000579EA15	A.17645167EA01
A6.00	A.29600000EA14	A.19694079EA16	A.49774443EA15	A.17220949EA01
A7.00	A.29600000EA14	A.20662188EA16	A.49065668EA15	A.17252511EA01
A8.00	A.29600000EA14	A.21533927EA16	A.50698836EA15	A.17540770EA01
A9.00	A.29600000EA14	A.22318884EA16	A.51920948EA15	A.17963597EA01
A10.00	A.29600000EA14	A.23025701EA16	A.53317887EA15	A.18446909EA01
A11.00	A.29600000EA14	A.23662157EA16	A.54762054EA15	A.18946562EA01
A12.00	A.29600000EA14	A.24235257EA16	A.56179507EA15	A.19436971EA01
A13.00	A.29600000EA14	A.24751306EA16	A.57529398EA15	A.19904007EA01
A14.00	A.29600000EA14	A.25215983EA16	A.58791118EA15	A.20340536EA01
A15.00	A.29600000EA14	A.25634403EA16	A.59956271EA15	A.20743656EA01
A16.00	A.29600000EA14	A.26011170EA16	A.61023677EA15	A.21112956EA01
A1.00	A.00000000E-99	A.23421852EA16	A.81347484EA15	A.28144582EA01
A2.00	A.00000000E-99	A.21090293EA16	A.97720123EA15	A.33809184EA01
A3.00	A.00000000E-99	A.18990832EA16	A.11067568EA16	A.38291545EA01
A4.00	A.00000000E-99	A.17100366EA16	A.12068487EA16	A.41754520EA01
A5.00	A.00000000E-99	A.15398089EA16	A.12816203EA16	A.44341467EA01
A6.00	A.00000000E-99	A.13865270EA16	A.13347135EA16	A.46178385EA01
A7.00	A.00000000E-99	A.12485036EA16	A.13693260EA16	A.47375907EA01
A8.00	A.00000000E-99	A.11242200EA16	A.13802612EA16	A.48031027EA01
A1.00	A.29600000EA14	A.13051670EA16	A.99044600EA15	A.34267426EA01
A2.00	A.29600000EA14	A.14681014EA16	A.75499435EA15	A.26121275EA01
A3.00	A.29600000EA14	A.16148161EA16	A.62011400EA15	A.21454719EA01
A4.00	A.29600000EA14	A.17469256EA16	A.54712626EA15	A.18929461EA01
A5.00	A.29600000EA14	A.18658039EA16	A.51185400EA15	A.17709112EA01
A6.00	A.29600000EA14	A.19730004EA16	A.49922543EA15	A.17272188EA01
A7.00	A.29600000EA14	A.20694535EA16	A.49987512EA15	A.17294667EA01
A8.00	A.29600000EA14	A.21563351EA16	A.50801316EA15	A.17576227EA01
A9.00	A.29600000EA14	A.22345109EA16	A.52008675EA15	A.17993940EA01
A10.00	A.29600000EA14	A.23049316EA16	A.53394025EA15	A.18473251EA01
A11.00	A.29600000EA14	A.23683420EA16	A.54828817EA15	A.18969661EA01
A12.00	A.29600000EA14	A.24256403EA16	A.56230494EA15	A.19457380EA01
A13.00	A.29600000EA14	A.24768565EA16	A.57581804EA15	A.19922138EA01
A14.00	A.29600000EA14	A.25231504EA16	A.58837061EA15	A.20356709EA01
A15.00	A.29600000EA14	A.25648378EA16	A.59998078EA15	A.20758119EA01
A16.00	A.29600000EA14	A.26023754EA16	A.61061164EA15	A.21125919EA01
A1.00	A.00000000E-99	A.23433187EA16	A.81394204EA15	A.28160745EA01
A2.00	A.00000000E-99	A.21100500EA16	A.97774231EA15	A.33827905EA01
A3.00	A.00000000E-99	A.19000025EA16	A.11073556EA16	A.38312260EA01
A4.00	A.00000000E-99	A.17108643EA16	A.12074915EA16	A.41776761EA01
A5.00	A.00000000E-99	A.15405541EA16	A.12822951EA16	A.44364813EA01
A6.00	A.00000000E-99	A.13871978EA16	A.13354100EA16	A.46202482EA01
A7.00	A.00000000E-99	A.12491077EA16	A.13700354EA16	A.47400450EA01

XENON BUILDUP, 5 MW, 16 HRS. ON-8 HRS. OFF.

t	ϕ	I	X	$\Delta K/K$
A8.00	A.00000000E-99	A.11247640EA16	A.13889762EA16	A.48055764EA01
A1.00	A.29600000EA14	A.13056568EA16	A.99093870EA15	A.34284471EA01
A2.00	A.29600000EA14	A.14685423EA16	A.75534320EA15	A.26133344EA01
A3.00	A.29600000EA14	A.16152129EA16	A.62036938EA15	A.21463524EA01
A4.00	A.29600000EA14	A.17472830EA16	A.54731797EA15	A.18936093EA01
A5.00	A.29600000EA14	A.18662058EA16	A.51200308EA15	A.17714269EA01
A6.00	A.29600000EA14	A.19732903EA16	A.49934492EA15	A.17276323EA01
A7.00	A.29600000EA14	A.20697147EA16	A.49997343EA15	A.17298068EA01
A8.00	A.29600000EA14	A.21565403EA16	A.50809586EA15	A.17579088EA01
A9.00	A.29600000EA14	A.22347229EA16	A.52015759EA15	A.17996399EA01
A10.00	A.29600000EA14	A.23051225EA16	A.53400176EA15	A.18475379EA01
A11.00	A.29600000EA14	A.23685140EA16	A.54834213EA15	A.18971527EA01
A12.00	A.29600000EA14	A.24255953EA16	A.56243264EA15	A.19459030EA01
A13.00	A.29600000EA14	A.24769940EA16	A.57586042EA15	A.19923604EA01
A14.00	A.29600000EA14	A.25232762EA16	A.58841643EA15	A.20358017EA01
A15.00	A.29600000EA14	A.25649510EA16	A.60001462EA15	A.20759291EA01
A16.00	A.29600000EA14	A.26024772EA16	A.61064178EA15	A.21126969EA01
A1.00	A.00000000E-99	A.23434103EA16	A.81397988EA15	A.28162054EA01
A2.00	A.00000000E-99	A.21101325EA16	A.97778610EA15	A.33829417EA01
A3.00	A.00000000E-99	A.19000767EA16	A.11074040EA16	A.38313935EA01
A4.00	A.00000000E-99	A.17109313EA16	A.12075435EA16	A.41778559EA01
A5.00	A.00000000E-99	A.15406144EA16	A.12823496EA16	A.44366698EA01
A6.00	A.00000000E-99	A.13872522EA16	A.13354664EA16	A.46204433EA01
A7.00	A.00000000E-99	A.12491566EA16	A.13700929EA16	A.47402440EA01
A8.00	A.00000000E-99	A.11248080EA16	A.13890343EA16	A.48057773EA01
A1.00	A.00000000E-99	A.10128370EA16	A.13947456EA16	A.48255374EA01
A2.00	A.00000000E-99	A.91201346EA15	A.13893739EA16	A.48069525EA01
A3.00	A.00000000E-99	A.82122574EA15	A.13747688EA16	A.47564910EA01
A4.00	A.00000000E-99	A.73947562EA15	A.13526195EA16	A.46797895EA01
A5.00	A.00000000E-99	A.66586343EA15	A.13242812EA16	A.45817448EA01
A6.00	A.00000000E-99	A.59957908EA15	A.12909997EA16	A.44665976EA01
A7.00	A.00000000E-99	A.53989313EA15	A.12538340EA16	A.43380118EA01
A8.00	A.00000000E-99	A.48614869EA15	A.12136963EA16	A.41991433EA01
A9.00	A.00000000E-99	A.43775432EA15	A.11713699EA16	A.40527027EA01
A10.00	A.00000000E-99	A.39417765EA15	A.11275244EA16	A.39010062EA01
A11.00	A.00000000E-99	A.35493850EA15	A.10827297EA16	A.37460255EA01
A12.00	A.00000000E-99	A.31960568EA15	A.10374684EA16	A.35894306EA01
A13.00	A.00000000E-99	A.28779011EA15	A.99214611EA15	A.34326247EA01
A14.00	A.00000000E-99	A.25914167EA15	A.94710263EA15	A.32767833EA01
A15.00	A.00000000E-99	A.23334507EA15	A.90261958EA15	A.31228809EA01
A16.00	A.00000000E-99	A.21011643EA15	A.85892772EA15	A.29717159EA01
A17.00	A.00000000E-99	A.18920011EA15	A.81621390EA15	A.28239346EA01
A18.00	A.00000000E-99	A.17036593EA15	A.77462700EA15	A.26800526EA01
A19.00	A.00000000E-99	A.15340664EA15	A.73428304EA15	A.25404704EA01
A20.00	A.00000000E-99	A.13813562EA15	A.69526992EA15	A.24054931EA01
A21.00	A.00000000E-99	A.12438476EA15	A.65765124EA15	A.22753401EA01
A22.00	A.00000000E-99	A.11200274EA15	A.62147000EA15	A.21501603EA01
A23.00	A.00000000E-99	A.10085331EA15	A.58675160EA15	A.20300417EA01
A24.00	A.00000000E-99	A.90813720EA14	A.55350665EA15	A.19150209EA01
A25.00	A.00000000E-99	A.81773535EA14	A.52173328EA15	A.18050914EA01

XENON BUILDUP, 5 MW, 16 HRS. ON-8 HRS. OFF.

t	ϕ	I	X	$\Delta K/K$	
R26.00	R.00000000E-99	R.73633268ER14	R.49141922ER15	R.17002109ER01	706
R27.00	R.00000000E-99	R.66303337ER14	R.46254360ER15	R.16003071ER01	707
R28.00	R.00000000E-99	R.59703075ER14	R.43507859ER15	R.15052838ER01	708
R29.00	R.00000000E-99	R.53759846ER14	R.40899068ER15	R.14150249ER01	709
R30.00	R.00000000E-99	R.48408246ER14	R.38424191ER15	R.13293992ER01	710
R31.00	R.00000000E-99	R.43589379ER14	R.36079080ER15	R.12482631ER01	711
R32.00	R.00000000E-99	R.39250215ER14	R.33859334ER15	R.11714643ER01	712
R33.00	R.00000000E-99	R.35342998ER14	R.31760368ER15	R.10988444ER01	713
R34.00	R.00000000E-99	R.31824729ER14	R.29777475ER15	R.10302403ER01	714
R35.00	R.00000000E-99	R.28656692ER14	R.27905884ER15	R.96548710E-00	715
R36.00	R.00000000E-99	R.25804023ER14	R.26140802ER15	R.90441884E-00	716
R37.00	R.00000000E-99	R.23235329ER14	R.24477456ER15	R.84687043E-00	717
R38.00	R.00000000E-99	R.20922338ER14	R.22911118ER15	R.79267830E-00	718
R39.00	R.00000000E-99	R.18839599ER14	R.21437143ER15	R.74168175E-00	719
R40.00	R.00000000E-99	R.16964189ER14	R.20050975ER15	R.69372315E-00	720
R41.00	R.00000000E-99	R.15275469ER14	R.18748180ER15	R.64864907E-00	721
R42.00	R.00000000E-99	R.13754855ER14	R.17524446ER15	R.60631034E-00	722
R43.00	R.00000000E-99	R.12385612ER14	R.16375601ER15	R.56656263E-00	723
R44.00	R.00000000E-99	R.11152674ER14	R.15297616ER15	R.52926654E-00	724
R45.00	R.00000000E-99	R.10042468ER14	R.14286617ER15	R.49428802E-00	725
R46.00	R.00000000E-99	R.90427760ER13	R.13338878ER15	R.46149818E-00	726
R47.00	R.00000000E-99	R.81425995ER13	R.12450833ER15	R.43077359E-00	727
R48.00	R.00000000E-99	R.73320323ER13	R.11619071ER15	R.40199633E-00	728

TABLE 11

A SUMMARY OF MINEX-RUNS:
CHARACTERISTIC PARAMETERS AND
RESULTS OF THE PROBLEMS SOLVED
WITH THE MINEX CODE

SUMMARY OF MINEX RUNS

CHARACTERISTIC PARAMETERS						RESULTS													
OPERATING FLUX ϕ_o(nv)	CONTROL TIME b (HOURS)	SUBINTERVAL SIZE Δt (HOURS)	NUMBER OF SUB-INTERVALS	$\phi_{max} = \phi_o$	$\phi_{max} = 2\phi_o$	PEAK XENON POISONING $\Delta k/k$ %	TIME OF OCCURRENCE (HOURS) AFTER COMPLETE SHUTDOWN	$\frac{\rho_{max}(b)}{\rho_{max}(o)}$	$\Delta\rho_{max}$ $\frac{\Delta k}{k}$ %	OPTIMUM CONTROL SEQUENCE 1	2	3	4	5	6	7	8	9	10
3×10^{13}	0					5.45	9.0			O									
	1	0.5																	
	2	0.5	4	X		5.399	8.50	0.991	0.051	O	O	ϕ	ϕ						
		1.0	2	X		5.397	8.0	0.99	0.053	O	ϕ								
	3	0.5	6	X		5.247	8.0	0.963	0.263	O	O	O	ϕ	ϕ	ϕ				
		1.0	3	X		5.239	8.0	0.961	0.211	O	O	ϕ							
	4	0.5	8	X		5.05	8.0	0.927	0.40	O	O	O	O	O	ϕ	ϕ	ϕ		
		1.0	4	X		5.08	8.0	0.932	0.37	O	O	ϕ	ϕ						
	5	0.5	10	X		4.856	7.5	0.891	0.59	O	O	O	O	O	O	O	ϕ	ϕ	ϕ
		1.0	5	X		4.986	8.0	0.915	0.464	O	O	O	ϕ	ϕ					
	6	0.5																	
		1.0	6	X		4.86	7.0	0.892	0.59	O	O	O	ϕ	O	ϕ				
	3	0.5	6		X	5.2	8.0	0.954	0.25	O	O	O	O	O	2ϕ				
		1.0	3																
	7	0.5																	
		1.0	7	X		4.61	7.0	0.846	0.84	O	O	O	O	O	ϕ	ϕ			
	8	0.5																	
		1.0	8	X		4.425	7.0	0.812	1.025	O	O	O	O	O	O	ϕ	ϕ		
10^{14}	0					15.75	10.0												
	1	0.75	4	X		15.47	10.0	0.982	0.28	O	O	ϕ	ϕ						
		0.5																	
	2	0.5	4	X		14.77	9.50	0.938	0.98	O	O	O	ϕ						
		1.0	2	X		14.81	10.0	0.94	0.94	O	ϕ								
	3	0.5	6	X		13.99	10.0	0.888	1.76	O	O	O	ϕ	O	ϕ				
		1.0	3	X		13.86	10.0	0.880	1.61	O	O	ϕ							
	3	0.5	6		X	13.67	10.0	0.867	2.08	O	O	O	O	O	2ϕ				
		1.0																	
	4	0.5	8	X		12.98	9.5	0.824	2.77	O	O	O	O	O	O	ϕ	ϕ		
		1.0	4	X		12.978	10.0	0.8239	2.772	O	O	O	ϕ						

SUMMARY OF MINEX RUNS (Cont.)

CHARACTERISTIC PARAMETERS						RESULTS				OPTIMUM CONTROL SEQUENCE									
OPERATING FLUX ϕ_o(nv)	CONTROL TIME b (HOURS)	SUBINTERVAL SIZE ΔT (HOURS)	NUMBER OF SUBINTERVALS	$\phi_{max} = \phi_o$	$\phi_{max} = 2\phi_o$	PEAK XENON POISONING Δk/k %	TIME OF OCCURRENCE (HOURS) AFTER COMPLETE SHUTDOWN	$\frac{\rho_{max}(b)}{\rho_{max}(o)}$	$\Delta\rho_{max}$ $\frac{\Delta k}{k}$ %	1	2	3	4	5	6	7	8	9	10
10^{14}	5	0.5	10																
		1.0	5	X		12.63	10.0	0.801	3.12	O	O	O	Φ	Φ					
	6	0.5	12																
		1.0	6	X		11.42	9.0	0.726	4.33	O	O	O	O	O	Φ				
	7	0.5	14																
		1.0	7	X		10.74	9.0	0.682	5.01	O	O	O	O	O	O	Φ			
	8	0.5																	
		1.0	8	X		10.09	9.0	0.64	5.66	O	O	O	O	O	O	O	Φ		
	9																		
10^{15}	0					146.53	11.0												
	1	0.75	4	X		136.71	11.0	0.932	9.82	O	O	O	Φ						
		0.5																	
	2	0.5	4	X		127.02	11.0	0.867	19.51	O	O	O	Φ						
		1.0	2	X		134.17	11.0	0.915	12.36	O	Φ								
	3	0.5	6	X		115.19	11.0	0.787	31.34	O	O	O	O	O	Φ				
		1.0	3	X		122.33	11.0	0.8358	24.20	O	O	Φ							
	3	0.5	6		X	122.22	11.0	0.834	24.31	O	O	O	O	O	2Φ				
		1.0	3		X														
	4	0.5	8	X		104.51	11.0	0.714	42.02	O	O	O	O	O	O	O	Φ		
		1.0	4	X		111.66	11.0	0.762	34.87	O	O	O	Φ						
	5	0.5	10																
		1.0	5	X		98.46	10.0	0.672	48.07	O	O	Φ	Φ	Φ					
	6	0.5	12																
		1.0	6	X		93.39	13.0	0.637	53.14	O	O	O	O	O	Φ				
	6	0.5																	
		1.0	6		X	107.68	11.0	0.734	38.85	O	O	O	O	O	2Φ				
	7	0.5																	
		1.0	7	X		85.59	11.0	0.584	60.94	O	O	O	O	O	O	Φ			
	8																		
		1.0	8	X		78.57	11.0	0.537	67.96	O	O	O	O	O	O	O	Φ		

SUMMARY OF MINEX RUNS (Cont.)

CHARACTERISTIC PARAMETERS						RESULTS													
OPERATING FLUX ϕ_0(nv)	CONTROL TIME b (HOURS)	SUBINTERVAL SIZE ΔT (HOURS)	NUMBER OF SUBINTERVALS	$\phi_{max} = \phi_0$	$\phi_{max} = 2\phi_0$	PEAK XENON POISONING $\Delta k/k$ %	TIME OF OCCURRENCE (HOURS) AFTER COMPLETE SHUTDOWN	$\rho_{max}(b) / \rho_{max}(o)$	$\Delta\rho_{max}$ $\frac{\Delta k}{k}$ %	OPTIMUM CONTROL SEQUENCE 1	2	3	4	5	6	7	8	9	10
10^{15}	9																		
10^{16}	0					2353.57													
	1	0.5	2	X		2242.67	11.0	0.953	110.9	O	Φ								
	2	0.5	4	X		2032.32	11.0	0.864	321.3	O	O	O	Φ						
		1.0	2	X		2147.08	11.0	0.913	206.5	O	Φ								
	3	0.5	6	X		1842.83	11.0	0.785	510.8	O	O	O	O	O	Φ				
		1.0	3	X		1957.60	11.0	0.832	396.0	O	O	Φ							
	4																		
		1.0	4	X		1786.92	11.0	0.76	566.7	O	O	O	Φ						
	5																		
		1.0	5	X		1633.16	11.0	0.694	720.41	O	O	O	O	Φ					
	6	0.5																	
		1.0	6	X		1494.65	11.0	0.636	858.9	O	O	O	O	O	Φ				

TABLE 12. IODINE NUMBER DENSITY (I), XENON NUMBER DENSITY (X), CONTROL FLUX (ϕ) AND NEGATIVE REACTIVITY DUE TO XENON BUILDUP VS. TIME UNDER THE FOLLOWING CONDITIONS: OPERATING THERMAL FLUX $\phi = 10^{13}$nv, b = 2 HOURS, Δt = 0.5 HOUR AND $\phi_{max} = \phi_o$

t	ϕ	I	X	$\Delta K/K$
+.00	+.30000000E+16	+.70000000E+15	+.00000000E-99	+2.423
+.50	+.28467670E+16	+.82345680E+15	+.00000000E-99	+2.850
+1.00	+.27013609E+16	+.93468354E+15	+.30000000E+14	+3.235
+1.50	+.27156763E+16	+.87496592E+15	+.30000000E+14	+3.028
+2.00	+.27292606E+16	+.82841894E+15	+.00000000E-99	+2.867
+2.50	+.25898565E+16	+.93360516E+15	+.00000000E-99	+3.231
+3.00	+.24575727E+16	+.10279302E+16	+.00000000E-99	+3.558
+3.50	+.23320459E+16	+.11121530E+16	+.00000000E-99	+3.849
+4.00	+.22129306E+16	+.11869862E+16	+.00000000E-99	+4.108
+4.50	+.20998994E+16	+.12530990E+16	+.00000000E-99	+4.337
+5.00	+.19926415E+16	+.13111187E+16	+.00000000E-99	+4.538
+5.50	+.18908622E+16	+.13616346E+16	+.00000000E-99	+4.713
+6.00	+.17942815E+16	+.14051986E+16	+.00000000E-99	+4.864
+6.50	+.17026339E+16	+.14423285E+16	+.00000000E-99	+4.992
+7.00	+.16156675E+16	+.14735096E+16	+.00000000E-99	+5.100
+7.50	+.15331431E+16	+.14991966E+16	+.00000000E-99	+5.189
+8.00	+.14548339E+16	+.15198152E+16	+.00000000E-99	+5.260
+8.50	+.13805246E+16	+.15357642E+16	+.00000000E-99	+5.316
+9.00	+.13100108E+16	+.15474165E+16	+.00000000E-99	+5.356
+9.50	+.12430987E+16	+.15551212E+16	+.00000000E-99	+5.383
+10.00	+.11796044E+16	+.15592047E+16	+.00000000E-99	+5.397
+10.50	+.11193532E+16	+.15599722E+16	+.00000000E-99	+5.399
+11.50	+.10079261E+16	+.15526808E+16	+.00000000E-99	+5.374
+12.50	+.90759066E+15	+.15353064E+16	+.00000000E-99	+5.314
+13.50	+.81724321E+15	+.15096420E+16	+.00000000E-99	+5.225
+14.50	+.73588956E+15	+.14772446E+16	+.00000000E-99	+5.113
+15.50	+.66263437E+15	+.14394625E+16	+.00000000E-99	+4.982
+16.50	+.59667147E+15	+.13974611E+16	+.00000000E-99	+4.837
+17.50	+.53727495E+15	+.13522429E+16	+.00000000E-99	+4.680
+18.50	+.48379115E+15	+.13046687E+16	+.00000000E-99	+4.516
+19.50	+.43563146E+15	+.12554736E+16	+.00000000E-99	+4.345
+20.50	+.39226591E+15	+.12052834E+16	+.00000000E-99	+4.172
+21.50	+.35321725E+15	+.11546276E+16	+.00000000E-99	+3.996
+22.50	+.31805575E+15	+.11039510E+16	+.00000000E-99	+3.821
+23.50	+.28639447E+15	+.10536259E+16	+.00000000E-99	+3.647
+24.50	+.25788495E+15	+.10039598E+16	+.00000000E-99	+3.475
+25.50	+.23221347E+15	+.95520454E+15	+.00000000E-99	+3.306
+26.50	+.20909749E+15	+.90756434E+15	+.00000000E-99	+3.141
+27.50	+.18828260E+15	+.86120127E+15	+.00000000E-99	+2.981
+28.50	+.16953977E+15	+.81624129E+15	+.00000000E-99	+2.825
+29.50	+.15266272E+15	+.77277934E+15	+.00000000E-99	+2.674
+30.50	+.13746573E+15	+.73088376E+15	+.00000000E-99	+2.529

TABLE 13. IODINE NUMBER DENSITY (I), XENON NUMBER DENSITY (X), CONTROL FLUX AND NEGATIVE REACTIVITY DUE TO XENON BUILDUP VS. TIME UNDER THE FOLLOWING CONDITIONS: OPERATING THERMAL FLUX = 10^{13}nv, b = 4 HOURS, Δt = 1 HOUR AND $\phi_{max} = \phi_0$

t	ϕ	I	X	$\Delta K/K$
+.00	+.30000000E+16	+.70000000E+15	+.00000000E-99	+2.423
+1.00	+.27013609E+16	+.93468354E+15	+.00000000E-99	+3.235
+2.00	+.24324503E+16	+.11237755E+16	+.30000000E+14	+3.889
+3.00	+.24871194E+16	+.92507221E+15	+.30000000E+14	+3.202
+4.00	+.25363463E+16	+.80528450E+15	+.00000000E-99	+2.787
+5.00	+.22838625E+16	+.98810666E+15	+.00000000E-99	+3.420
+6.00	+.20565125E+16	+.11335222E+16	+.00000000E-99	+3.923
+7.00	+.18517944E+16	+.12466577E+16	+.00000000E-99	+4.315
+8.00	+.16674552E+16	+.13320271E+16	+.00000000E-99	+4.610
+9.00	+.15014663E+16	+.13935996E+16	+.00000000E-99	+4.823
+10.00	+.13520011E+16	+.14348616E+16	+.00000000E-99	+4.966
+11.00	+.12174146E+16	+.14588705E+16	+.00000000E-99	+5.049
+12.00	+.10962257E+16	+.14683039E+16	+.00000000E-99	+5.082
+13.00	+.98710086E+15	+.14655038E+16	+.00000000E-99	+5.072
+14.00	+.88883843E+15	+.14525121E+16	+.00000000E-99	+5.027
+15.00	+.80035771E+15	+.14311079E+16	+.00000000E-99	+4.953
+16.00	+.72068492E+15	+.14028374E+16	+.00000000E-99	+4.855
+17.00	+.64894328E+15	+.13690414E+16	+.00000000E-99	+4.738
+18.00	+.58434328E+15	+.13308789E+16	+.00000000E-99	+4.606
+19.00	+.52617400E+15	+.12893492E+16	+.00000000E-99	+4.463
+20.00	+.47379527E+15	+.12453107E+16	+.00000000E-99	+4.310
+21.00	+.42663065E+15	+.11994986E+16	+.00000000E-99	+4.152
+22.00	+.38416109E+15	+.11525388E+16	+.00000000E-99	+3.989
+23.00	+.34591924E+15	+.11049627E+16	+.00000000E-99	+3.824
+24.00	+.31148423E+15	+.10572180E+16	+.00000000E-99	+3.659
+25.00	+.28047712E+15	+.10096798E+16	+.00000000E-99	+3.494
+26.00	+.25255666E+15	+.96265919E+15	+.00000000E-99	+3.332
+27.00	+.22741557E+15	+.91641261E+15	+.00000000E-99	+3.172
+28.00	+.20477720E+15	+.87114848E+15	+.00000000E-99	+3.015
+29.00	+.18439239E+15	+.82703347E+15	+.00000000E-99	+2.862
+30.00	+.16603682E+15	+.78419832E+15	+.00000000E-99	+2.714
+31.00	+.14950848E+15	+.74274290E+15	+.00000000E-99	+2.570
+32.00	+.13462549E+15	+.70274052E+15	+.00000000E-99	+2.432

TABLE 14. IODINE NUMBER DENSITY (I), XENON NUMBER DENSITY (X), CONTROL FLUX AND NEGATIVE REACTIVITY DUE TO XENON BUILDUP VS. TIME UNDER THE FOLLOWING CONDITIONS: OPERATING THERMAL FLUX = 10^{13}nv, b = 4 HOURS, Δt = 0.5 HOUR AND $\phi_{max} = \phi_o$

t	I	X	ϕ	$\Delta K/K$
+.00	+.30000000E+16	+.70000000E+15	+.00000000E-99	+2.423
+.50	+.28467670E+16	+.82345680E+15	+.00000000E-99	+2.850
+1.00	+.27013609E+16	+.93468354E+15	+.00000000E-99	+3.235
+1.50	+.25633819E+16	+.10345252E+16	+.00000000E-99	+3.580
+2.00	+.24324503E+16	+.11237755E+16	+.00000000E-99	+3.889
+2.50	+.23082065E+16	+.12031800E+16	+.30000000E+14	+4.164
+3.00	+.23426035E+16	+.10691332E+16	+.30000000E+14	+3.700
+3.50	+.23752436E+16	+.96475421E+15	+.30000000E+14	+3.339
+4.00	+.24062166E+16	+.88374589E+15	+.00000000E-99	+3.059
+4.50	+.22833128E+16	+.97077466E+15	+.00000000E-99	+3.360
+5.00	+.21666867E+16	+.10484401E+16	+.00000000E-99	+3.629
+5.50	+.20560175E+16	+.11174035E+16	+.00000000E-99	+3.867
+6.00	+.19510011E+16	+.11782857E+16	+.00000000E-99	+4.078
+6.50	+.18513487E+16	+.12316681E+16	+.00000000E-99	+4.263
+7.00	+.17567864E+16	+.12780998E+16	+.00000000E-99	+4.424
+7.50	+.16670541E+16	+.13180906E+16	+.00000000E-99	+4.562
+8.00	+.15819050E+16	+.13521215E+16	+.00000000E-99	+4.680
+8.50	+.15011052E+16	+.13806427E+16	+.00000000E-99	+4.779
+9.00	+.14244324E+16	+.14040761E+16	+.00000000E-99	+4.860
+9.50	+.13516760E+16	+.14228166E+16	+.00000000E-99	+4.925
+10.00	+.12826358E+16	+.14372339E+16	+.00000000E-99	+4.974
+10.50	+.12171219E+16	+.14476742E+16	+.00000000E-99	+5.011
+11.00	+.11549544E+16	+.14544611E+16	+.00000000E-99	+5.034
+11.50	+.10959622E+16	+.14578974E+16	+.00000000E-99	+5.046
+12.00	+.10399835E+16	+.14582662E+16	+.00000000E-99	+5.047
+13.00	+.93645701E+15	+.14508412E+16	+.00000000E-99	+5.022
+14.00	+.84323603E+15	+.14340955E+16	+.00000000E-99	+4.964
+15.00	+.75929487E+15	+.14096918E+16	+.00000000E-99	+4.879
+16.00	+.68370976E+15	+.13790733E+16	+.00000000E-99	+4.773
+17.00	+.61564887E+15	+.13434902E+16	+.00000000E-99	+4.650
+18.00	+.55436322E+15	+.13040218E+16	+.00000000E-99	+4.513
+19.00	+.49917834E+15	+.12615974E+16	+.00000000E-99	+4.366
+20.00	+.44948693E+15	+.12170142E+16	+.00000000E-99	+4.212
+21.00	+.40474212E+15	+.11709529E+16	+.00000000E-99	+4.053
+22.00	+.36445151E+15	+.11239928E+16	+.00000000E-99	+3.890
+23.00	+.32817169E+15	+.10766240E+16	+.00000000E-99	+3.726
+24.00	+.29550338E+15	+.10292585E+16	+.00000000E-99	+3.562
+25.00	+.26608709E+15	+.98223981E+15	+.00000000E-99	+3.400
+26.00	+.23959910E+15	+.93585220E+15	+.00000000E-99	+3.239
+27.00	+.21574789E+15	+.89032901E+15	+.00000000E-99	+3.081
+28.00	+.19427100E+15	+.84585833E+15	+.00000000E-99	+2.927
+29.00	+.17493206E+15	+.80258945E+15	+.00000000E-99	+2.778
+30.00	+.15751825E+15	+.76063827E+15	+.00000000E-99	+2.632
+31.00	+.14183792E+15	+.72009199E+15	+.00000000E-99	+2.492
+32.00	+.12771849E+15	+.68101316E+15	+.00000000E-99	+2.357

