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NASAP - A COMPUTER CODE FOR THE EVALUATION OF THE NON-PROLIFERATION ALTERNATIVE SYSTEMS ASSESSMENT PROGRAM CONCEPTS

FINAL REPORT IN SUPPORT OF TASK 2

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ABSTRACT

The Non-Proliferation Alternative Systems Assessment Program (NASAP) computer code was developed to calculate the LWR and NASAP choice reactor cost through an arbitrary year T_N. The final cost is arrived at by calculation of cost contributory factors for both LWR and NASAP choice reactors.

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INTRODUCTION

The Non-proliferation Alternative Systems Assessment Program (NASAP) computer code was developed to calculate the total LWR and NASAP choice reactor cost through an arbitrary year T_N. The final cost is arrived at by calculation of cost contributary factors for both LWR and NASAP choice reactors. The cost contributary factors evaluated are:

1. Scheduling.

2. Plants installed.

3. U_3O_8 utilization.

4. U_3O_8 cost increase factors.

5. Research and development costs.

6. First-time engineering costs.

7. Fuel cost contribution to power cost.

8. Plant capital cost contribution to power cost.

9. Operation and maintenance cost contribution to power cost.

I. Scheduling

It is assumed that the net nuclear growth rate (i.e., additions, defined as plant installations minus plant retirements) and the NASAP choice installation rate (including replacement of retirements) are known, (Figure 1).

$$a(t) = a_i \quad i = 1,N \quad \text{net nuclear growth rate (Gwe/year)} \qquad (1)$$

$$r(t) = r_i \quad i = 1,N \quad \text{NASAP choice installation rate (Gwe/year)} \qquad (2)$$

The reference installation time (T_{RI}) is defined as the time from a reference starting year (T_I) required to arrive at full scale NASAP deployment. This time includes the time required to:

1. perform research and development (ΔT_{RD}) (years),
2. construct the lead plant (ΔT_c) (years),
3. operate the lead plant (ΔT_o) (years),
4. accelerate to equal full nuclear installation rate (ΔT_a) (years)

$$T_{RI} = T_I + \Delta T_{RD} + \Delta T_c + \Delta T_o + \Delta T_a \qquad \text{(years)} \qquad (3)$$

II. Plants Installed

The net plant addition rate (i.e., the nuclear growth rate) a_i is defined as:

$$a_i = g_i - (g_i[t_i - \Delta R]) + r_i - (r_i[t_i - \Delta R]) \qquad \text{(Gwe/year)} \qquad (4)$$

$$a_i = g_i - g_i' + r_i - r_i' \qquad \text{(Gwe/year)} \qquad (4a)$$

where:

g_i = LWR installation rate (Gwe/year)

g_i' = LWR retirement rate = $(g_{i-\Delta R})$ (Gwe/year)

r_i = NASAP choice installation rate (Gwe/year)