TABLE 15. IODINE NUMBER DENSITY (I), XENON NUMBER DENSITY (X), CONTROL FLUX AND NEGATIVE REACTIVITY DUE TO XENON BUILD-UP VS. TIME UNDER THE FOLLOWING CONDITIONS: OPERATING THERMAL FLUX = 10^{14}nv, b = 2 HOURS, Δt = 0.5 HOUR AND $\Phi_{max} = \Phi_0$

t	I	X	Φ	$\Delta K/K$
+.00	+.98588954E+16	+.79713394E+15	+.00000000E-99	+2.759
+.50	+.93570384E+16	+.12594035E+16	+.00000000E-99	+4.359
+1.00	+.88807280E+16	+.16794770E+16	+.00000000E-99	+5.813
+1.50	+.84286640E+16	+.20601951E+16	+.10000000E+15	+7.131
+2.00	+.85055276E+16	+.13789200E+16	+.00000000E-99	+4.773
+2.50	+.80725625E+16	+.17520755E+16	+.00000000E-99	+6.064
+3.00	+.76616373E+16	+.20897802E+16	+.00000000E-99	+7.233
+3.50	+.72716297E+16	+.23944487E+16	+.00000000E-99	+8.288
+4.00	+.69014751E+16	+.26683516E+16	+.00000000E-99	+9.236
+4.50	+.65501629E+16	+.29136208E+16	+.00000000E-99	+10.085
+5.00	+.62167342E+16	+.31322592E+16	+.00000000E-99	+10.842
+5.50	+.59002782E+16	+.33261478E+16	+.00000000E-99	+11.513
+6.00	+.55999314E+16	+.34970520E+16	+.00000000E-99	+12.104
+6.50	+.53148731E+16	+.36466283E+16	+.00000000E-99	+12.622
+7.00	+.50443255E+16	+.37764312E+16	+.00000000E-99	+13.072
+7.50	+.47875500E+16	+.38879187E+16	+.00000000E-99	+13.457
+8.00	+.45438453E+16	+.39824576E+16	+.00000000E-99	+13.785
+8.50	+.43125462E+16	+.40613287E+16	+.00000000E-99	+14.058
+9.00	+.40930211E+16	+.41257330E+16	+.00000000E-99	+14.281
+9.50	+.38846705E+16	+.41767950E+16	+.00000000E-99	+14.457
+10.00	+.36869259E+16	+.42155672E+16	+.00000000E-99	+14.592
+10.50	+.34992476E+16	+.42430344E+16	+.00000000E-99	+14.687
+11.00	+.33211229E+16	+.42601191E+16	+.00000000E-99	+14.746
+11.50	+.31520655E+16	+.42676830E+16	+.00000000E-99	+14.772
+12.50	+.28393299E+16	+.42574235E+16	+.00000000E-99	+14.736
+13.50	+.25576230E+16	+.42180810E+16	+.00000000E-99	+14.600
+14.50	+.23038662E+16	+.41547339E+16	+.00000000E-99	+14.381
+15.50	+.20752865E+16	+.40717963E+16	+.00000000E-99	+14.094
+16.50	+.18693858E+16	+.39730977E+16	+.00000000E-99	+13.752
+17.50	+.16839139E+16	+.38619494E+16	+.00000000E-99	+13.368
+18.50	+.15168437E+16	+.37412073E+16	+.00000000E-99	+12.950
+19.50	+.13663493E+16	+.36133255E+16	+.00000000E-99	+12.507
+20.50	+.12307871E+16	+.34804054E+16	+.00000000E-99	+12.047
+21.50	+.11086749E+16	+.33442382E+16	+.00000000E-99	+11.576
+22.50	+.99867860E+15	+.32063439E+16	+.00000000E-99	+11.098
+23.50	+.89959294E+15	+.30680038E+16	+.00000000E-99	+10.619
+24.50	+.81033831E+15	+.29302908E+16	+.00000000E-99	+10.143
+25.50	+.72993923E+15	+.27940973E+16	+.00000000E-99	+9.671
+26.50	+.65751708E+15	+.26601579E+16	+.00000000E-99	+9.208
+27.50	+.59228047E+15	+.25290682E+16	+.00000000E-99	+8.754
+28.50	+.53351645E+15	+.24013067E+16	+.00000000E-99	+8.312
+29.50	+.48058280E+15	+.22772480E+16	+.00000000E-99	+7.882
+30.50	+.43290109E+15	+.21571788E+16	+.00000000E-99	+7.467
+31.50	+.38995023E+15	+.20413097E+16	+.00000000E-99	+7.065

TABLE 16. IODINE NUMBER DENSITY (I), XENON NUMBER DENSITY (X), CONTROL FLUX AND NEGATIVE REACTIVITY DUE TO XENON BUILDUP VS. TIME UNDER THE FOLLOWING CONDITIONS: OPERATING THERMAL FLUX = 10^{14}nv, b = 4 HOURS, Δt = 1 HOUR AND $\Phi_{max} = \Phi_o$

t	I	X	ϕ	$\Delta K/K$
+.00	+.98588954E+16	+.79713394E+15	+.00000000E-99	+2.7592
+1.00	+.88807280E+16	+.16794770E+16	+.00000000E-99	+5.8134
+2.00	+.79996116E+16	+.24042286E+16	+.00000000E-99	+8.3221
+3.00	+.72059167E+16	+.29921290E+16	+.10000000E+15	+10.3572
+4.00	+.74770509E+16	+.12089799E+16	+.00000000E-99	+4.1848
+5.00	+.67352030E+16	+.18341164E+16	+.00000000E-99	+6.3487
+6.00	+.60669588E+16	+.23429437E+16	+.00000000E-99	+8.1100
+7.00	+.54650157E+16	+.27509568E+16	+.00000000E-99	+9.5223
+8.00	+.49227961E+16	+.30718250E+16	+.00000000E-99	+10.6330
+9.00	+.44343737E+16	+.33175944E+16	+.00000000E-99	+11.4837
+10.00	+.39944111E+16	+.34988677E+16	+.00000000E-99	+12.1112
+11.00	+.35981008E+16	+.36249672E+16	+.00000000E-99	+12.5477
+12.00	+.32411106E+16	+.37040756E+16	+.00000000E-99	+12.8215
+13.00	+.29195397E+16	+.37433677E+16	+.00000000E-99	+12.9576
+14.00	+.26298744E+16	+.37491251E+16	+.00000000E-99	+12.9775
+15.00	+.23689489E+16	+.37268364E+16	+.00000000E-99	+12.9003
+16.00	+.21339116E+16	+.36812821E+16	+.00000000E-99	+12.7426
+17.00	+.19221938E+16	+.36166271E+16	+.00000000E-99	+12.5188
+18.00	+.17314821E+16	+.35364872E+16	+.00000000E-99	+12.2414
+19.00	+.15596927E+16	+.34439946E+16	+.00000000E-99	+11.9213
+20.00	+.14049475E+16	+.33418546E+16	+.00000000E-99	+11.5677
+21.00	+.12655557E+16	+.32323949E+16	+.00000000E-99	+11.1888
+22.00	+.11399940E+16	+.31176138E+16	+.00000000E-99	+10.7915
+23.00	+.10268902E+16	+.29992183E+16	+.00000000E-99	+10.3817
+24.00	+.92500631E+15	+.28786595E+16	+.00000000E-99	+9.9644
+25.00	+.83323018E+15	+.27571660E+16	+.00000000E-99	+9.5438
+26.00	+.75055984E+15	+.26357698E+16	+.00000000E-99	+9.1236
+27.00	+.67609182E+15	+.25153325E+16	+.00000000E-99	+8.7067
+28.00	+.60901226E+15	+.23965662E+16	+.00000000E-99	+8.2956
+29.00	+.54858818E+15	+.22800546E+16	+.00000000E-99	+7.8923
+30.00	+.49415919E+15	+.21662680E+16	+.00000000E-99	+7.4984
+31.00	+.44513045E+15	+.20555796E+16	+.00000000E-99	+7.1153
+32.00	+.40096621E+15	+.19482789E+16	+.00000000E-99	+6.7439
+33.00	+.36118381E+15	+.18445831E+16	+.00000000E-99	+6.3849
+34.00	+.32534851E+15	+.17446473E+16	+.00000000E-99	+6.0390

TABLE 17. IODINE NUMBER DENSITY (I), XENON NUMBER DENSITY (X), CONTROL FLUX AND NEGATIVE REACTIVITY DUE TO XENON BUILD-UP VS. TIME UNDER THE FOLLOWING CONDITIONS: OPERATING THERMAL FLUX = 10^{14}nv, b = 7 HOURS, Δt = 1 HOUR AND $\phi_{max} = \phi_o$

t	I	X	ϕ	$\Delta K/K$
+.00	+.98588954E+16	+.79713394E+15	+.00000000E-99	+2.7592
+1.00	+.88807280E+16	+.16704770E+16	+.00000000E-99	+5.8134
+2.00	+.79996116E+16	+.24042286E+16	+.00000000E-99	+8.3221
+3.00	+.72059167E+16	+.20921290E+16	+.00000000E-99	+10.3572
+4.00	+.64909696E+16	+.34614875E+16	+.00000000E-99	+11.9818
+5.00	+.58469578E+16	+.38284523E+16	+.00000000E-99	+13.2521
+6.00	+.52668427E+16	+.41072504E+16	+.10000000E+15	+14.2171
+7.00	+.57303701E+16	+.13862342E+16	+.00000000E-99	+4.7984
+8.00	+.51618227E+16	+.18318436E+16	+.00000000E-99	+6.3408
+9.00	+.46496845E+16	+.21907550E+16	+.00000000E-99	+7.5832
+10.00	+.41883593E+16	+.24746651E+16	+.00000000E-99	+8.5660
+11.00	+.37728052E+16	+.26938848E+16	+.00000000E-99	+9.3248
+12.00	+.33984816E+16	+.28574944E+16	+.00000000E-99	+9.8911
+13.00	+.30612975E+16	+.29734778E+16	+.00000000E-99	+10.2926
+14.00	+.27575676E+16	+.30488477E+16	+.00000000E-99	+10.5535
+15.00	+.24839727E+16	+.30897537E+16	+.00000000E-99	+10.6951
+16.00	+.22375233E+16	+.31015822E+16	+.00000000E-99	+10.7360
+17.00	+.20155254E+16	+.30890460E+16	+.00000000E-99	+10.6926
+18.00	+.18155540E+16	+.30562472E+16	+.00000000E-99	+10.5791
+19.00	+.16354229E+16	+.30067629E+16	+.00000000E-99	+10.4078
+20.00	+.14731639E+16	+.29437018E+16	+.00000000E-99	+10.1895
+21.00	+.13270038E+16	+.28697572E+16	+.00000000E-99	+9.9336
+22.00	+.11953454E+16	+.27872584E+16	+.00000000E-99	+9.6480
+23.00	+.10767492E+16	+.26982115E+16	+.00000000E-99	+9.3398
+24.00	+.96991950E+15	+.26043394E+16	+.00000000E-99	+9.0148
+25.00	+.87368722E+15	+.25071162E+16	+.00000000E-99	+8.6783
+26.00	+.78700282E+15	+.24077973E+16	+.00000000E-99	+8.3345
+27.00	+.70891905E+15	+.23074458E+16	+.00000000E-99	+7.9871
+28.00	+.63858245E+15	+.22069570E+16	+.00000000E-99	+7.6393
+29.00	+.57522442E+15	+.21070807E+16	+.00000000E-99	+7.2936
+30.00	+.51815265E+15	+.20084370E+16	+.00000000E-99	+6.9521
+31.00	+.46674336E+15	+.19115361E+16	+.00000000E-99	+6.6167
+32.00	+.42043472E+15	+.18167915E+16	+.00000000E-99	+6.2887
+33.00	+.37872073E+15	+.17245329E+16	+.00000000E-99	+5.9694
+34.00	+.34114546E+15	+.16350167E+16	+.00000000E-99	+5.6595
+35.00	+.30729827E+15	+.15484382E+16	+.00000000E-99	+5.3598
+36.00	+.27680935E+15	+.14649389E+16	+.00000000E-99	+5.0708

TABLE 18. IODINE NUMBER DENSITY (I), XENON NUMBER DENSITY (X), CONTROL FLUX AND NEGATIVE REACTIVITY DUE TO XENON BUILD-UP VS. TIME UNDER THE FOLLOWING CONDITIONS: OPERATING THERMAL FLUX = 10^{14}nv, b = 8 HOURS, Δt = 1 HOUR AND $\phi_{max} = \phi_o$

t	I	X	ϕ	$\Delta K/K$
+.00	+.98588954E+16	+.79713394E+15	+.00000000E-99	+2.7592
+1.00	+.88807280E+16	+.16794770E+16	+.00000000E-99	+5.8134
+2.00	+.79996116E+16	+.24042286E+16	+.00000000E-99	+8.3221
+3.00	+.72059167E+16	+.29921290E+16	+.00000000E-99	+10.3572
+4.00	+.64909696E+16	+.34614875E+16	+.00000000E-99	+11.9818
+5.00	+.58469578E+16	+.38284523E+16	+.00000000E-99	+13.2521
+6.00	+.52668427E+16	+.41072504E+16	+.00000000E-99	+14.2171
+7.00	+.47442852E+16	+.43103992E+16	+.10000000E+15	+14.9203
+8.00	+.52596601E+16	+.14094210E+16	+.00000000E-99	+4.8786
+9.00	+.47378152E+16	+.18084414E+16	+.00000000E-99	+6.2598
+10.00	+.42677461E+16	+.21286123E+16	+.00000000E-99	+7.3681
+11.00	+.38443158E+16	+.23806176E+16	+.00000000E-99	+8.2404
+12.00	+.34628975E+16	+.25738721E+16	+.00000000E-99	+8.9094
+13.00	+.31193222E+16	+.27166636E+16	+.00000000E-99	+9.4036
+14.00	+.28098350E+16	+.28162793E+16	+.00000000E-99	+9.7485
+15.00	+.25310540E+16	+.28791156E+16	+.00000000E-99	+9.9660
+16.00	+.22799332E+16	+.29107814E+16	+.00000000E-99	+10.0756
+17.00	+.20537279E+16	+.29161876E+16	+.00000000E-99	+10.0943
+18.00	+.18499664E+16	+.28996270E+16	+.00000000E-99	+10.0370
+19.00	+.16664210E+16	+.28648360E+16	+.00000000E-99	+9.9165
+20.00	+.15010865E+16	+.28150720E+16	+.00000000E-99	+9.7443
+21.00	+.13521560E+16	+.27531630E+16	+.00000000E-99	+9.5300
+22.00	+.12180018E+16	+.26815579E+16	+.00000000E-99	+9.2821
+23.00	+.10971582E+16	+.26023730E+16	+.00000000E-99	+9.0080
+24.00	+.98830352E+15	+.25174302E+16	+.00000000E-99	+8.7140
+25.00	+.89024726E+15	+.24282924E+16	+.00000000E-99	+8.4054
+26.00	+.80191986E+15	+.23362963E+16	+.00000000E-99	+8.0870
+27.00	+.72235602E+15	+.22425771E+16	+.00000000E-99	+7.7626
+28.00	+.65068629E+15	+.21480961E+16	+.00000000E-99	+7.4355
+29.00	+.58612740E+15	+.20536627E+16	+.00000000E-99	+7.1087
+30.00	+.52797386E+15	+.19599514E+16	+.00000000E-99	+6.7843
+31.00	+.47559017E+15	+.18675200E+16	+.00000000E-99	+6.4643
+32.00	+.42840378E+15	+.17768260E+16	+.00000000E-99	+6.1504
+33.00	+.38589912E+15	+.16882389E+16	+.00000000E-99	+5.8438
+34.00	+.34761163E+15	+.16020516E+16	+.00000000E-99	+5.5454
+35.00	+.31312295E+15	+.15184918E+16	+.00000000E-99	+5.2562
+36.00	+.28205609E+15	+.14377300E+16	+.00000000E-99	+4.9766
+37.00	+.25407157E+15	+.13598888E+16	+.00000000E-99	+4.7072

TABLE 19. IODINE NUMBER DENSITY (I), XENON NUMBER DENSITY (X), CONTROL FLUX AND NEGATIVE REACTIVITY DUE TO XENON BUILD-UP VS. TIME UNDER THE FOLLOWING CONDITIONS: OPERATING THERMAL FLUX = 10^{15}nv, b = 2 HOURS, Δt = 0.5 HOUR AND $\phi_{max} = \phi_o$

t	I	X	ϕ	$\Delta K/K$
+.00	+.98482476E+17	+.83872872E+15	+.00000000E-99	+2.903
+.50	+.93469325E+17	+.57208652E+16	+.00000000E-99	+19.802
+1.00	+.88711363E+16	+.10171683E+17	+.00000000E-99	+35.209
+1.50	+.84195602E+17	+.14219909E+17	+.10000000E+16	+49.221
+2.00	+.84968045E+17	+.73774069E+15	+.00000000E-99	+2.553
+3.00	+.76537793E+17	+.87888367E+16	+.00000000E-99	+30.422
+4.00	+.68943970E+17	+.15449378E+17	+.00000000E-99	+53.477
+5.00	+.62103580E+17	+.20900193E+17	+.00000000E-99	+72.345
+6.00	+.55941876E+17	+.25301384E+17	+.00000000E-99	+87.580
+7.00	+.50391518E+17	+.28794166E+17	+.00000000E-99	+99.670
+8.00	+.45391851E+17	+.31503033E+17	+.00000000E-99	+109.047
+9.00	+.40888234E+17	+.33537630E+17	+.00000000E-99	+116.089
+10.00	+.36831453E+17	+.34994403E+17	+.00000000E-99	+121.132
+11.00	+.33177172E+17	+.35958065E+17	+.00000000E-99	+124.468
+12.00	+.29885459E+17	+.36502944E+17	+.00000000E-99	+126.354
+13.00	+.26920342E+17	+.36694137E+17	+.00000000E-99	+127.016
+14.00	+.24249415E+17	+.36588610E+17	+.00000000E-99	+126.650
+15.00	+.21843492E+17	+.36236006E+17	+.00000000E-99	+125.430
+16.00	+.19676277E+17	+.35679592E+17	+.00000000E-99	+123.504
+17.00	+.17724082E+17	+.34956990E+17	+.00000000E-99	+121.003
+18.00	+.15965576E+17	+.34100823E+17	+.00000000E-99	+118.039
+19.00	+.14381552E+17	+.33139287E+17	+.00000000E-99	+114.711
+20.00	+.12954685E+17	+.32096718E+17	+.00000000E-99	+111.102
+21.00	+.11669388E+17	+.30993999E+17	+.00000000E-99	+107.285
+22.00	+.10511614E+17	+.29849017E+17	+.00000000E-99	+103.321
+23.00	+.94686989E+16	+.28677013E+17	+.00000000E-99	+99.264
+24.00	+.85292455E+16	+.27490920E+17	+.00000000E-99	+95.159
+25.00	+.76830021E+16	+.26301625E+17	+.00000000E-99	+91.042
+26.00	+.69207201E+16	+.25118260E+17	+.00000000E-99	+86.946
+27.00	+.62340694E+16	+.23948398E+17	+.00000000E-99	+82.896
+28.00	+.56155464E+16	+.22798272E+17	+.00000000E-99	+78.915
+29.00	+.50583913E+16	+.21672942E+17	+.00000000E-99	+75.020
+30.00	+.45565155E+16	+.20576452E+17	+.00000000E-99	+71.225
+31.00	+.41044342E+16	+.19511976E+17	+.00000000E-99	+67.540
+32.00	+.36972073E+16	+.18481932E+17	+.00000000E-99	+63.974
+33.00	+.33303845E+16	+.17488088E+17	+.00000000E-99	+60.534

TABLE 20. IODINE NUMBER DENSITY (I), XENON NUMBER DENSITY (X), CONTROL FLUX AND NEGATIVE REACTIVITY DUE TO XENON BUILD-UP VS. TIME UNDER THE FOLLOWING CONDITIONS: OPERATING THERMAL FLUX = 10^{15}nv, b = 4 HOURS, Δt = 0.5 HOUR AND $\Phi_{max} = \Phi_0$

t	I	X	ϕ	$\Delta K/K$
+.00	+.98482476E+17	+.83872872E+15	+.00000000E-99	+2.903
+.50	+.93469325E+17	+.57208652E+16	+.00000000E-99	+19.802
+1.00	+.88711363E+17	+.10171683E+17	+.00000000E-99	+35.209
+1.50	+.84195602E+17	+.14219909E+17	+.00000000E-99	+49.221
+2.00	+.79909712E+17	+.17892588E+17	+.00000000E-99	+61.934
+2.50	+.75841992E+17	+.21215125E+17	+.00000000E-99	+73.435
+3.00	+.71981337E+17	+.24211402E+17	+.00000000E-99	+83.807
+3.50	+.68317205E+17	+.26903855E+17	+.10000000E+16	+93.127
+4.00	+.69898088E+17	+.62409495E+15	+.00000000E-99	+2.160
+5.00	+.62963034E+17	+.72460751E+16	+.00000000E-99	+25.082
+6.00	+.56716060E+17	+.12724059E+17	+.00000000E-99	+44.044
+7.00	+.51088890E+17	+.17207033E+17	+.00000000E-99	+59.561
+8.00	+.46020034E+17	+.20826628E+17	+.00000000E-99	+72.091
+9.00	+.41454095E+17	+.23699004E+17	+.00000000E-99	+82.033
+10.00	+.37341170E+17	+.25926566E+17	+.00000000E-99	+89.744
+11.00	+.33636317E+17	+.27599504E+17	+.00000000E-99	+95.535
+12.00	+.30299051E+17	+.28797163E+17	+.00000000E-99	+99.680
+13.00	+.27292898E+17	+.29589224E+17	+.00000000E-99	+102.422
+14.00	+.24585002E+17	+.30036828E+17	+.00000000E-99	+103.971
+15.00	+.22145779E+17	+.30193520E+17	+.00000000E-99	+104.514
+16.00	+.19948565E+17	+.30106173E+17	+.00000000E-99	+104.211
+17.00	+.17969356E+17	+.29815612E+17	+.00000000E-99	+103.206
+18.00	+.16186521E+17	+.29357426E+17	+.00000000E-99	+101.620
+19.00	+.14580570E+17	+.28762557E+17	+.00000000E-99	+99.561
+20.00	+.13133956E+17	+.28057840E+17	+.00000000E-99	+97.121
+21.00	+.11830874E+17	+.27266480E+17	+.00000000E-99	+94.382
+22.00	+.10657079E+17	+.26408478E+17	+.00000000E-99	+91.412
+23.00	+.95997334E+16	+.25501017E+17	+.00000000E-99	+88.271
+24.00	+.86472794E+16	+.24558817E+17	+.00000000E-99	+85.009
+25.00	+.77893248E+16	+.23594410E+17	+.00000000E-99	+81.671
+26.00	+.70164938E+16	+.22618420E+17	+.00000000E-99	+78.293
+27.00	+.63203411E+16	+.21639826E+17	+.00000000E-99	+74.905
+28.00	+.56932585E+16	+.20666123E+17	+.00000000E-99	+71.535
+29.00	+.51283930E+16	+.19703545E+17	+.00000000E-99	+68.203
+30.00	+.46195719E+16	+.18757215E+17	+.00000000E-99	+64.927
+31.00	+.41612343E+16	+.17831301E+17	+.00000000E-99	+61.722
+32.00	+.37483720E+16	+.16929125E+17	+.00000000E-99	+58.599
+33.00	+.33764729E+16	+.16053297E+17	+.00000000E-99	+55.568
+34.00	+.30414724E+16	+.15205803E+17	+.00000000E-99	+52.634
+35.00	+.27397096E+16	+.14388099E+17	+.00000000E-99	+49.804

TABLE 22. IODINE NUMBER DENSITY (I), XENON NUMBER DENSITY (X), CONTROL FLUX AND NEGATIVE REACTIVITY DUE TO XENON BUILD-UP VS. TIME UNDER THE FOLLOWING CONDITIONS: OPERATING THERMAL FLUX = 10^{15}nv, b = 6 HOURS, Δt = 1 HOUR AND $\phi_{max} = \phi_o$

t	I	X	ϕ	$\Delta K/K$
+.00	+.98482476E+17	+.83872872E+15	+.00000000E-99	+2.903
+1.00	+.88711363E+17	+.10171683E+17	+.00000000E-99	+35.209
+2.00	+.79909712E+17	+.17892588E+17	+.00000000E-99	+61.934
+3.00	+.71981337E+17	+.24211402E+17	+.00000000E-99	+83.807
+4.00	+.64839594E+17	+.29313568E+17	+.00000000E-99	+101.468
+5.00	+.58406435E+17	+.33362766E+17	+.10000000E+16	+115.484
+6.00	+.62471230E+17	+.54561206E+15	+.00000000E-99	+1.888
+7.00	+.56273049E+17	+.64648759E+16	+.00000000E-99	+22.378
+8.00	+.50689834E+17	+.11361637E+17	+.00000000E-99	+39.328
+9.00	+.45660568E+17	+.15369043E+17	+.00000000E-99	+53.199
+10.00	+.41130291E+17	+.18604751E+17	+.00000000E-99	+64.400
+11.00	+.37049498E+17	+.21172581E+17	+.00000000E-99	+73.288
+12.00	+.33373584E+17	+.23164063E+17	+.00000000E-99	+80.181
+13.00	+.30062380E+17	+.24659810E+17	+.00000000E-99	+85.355
+14.00	+.27079708E+17	+.25730733E+17	+.00000000E-99	+89.066
+15.00	+.24392968E+17	+.26439121E+17	+.00000000E-99	+91.518
+16.00	+.21972798E+17	+.26839612E+17	+.00000000E-99	+92.904
+17.00	+.19792751E+17	+.26980070E+17	+.00000000E-99	+93.391
+18.00	+.17829003E+17	+.26902401E+17	+.00000000E-99	+93.122
+19.00	+.16060089E+17	+.26643074E+17	+.00000000E-99	+92.224
+20.00	+.14466682E+17	+.26233908E+17	+.00000000E-99	+90.808
+21.00	+.13031369E+17	+.25702560E+17	+.00000000E-99	+88.968
+22.00	+.11738465E+17	+.25073013E+17	+.00000000E-99	+86.789
+23.00	+.10573838E+17	+.24366008E+17	+.00000000E-99	+84.342
+24.00	+.95247523E+16	+.23599417E+17	+.00000000E-99	+81.686
+25.00	+.85797373E+16	+.22788605E+17	+.00000000E-99	+78.882
+26.00	+.77284841E+16	+.21946728E+17	+.00000000E-99	+75.968
+27.00	+.69616897E+16	+.21084987E+17	+.00000000E-99	+72.985
+28.00	+.62709742E+16	+.20212884E+17	+.00000000E-99	+69.966
+29.00	+.56487898E+16	+.19338436E+17	+.00000000E-99	+66.939
+30.00	+.50883365E+16	+.18468348E+17	+.00000000E-99	+63.927
+31.00	+.45834894E+16	+.17608194E+17	+.00000000E-99	+60.950
+32.00	+.41287322E+16	+.16762551E+17	+.00000000E-99	+58.023
+33.00	+.37190947E+16	+.15935141E+17	+.00000000E-99	+55.159
+34.00	+.33500998E+16	+.15128939E+17	+.00000000E-99	+52.368
+35.00	+.30177155E+16	+.14346278E+17	+.00000000E-99	+49.659
+36.00	+.27183096E+16	+.13588933E+17	+.00000000E-99	+47.037
+37.00	+.24486098E+16	+.12858205E+17	+.00000000E-99	+44.508

TABLE 23. IODINE NUMBER DENSITY (I), XENON NUMBER DENSITY (X), CONTROL FLUX AND NEGATIVE REACTIVITY DUE TO XENON BUILD-UP VS. TIME UNDER THE FOLLOWING CONDITIONS: OPERATING THERMAL FLUX = 10^{15}nv, b = 7 HOURS, Δt = 1 HOUR AND $\phi_{max} = \phi_o$

t	I	X	ϕ	$\Delta K/K$
+.00	+.98482476E+17	+.83872872E+15	+.00000000E-99	+2.903
+1.00	+.88711363E+17	+.10171683E+17	+.00000000E-99	+35.209
+2.00	+.79909712E+17	+.17892588E+17	+.00000000E-99	+61.934
+3.00	+.71981337E+17	+.24211402E+17	+.00000000E-99	+83.807
+4.00	+.64839594E+17	+.29313568E+17	+.00000000E-99	+101.468
+5.00	+.58406435E+17	+.33392766E+17	+.00000000E-99	+115.588
+6.00	+.52611552E+17	+.36503305E+17	+.10000000E+16	+126.355
+7.00	+.57251419E+17	+.50319041E+15	+.00000000E-99	+1.741
+8.00	+.51571129E+17	+.59276369E+16	+.00000000E-99	+20.518
+9.00	+.46454422E+17	+.10415037E+17	+.00000000E-99	+36.051
+10.00	+.41845382E+17	+.14087406E+17	+.00000000E-99	+48.763
+11.00	+.37693636E+17	+.17052568E+17	+.00000000E-99	+59.027
+12.00	+.33953816E+17	+.19405663E+17	+.00000000E-99	+67.172
+13.00	+.30585048E+17	+.21230585E+17	+.00000000E-99	+73.489
+14.00	+.27550516E+17	+.22601210E+17	+.00000000E-99	+78.233
+15.00	+.24817065E+17	+.23582513E+17	+.00000000E-99	+81.630
+16.00	+.22354811E+17	+.24231585E+17	+.00000000E-99	+83.877
+17.00	+.20136860E+17	+.24598501E+17	+.00000000E-99	+85.147
+18.00	+.18138970E+17	+.24727111E+17	+.00000000E-99	+85.592
+19.00	+.16339301E+17	+.24655831E+17	+.00000000E-99	+85.345
+20.00	+.14718190E+17	+.24418083E+17	+.00000000E-99	+84.522
+21.00	+.13257922E+17	+.24043020E+17	+.00000000E-99	+83.224
+22.00	+.11942542E+17	+.23555994E+17	+.00000000E-99	+81.538
+23.00	+.10757668E+17	+.22978980E+17	+.00000000E-99	+79.541
+24.00	+.96903446E+16	+.22330983E+17	+.00000000E-99	+77.298
+25.00	+.87289003E+16	+.21628381E+17	+.00000000E-99	+74.866
+26.00	+.78628476E+16	+.20885259E+17	+.00000000E-99	+72.293
+27.00	+.70827224E+16	+.20113673E+17	+.00000000E-99	+69.623
+28.00	+.63799988E+16	+.19323884E+17	+.00000000E-99	+66.889
+29.00	+.57469971E+16	+.18524608E+17	+.00000000E-99	+64.122
+30.00	+.51768002E+16	+.17723181E+17	+.00000000E-99	+61.348
+31.00	+.46631763E+16	+.16925754E+17	+.00000000E-99	+58.588
+32.00	+.42005126E+16	+.16137431E+17	+.00000000E-99	+55.859
+33.00	+.37837529E+16	+.15362409E+17	+.00000000E-99	+53.176
+34.00	+.34083428E+16	+.14604100E+17	+.00000000E-99	+50.551
+35.00	+.30701799E+16	+.13865228E+17	+.00000000E-99	+47.994
+36.00	+.27655685E+16	+.13147933E+17	+.00000000E-99	+45.511
+37.00	+.24911801E+16	+.12453843E+17	+.00000000E-99	+43.108
+38.00	+.22440155E+16	+.11784147E+17	+.00000000E-99	+40.790

TABLE 24. IODINE NUMBER DENSITY (I), XENON NUMBER DENSITY (X), CONTROL FLUX AND NEGATIVE REACTIVITY DUE TO XENON BUILD-UP VS. TIME UNDER THE FOLLOWING CONDITIONS: OPERATING THERMAL FLUX = 10^{15}nv, b = 8 HOURS, Δt = 1 HOUR AND $\phi_{max} = \phi_0$

t	I	X	ϕ	$\Delta K/K$
+.00	+.98482476E+17	+.83872872E+15	+.00000000E-99	+2.903
+1.00	+.88711363E+17	+.10171683E+17	+.00000000E-99	+35.209
+2.00	+.79909712E+17	+.17892588E+17	+.00000000E-99	+61.934
+3.00	+.71981337E+17	+.24211402E+17	+.00000000E-99	+83.807
+4.00	+.64839594E+17	+.29313568E+17	+.00000000E-99	+101.468
+5.00	+.58406435E+17	+.33362766E+17	+.00000000E-99	+115.484
+6.00	+.52611552E+17	+.36503305E+17	+.00000000E-99	+126.355
+7.00	+.47391617E+17	+.38862270E+17	+.10000000E+16	+134.521
+8.00	+.52549494E+17	+.46497741E+15	+.00000000E-99	+1.609
+9.00	+.47335712E+17	+.54436996E+16	+.00000000E-99	+18.843
+10.00	+.42639232E+17	+.95623531E+16	+.00000000E-99	+33.099
+11.00	+.38408722E+17	+.12932921E+17	+.00000000E-99	+44.767
+12.00	+.34597653E+17	+.15654377E+17	+.00000000E-99	+54.187
+13.00	+.31165273E+17	+.17814050E+17	+.00000000E-99	+61.663
+14.00	+.28073175E+17	+.19488938E+17	+.00000000E-99	+67.460
+15.00	+.25287866E+17	+.20746848E+17	+.00000000E-99	+71.814
+16.00	+.22778909E+17	+.21647427E+17	+.00000000E-99	+74.932
+17.00	+.20518883E+17	+.22243070E+17	+.00000000E-99	+76.993
+18.00	+.18483093E+17	+.22579734E+17	+.00000000E-99	+78.159
+19.00	+.16649283E+17	+.22697683E+17	+.00000000E-99	+78.567
+20.00	+.14997421E+17	+.22632162E+17	+.00000000E-99	+78.340
+21.00	+.13509448E+17	+.22413854E+17	+.00000000E-99	+77.585
+22.00	+.12169110E+17	+.22069515E+17	+.00000000E-99	+76.393
+23.00	+.10961755E+17	+.21622412E+17	+.00000000E-99	+74.845
+24.00	+.98741833E+16	+.21092715E+17	+.00000000E-99	+73.012
+25.00	+.88944993E+16	+.20497866E+17	+.00000000E-99	+70.953
+26.00	+.80120163E+16	+.19852910E+17	+.00000000E-99	+68.720
+27.00	+.72170903E+16	+.19170764E+17	+.00000000E-99	+66.359
+28.00	+.65010349E+16	+.18462493E+17	+.00000000E-99	+63.907
+29.00	+.58560244E+16	+.17737517E+17	+.00000000E-99	+61.398
+30.00	+.52750101E+16	+.17003834E+17	+.00000000E-99	+58.858
+31.00	+.47516420E+16	+.16268186E+17	+.00000000E-99	+56.312
+32.00	+.42802011E+16	+.15536211E+17	+.00000000E-99	+53.778
+33.00	+.38555348E+16	+.14812594E+17	+.00000000E-99	+51.273
+34.00	+.34730030E+16	+.14101195E+17	+.00000000E-99	+48.811
+35.00	+.31284245E+16	+.13405134E+17	+.00000000E-99	+46.401
+36.00	+.28180345E+16	+.12726914E+17	+.00000000E-99	+44.053
+37.00	+.25384406E+16	+.12068503E+17	+.00000000E-99	+41.774
+38.00	+.22865870E+16	+.11431390E+17	+.00000000E-99	+39.569
+39.00	+.20597218E+16	+.10816673E+17	+.00000000E-99	+37.441

TABLE 25. IODINE NUMBER DENSITY (I), XENON NUMBER DENSITY (X), CONTROL FLUX AND NEGATIVE REACTIVITY DUE TO XENON BUILD-UP VS. TIME UNDER THE FOLLOWING CONDITIONS: OPERATING THERMAL FLUX = 10^{15}nv, b = 6 HOURS, Δt = 1 HOUR AND $\phi_{max} = 2\phi_o$

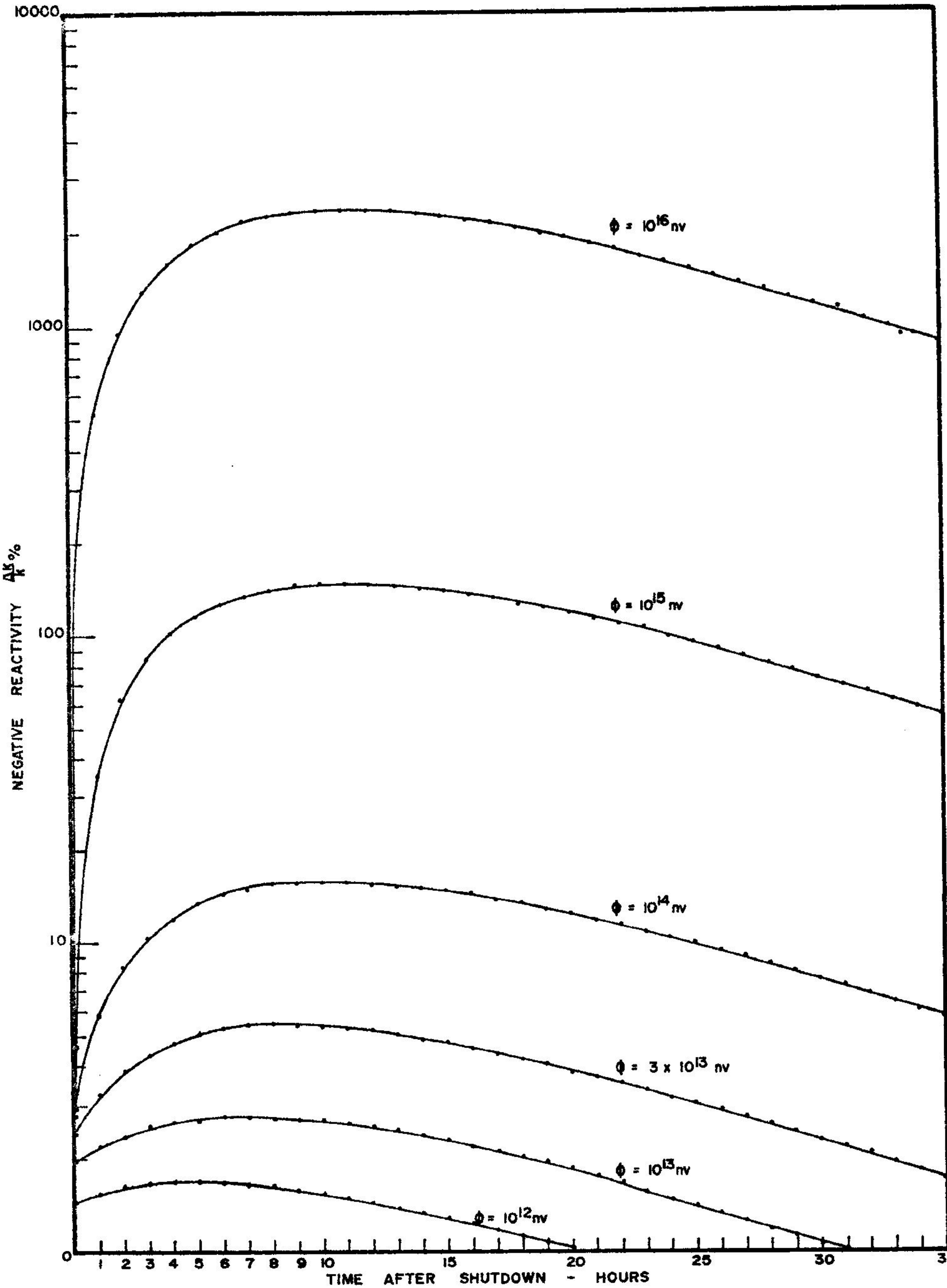
t	I	X	ϕ	$\Delta K/K$
+.00	+.98482476E+17	+.83872872E+15	+.00000000E-99	+2.903
+1.00	+.88711363E+17	+.10171683E+17	+.00000000E-99	+35.209
+2.00	+.79909712E+17	+.17892588E+17	+.00000000E-99	+61.934
+3.00	+.71981337E+17	+.24211402E+17	+.00000000E-99	+83.807
+4.00	+.64839594E+17	+.29313568E+17	+.00000000E-99	+101.468
+5.00	+.58406435E+17	+.33362766E+17	+.20000000E+16	+115.484
+6.00	+.72330754E+17	+.33485600E+15	+.00000000E-99	+1.159
+7.00	+.65154336E+17	+.72099571E+16	+.00000000E-99	+24.957
+8.00	+.58689944E+17	+.12899598E+17	+.00000000E-99	+44.651
+9.00	+.52866933E+17	+.17558072E+17	+.00000000E-99	+60.776
+10.00	+.47621662E+17	+.21321694E+17	+.00000000E-99	+73.804
+11.00	+.42896812E+17	+.24310775E+17	+.00000000E-99	+84.151
+12.00	+.38640746E+17	+.26631383E+17	+.00000000E-99	+92.184
+13.00	+.34806953E+17	+.28376938E+17	+.00000000E-99	+98.226
+14.00	+.31355386E+17	+.29629619E+17	+.00000000E-99	+102.562
+15.00	+.28242759E+17	+.30461620E+17	+.00000000E-99	+105.442
+16.00	+.25440628E+17	+.30936266E+17	+.00000000E-99	+107.085
+17.00	+.22916513E+17	+.31109047E+17	+.00000000E-99	+107.683
+18.00	+.20642832E+17	+.31028520E+17	+.00000000E-99	+107.404
+19.00	+.18594735E+17	+.30736981E+17	+.00000000E-99	+106.395
+20.00	+.16749848E+17	+.30271318E+17	+.00000000E-99	+104.783
+21.00	+.15088005E+17	+.29663602E+17	+.00000000E-99	+102.680
+22.00	+.13591049E+17	+.28941643E+17	+.00000000E-99	+100.180
+23.00	+.12242614E+17	+.28129491E+17	+.00000000E-99	+97.369
+24.00	+.11027966E+17	+.27247887E+17	+.00000000E-99	+94.318
+25.00	+.99338286E+16	+.26314651E+17	+.00000000E-99	+91.087
+26.00	+.89482266E+16	+.25345043E+17	+.00000000E-99	+87.731
+27.00	+.80604130E+16	+.24352055E+17	+.00000000E-99	+84.294
+28.00	+.72606856E+16	+.23346731E+17	+.00000000E-99	+80.814
+29.00	+.65403045E+16	+.22338366E+17	+.00000000E-99	+77.323
+30.00	+.58913980E+16	+.21334750E+17	+.00000000E-99	+73.849
+31.00	+.53068735E+16	+.20342350E+17	+.00000000E-99	+70.414
+32.00	+.47803443E+16	+.19366513E+17	+.00000000E-99	+67.036
+33.00	+.43060557E+16	+.18411538E+17	+.00000000E-99	+63.731
+34.00	+.38788247E+16	+.17480901E+17	+.00000000E-99	+60.509
+35.00	+.34939824E+16	+.16577315E+17	+.00000000E-99	+57.382
+36.00	+.31473228E+16	+.15702852E+17	+.00000000E-99	+54.355
+37.00	+.28350575E+16	+.14859034E+17	+.00000000E-99	+51.434

TABLE 26. IODINE NUMBER DENSITY (I), XENON NUMBER DENSITY (X), CONTROL FLUX AND NEGATIVE REACTIVITY DUE TO XENON BUILD-UP VS. TIME FOR MINIMIZING THE VALUE OF XENON BUILDUP AT A GIVEN TIME UNDER THE FOLLOWING CONDITIONS: OPERATING THERMAL FLUX = 10^{14}nv, t = 6 HOURS AFTER TERMINATION OF FULL POWER OPERATION, Δt = 1 HOUR, $\phi_{max} = \phi_o$

t	I	X	ϕ	$\Delta K/K$
+.00	+.98588954E+16	+.79713394E+15	+.00000000E-99	+2.759
+1.00	+.88807280E+16	+.16794770E+16	+.00000000E-99	+5.813
+2.00	+.79996116E+16	+.24042286E+16	+.10000000E+15	+8.322
+3.00	+.81919959E+16	+.11032369E+16	+.10000000E+15	+3.818
+4.00	+.83652925E+16	+.78512191E+15	+.00000000E-99	+2.717
+5.00	+.75353158E+16	+.15258681E+16	+.00000000E-99	+5.281
+6.00	+.67876869E+16	+.21334747E+16	+.00000000E-99	+7.384
+7.00	+.61142357E+16	+.26254984E+16	+.00000000E-99	+9.088
+8.00	+.55076022E+16	+.30174351E+16	+.00000000E-99	+10.444
+9.00	+.49611571E+16	+.33229508E+16	+.00000000E-99	+11.502
+10.00	+.44689289E+16	+.35540829E+16	+.00000000E-99	+12.302
+11.00	+.40255379E+16	+.37214227E+16	+.00000000E-99	+12.881
+12.00	+.36261387E+16	+.38342761E+16	+.00000000E-99	+13.272
+13.00	+.32663667E+16	+.39008097E+16	+.00000000E-99	+13.502
+14.00	+.29422902E+16	+.39281778E+16	+.00000000E-99	+13.597
+15.00	+.26503681E+16	+.39226427E+16	+.00000000E-99	+13.578
+16.00	+.23874089E+16	+.38896670E+16	+.00000000E-99	+13.464
+17.00	+.21505406E+16	+.38340105E+16	+.00000000E-99	+13.271
+18.00	+.19371733E+16	+.37598147E+16	+.00000000E-99	+13.014
+19.00	+.17449759E+16	+.36706719E+16	+.00000000E-99	+12.705
+20.00	+.15718475E+16	+.35696909E+16	+.00000000E-99	+12.356
+21.00	+.14158967E+16	+.34595524E+16	+.00000000E-99	+11.975
+22.00	+.12754184E+16	+.33425520E+16	+.00000000E-99	+11.570
+23.00	+.11408778E+16	+.32206953E+16	+.00000000E-99	+11.148
+24.00	+.10348925E+16	+.30956365E+16	+.00000000E-99	+10.715
+25.00	+.93221459E+15	+.29688164E+16	+.00000000E-99	+10.276
+26.00	+.83972332E+15	+.28414422E+16	+.00000000E-99	+9.835
+27.00	+.75640875E+15	+.27145252E+16	+.00000000E-99	+9.396
+28.00	+.68136039E+15	+.25889081E+16	+.00000000E-99	+8.961

Figure 1

Negative reactivity due to after shutdown xenon buildup for various operating fluxes


10000
1000
100
10
0
NEGATIVE REACTIVITY Δk/k %
φ = 10^16 nv
φ = 10^15 nv
φ = 10^14 nv
φ = 3 x 10^13 nv
φ = 10^13 nv
φ = 10^12 nv
0 1 2 3 4 5 6 7 8 9 10 15 20 25 30 35
TIME AFTER SHUTDOWN - HOURS

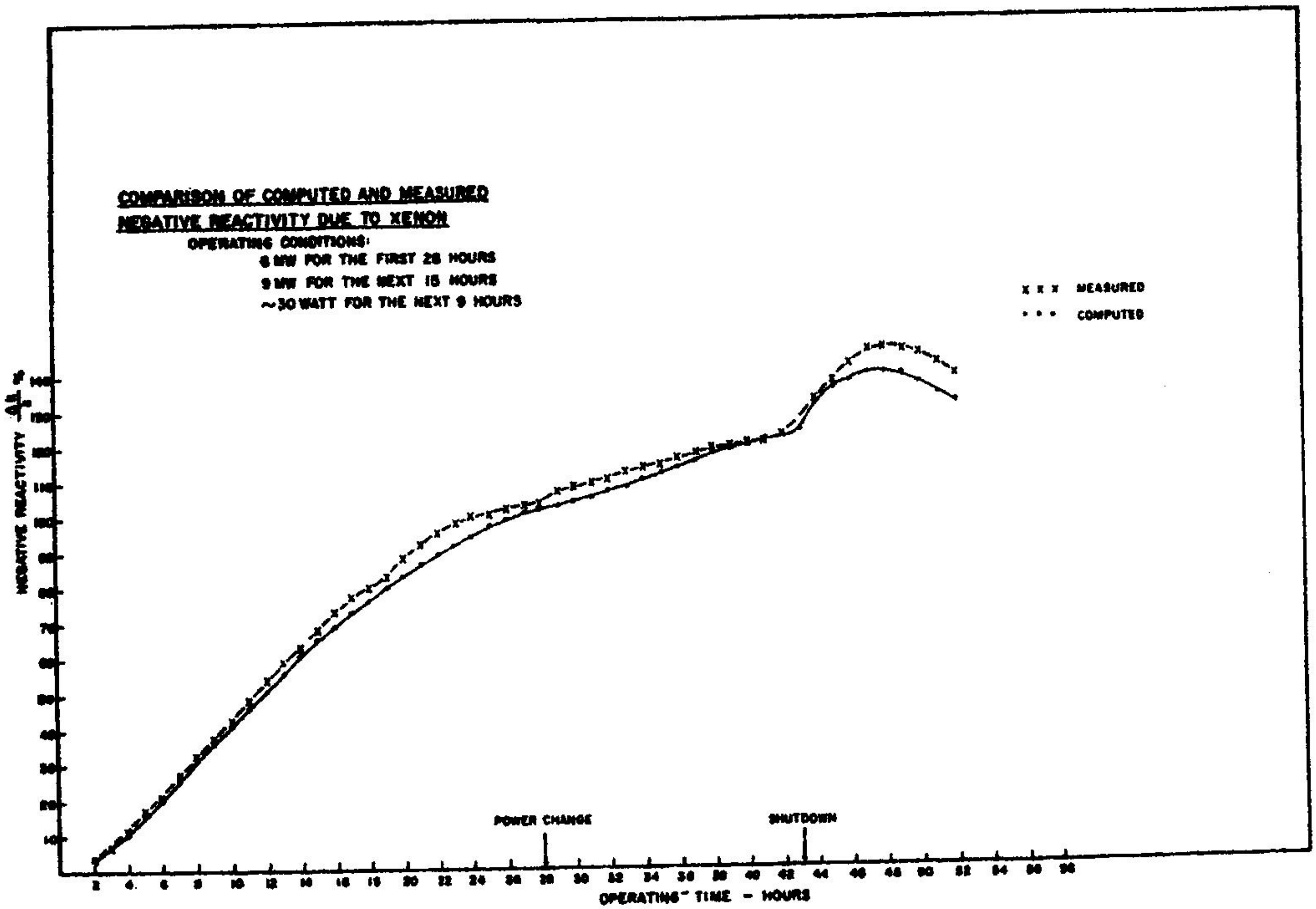


Figure 2. Comparison of PREX-computed and measured negative reactivity due to xenon buildup in the Puerto Rico Nuclear Center Research Reactor

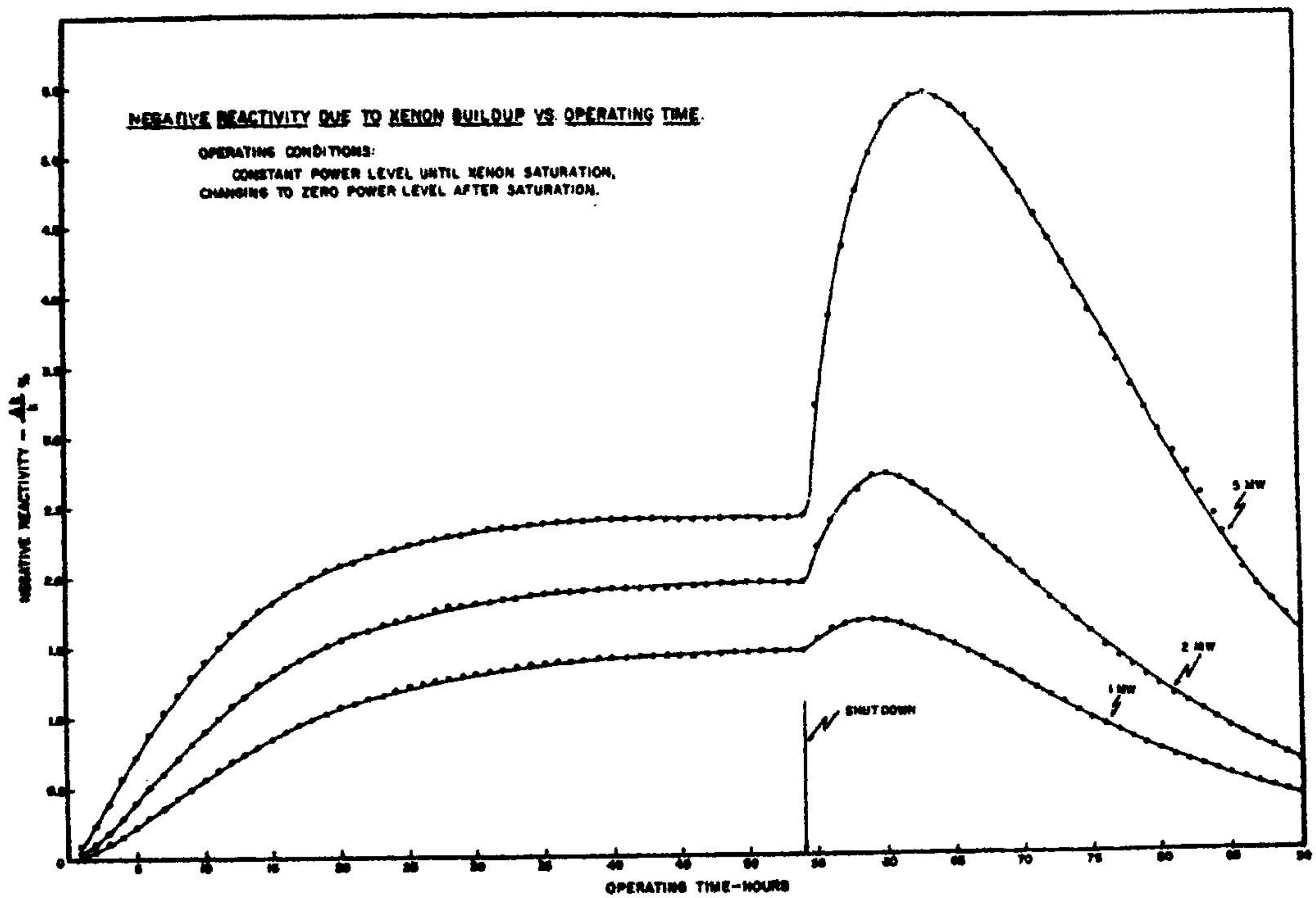


Figure 3. Negative reactivity due to xenon buildup versus operating time -- continuous operation

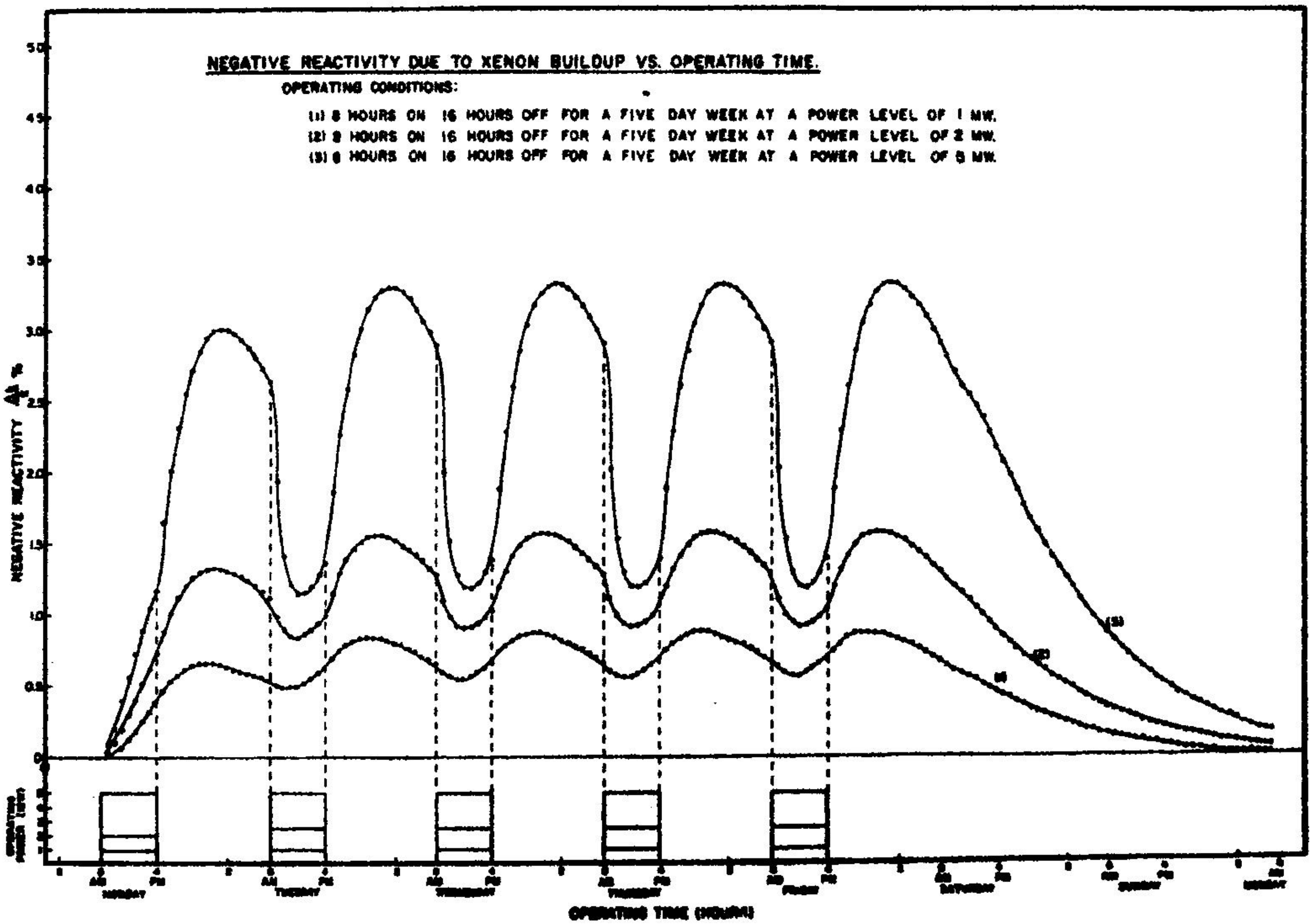


Figure 4. Negative reactivity due to xenon buildup versus operating time — one shift operation

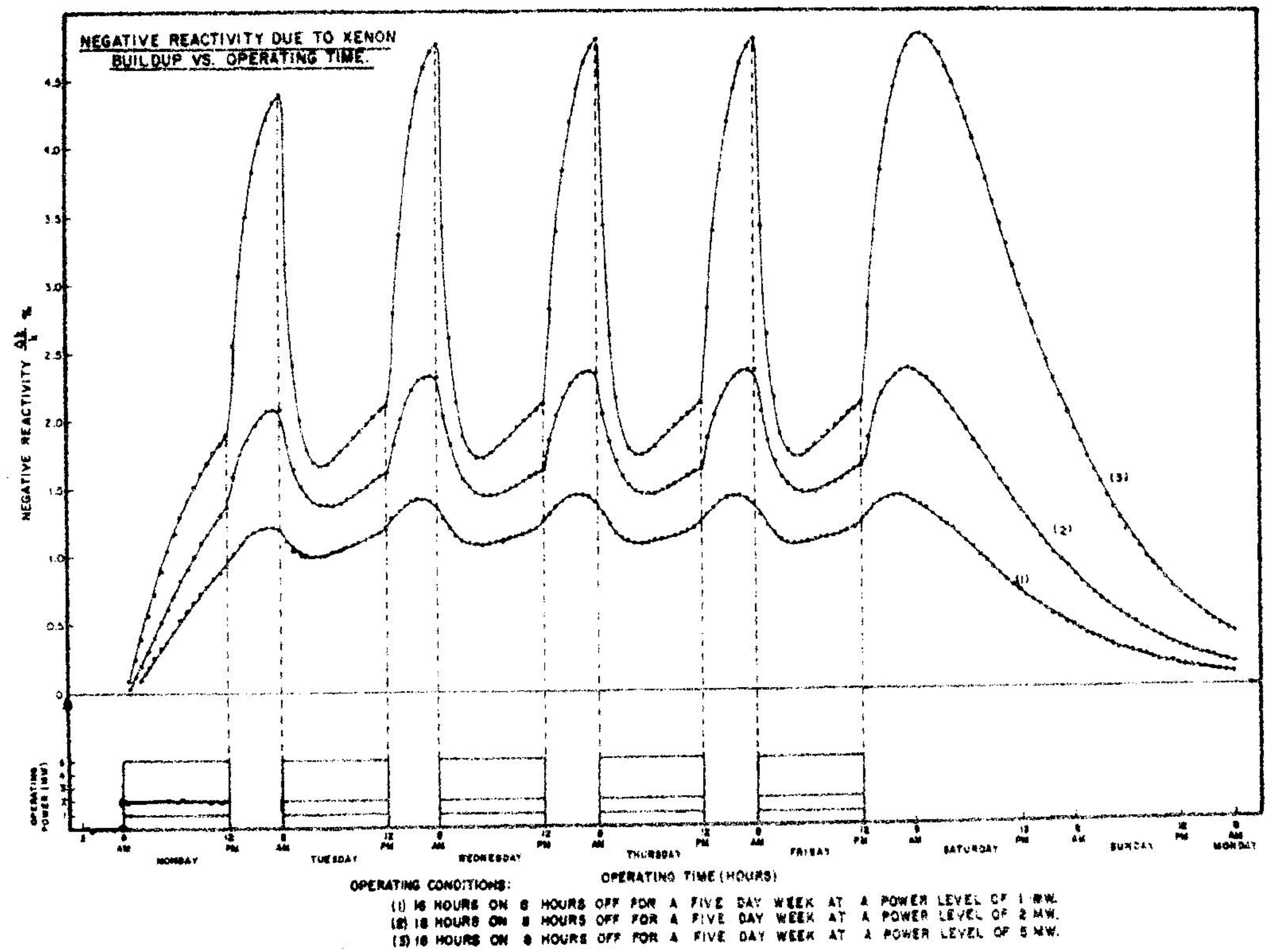


Figure 5. Negative reactivity due to xenon buildup versus operating time -- two shift operation

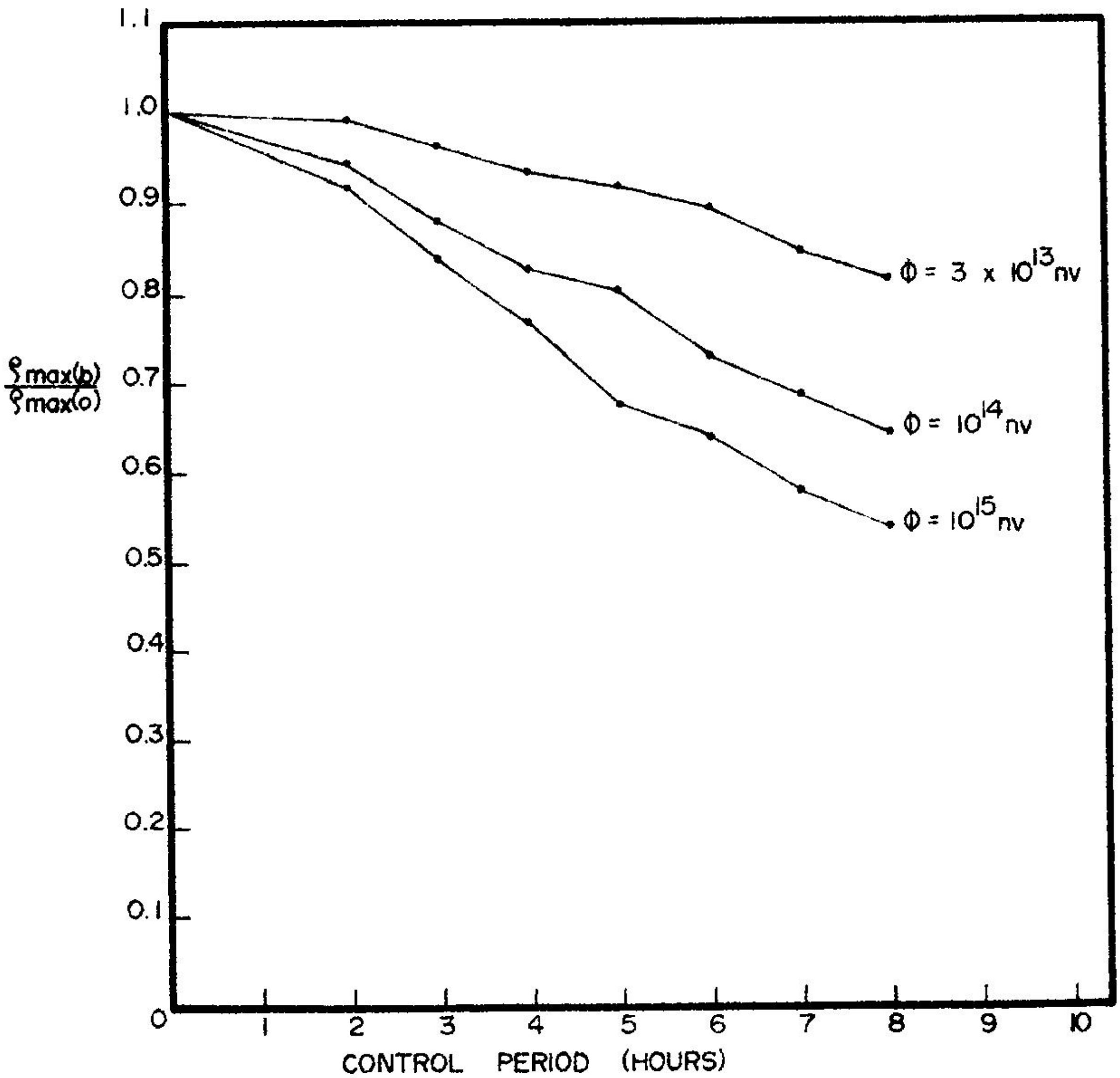


Figure 6. Ratio of the optimized after shutdown xenon peak to the peak obtained with immediate shutdown for several different operating fluxes, for t - 1 hour

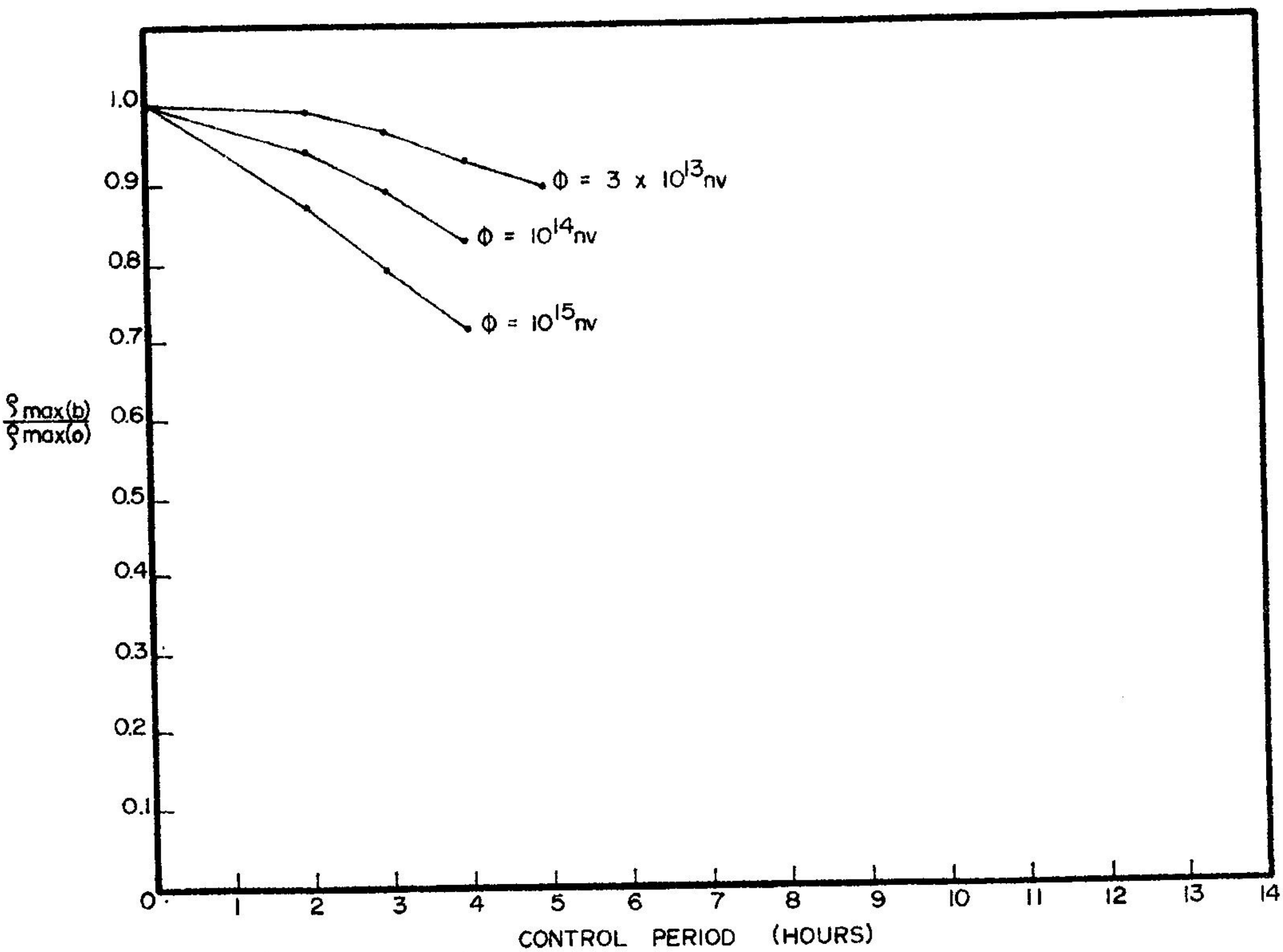
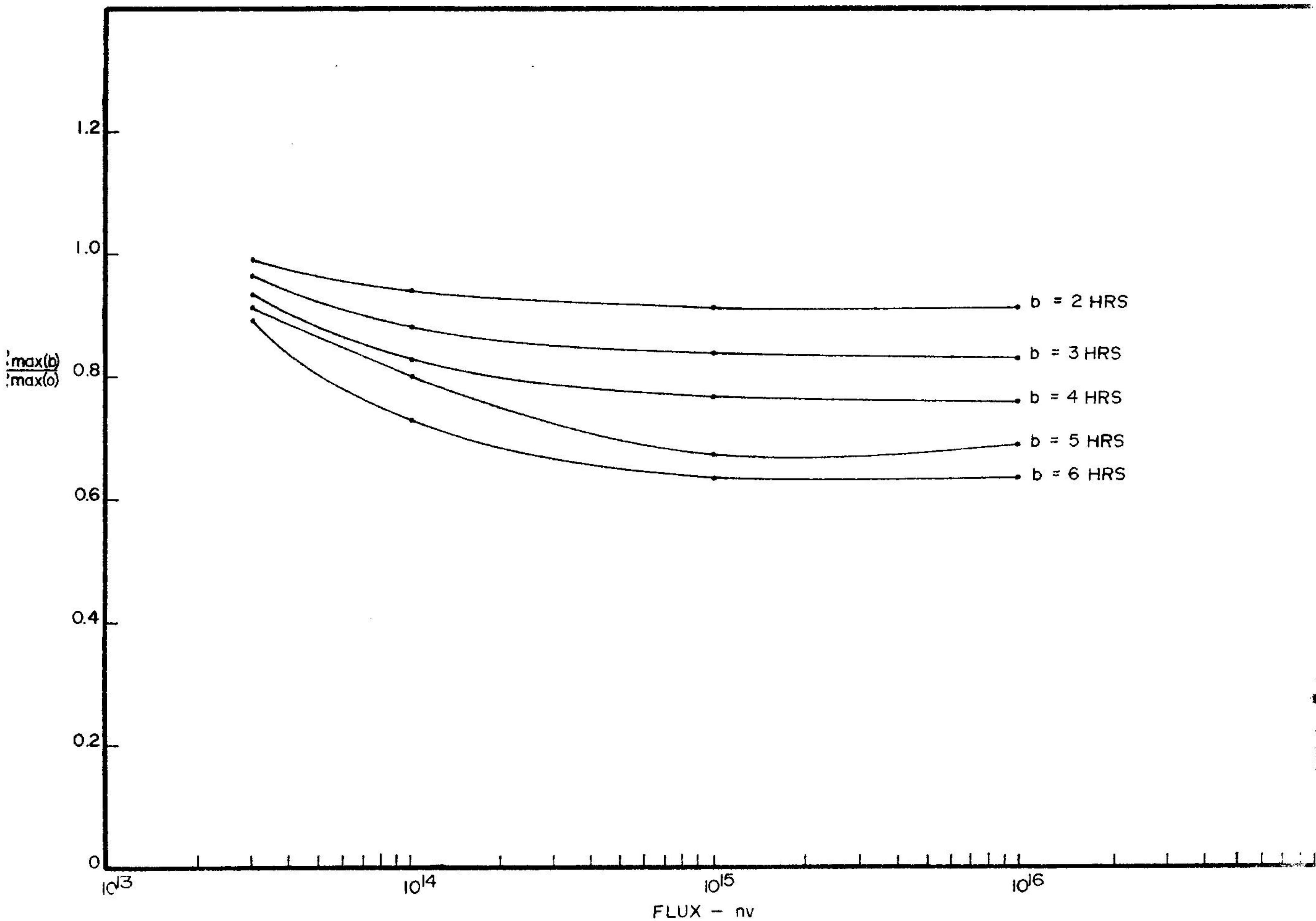


Figure 7. Ratio of the optimized after shutdown xenon peak to the peak obtained with immediate shutdown for several different operating fluxes for t - 0.5 hour

Figure 8

Ratio of the optimized after
shutdwon xenon peak to the
peak obtained with immediate
shutdown versus steady state
operating flux, for several
different control periods (b)



max(b) / max(o)
1.2
1.0
0.8
0.6
0.4
0.2
0
b = 2 HRS
b = 3 HRS
b = 4 HRS
b = 5 HRS
b = 6 HRS
10^13
10^14
10^15
10^16
FLUX – nv

Figure 9

MINEX-optimized after shutdown xenon buildup as compared to the xenon buildup following shutdown in a single step

Control parameters: $\Phi_o = 10^{13}$ nv,

$b = 2$ hours, $\Delta t = 0.5$ hours,

$\Phi_{max} = \Phi_o$

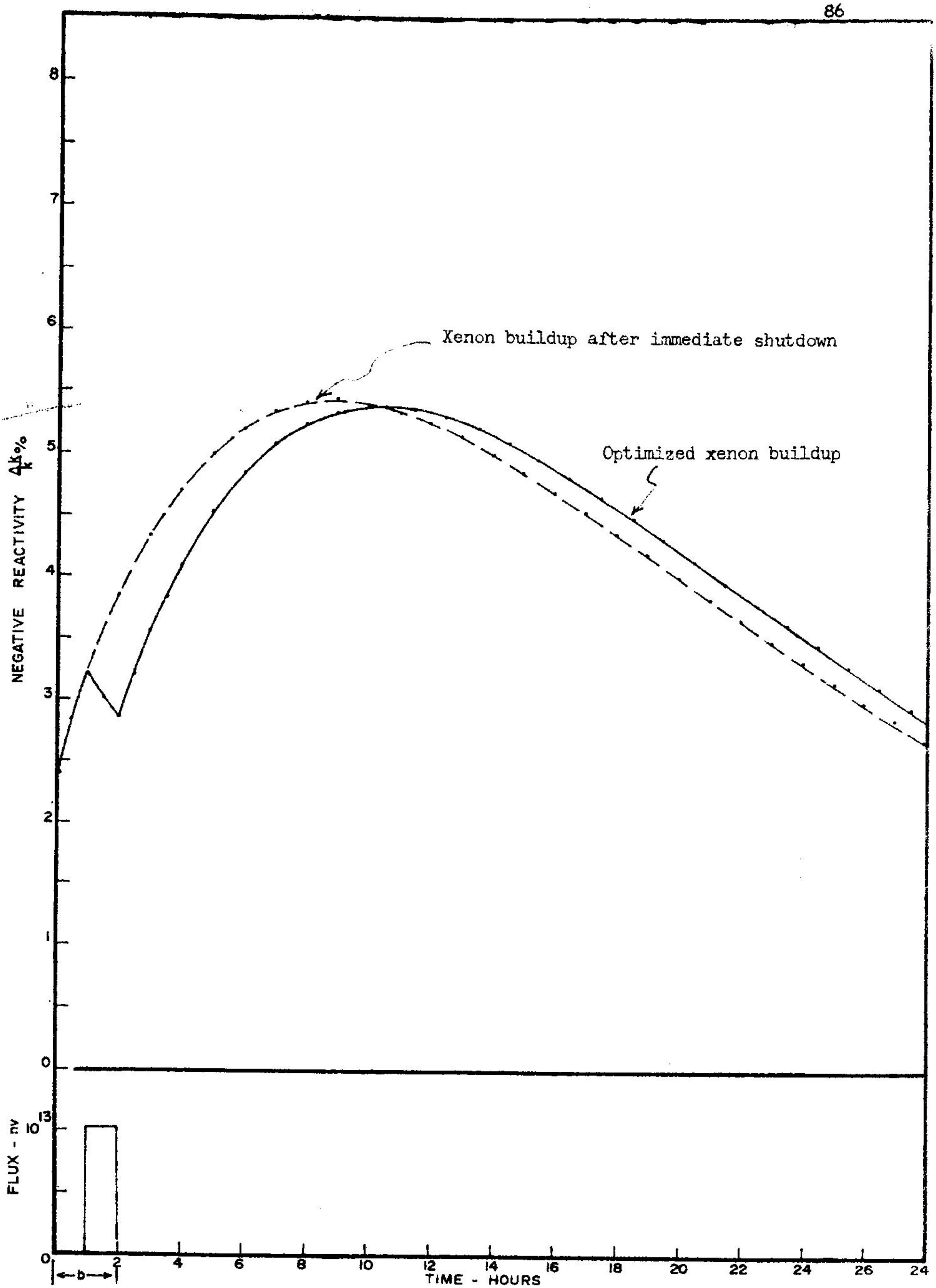
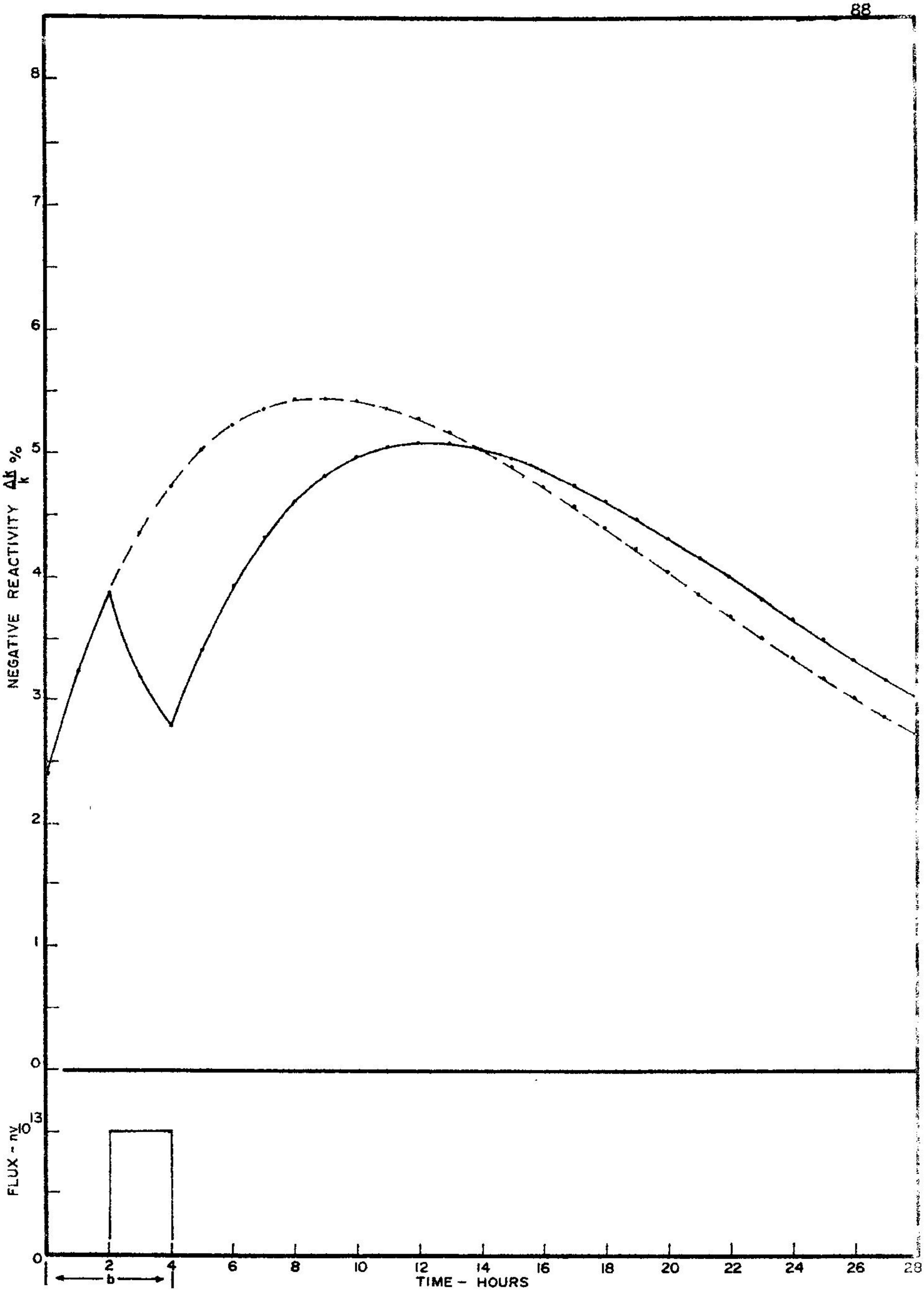

Xenon buildup after immediate shutdown
Optimized xenon buildup
NEGATIVE REACTIVITY $\frac{\Delta k}{k}$%
FLUX - nv
10^{13}
b
TIME - HOURS
0
1
2
3
4
5
6
7
8
10
12
14
16
18
20
22
24
26

Figure 10

MINEX-optimized after shutdown xenon buildup as compared to the xenon buildup following shutdown, in a single step

Control parameters: $\Phi_o = 10^{13} nv$, $b = 4$ hours, $\Delta t = 1$ hour, $\Phi_{max} = \Phi_o$


NEGATIVE REACTIVITY $\frac{\Delta k}{k}$ %
FLUX - nv
10^{13}
TIME - HOURS
b
0
1
2
3
4
5
6
7
8
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28

<u>Figure 11</u>

MINEX-optimized after shutdown

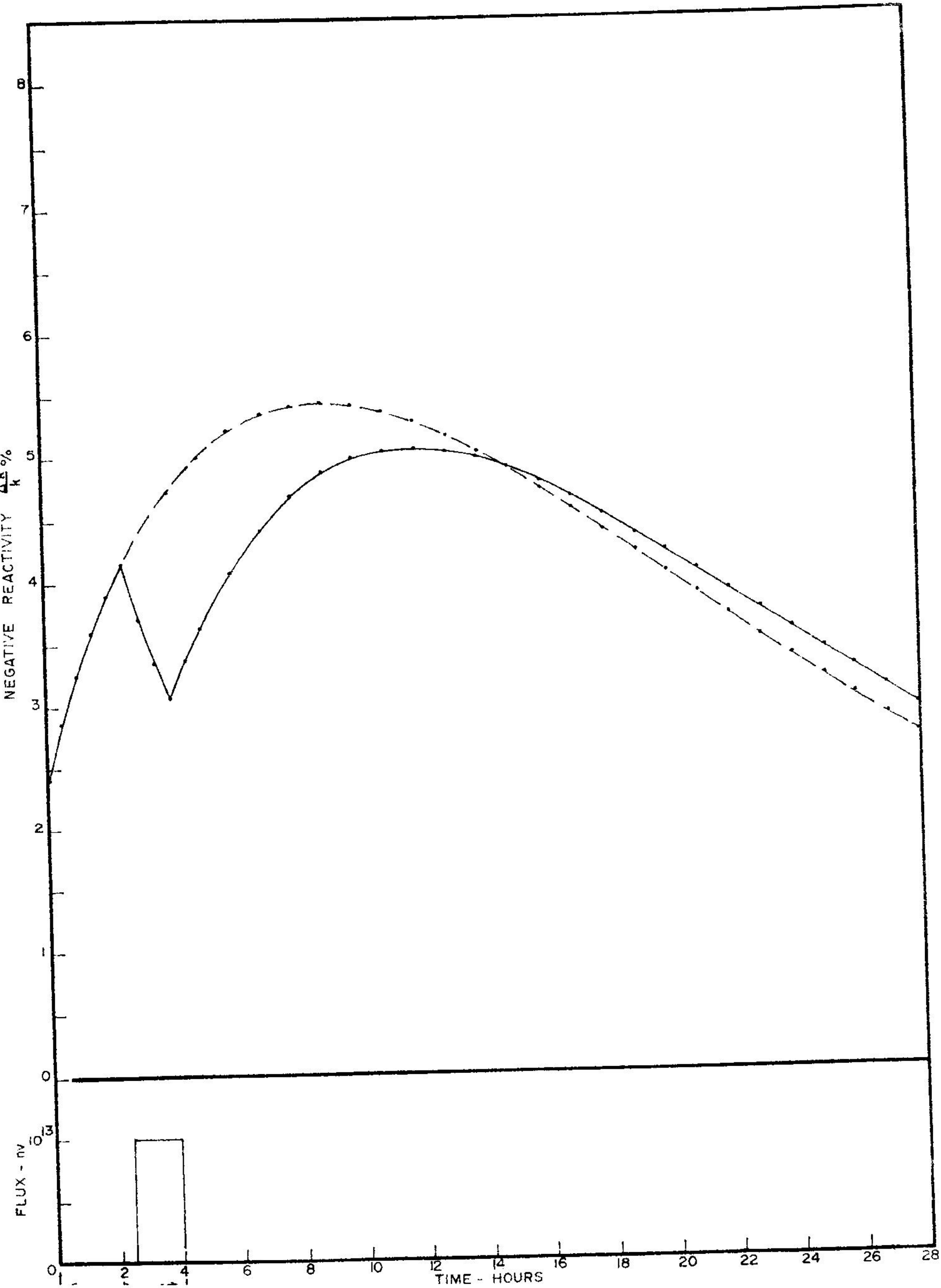
xenon buildup as compared to the

xenon buildup following shutdown,

in a single step

Control parameters: $\Phi_o = 10^{13}$ nv,

$b = 4$ hours, $\Delta t = 0.5$ hour, $\Phi_{max} = \Phi_o$



NEGATIVE REACTIVITY Δk/k %
FLUX - nv
TIME - HOURS

Figure 12

MINEX-optimized after shutdown

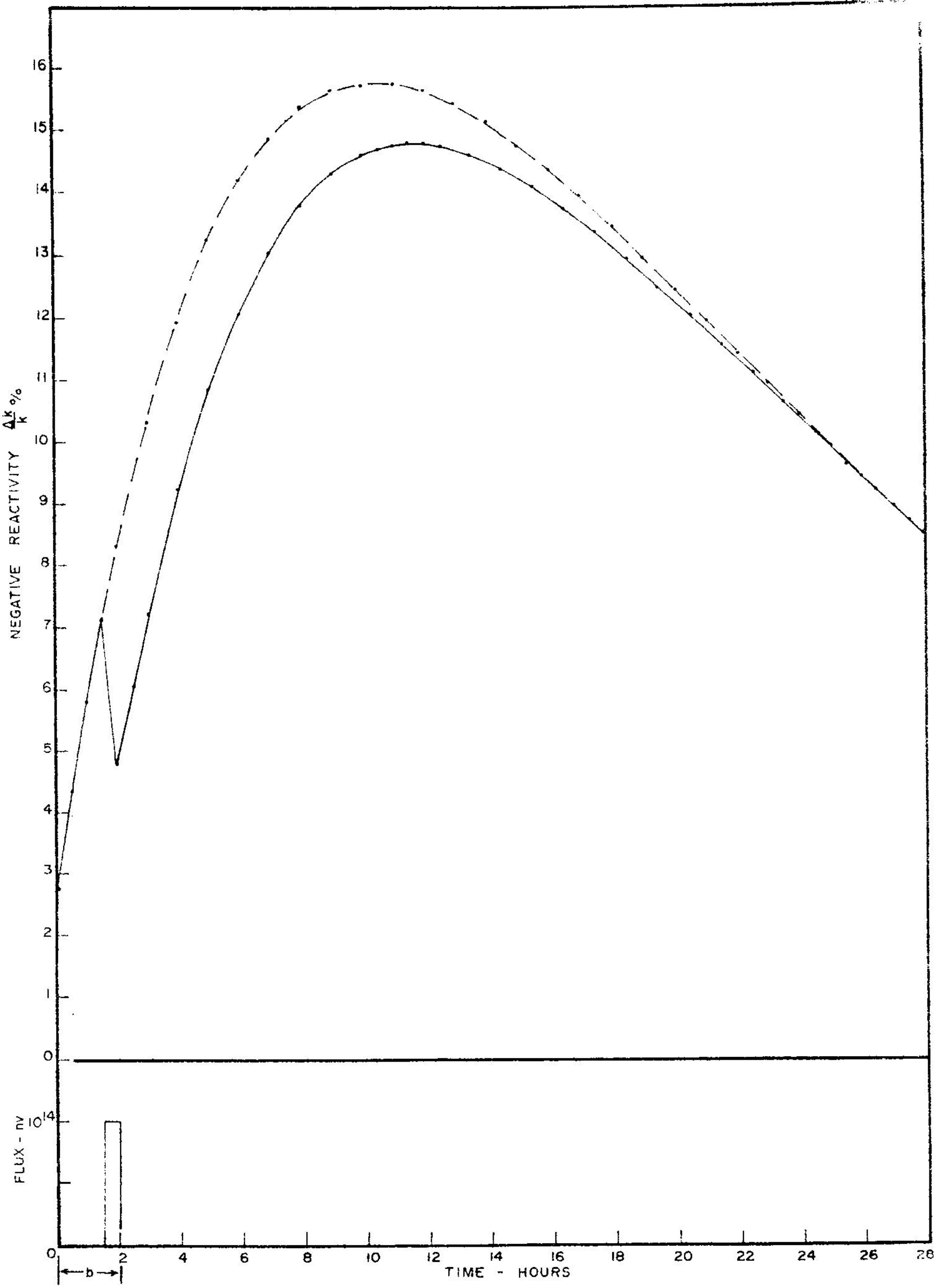
xenon buildup as compared to the

xenon buildup following shutdown,

in a single step

Control parameters: $\Phi_o = 10^{13}$ nv,

b = 2 hours, Δt = 0.5 hour, $\Phi_{max} = \Phi_o$

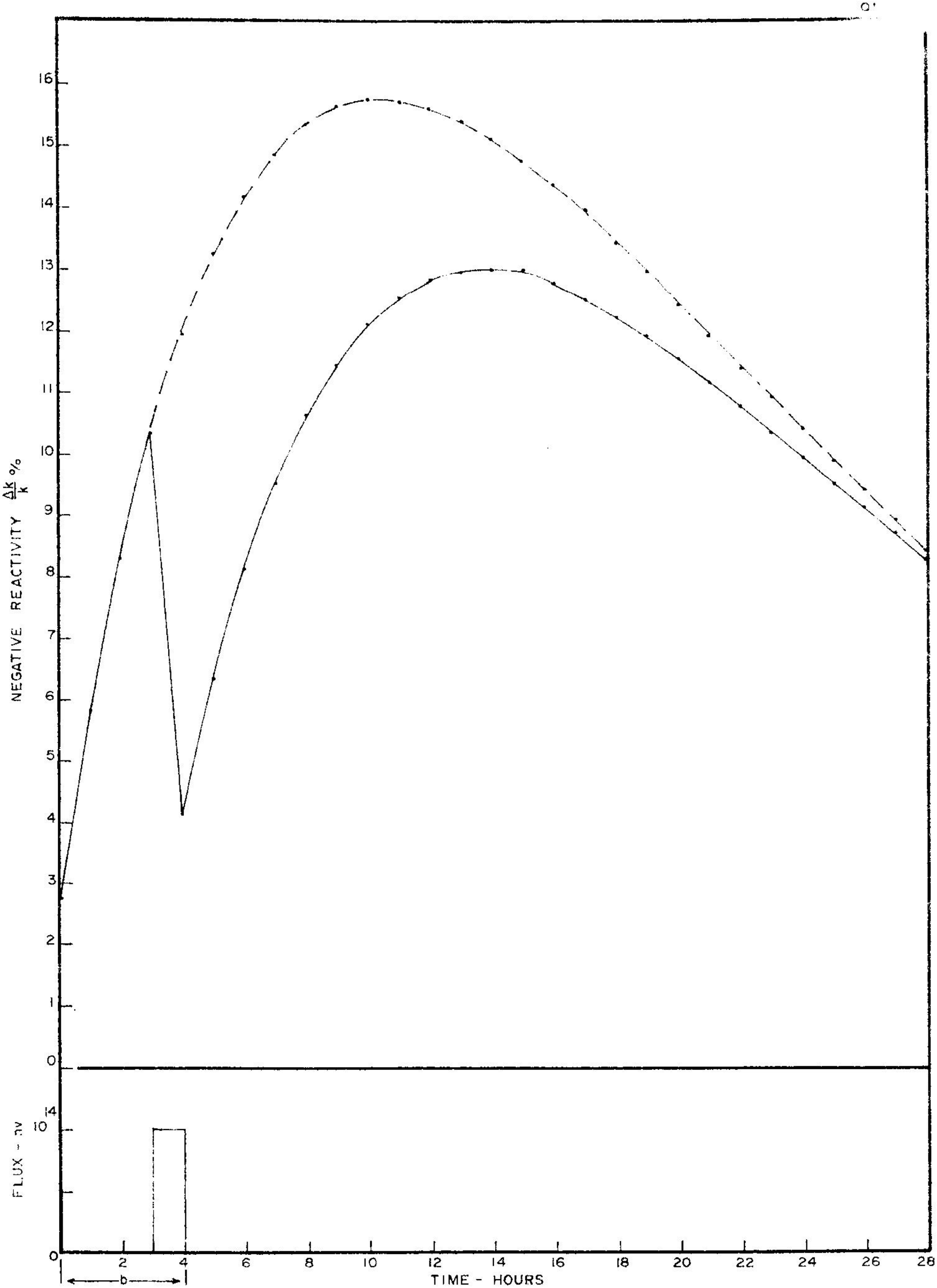


NEGATIVE REACTIVITY $\frac{\Delta k}{k}$ %
FLUX - nv
10^{14}
TIME - HOURS
b
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
1
3
5
7
9
11
13
15
16

Figure 13

MINEX-optimized after shutdown xenon buildup as compared to the xenon buildup following shutdown, in a single step

Control parameters: $\phi_o = 10^{14}$ nv, $h = 4$ hours, $\Delta t = 1$ hour, $\phi_{max} = \phi_o$

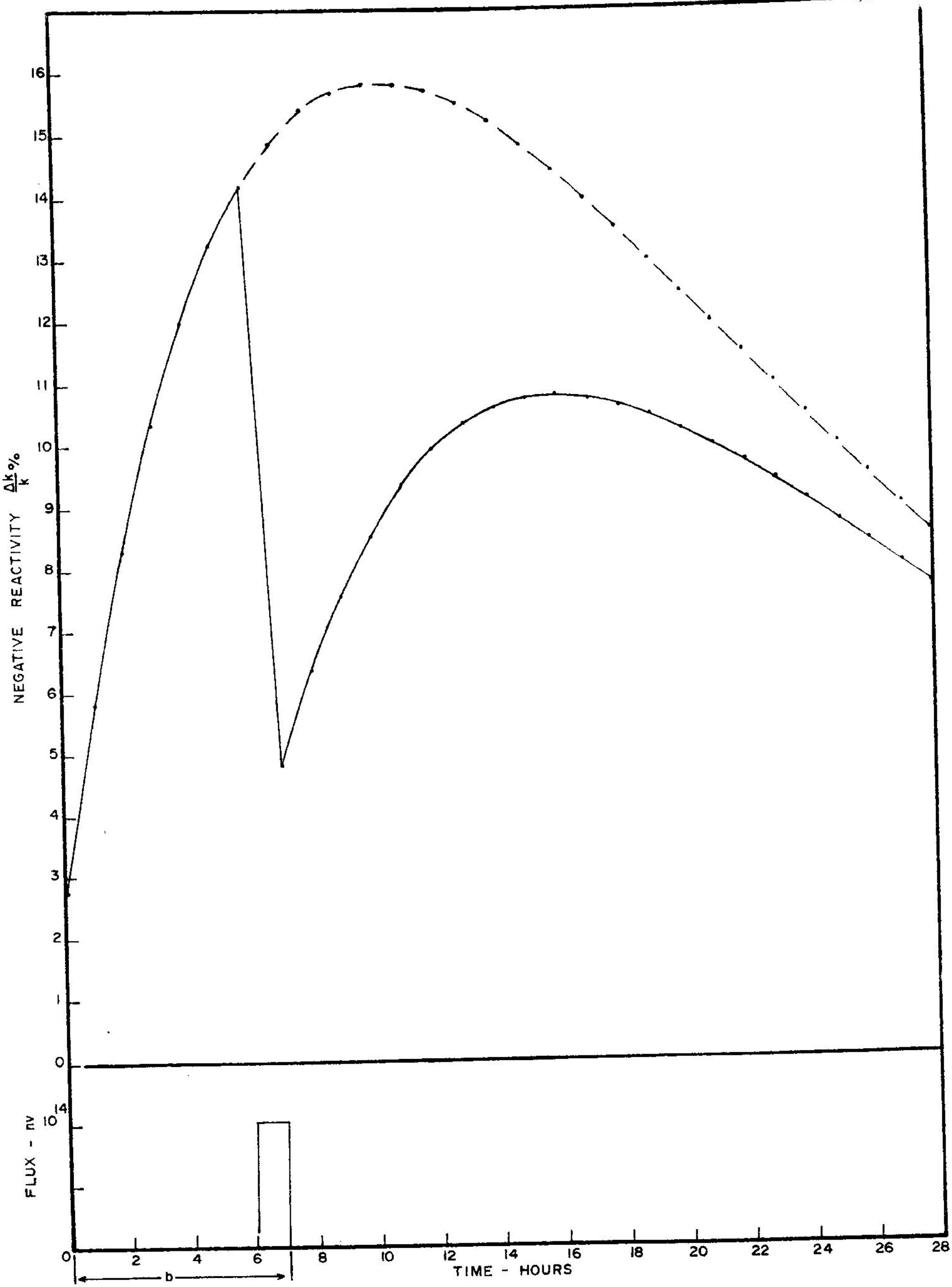


NEGATIVE REACTIVITY $\frac{\Delta k}{k}$ %
FLUX - nv
10^{14}
TIME - HOURS
b

Figure 14

MINEX-optimized after shutdown xenon buildup as compared to the xenon buildup following shutdown, in a single step

Control parameters: $\Phi_o = 10^{14}$ nv, $b = 7$ hours, $\Delta t = 1$ hour, $\Phi_{max} = \Phi_o$



16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
NEGATIVE REACTIVITY $\frac{\Delta k}{k}$%
FLUX - nv
10^{14}
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
TIME - HOURS
b

Figure 15

MINEX-optimized after shutdown xenon buildup as compared to the xenon buildup following shutdown, in a single step

Control parameters: $\phi_o = 10^{14}$nv, b = 6 hours, Δt = 1 hour, $\phi_{max} = \phi_o$

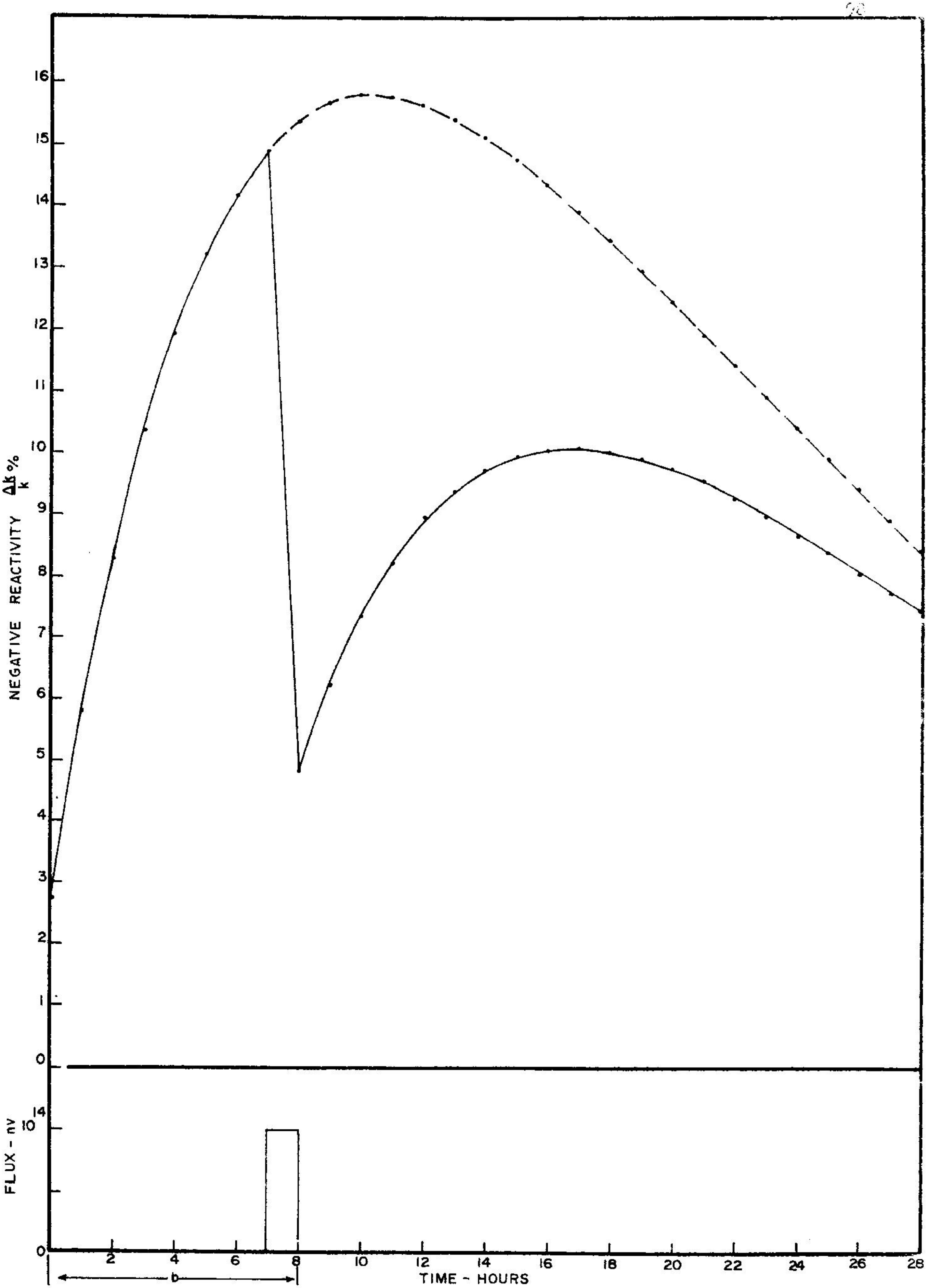

16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
NEGATIVE REACTIVITY $\frac{\Delta k}{k}$ %
FLUX - nv
10^{14}
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
TIME - HOURS
b

Figure 16

MINEX-optimized after shutdown xenon buildup as compared to the xenon buildup following shutdown, in a single step

Control parameters: $\phi_o = 10^{15}$nv, $b = 2$ hours, $\Delta t = 0.5$ hour, $\phi_{max} = \phi_o$

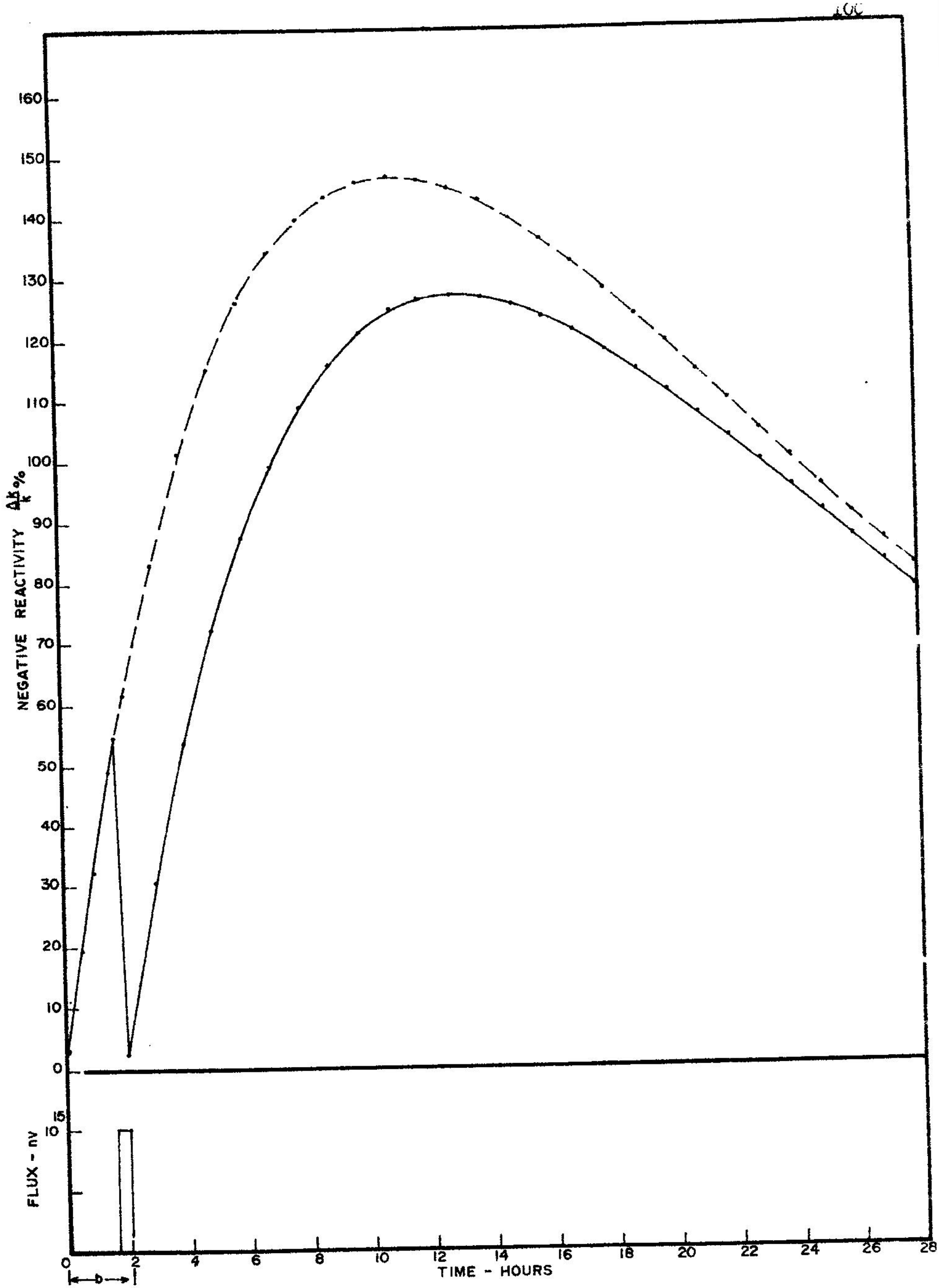
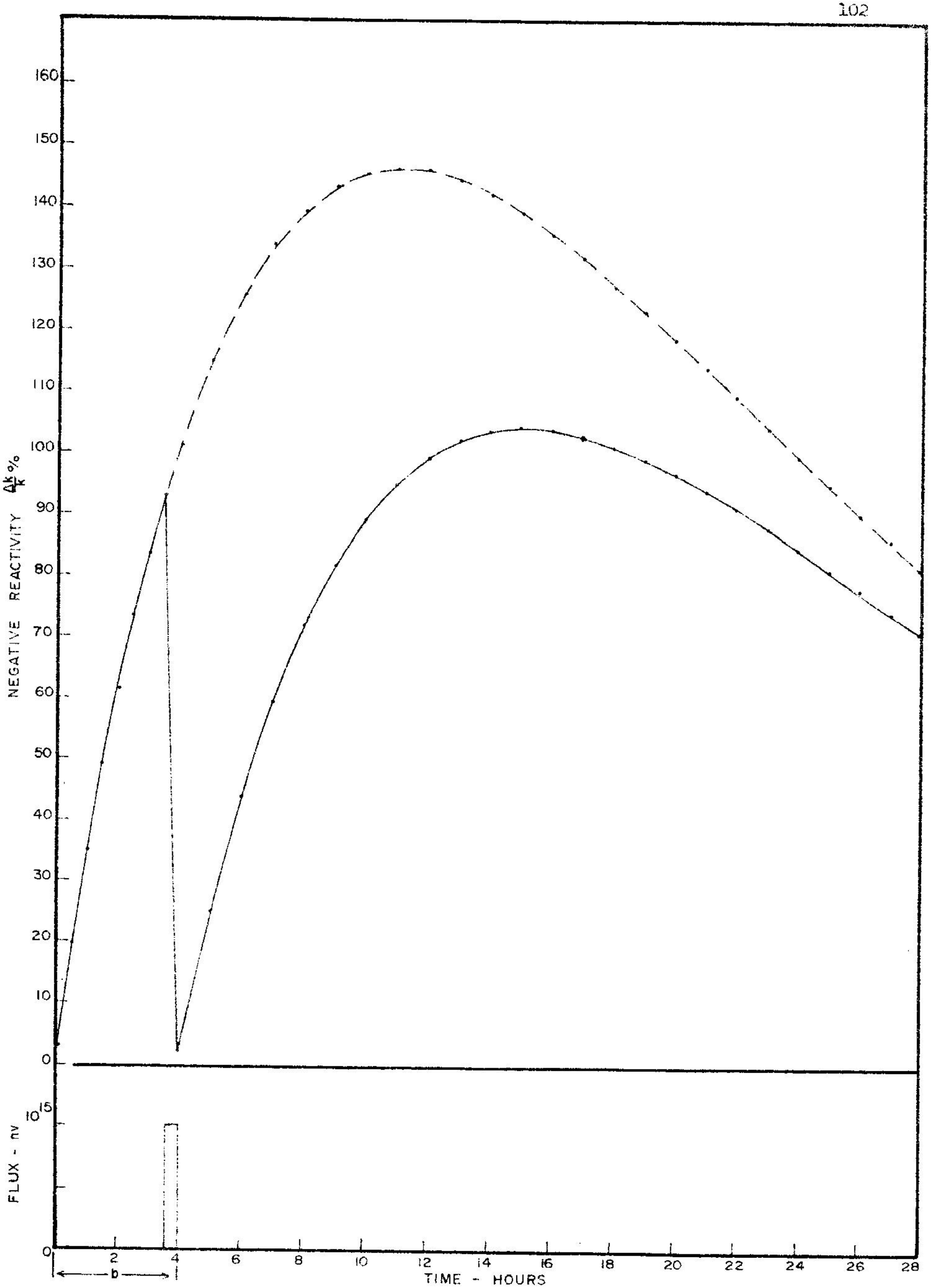

NEGATIVE REACTIVITY $\frac{\Delta k}{k}$%
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
FLUX - nv
15
10
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
TIME - HOURS
b

Figure 17

MINEX-optimized after shutdown xenon buildup as compared to the xenon buildup following shutdown, in a single step

Control parameters: $\phi_o = 10^{15}$nv, $b = 4$ hours, $\Delta t = 0.5$ hour, $\phi_{max} = \phi_o$



NEGATIVE REACTIVITY Δk/k %
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
FLUX - nv
10^15
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
b
TIME - HOURS

Figure 18

MINEX-optimized after shutdown xenon buildup as compared to the xenon buildup following shutdown, in a single step

Control parameters: $\Phi_o = 10^{15}$nv, b = 4 hours, Δt = 1 hour, $\Phi_{max} = \Phi_o$

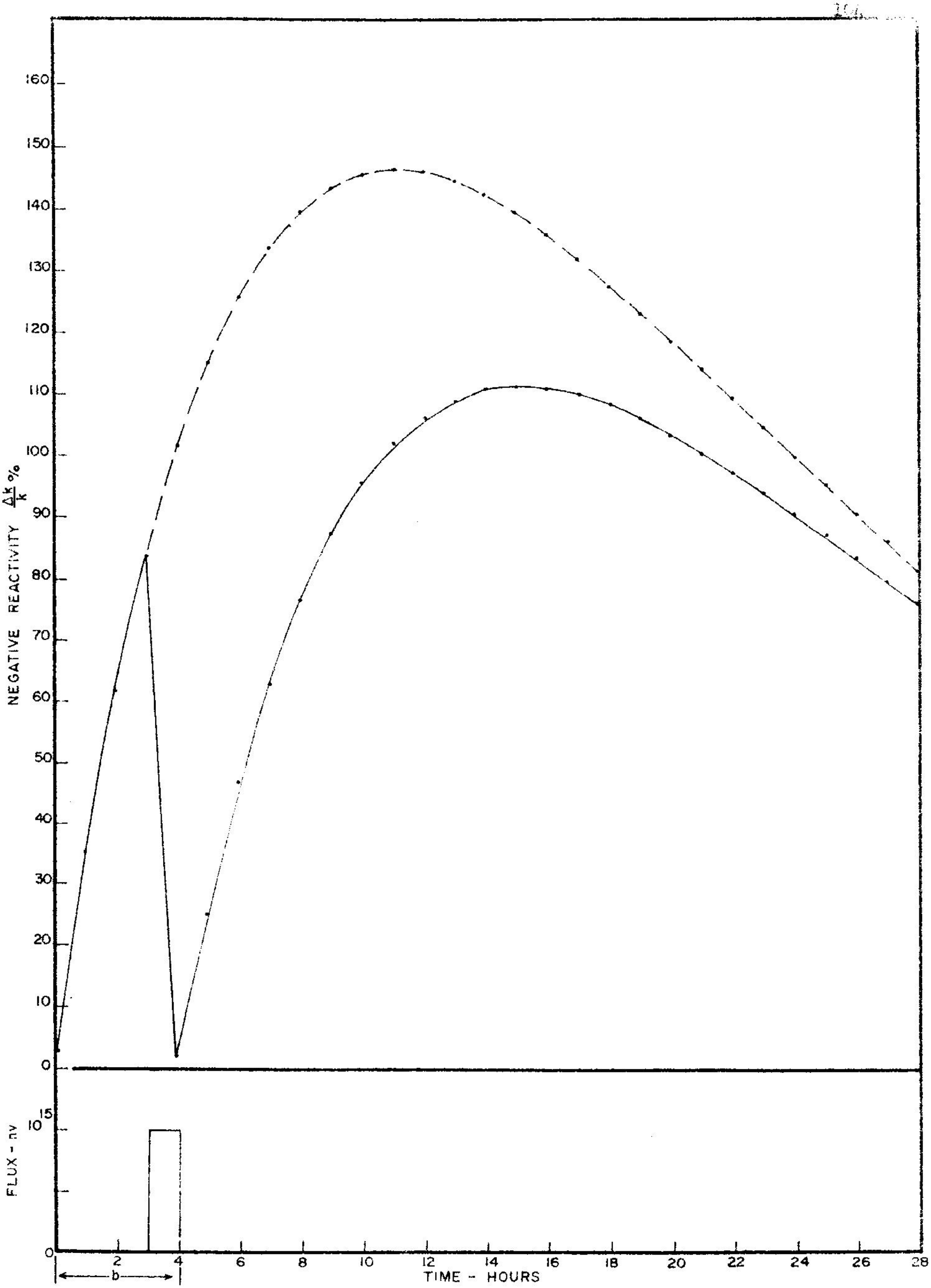

NEGATIVE REACTIVITY $\frac{\Delta k}{k}$ %
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
FLUX - nv
10^{15}
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
b
TIME - HOURS

Figure 19

MINEX-optimized after shutdown xenon buildup as compared to the xenon buildup following shutdown, in a single step

Control parameters: $\Phi_o = 10^{15}$nv, b = 6 hours, Δt = 1 hour, $\Phi_{max} = \Phi_o$

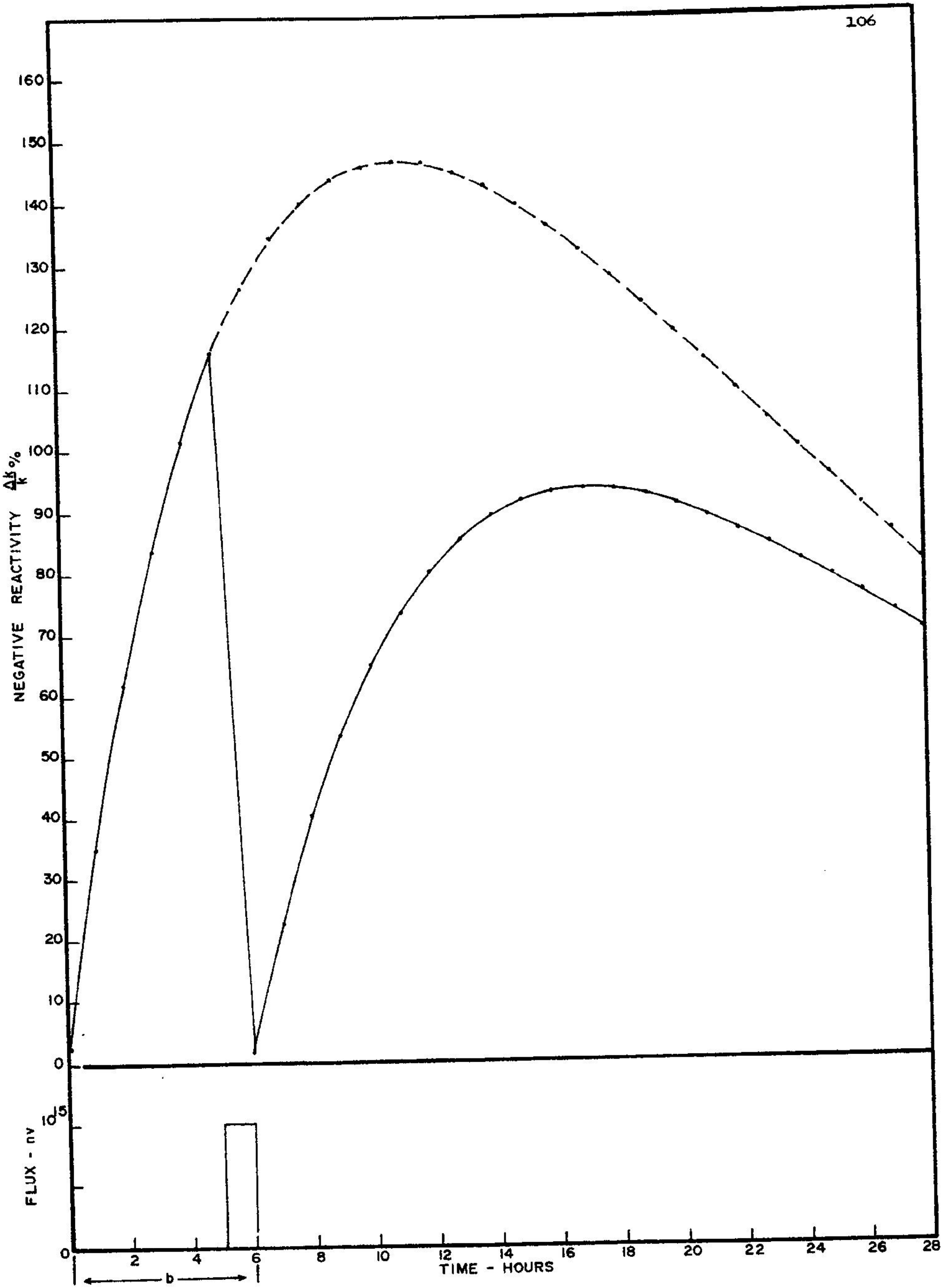

NEGATIVE REACTIVITY $\frac{\Delta k}{k}$%
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
FLUX - nv
10^{15}
0
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
TIME - HOURS
b

Figure 20

MINEX-optimized after shutdown
xenon buildup as compared to the
xenon buildup following shutdown,
in a single step
Control parameters: $\Phi_o = 10^{15}$nv,
b = 7 hours, Δt = 1 hour, $\Phi_{max} = \Phi_o$

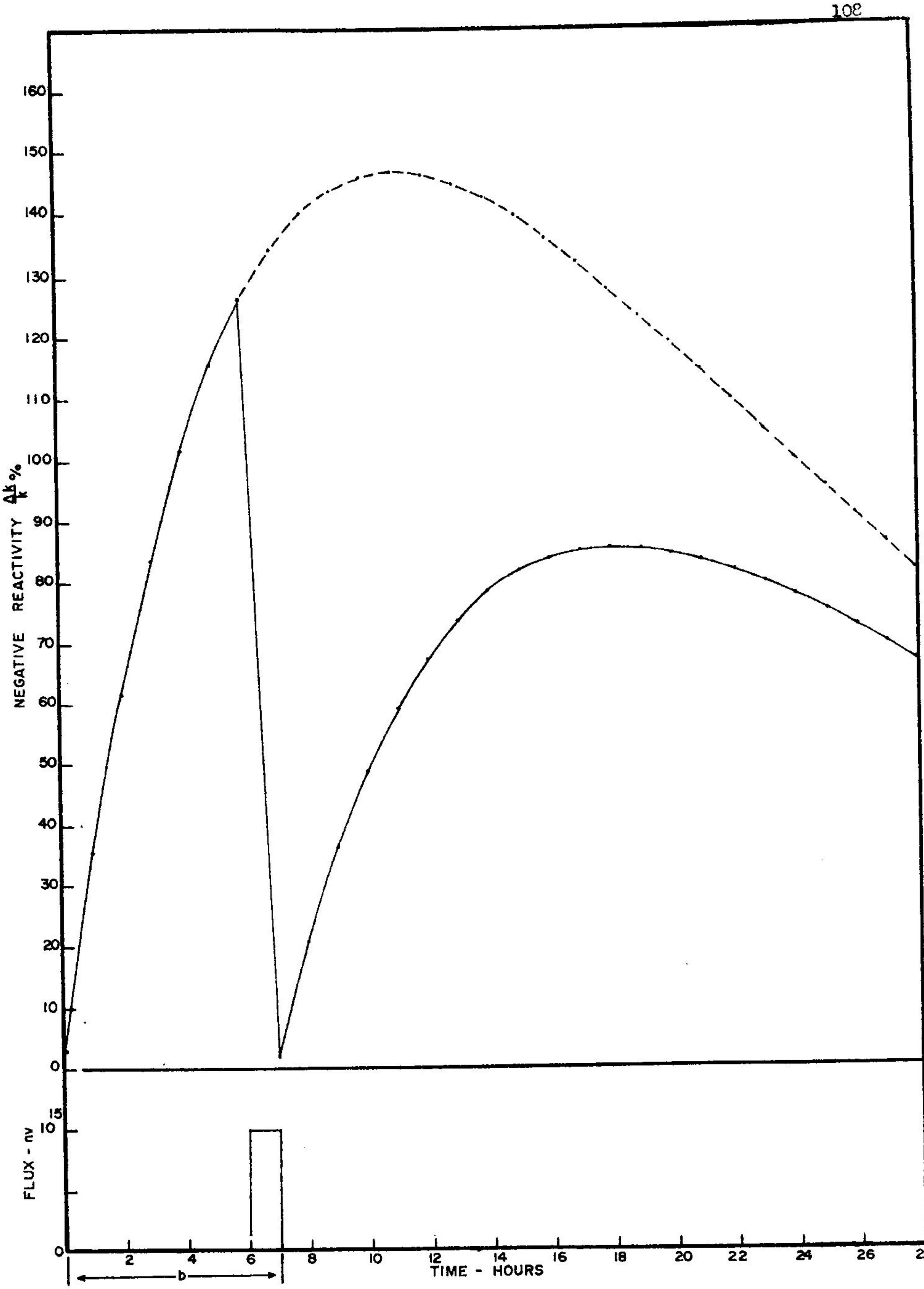

NEGATIVE REACTIVITY $\frac{\Delta k}{k}$ %
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
FLUX - nv
15
10
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
TIME - HOURS
b

Figure 21

MINEX-optimized after shutdown xenon buildup as compared to the xenon buildup following shutdown, in a single step

Control parameters: $\Phi_o = 10^{15}$nv, b = 8 hours, $\Delta t = 1$ hour, $\Phi_{max} = \Phi_o$

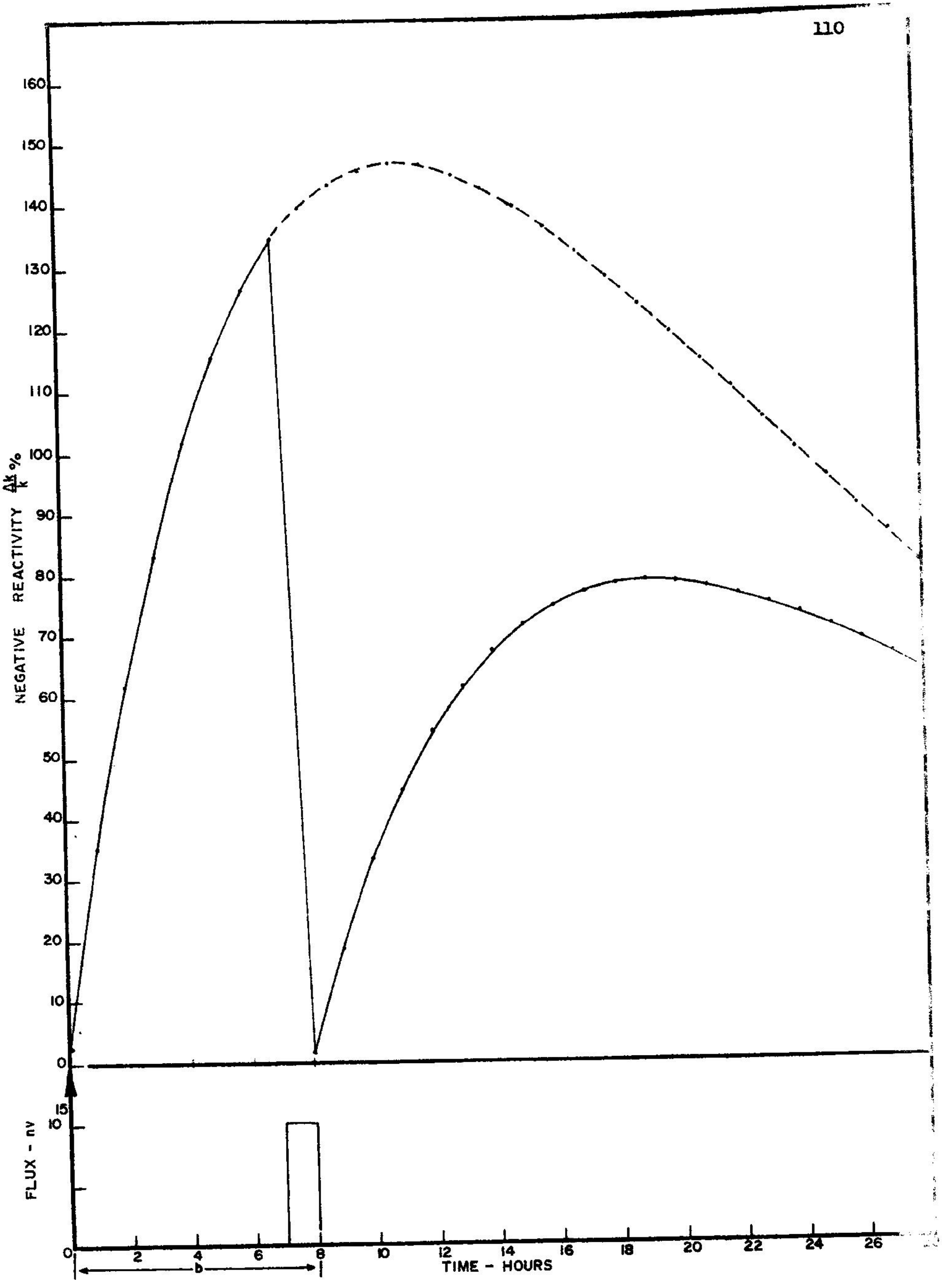
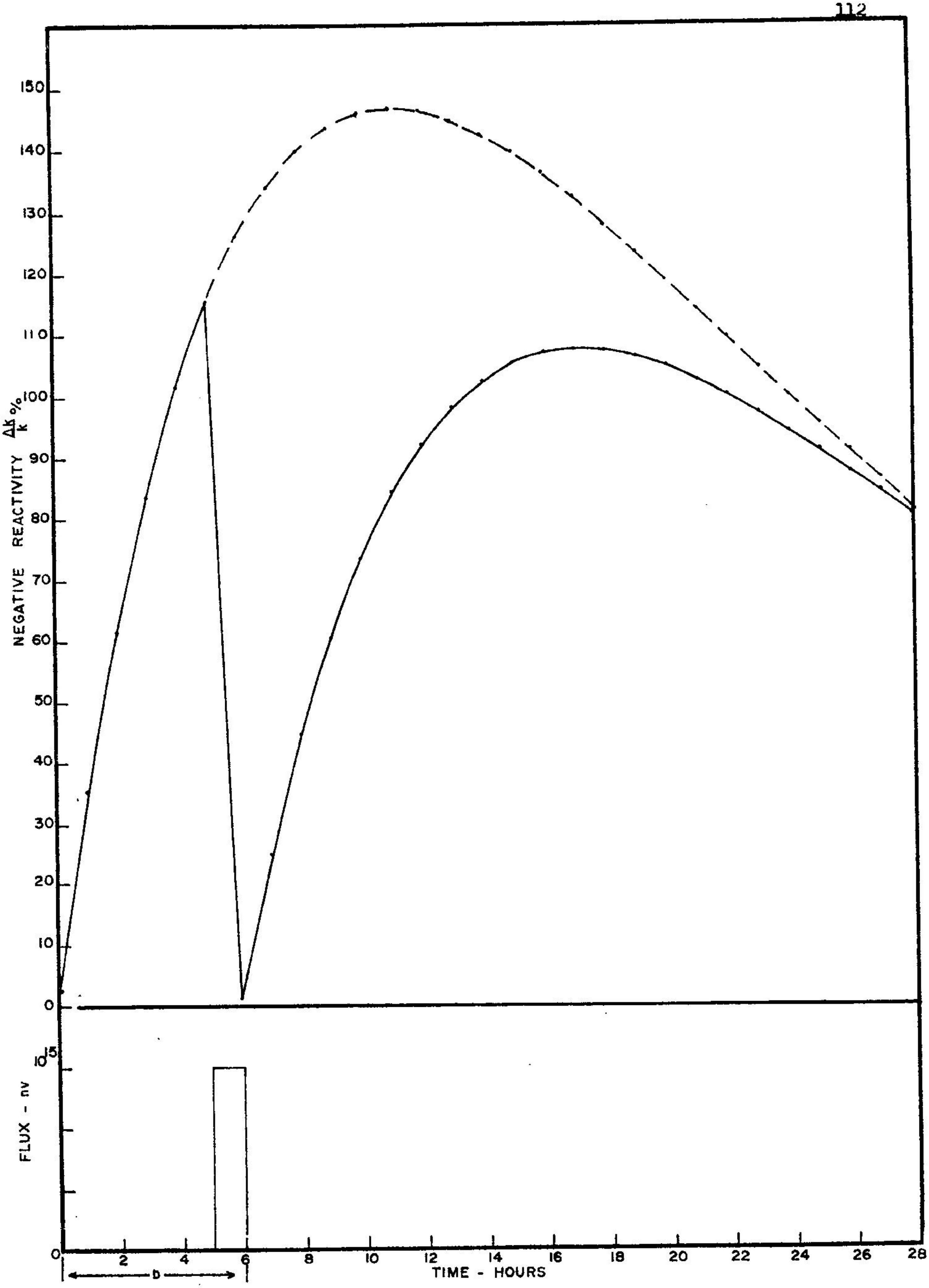

NEGATIVE REACTIVITY $\frac{\Delta k}{k}$ %
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
FLUX - nV
15
10
0
0
2
4
6
8
10
12
14
16
18
20
22
24
26
TIME - HOURS
b

Figure 22

MINEX-optimized after shutdown xenon buildup as compared to the xenon buildup following shutdown, in a single step

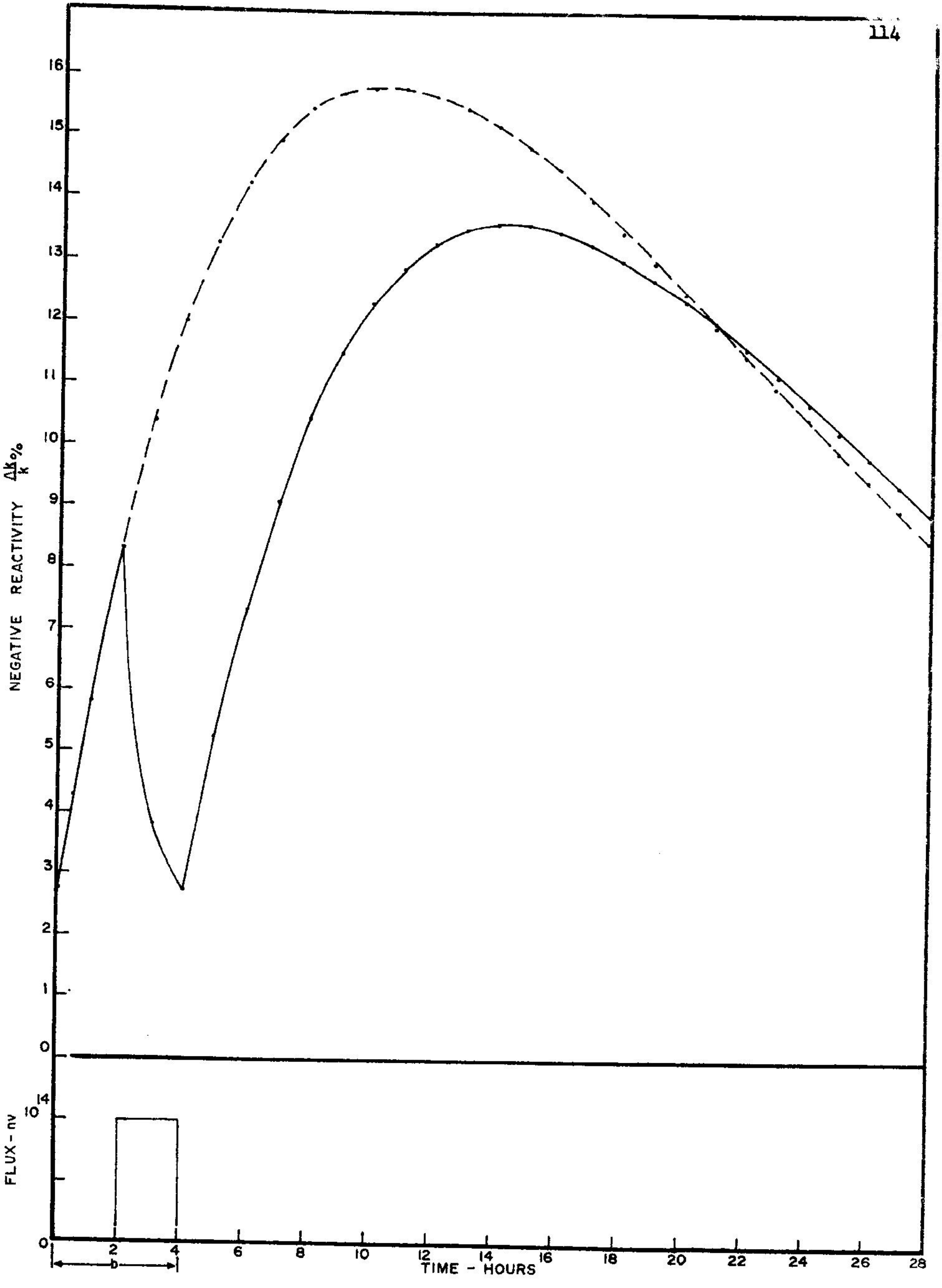
Control parameters: $\phi_o = 10^{15} nv$, $b = 6$ hours, $\Delta t = 1$ hour, $\phi_{max} = 2\phi_o$



NEGATIVE REACTIVITY $\frac{\Delta k}{k}$ %
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
FLUX - nv
10^{15}
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
TIME - HOURS
b

Figure 23

MINEX-optimized xenon buildup for minimizing the xenon concentration six hours after completing full power operation


16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
NEGATIVE REACTIVITY $\frac{\Delta k}{k}\%$
FLUX - nv
10^{14}
0
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
b
TIME - HOURS

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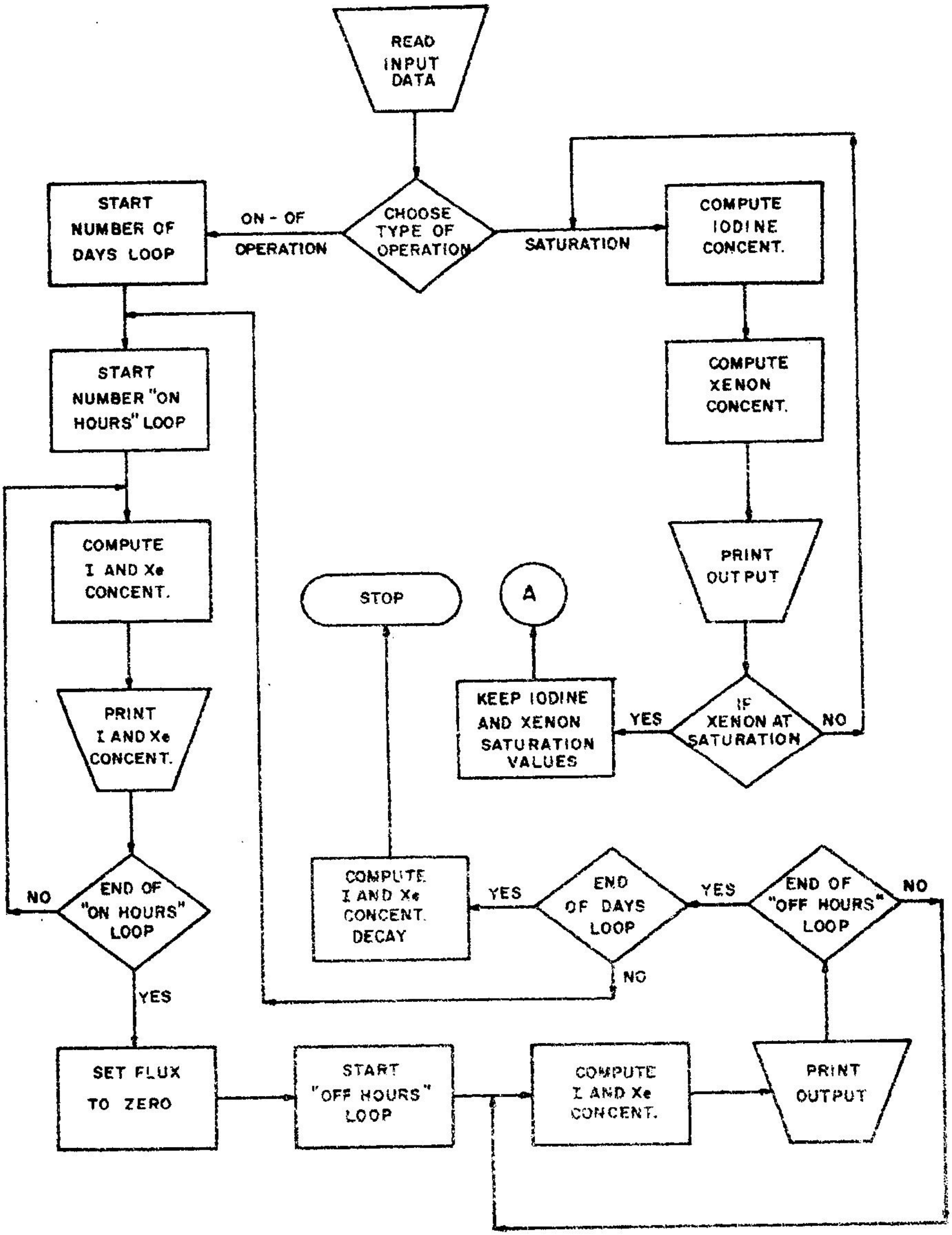
18. M. Ash: Optimal Shutdown Control of Nuclear Reactors, Academic Press, New York 1966

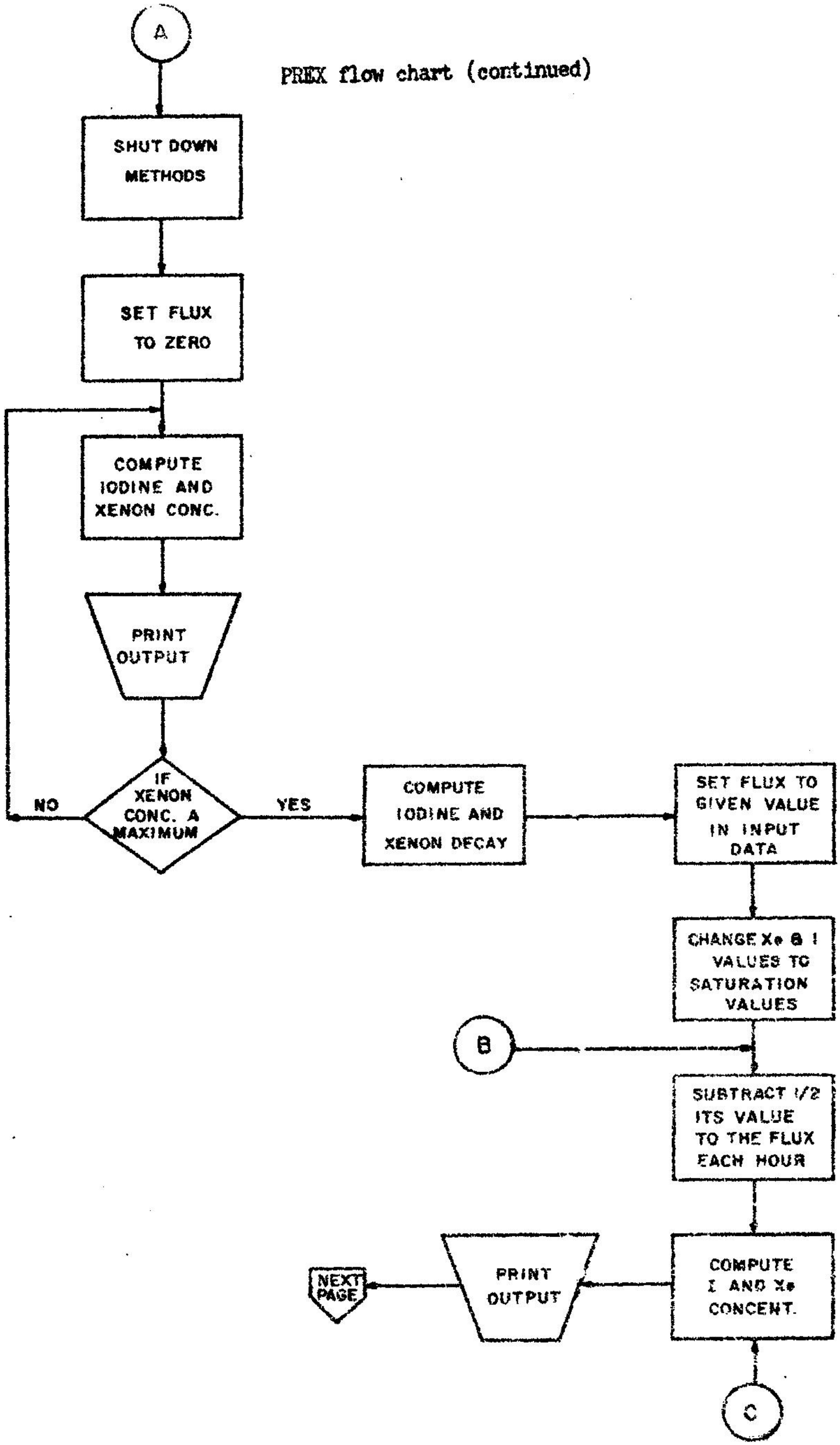
APPENDIX 1

Flow chart and program listing for PREX -- a FORTRAN program, written for the IBM-1620 computer, to determine the xenon-135 and iodine-135 number densities as a function of time, for arbitrary operating fluxes

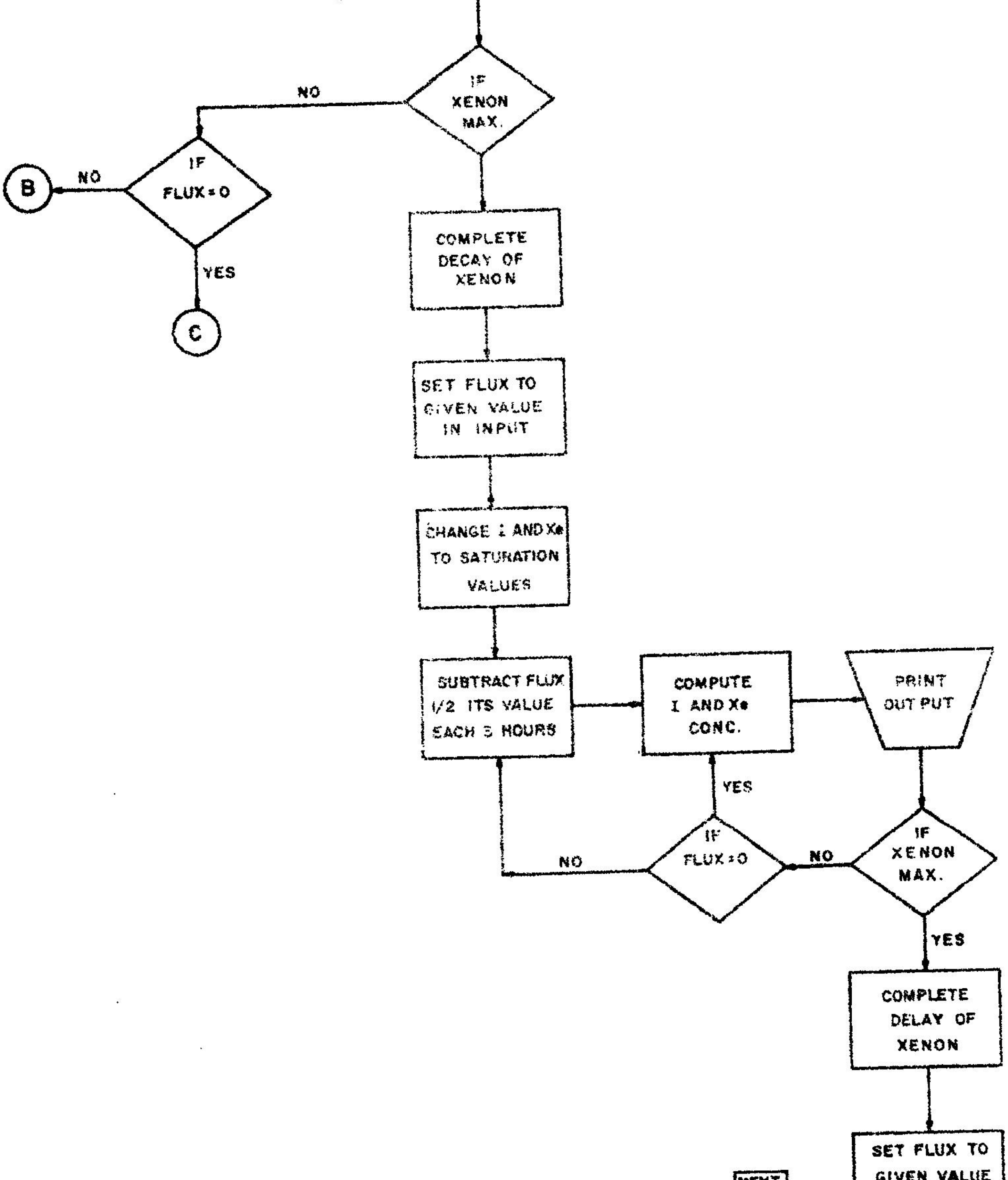
Figure 24. Flow chart of PREX-program



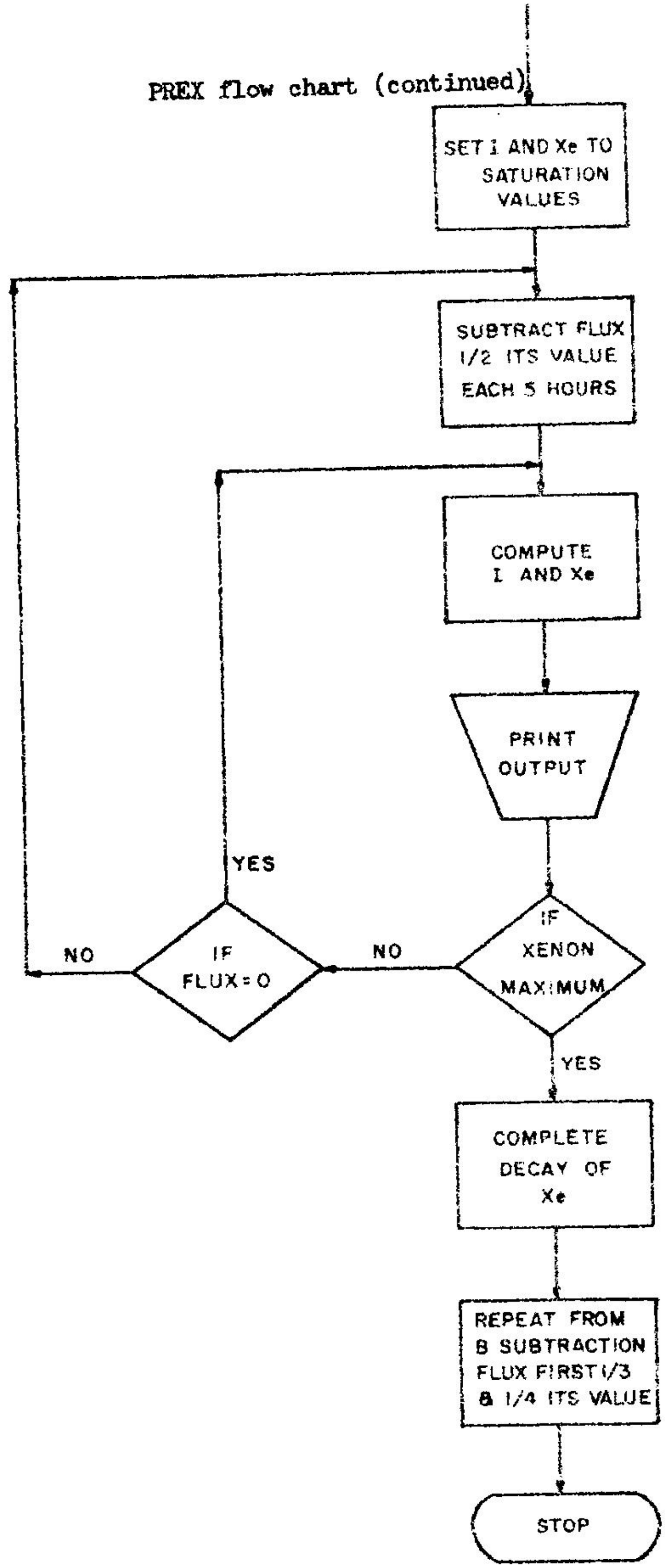
PREX flow chart (continued)



PREX flow chart (continued)



PREX flow chart (continued)



Listing of the PREX-program

```
08300 C      XENON CONCENT PROGRAM
08300 C      AMSDR
08300 C
08300        DIMENSION TEMP(10),GI(10),GX(10),TAC(10),GSF(10),FLUX(10),ZETA(10)
                                                                            )
08300 1000   FORMAT(49H
08422 1001   FORMAT(E14.8,E14.8,E14.8,E14.8,E14.8)
08464  1002  FORMAT(I2,I2,I2,I2,I2)
08506 1003   FORMAT(I2,E14.8,E14.8,E14.8,E14.8,E14.8)
08554  2000  FORMAT(5HTEMP=,E14.8,1HK)
08602  2001  FORMAT(5HFLUX=,E14.8)
08642  2002  FORMAT(5H    T,11X,1HF,16X,1HI,14X,1HX,16X,2HRO)
08856  2003  FORMAT(1H )
08882  2004  FORMAT(I4,I4)
08910  2005  FORMAT(F7.2,2X,E14.8,2X,E14.8,2X,E14.8,2X,E14.8)
08996      1 READ 1000
09020        IF(SENSE SWITCH 3)2,3
09040      2 PRINT 1000
09064      3 PUNCH 1000
09088        READ 1001,DCI,ACI,YI
09136        READ 1001,DCX,ACX,YX
09184        READ 1001,AFM,SIGF
09220        READ 1002,KLS1,KLS3,NHON,NHOFF,NHF
09292        READ 1002,KP1,KP2
09328        IT=0
09352      4 IT=IT+1
09388        READ 1003,LAST,ZETA(IT)
09448        READ 1003,LAST,TEMP(IT),GI(IT),GX(IT),TAC(IT),GSF(IT)
09652        IF(LAST-1)4,5,4
09720      5 IF=0
09744      6 IF=IF+1
09780        READ 1003,LAST,FLUX(IF)
09840        IF(LAST-1)6,7,6
09908      7 KT=0
09932        IF(SENSE SWITCH1)90,8
09952     90 READ 2004,KF,KT
09988        GO TO 95
09996      8 KT=KT+1
T0032        IF(SENSE SWITCH 3)9,100
T0052      9 PRINT 2000,TEMP(KT)
T0100    100 PUNCH 2000,TEMP(KT)
T0148        ACIC=(ACI/1.128)*(293./TEMP(KT))**.5*GI(KT)
T0304        ACXC=(ACX/1.128)*(293./TEMP(KT))**.5*GX(KT)
T0460        SIGFC=(SIGF/1.128)*(293./TEMP(KT))**.5*GSF(KT)
T0616        SIGFC=SIGFC*AFM
T0652        KF=0
T0676     10 KF=KF+1
T0712        IF(SENSE SWITCH 3)11,12
T0732     11 PRINT 2001,FLUX(KF)
T0780     12 PUNCH 2001,FLUX(KF)
T0828        IF(SENSE SWITCH 3)50,51
T0848     50 PRINT 2002
T0872     51 PUNCH 2002
T0896        TIME=0.0
T0920        CI=0.0
T0944        CX=0.0
T0968        GO TO(14,13),KLS1
T1044     13 DO 43J=1,KLS3
T1056        DO18 J1=1,NHON
T1068     14 CXA=CX
T1092        LOUT=1
T1116        FIC=FLUX(KF)
T1134        GO TO 70
T1172  [illegible]
```

Listing of the PREX-program (continued)

```
T1196   61 DET=TIMEH/60.
T1232      TIME=TIME+DET
T1268      RO=CX*ACXC*ZETA(KT)/(TAC(KT)*(1.+ZETA(KT)))*100
T1460      IF(SENSE SWITCH 3)15,16
T1480   15 PRINT 2005,TIME,FIC,CI,CX,RO
T1552   16 PUNCH 2005,TIME,FIC,CI,CX,RO
T1624      GO TO(52,35,73,76,997),KEL
T1712   52 GO TO(17,18),KLS1
T1788   17 IF(CXA)53,14,53
T1844   53 RATIO=CX/CXA*1000.
T1892      KRAF=RATIO
T1928      IF(KRAF-1000)19,19,14
T1996   18 CONTINUE
T2032   19 GCX=CX
T2056      GCI=CI
T2080      IF(SENSE SWITCH 3)20,21
T2100   20 PRINT 2003
T2124   21 PUNCH 2003
T2148   22 KCONT=1
T2172   23 FI=FLUX(KF)
T2220      GO TO(24,25,26,27,95,44),KCONT
T2312   24 RI=FI
T2336      KCONT=2
T2360      GO TO 28
T2368   25 RI=FI/2.
T2404      KCONT=3
T2428      GO TO 28
T2436   26 RI=FI/3.
T2472      KCONT=4
T2496      GO TO 28
T2504   27 RI=FI/4.
T2540      KCONT=5
T2564   28 CX=GCX
T2588      CI=GCI
T2612      CXM=0.0
T2636      TIME=0.0
T2660      GO TO(32,29),KLS1
T2736   29 DO 37 J3=1,NHOFF
T2748      GO TO 701
T2756   32 KKK=0
T2780  700 KKK=KKK+1
T2816      KK=1
T2840      GO TO(701,699,703,408),KKK
T2924  701 FI=FI-RI
T2960      IF(FI)33,33,34
T3016   33 FI=0.0
T3040   34 KEL=2
T3064      LOUT=2
T3088      FIC=FI
T3112      GO TO 70
T3120  699 KKKK=1
T3144  702 GO TO(711,712,713,716,717),KK
T3232  711 GO TO(701,731,731),KKK
T3312  731 KK=2
T3336      GO TO 701
T3344  712 KK=3
T3368      GO TO 34
T3376  713 GO TO(714,715),KKKK
T3452  714 KK=1
T3476      GO TO 34
T3484  715 KK=4
T3508      GO TO 34
T3516  703 KKKK=2
T3540      GO TO 702
T3548  716 KK=5
```

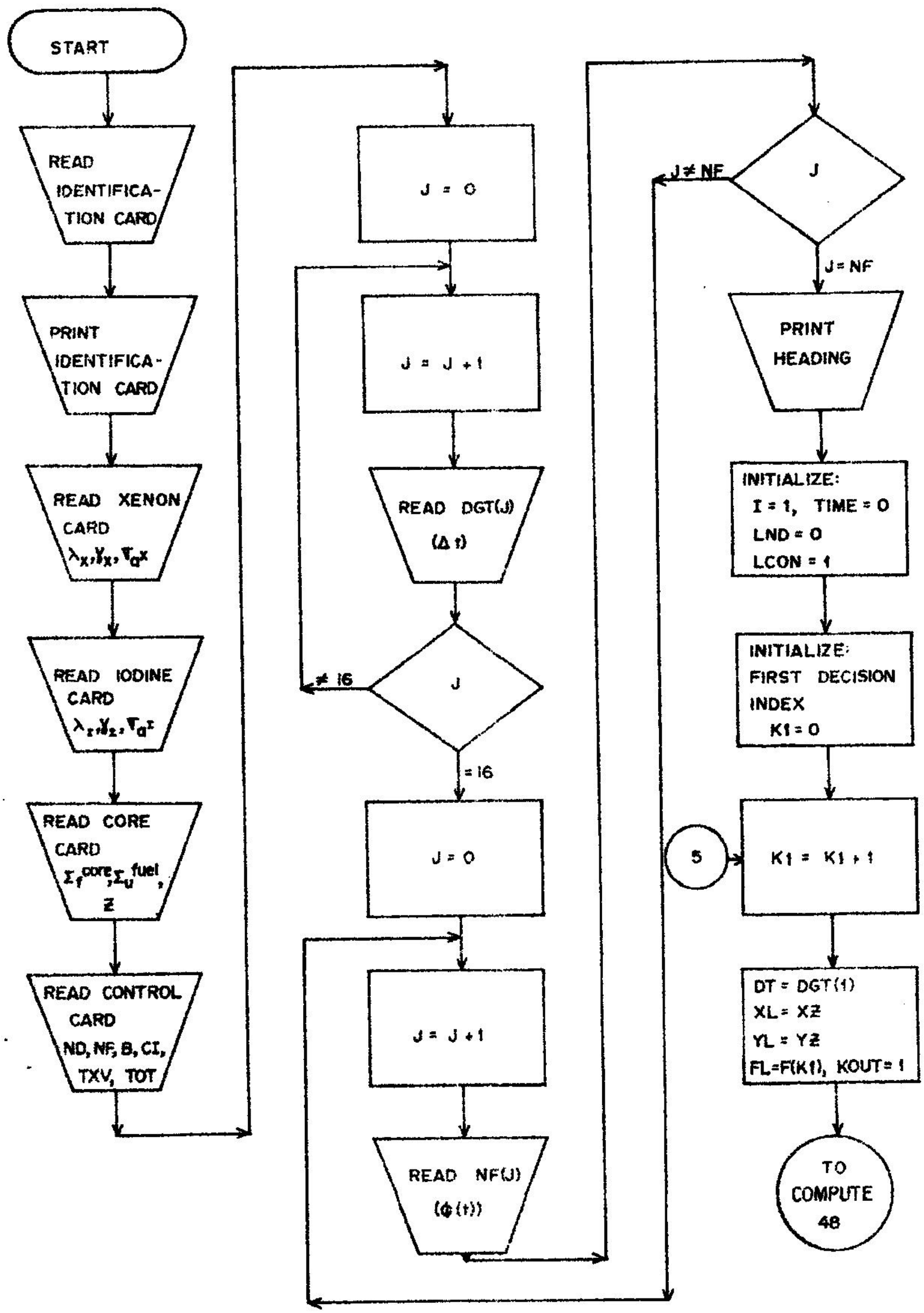
Listing of the PREX-program (continued)

```
T3484    715 [illegible]
T3508        GO TO 34
T3516    703 KKK=2
T3540        GO TO 702
T3548    716 KK=5
T3572        GO TO 34
T3580    717 KK=1
T3604        GO TO 34
T3612     35 GO TO(39,37),KLS1
T3688     37 CONTINUE
T3724     38 CXM=CX
T3748        GO TO(702,40),KLS1
T3824     39 IF(CX-CXM)40,38,38
T3892     40 IF(SENSE SWITCH 3)41,42
T3912     41 PRINT 2003
T3936     42 PUNCH 2003
T3960        GO TO 43
T3968     70 TIMEH=0.
T3992        IH=0
T4016     71 IH=IH+1
T4052        TIMEH=TIMEH+5.
T4088        DELTI=300.*(YI*SIGFC*FIC-DCI*CI-ACIC*CI*FIC)
T4268        CI=CI+DELTI
T4304        DELTX=300.*(YX*SIGFC*FIC+DCI*CI-ACXC*CX*FIC-DCX*CX)
T4532        CX=CX+DELTX
T4568        GO TO(73,73,72,73,73,72,73,73,72,73,73,73),IH
T4684     72 GO TO(73,74),KP1
T4760     74 KEL=3
T4784        GO TO 61
T4792     73 IF(IH-6)76,75,76
T4860     75 GO TO (76,77),KP2
T4936     77 KEL=4
T4960        GO TO 61
T4968     76 IF(IH-12)71,78,78
T5036     78 GO TO(60,61,998),LOUT
T5116     43 TIME=0.0
T5176        DO 997 JAM=1,NHF
T5188        LOUT=3
T5212        FIC=0.0
T5236        GO TO 70
T5244    998 KEL=5
T5268        GO TO 61
T5276    997 CONTINUE
T5312        GO TO(400,95),KLS1
T5388    400 IF(KCONT-2)402,401,402
T5456    401 KKK=3
T5480    402 CX=GCX
T5504        CI=GCI
T5528        CXM=0.
T5576        FI=FLUX(KF)
T5624        GO TO 700
T5632    408 IF(SENSE SWITCH 4)409,410
T5652    409 PRINT 2003
T5676        PRINT 2003
T5700    410 PUNCH 2003
T5724        PUNCH 2003
T5748        GO TO 23
T5756     95 IF(SENSE SWITCH 4)91,45
T5776     91 PUNCH 2004,KF,KT
T5812        GO TO 47
T5820     45 IF(KF-IF)10,46,10
T5888     46 IF(KT-IT)8,47,8
T5956     47 PAUSE
T5968        GO TO 1
T5976        END
```

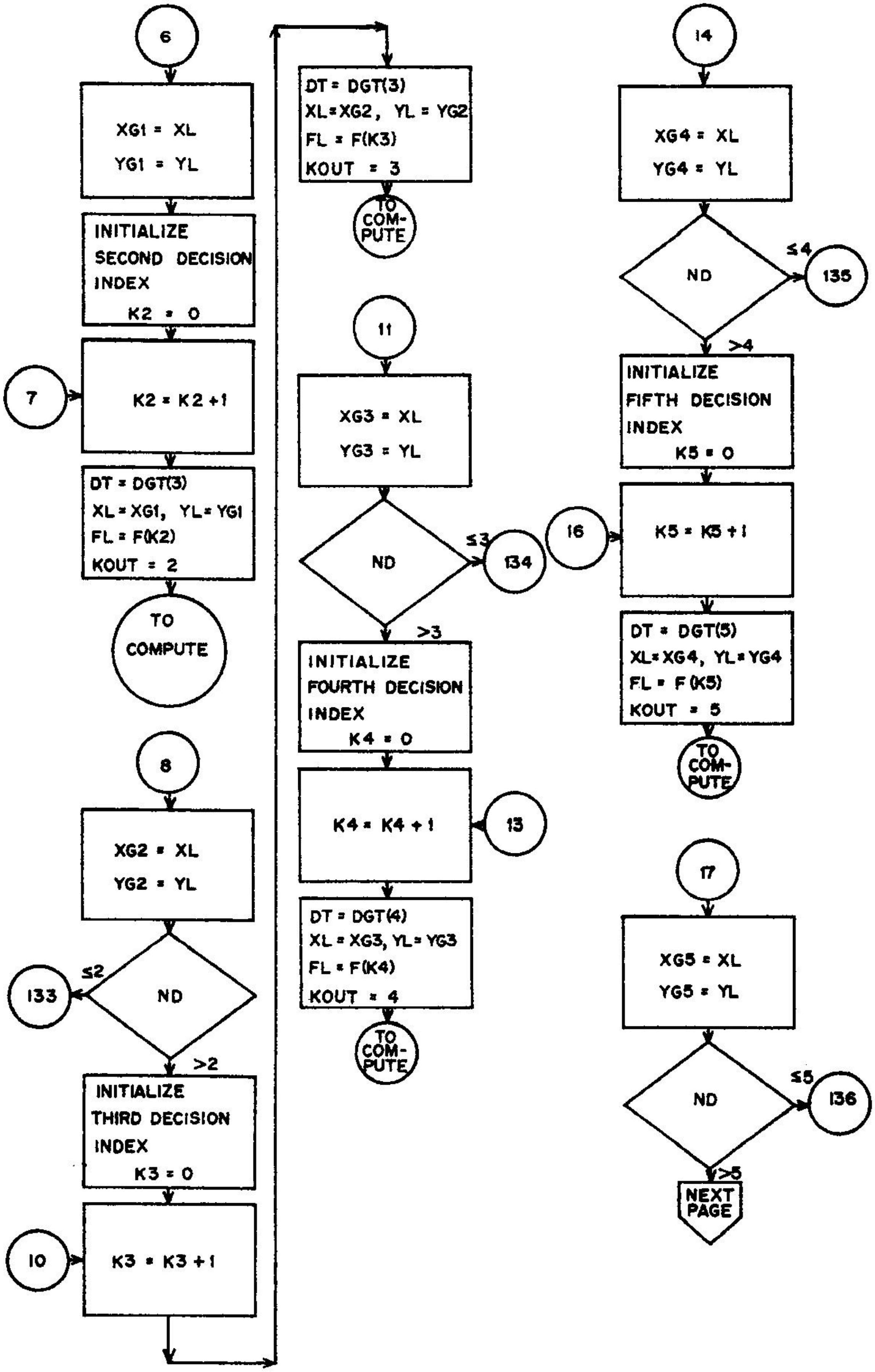
APPENDIX 2

Flow chart and program listing for MINEX -- a FORTRAN program written for the IBM-1620 computer to minimize the after shutdown xenon peak as a functional of the control flux pattern

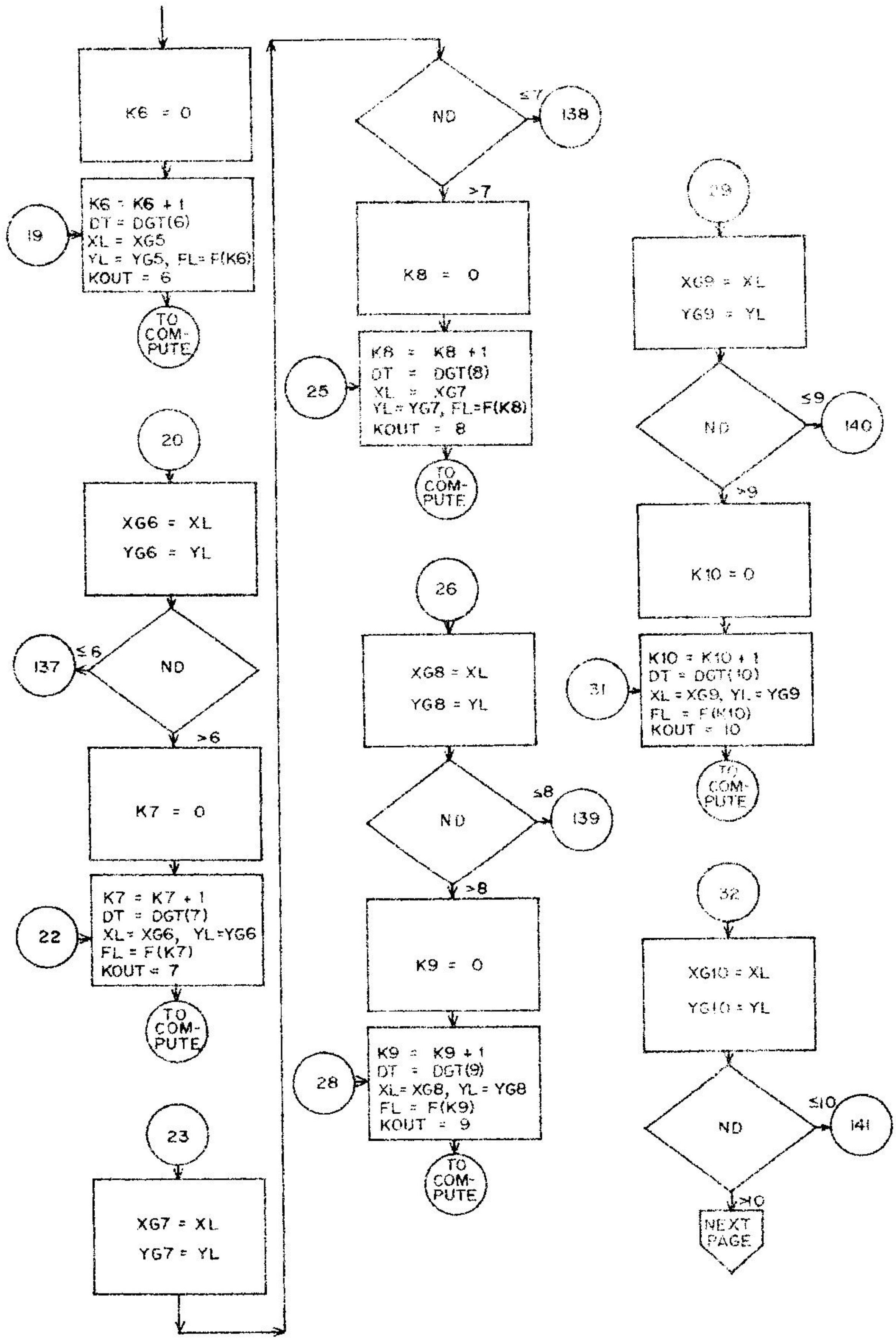
Figure 25. Flow chart of MINEX-program



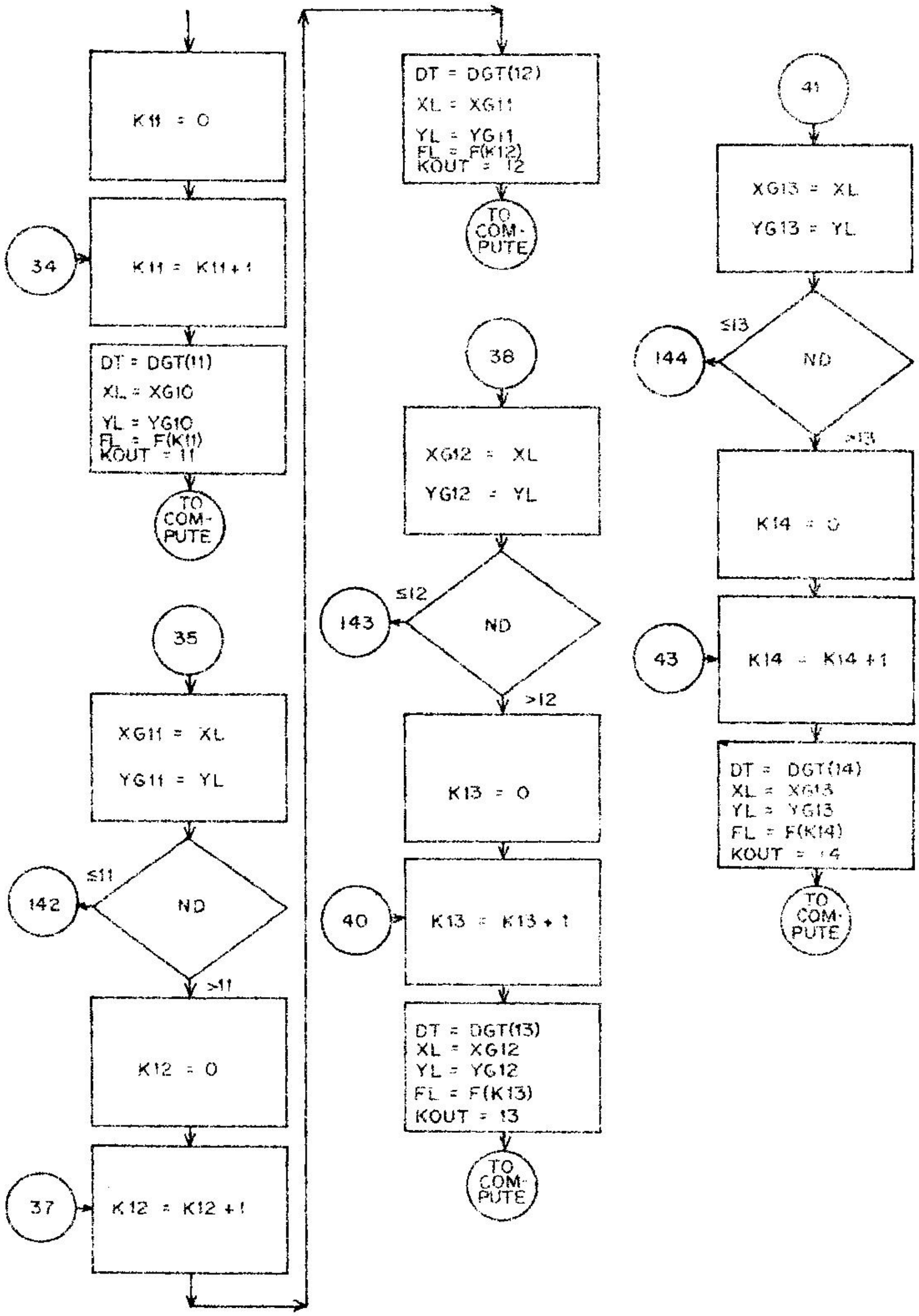
Flow chart of MINEX-program (continued)



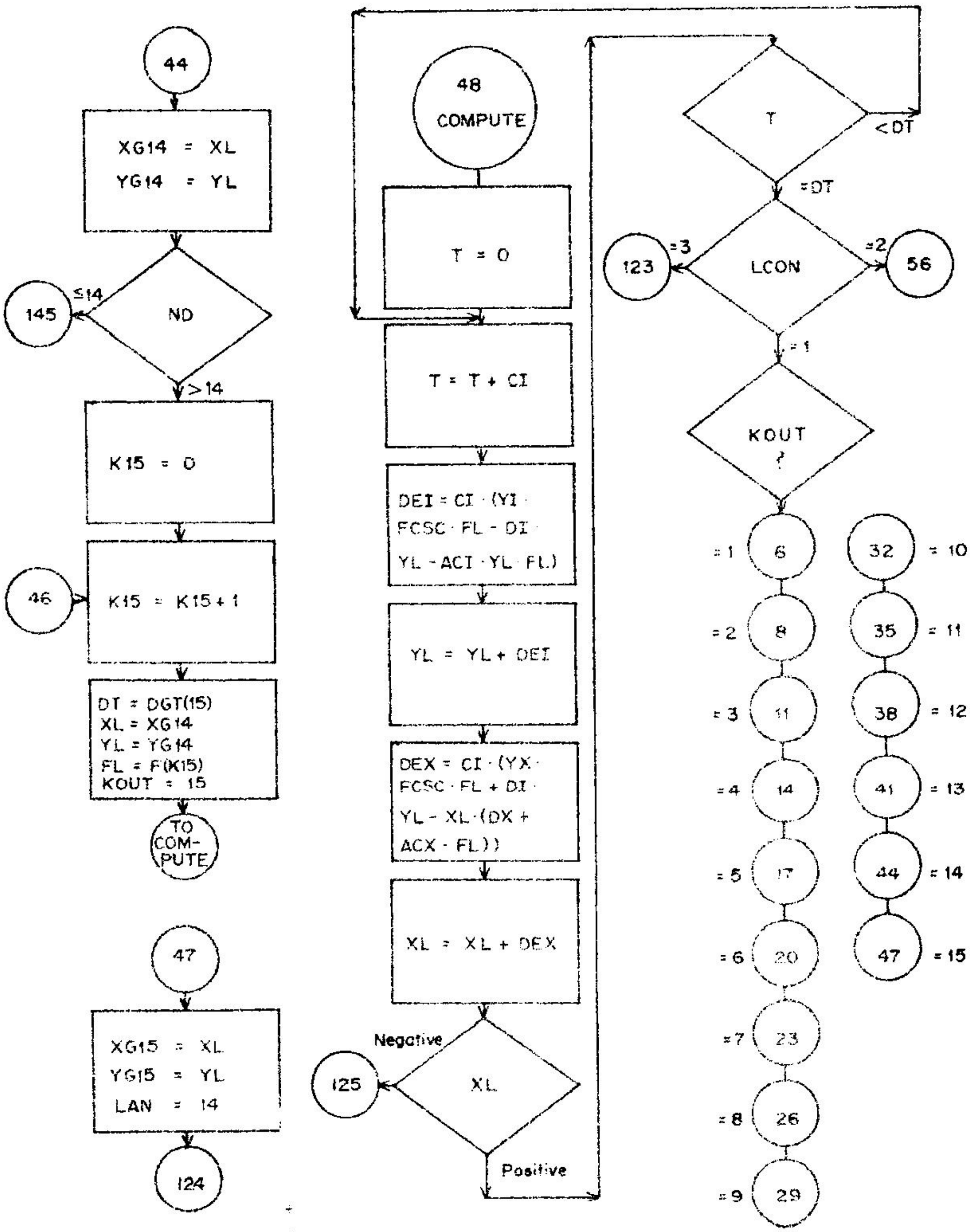
Flow chart of MINEX-program (continued)



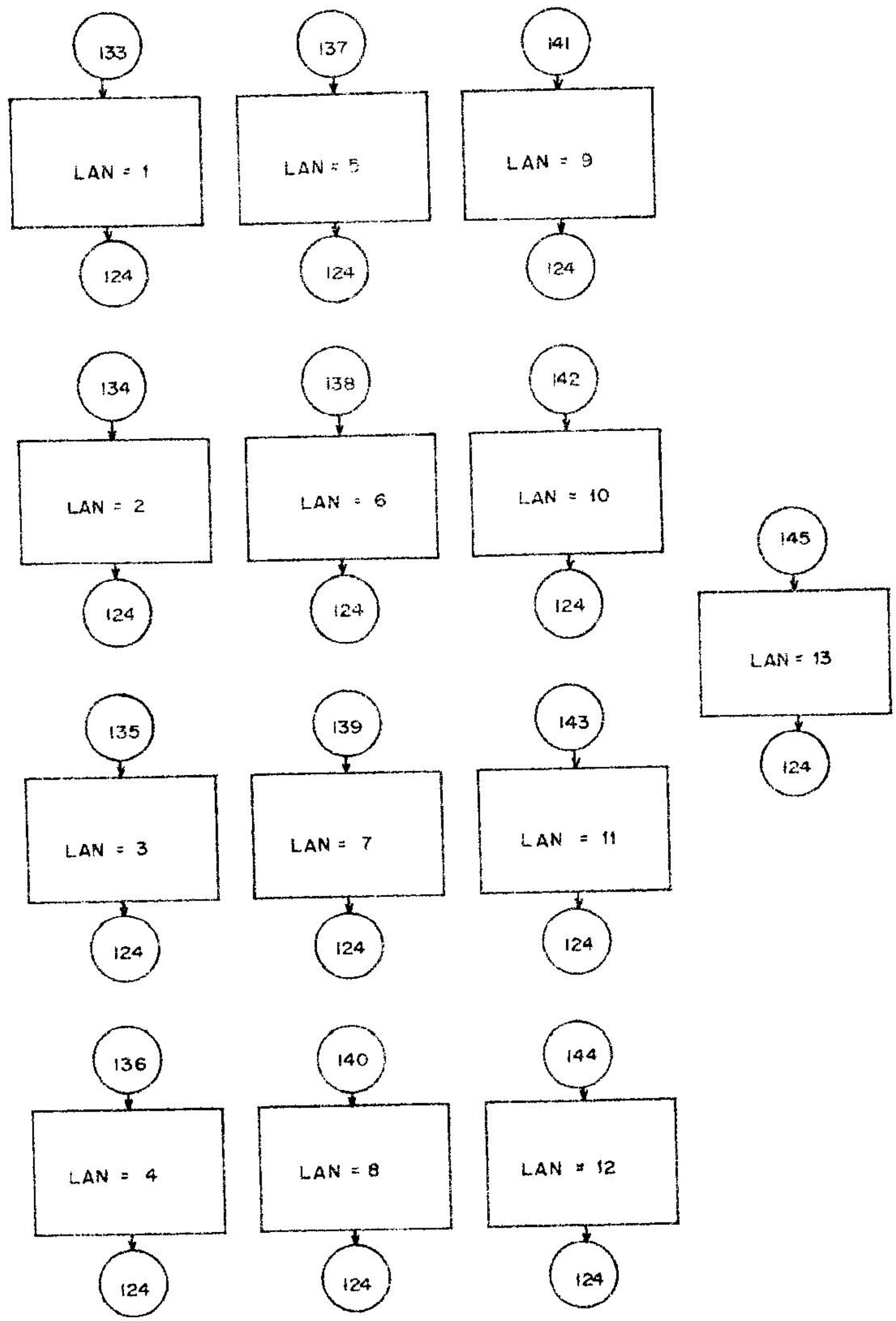
Flow chart of MINEX-program (continued)



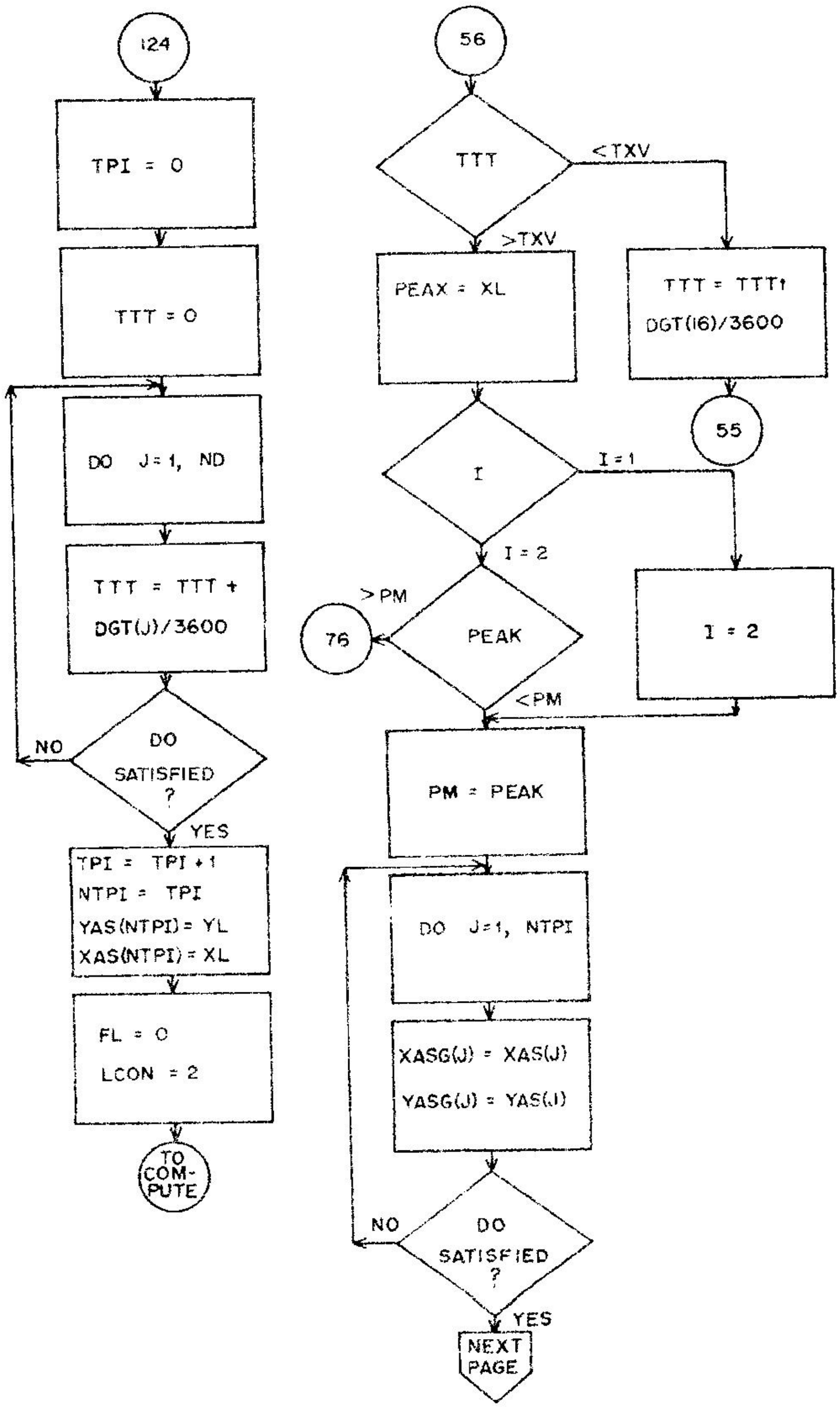
Flow chart of MINEX-program (continued)



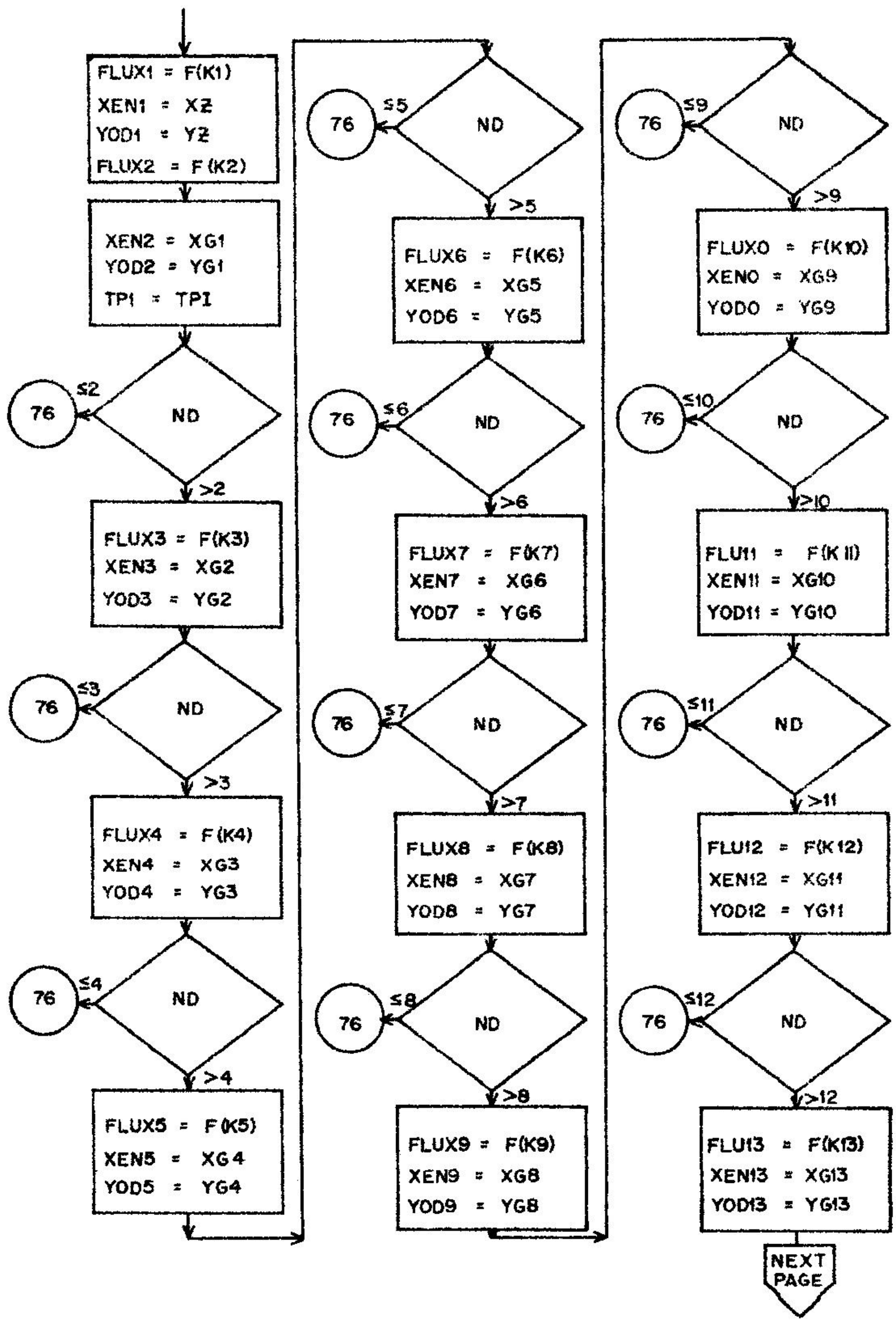
Flow chart of MINEX-program (continued)



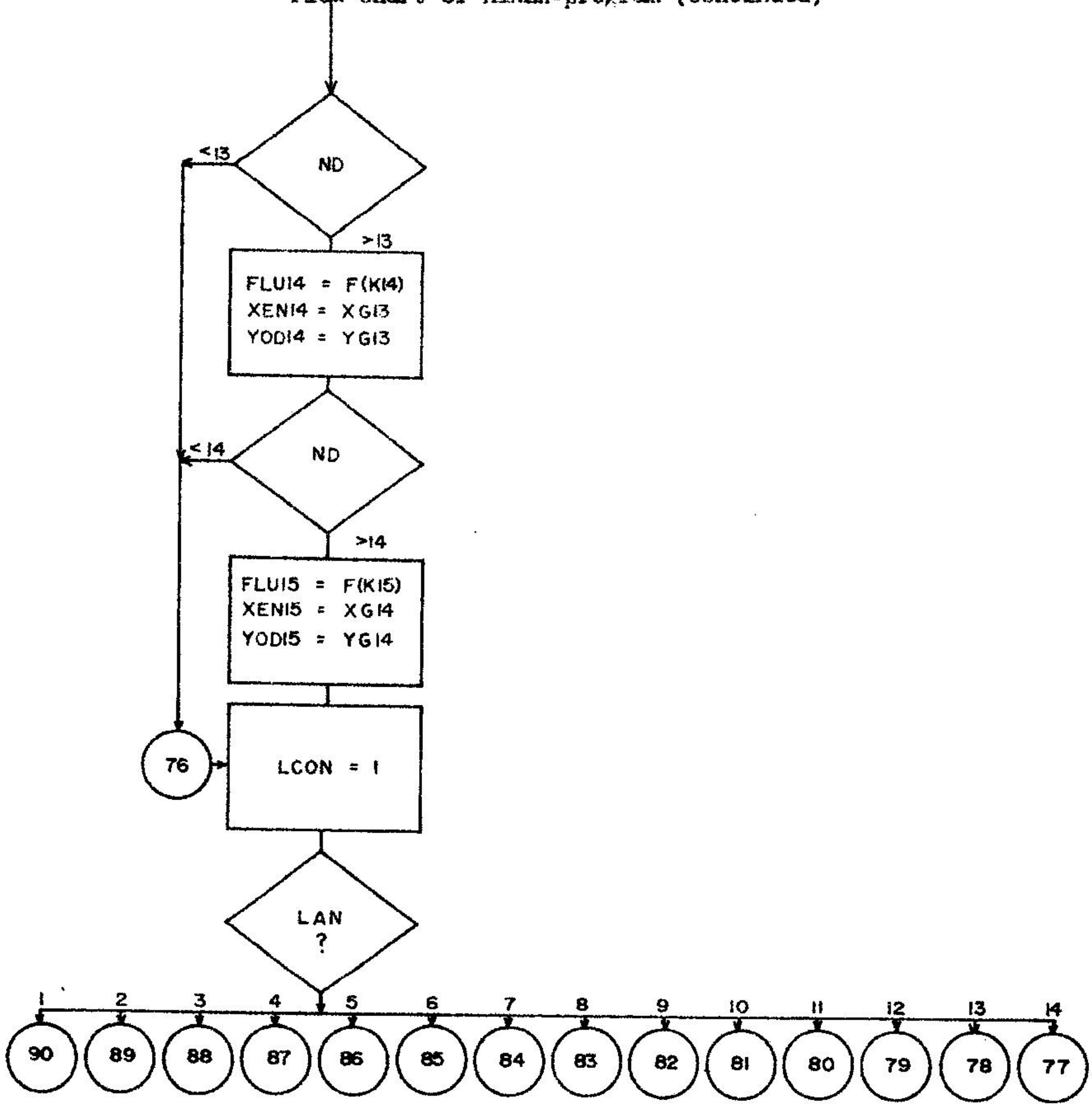
Flow chart of MINEX-program (continued)



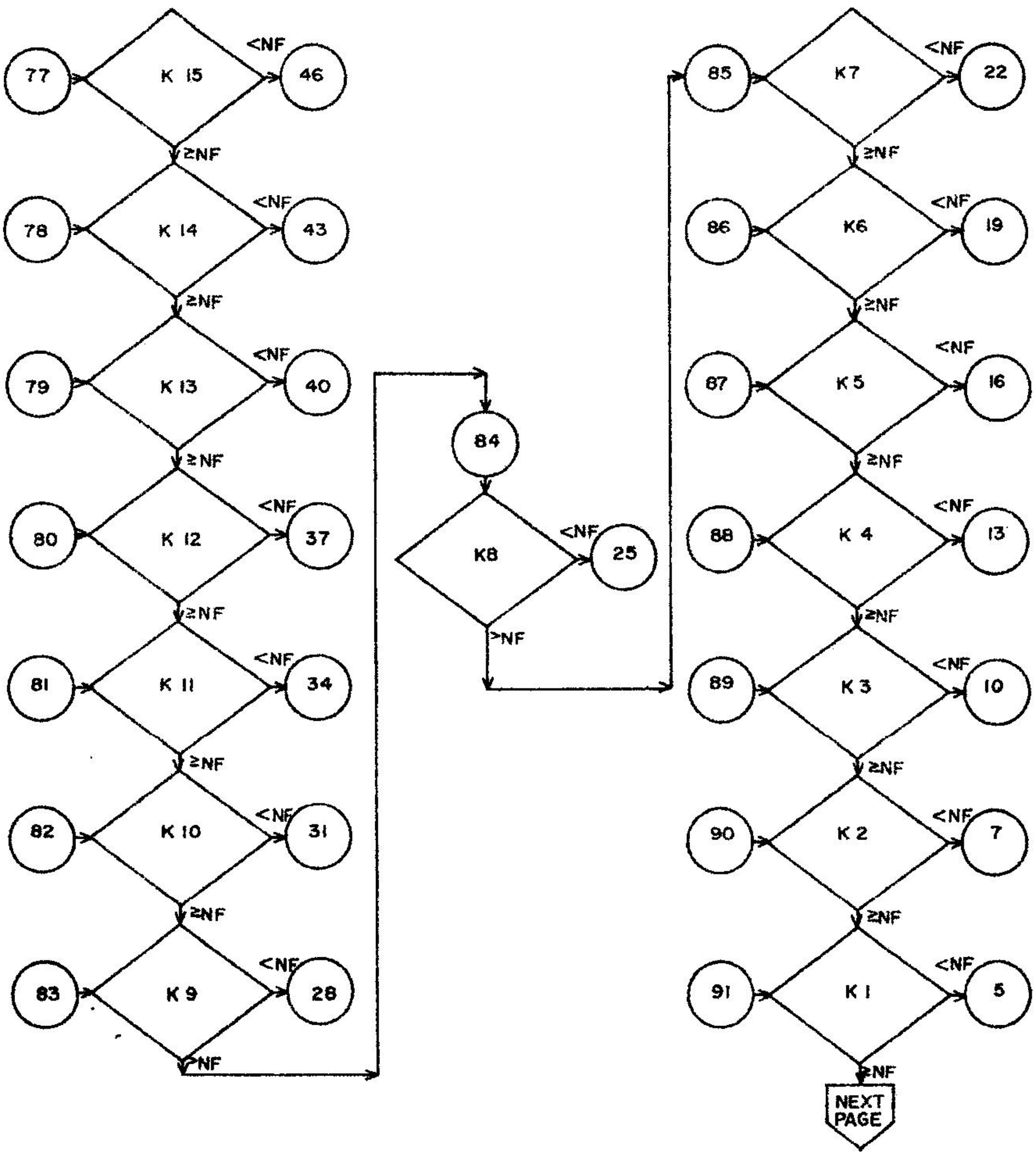
Flow chart of MINEX-program (continued)



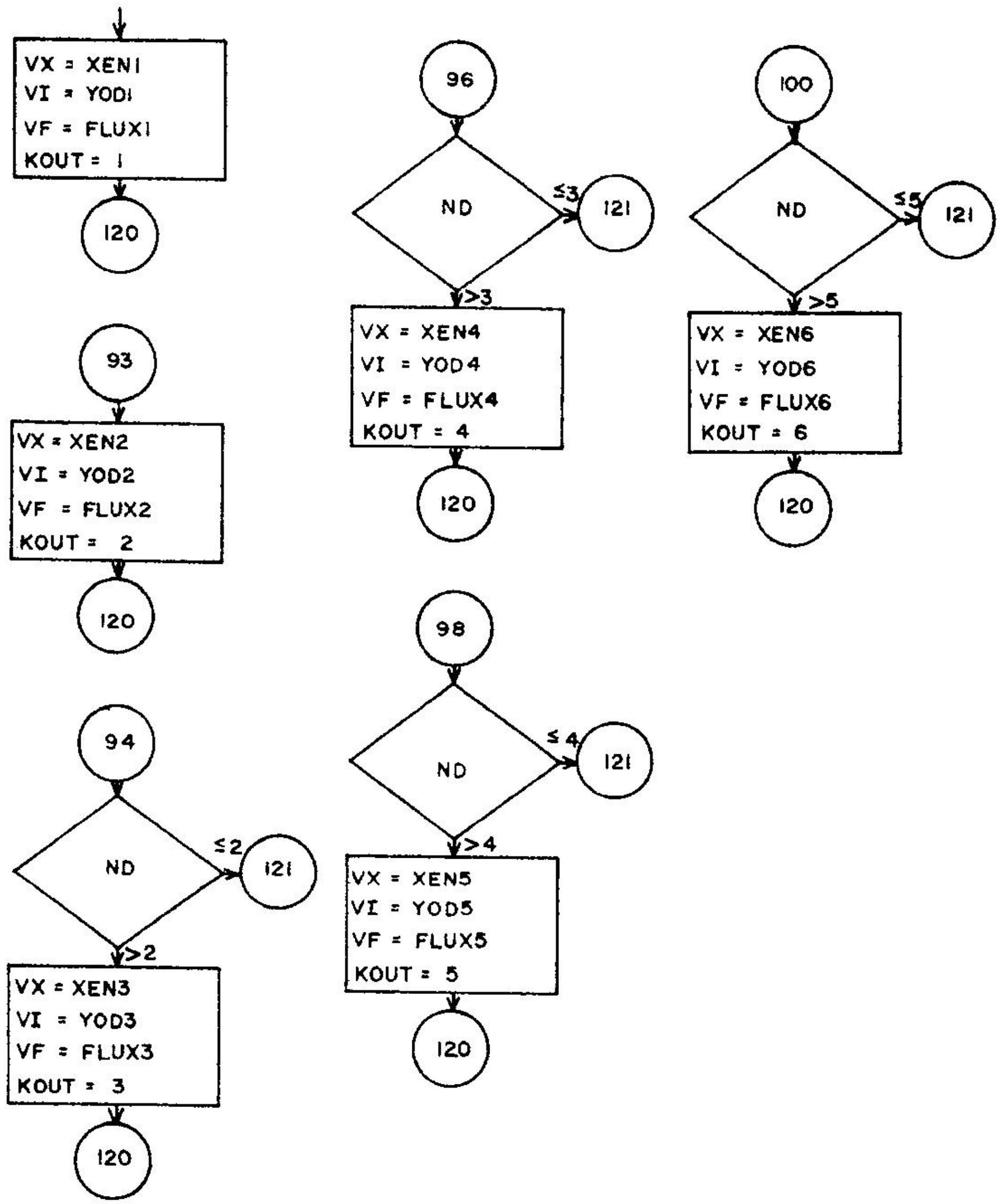
Flow chart of MINEX-program (continued)



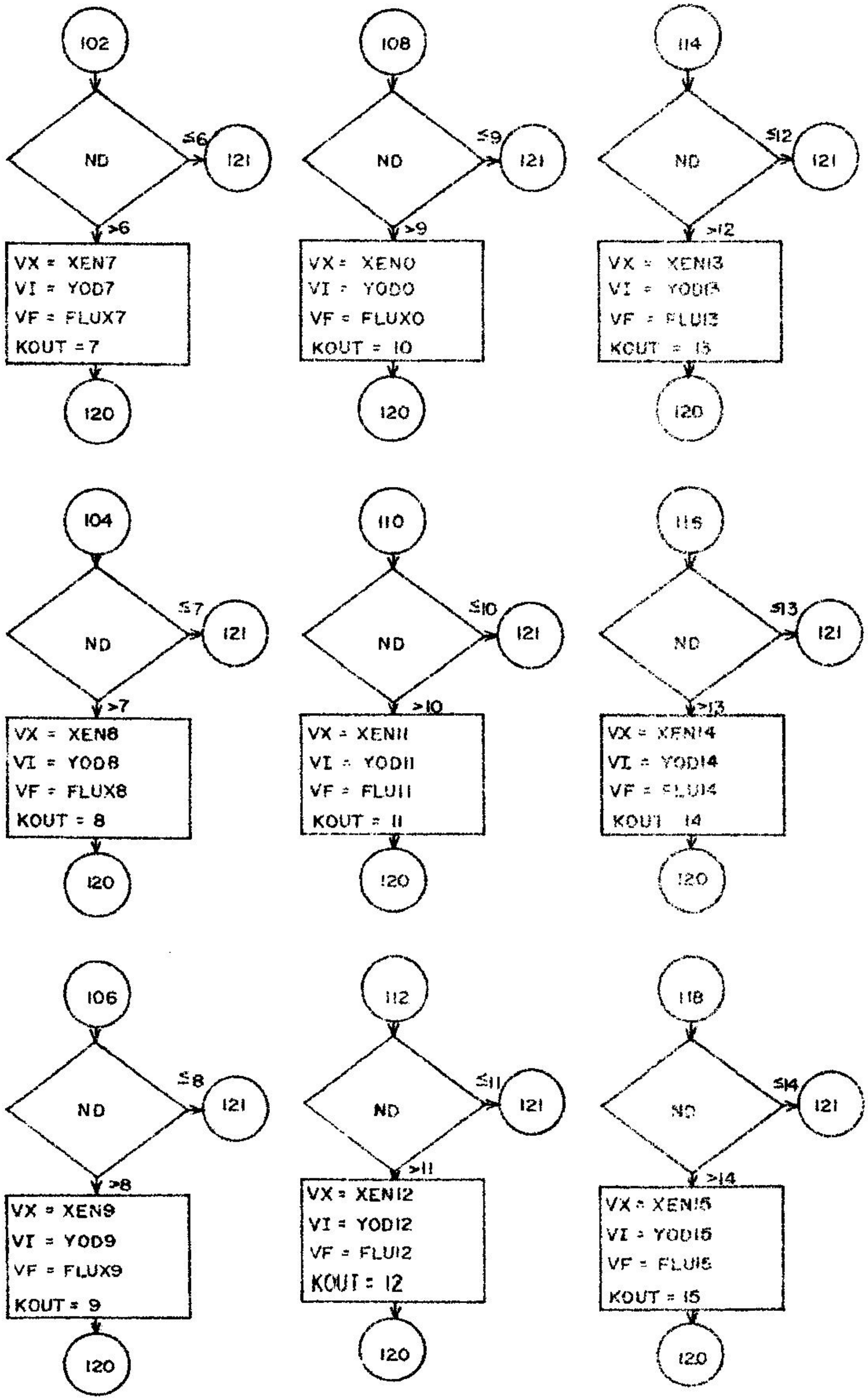
Flow chart of MINEX-program (continued)



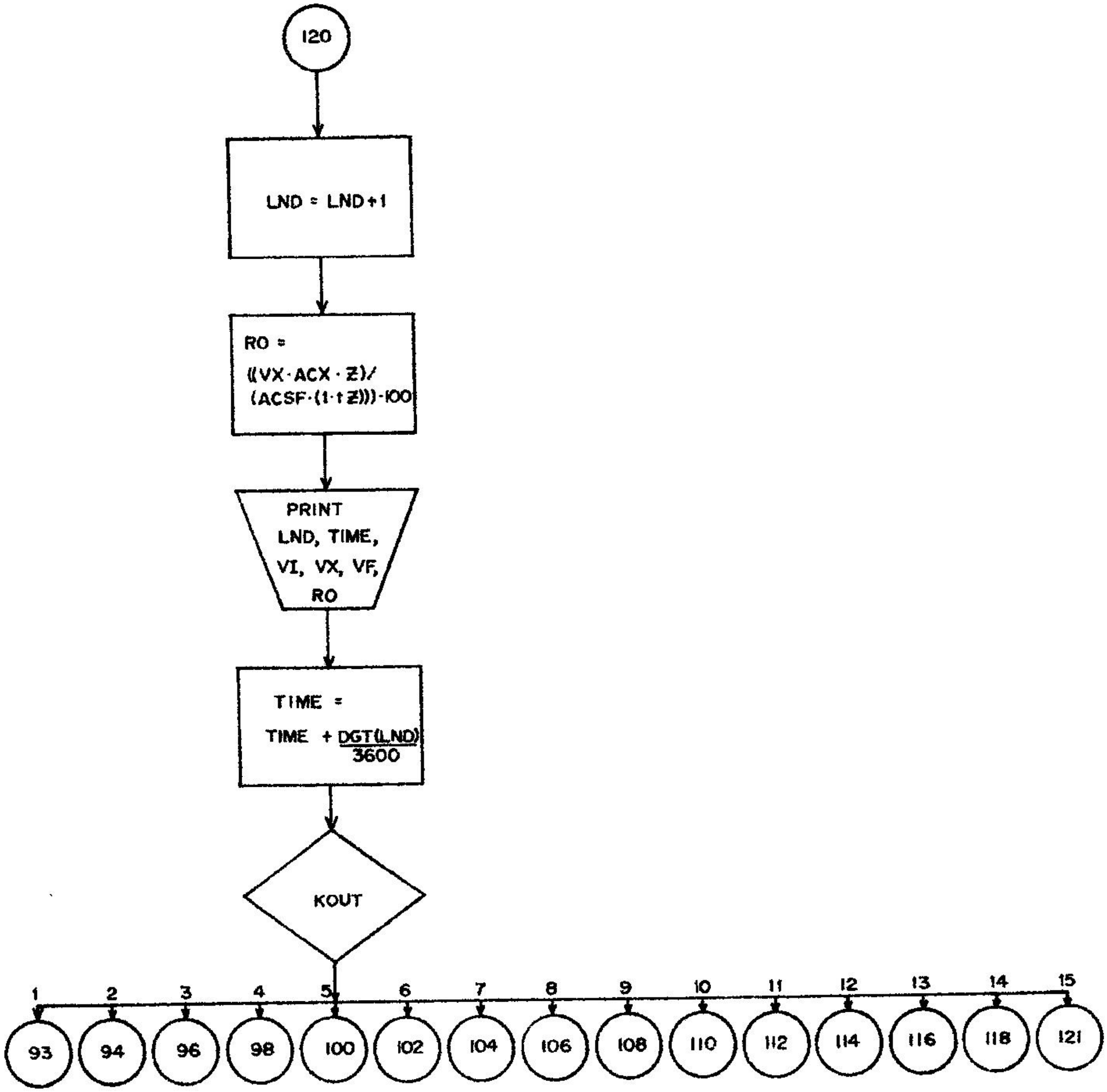
Flow chart of MINEX-program (continued)



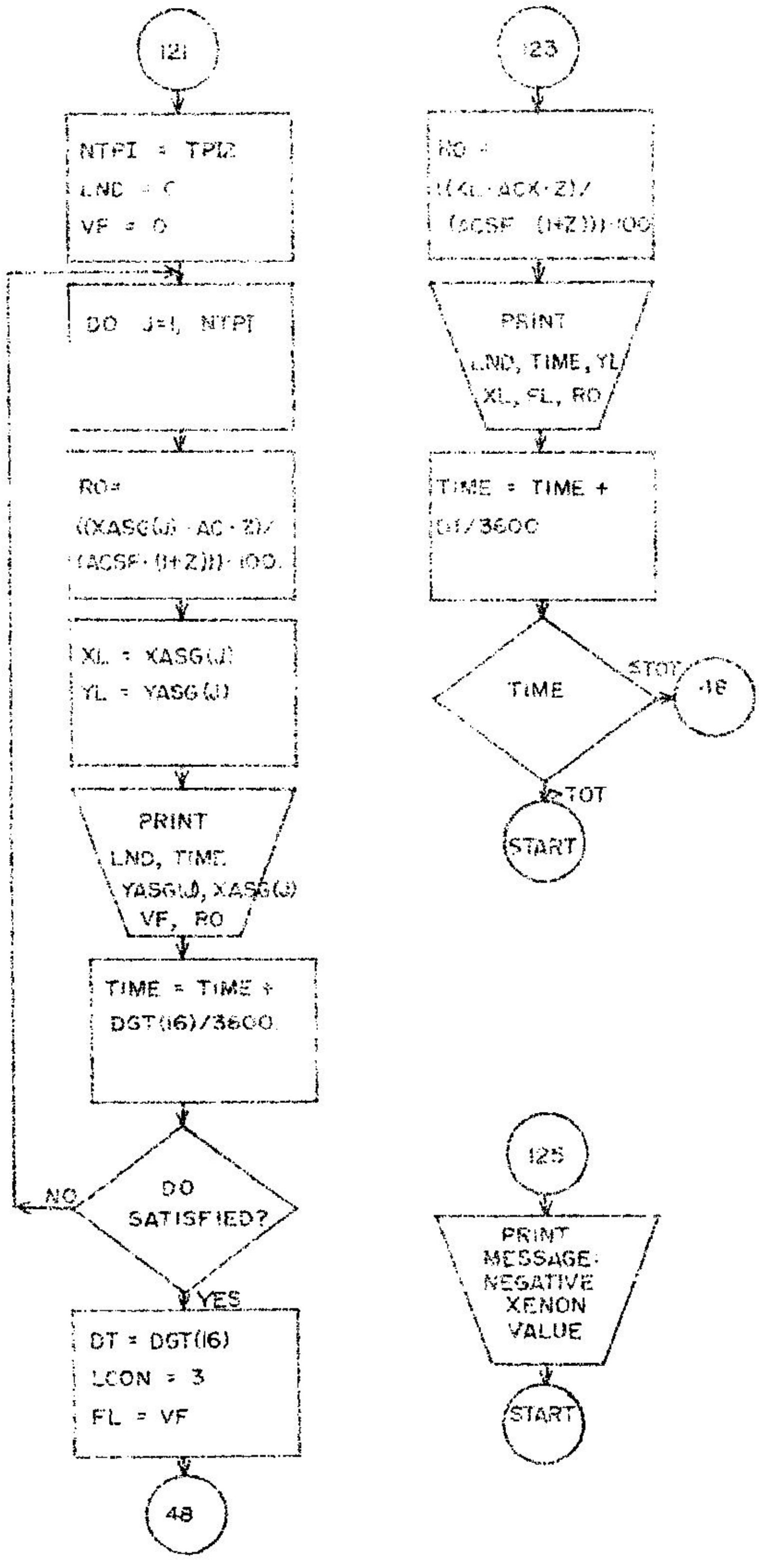
Flow chart of MINEX-program (continued)



Flow chart of MINEX-program (continued)



Flow chart of MINEX-program (continued)



Listing of the MINEX-program

```
08300 C      M I N E X   CODE
08300 C      AMSDR
08300 C
08300        DIMENSION F(5),XAS(50),YAS(50),XASG(50),YASG(50),DGT(16)
08300      1 READ 131
08324        PRINT 132
08348        PRINT 131
08372        READ 126,DX,YX,ACX
08420        READ 126,DI,YI,ACI
08468        READ 126,FCSC,ACSF,Z
08516        READ 126,FZ,XZ,YZ
08564        READ 127,ND,NF,B,CI,TXV,TOT
08648        DO 2 J=1,16
08660      2 READ 126,DGT(J)
08744        DO 3 J=1,NF
08756        READ 126,F(J)
08804      3 CONTINUE
08840        PRINT 130
08864      4 I=1
08888        TIME=0.
08912        LND=0
08936        LCON=1
08960        K1=0
08984      5 K1=K1+1
09020        DT=DGT(1)
09044        XL=XZ
09068        YL=YZ
09092        FL=F(K1)
09140        KOUT=1
09164        GO TO 48
09172      6 XG1=XL
09196        YG1=YL
09220        K2=0
09244      7 K2=K2+1
09280        DT=DGT(2)
09304        XL=XG1
09328        YL=YG1
09352        FL=F(K2)
09400        KOUT=2
09424        GO TO 48
09432      8 XG2=XL
09456        YG2=YL
09480        IF(ND-2)133,133,9
09548      9 K3=0
09572     10 K3=K3+1
09608        DT=DGT(3)
09632        XL=XG2
09656        YL=YG2
09680        FL=F(K3)
09728        KOUT=3
09752        GO TO 48
09760     11 XG3=XL
09784        YG3=YL
09808        IF(ND-3)134,134,12
09876     12 K4=0
09900     13 K4=K4+1
09936        DT=DGT(4)
09960        XL=XG3
```

Listing of the MINEX-program (continued)

```
09984       YL=YG3
T0008      FL=F(K4)
T0056       KOUT=4
T0080      GO TO 48
T0088    14 XG4=XL
T0112       YG4=YL
T0136      IF(ND-4)135,135,15
T0204    15 K5=0
T0228    16 K5=K5+1
T0264       DT=DGT(5)
T0288       XL=XG4
T0312      YL=YG4
T0336       FL=F(K5)
T0384      KOUT=5
T0408       GO TO 48
T0416    17 XG5=XL
T0440       YG5=YL
T0464       IF(ND-5)136,136,18
T0532    18 K6=0
T0556     19 K6=K6+1
T0592       DT=DGT(6)
T0616       XL=XG5
T0640      YL=YG5
T0664       FL=F(K6)
T0712      KOUT=6
T0736      GO TO 48
T0744    20 XG6=XL
T0768      YG6=YL
T0792       IF(ND-6)137,137,21
T0860    21 K7=0
T0884    22 K7=K7+1
T0920       DT=DGT(7)
T0944       XL=XG6
T0968      YL=YG6
T0992       FL=F(K7)
T1040       KOUT=7
T1064       GO TO 48
T1072    23 XG7=XL
T1096       YG7=YL
T1120       IF(ND-7)138,138,24
T1188    24 K8=0
T1212    25 K8=K8+1
T1248       DT=DGT(8)
T1272       XL=XG7
T1296       YL=YG7
T1320      FL=F(K8)
T1344       KOUT=8
T1392       GO TO 48
T1400    26 XG8=XL
T1424       YG8=YL
T1448       IF(ND-8)139,139,27
T1516    27 K9=0
T1540    28 K9=K9+1
T1576      DT=DGT(9)
T1600       XL=XG8
T1624      YL=YG8
T1648       FL=F(K9)
T1696       KOUT=9
```

Listing of the MINEX-program (continued)

```
T1720      GO TO 48
T1728   29 XG9=XL
T1752      YG9=YL
T1776      IF(ND-9)140,140,30
T1844   30 K10=0
T1868   31 K10=K10+1
T1904      DT=DGT(10)
T1928      XL=XG9
T1952      YL=YG9
T1976      FL=F(K10)
T2024      KOUT=10
T2048      GO TO 48
T2056   32 XG10=XL
T2080      YG10=YL
T2104      IF(ND-10)141,141,33
T2172   33 K11=0
T2196   34 K11=K11+1
T2232      DT=DGT(11)
T2256      XL=XG10
T2280      YL=YG10
T2304      FL=F(K11)
T2352      KOUT=11
T2376      GO TO 48
T2384   35 XG11=XL
T2408      YG11=YL
T2432      IF(ND-11)142,142,36
T2500   36 K12=0
T2524   37 K12=K12+1
T2560      DT=DGT(12)
T2584      XL=XG11
T2608      YL=YG11
T2632      FL=F(K12)
T2680      KOUT=12
T2704      GO TO 48
T2712   38 XG12=XL
T2736      YG12=YL
T2760      IF(ND-12)143,143,39
T2828   39 K13=0
T2852   40 K13=K13+1
T2888      DT=DGT(13)
T2912      XL=XG12
T2936      YL=YG12
T2960      FL=F(K13)
T3008      KOUT=13
T3032      GO TO 48
T3040   41 XG13=XL
T3064      YG13=YL
T3088      IF(ND-13)144,144,42
T3156   42 K14=0
T3180   43 K14=K14+1
T3216      DT=DGT(14)
T3240      XL=XG13
T3264      YL=YG13
T3288      FL=F(K14)
T3336      KOUT=14
T3360      GO TO 48
T3368   44 XG14=XL
T3392      YG14=YL
```

Listing of the MINEX-program (continued)

```
T3416        IF(ND-14)145,145,45
T3484     45 K15=0
T3508     46 K15=K15+1
T3544        DT=DGT(15)
T3568        XL=XG14
T3592        YL=YG14
T3616       FL=F(K15)
T3664        KOUT=15
T3688        GO TO 48
T3696     47 XG15=XL
T3720       YG15=YL
T3744        LAN=14
T3768       GO TO 124
T3776     48 T=0.
T3800    49 T=T+CI
T3836        DEI=CI*(YI*FCSC*FL-DI*YL-ACI*YL*FL)
T4016        YL=YL+DEI
T4052        DEX=CI*(YX*FCSC*FL+DI*YL-XL*(DX+ACX*FL))
T4244        XL=XL+DEX
T4280        IF(XL)125,50,50
T4336    50 IF(T-DT)49,51,51
T4404     51 GO TO(52,56,123),LCON
T4484     52 GO TO(6,8,11,14,17,20,23,26,29,32,35,38,41,44,47),KOUT
T4612     53 TTT=0.
T4636        DO 54 J=1,ND
T4648        TTT=TTT+DGT(J)/3600.
T4720     54 CONTINUE
T4756     55 TPI=TPI+1.
T4792       NTPI=TPI
T4828        YAS(NTPI)=YL
T4876        XAS(NTPI)=XL
T4924        FL=0.
T4948        LCON=2
T4972        GO TO 48
T4980    56 IF(TTT-TXV)57,57,58
T5048     57 TTT=TTT+DGT(16)/3600.
T5096        GO TO 55
T5104     58 PEAK=XL
T5128        GO TO(59,60),I
T5204     59 I=2
T5228        GO TO 61
T5236     60 IF(PEAK-PM)61,61,76
T5304     61 PM=PEAK
T5328        DO 62 J=1,NTPI
T5340        XASG(J)=XAS(J)
T5412     62 YASG(J)=YAS(J)
T5520      FLUX1=F(K1)
T5568        XEN1=XZ
T5592        YOD1=YZ
T5616        FLUX2=F(K2)
T5664        XEN2=XG1
T5688        YOD2=YG1
T5712        TPI2=TPI
T5736        IF(ND-2)76,76,63
T5804     63 FLUX3=F(K3)
T5852        XEN3=XG2
T5876        YOD3=YG2
```

Listing of the MINEX-program (continued)

```
      IF(ND-3)76,76,64
   64 FLUX4=F(K4)
      XEN4=XG3
      YOD4=YG3
      IF(ND-4)76,76,65
   65 FLUX5=F(K5)
      XEN5=XG4
      YOD5=YG4
      IF(ND-5)76,76,66
   66 FLUX6=F(K6)
      XEN6=XG5
      YOD6=YG5
      IF(ND-6)76,76,67
   67 FLUX7=F(K7)
      XEN7=XG6
      YOD7=YG6
      IF(ND-7)76,76,68
   68 FLUX8=F(K8)
      XEN8=XG7
      YOD8=YG7
      IF(ND-8)76,76,69
   69 FLUX9=F(K9)
      XEN9=XG8
      YOD9=YG8
      IF(ND-9)76,76,70
   70 FLUX0=F(K10)
      XEN0=XG9
      YOD0=YG9
      IF(ND-10)76,76,71
   71 FLU11=F(K11)
      XEN11=XG10
      YOD11=YG10
      IF(ND-11)76,76,72
   72 FLU12=F(K12)
      XEN12=XG11
      YOD12=YG11
      IF(ND-12)76,76,73
   73 FLU13=F(K13)
      XEN13=XG12
      YOD13=YG12
      IF(ND-13)76,76,74
   74 FLU14=F(K14)
      XEN14=XG13
      YOD14=YG13
      IF(ND-14)76,76,75
   75 FLU15=F(K15)
      XEN15=XG14
      YOD15=YG14
   76 LCON=1
      GO TO(90,89,88,87,86,85,84,83,82,81,80,79,78,77),LAN
   77IF(K15-NF)46,78,78
   78 IF(K14-NF)43,79,79
   79 IF(K13-NF)40,80,80
   80 IF(K12-NF)37,81,81
   81 IF(K11-NF)34,82,82
   82 IF(K10-NF)31,83,83
   83 IF(K9-NF)28,84,84
   84 IF(K8-NF)25,85,85
```

Listing of the MINEX-program (continued)

```
T8560      85 IF(K7-NF)22,86,86
T8628      86 IF(K6-NF)19,87,87
T8696      87 IF(K5-NF)16,88,88
T8764      88 IF(K4-NF)13,89,89
T8832      89 IF(K3-NF)10,90,90
T8900      90 IF(K2-NF)7,91,91
T8968      91 IF(K1-NF)5,92,92
T9036      92 VX=XEN1
T9060         VI=YOD1
T9084         VF=FLUX1
T9108         KOUT=1
T9132         GO TO 120
T9140      93 VX=XEN2
T9164         VI=YOD2
T9188         VF=FLUX2
T9212         KOUT=2
T9236         GO TO 120
T9244      94 IF(ND-2)121,121,95
T9312      95 VX=XEN3
T9336         VI=YOD3
T9360         VF=FLUX3
T9384         KOUT=3
T9408         GO TO 120
T9416      96 IF(ND-3)121,121,97
T9484      97 VX=XEN4
T9508         VI=YOD4
T9532         VF=FLUX4
T9556         KOUT=4
T9580         GO TO 120
T9588      98 IF(ND-4)121,121,99
T9656      99 VX=XEN5
T9680         VI=YOD5
T9704         VF=FLUX5
T9728         KOUT=5
T9752         GO TO 120
T9760     100 IF(ND-5)121,121,101
T9828     101 VX=XEN6
T9852         VI=YOD6
T9876         VF=FLUX6
T9900         KOUT=6
T9924         GO TO 120
T9932     102 IF(ND-6)121,121,103
Z0000     103 VX=XEN7
Z0024         VI=YOD7
Z0048         VF=FLUX7
Z0072         KOUT=7
Z0096         GO TO 120
Z0104     104 IF(ND-7)121,121,105
Z0172     105 VX=XEN8
Z0196         VI=YOD8
Z0220         VF=FLUX8
Z0244         KOUT=8
Z0268         GO TO 120
Z0276     106 IF(ND-8)121,121,107
Z0344     107 VX=XEN9
Z0368         VI=YOD9
Z0392         VF=FLUX9
```

Listing of the MINEX-program (continued)

```
Z0416        KOUT=9
Z0440        GO TO 120
Z0448    108 IF(ND-9)121,121,109
Z0516    109 VX=XENO
Z0540        VF=FLUXO
Z0564        VI=YODO
Z0588        KOUT=10
Z0612        GO TO 120
Z0620    110 IF(ND-10)121,121,111
Z0688    111 VX=XEN11
Z0712        VI=YOD11
Z0736        VF=FLU11
Z0760        KOUT=11
Z0784        GO TO 120
Z0792    112 IF(ND-11)121,121,113
Z0860    113 VX=XEN12
Z0884        VI=YOD12
Z0908        VF=FLU12
Z0932        KOUT=12
Z0956        GO TO 120
Z0964    114 IF(ND-12)121,121,115
Z1032    115 VX=XEN13
Z1056        VI=YOD13
Z1080        VF=FLU13
Z1104        KOUT=13
Z1128        GO TO 120
Z1136    116 IF(ND-13)121,121,117
Z1204    117 VX=XEN14
Z1228        VI=YOD14
Z1252        VF=FLU14
Z1276        KOUT=14
Z1300        GO TO 120
Z1308    118 IF(ND-14)121,121,119
Z1376    119 VX=XEN15
Z1400        VI=YOD15
Z1424        VF=FLU15
Z1448        KOUT=15
Z1472    120 LND=LND+1
Z1508        RO=((VX*ACX*Z)/(ACSF*(1.+Z)))*100.
Z1628        PRINT 129,LND,TIME,VI,VX,VF,RO
Z1712        TIME=TIME+DGT(LND)/3600.
Z1784        IF(KOUT-15)146,121,121
Z1852    146 GO TO(93,94,96,98,100,102,104,106,108,110,112,114,116,118),KOUT
Z1976    121 NTPI=TPI2
Z2012        LND=0
Z2036        VF=0.
Z2060        DO 122 J=1,NTPI
Z2072        RO=((XASG(J)*ACX*Z)/(ACSF*(1.+Z)))*100.
Z2216        XL=XASG(J)
Z2264        YL=YASG(J)
Z2312        PRINT 129,LND,TIME,YASG(J),XASG(J),VF,RO
Z2444        TIME=TIME+DGT(16)/3600.
Z2492    122 CONTINUE
Z2528        DT=DGT(16)
Z2552        LCON=3
Z2576        FL=VF
Z2600        GO TO 48
Z2608    123 RO=((XL*ACX*Z)/(ACSF*(1.+Z)))*100.
```

Listing of the MINEX-program (continued)

```
Σ2728        PRINT 129,LND,TIME,YL,XL,FL,RO
Σ2812        TIME=TIME+DT/3600.
Σ2860        IF(TIME-TOT)48,48,1
Σ2928    124 TPI=0.
Σ2952        GO TO 53
Σ2960    125 PRINT 128
Σ2984        GO TO 1
Σ2992    126 FORMAT(E14.8,E14.8,E14.8,E14.8,E14.8)
Σ3034    127 FORMAT(I4,I4,E14.8,E14.8,E14.8,E14.8)
Σ3082    128 FORMAT(20HNEGATIVE XENON VALUE)
Σ3146    129 FORMAT(1X,I3,5X,F6.2,2X,E14.8,2X,E14.8,2X,E14.8,1X,F8.2)
Σ3262    130 FORMAT(8HDECISION,2X,4HTIME,10X,1HI,14X,1HX,15X,4HFLUX,8X,2HRO,/)
Σ3500    131 FORMAT(49H                                                   )
Σ3622    132 FORMAT(1H ,///)
Σ3664    133 LAN=1
Σ3688        GO TO 124
Σ3696    134 LAN=2
Σ3720        GO TO 124
Σ3728    135 LAN=3
Σ3752        GO TO 124
Σ3760    136 LAN=4
Σ3784        GO TO 124
Σ3792    137 LAN=5
Σ3816        GO TO 124
Σ3824    138 LAN=6
Σ3848        GO TO 124
Σ3856    139 LAN=7
Σ3880        GO TO 124
Σ3888    140 LAN=8
Σ3912        GO TO 124
Σ3920    141 LAN=9
Σ3944        GO TO 124
Σ3952    142 LAN=10
Σ3976        GO TO 124
Σ3984    143 LAN=11
Σ4008        GO TO 124
Σ4016    144 LAN=12
Σ4040        GO TO 124
Σ4048    145 LAN=13
Σ4072        GO TO 124
Σ4080        END
```

APPENDIX 3

The Pontryagin Maximum Principle
and its application to the problem
of minimizing the after shutdown
xenon peak

A statement of the Pontryagin maximum principle and its application to minimizing the after shutdown xenon peak is presented herewith.

In order to state the maximum principle in its simplest form, the system is described by a set of state variables: $x_1, x_2, \ldots, x_n$ and a set of control variables: $u_1, u_2, \ldots, u_m$, which satisfy a set of ordinary differential equations and initial conditions given in the following form:

$$\frac{dx_1}{dt} = f_1(x_1, x_2, \ldots, x_n; u_1, u_2, \ldots, u_m; t) \quad x_1(0) = x_{10},$$

$$\frac{dx_2}{dt} = f_2(x_1, x_2, \ldots, x_n; u_1, u_2, \ldots, u_m; t) \quad x_2(0) = x_{20},$$

$$\vdots$$

$$\frac{dx_n}{dt} = f_n(x_1, x_2, \ldots, x_n; u_1, u_2, \ldots, u_m; t) \quad x_n(0) = x_{n0}$$

The state of the system then is determined by the state vector:

$$\bar{x} = (x_1, x_2, \ldots, x_n)$$

and by the control vector:

$$\bar{u} = (u_1, u_2, \ldots, u_m)$$

and the optimization problem may be stated as follows: It is required to find a control policy, i. e., the vector $\bar{u} = u_1, u_2, \ldots, u_m)$ which will transfer the above described system from its initial state $(x_{10}, x_{20}, \ldots, x_{n0})$ into a final state, within a duration T in such a fashion that a certain criterion functional

$$J[\bar{u}] = \int_0^T f_{n\ 1}(x_1, x_2, \ldots, x_n; u_1, u_2, \ldots, u_m; t)\, dt,$$

is minimized, with respect to the choice of $\bar{u}$.

Let us now define an additional state variable in the form of:

$$x_{n+1} = \int_0^t f_{n+1}(x_1, x_2, \ldots, x_n; u_1, u_2, \ldots, u_m; z)\, dz$$

which satisfies the differential equation

$$\frac{dx_{n+1}}{dt} = f_{n+1}(x_1, x_2, \ldots, x_n; u_1, u_2, \ldots, u_m; t)$$

the initial condition:

$$x_{\ +1}(0) = 0$$

and the final condition:

$$x_{n+1}(T) = J$$

Further, let us define a set of auxiliary variables of the system $p_1, p_2, \ldots, p_n$ with the aid of the following set of ordinary differential equations and final conditions:

$$\frac{-dp_1}{dt} = \frac{\partial f_1}{\partial x_1} p_1 + \frac{\partial f_2}{\partial x_1} p_2 + \ldots \quad + \frac{\partial f_{n+1}}{\partial x_1} p_{n+1} \qquad p_1(T) = 0$$

$$\frac{-dp_2}{dt} = \frac{\partial f_1}{\partial x_2} p_1 + \frac{\partial f_2}{\partial x_2} p_2 + \ldots \quad + \frac{\partial f_{n+1}}{\partial x_2} p_{n+1} \qquad p_2(T) = 0$$

$$\frac{-dp_n}{dt} = \frac{\partial f_1}{\partial x_n} p_1 + \frac{\partial f_2}{\partial x_n} p_2 + \ldots \quad + \frac{\partial f_{n+1}}{\partial x_n} p_{n+1} \qquad p_n(T) = 0$$

$$-\frac{dp_{n+1}}{dt} = \frac{\partial f_1}{\partial x_{n+1}} p_1 + \frac{\partial f_2}{\partial x_{n+1}} p_2 + \cdots + \frac{\partial f_{n+1}}{\partial x_{n+1}} p_{n+1} ; \quad p_{n+1}(T) = -1$$

Now define a function H as

$$H = p_1 \cdot f_1 + p_2 f_2 + \cdots \ p_{n+1} f_{n+1}$$

H is called the Hamiltonian of the system. From the definition of H it is evident that the state variables $x_1, x_2, \ldots, x_{n+1}$ and the auxiliary variables $p_1, p_2, \ldots, p_{n+1}$ satisfy the following equations:

$$\frac{dxi}{dt} = \frac{\partial H}{\partial pi} \qquad \text{and}$$

$$\frac{dpi}{dt} = -\frac{\partial H}{\partial xi} \qquad \text{for } i = 1, 2, \ldots, n+1$$

These equations are called the Hamilton canonical equations of the system.

From the canonical equations it follows that p_{n+1} is constant in time since H does not depend explicitly upon x_{n+1}.

With regard to the control functions $u_1, u_2, \ldots, u_m$ the maximum principle requires that they should be bounded, i. e., $ai \leq ui \leq bi$ for i = 1, 2, , m otherwise the optimization problem is meaningless.

With the above definitions and relationships in mind the maximum principle may then be stated as follows: The required optimal control vector $\bar{u}^*$, that will transfer the system from a given initial state $(x_{10}, x_{20}, \ldots, x_{n0})$ to a final state, minimizing the criterion functional J [u] , while satisfying the differential equations of the system's state variables is the same control vector that will maximize the Hamiltonian of the system, constructed as explained above. Thus $\bar{u}$ * satisfies the following equation:

$$\max_{\bar{u}} H\left\{\bar{p}(t), x(t), \bar{u}(t)\right\} =$$

$$H\left\{\bar{p}(t), x(t), \bar{u}^*(t)\right\}$$

H is constant in time as can be seen from differentiating it with respect to time:

$$\frac{dH}{dt} = \sum_{i+1}^{n+1}\left\{\frac{\partial H}{\partial p_i}\dot{p}_i + \frac{\partial H}{\partial x_i}\dot{x}_i\right\}$$

and applying the canonical equations, leading to:

$$\frac{dH}{dt} = \sum_{i+1}^{n+1}\left\{\dot{x}_i\ \dot{p}_i - \dot{x}_i\ \dot{p}_i\right\}$$

i. e.

H = const.

In order to apply the Pontryagin maximum principle to the problem of minimizing the after shutdown xenon peak, the numberdensities of xenon and iodine (X and I) are considered as state variables, x_1 and x_2; the flux during the control period b as control variable; the magnitude of the after shutdown xenon peak X_{max} as the criterion functional x_3.

X_{max} is computed from the terminal values of xenon and iodine numberdensities as given in equation (14), page 5 of this paper, so that using x_1 for the iodine numberdensity and x_2 for the xenon numberdensity one gets for the criterion functional:

$$x_3 = \left[X_1 + \left(1 - \frac{\lambda_X}{\lambda_I}\right) X_2\right]\left[\frac{\lambda_X}{\lambda_I} + \left(1 - \frac{\lambda_X}{\lambda_I}\right)\frac{\lambda_X}{\lambda_I}\,\frac{X_2}{X_1}\right]^{\frac{\lambda_X}{\lambda_I - \lambda_X}}$$

x_3 does not contain ϕ and t explicitly; it depends upon ϕ and t only through x_1 and x_2, therefore

$$\frac{dx_3}{dt} = \frac{\partial x_3}{\partial x_1}\dot{x}_1 + \frac{\partial x_3}{\partial x_2}\dot{x}_2 =$$

$$\frac{\partial x_3}{\partial x_1}(\gamma_I \Sigma_f \phi - \lambda_I X_1) + \frac{\partial x_3}{\partial x_2}(\gamma_X \Sigma_f \phi + \lambda_I X_1 - \lambda_X X_2 - \sigma_a^X X_2 \phi)$$

is a linear function of ϕ, therefore the Hamiltonian

$$H = p_1\dot{x}_1 + p_2\dot{x}_2 + p_3\dot{x}_3$$

is also a linear function of ϕ, so that it can be written as:

$H = \frac{\partial H}{\partial \phi}\cdot\phi$ + terms not dependent upon ϕ, where $\frac{\partial H}{\partial \phi}$ is not dependent upon ϕ.

Since ϕ is bounded, i. e.,

$$0 \leq \Phi \leq \Phi_{max}$$

the only two choices that will maximize H will be:

$$\phi = 0 \quad \text{for} \quad \frac{\partial H}{\partial \Phi} < 0$$

$$\phi = \phi_{max} \quad \text{for} \quad \frac{\partial H}{\partial \Phi} > 0$$

Consequently, the control flux pattern that will minimize x_3 (which is the same that will maximize H $[\Phi]$), is a switching function between the two admissible extreme values of the flux 0 and Φ_{max}.

For obvious reasons this type of control is referred to as pulse type or "bang-bang" control.