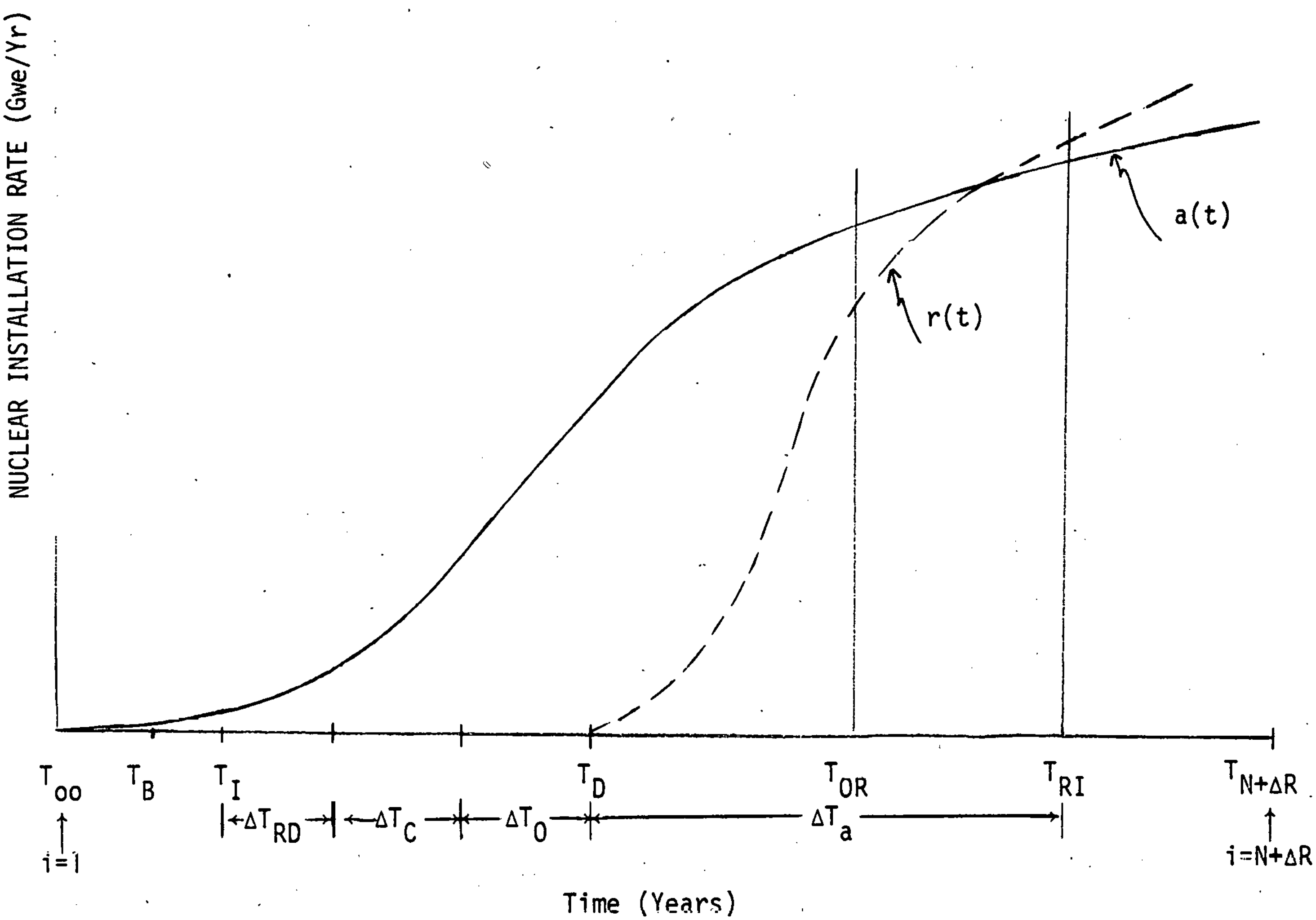
r_i' = NASAP choice retirement rate = $(r_{i-\Delta R})$ (Gwe/year)

ΔR = reactor lifetime (years)

t_i = time (years)

From equations (4) and (4a) the rate of LWR installation for the reactor lifetime of ΔR years is determined.

FIGURE 1



Where:

T_{oo} = Absolute base year (e.g., 1957)
T_B = Base year for cost calculations (e.g., 1978)
T_I = Reference starting year (e.g., 1979)
T_D = Year NASAP choice reactor deployment begins
T_{OR} = Year retirements begin
T_{RI} = Reference installation time

$$g_i = a_i - r_i \qquad i = 1,\Delta R \qquad \text{(Gwe/year)} \quad . \qquad (5)$$

Beyond reactor lifetime ΔR, the rate of LWR installation is

$$g_i = a_i + g_i' - r_i + r_i' \qquad i = \Delta R + 1,\ N + \Delta R \qquad \text{(Gwe/year)} \quad . \qquad (6)$$

The total number of LWR's in existence at a given time (t_i) is:

$$N_{LWR,i} = \sum_{j=1}^{i} g_j \, dx \qquad i = 1,\Delta R \qquad \text{(Gwe)} \qquad (7)$$

$$N_{LWR,i} = \left[\sum_{j=1}^{\Delta R} g_i + \sum_{j=\Delta R+1}^{i} (g_j - g_j') \right] dx \quad i = \Delta R + 1,\ N + \Delta R \quad . \quad \text{(Gwe)} \qquad (7a)$$

Correspondingly, the number of NASAP choice reactors on line at a given time (τ_i) is:

$$N_{NAS,i} = \sum_{j=1}^{i} r_j \, dx \qquad i = 1,\Delta R \qquad \text{(Gwe)} \qquad (8)$$

$$N_{NAS,i} = \left[\sum_{j=1}^{i} r_j + \sum_{j=\Delta R+1}^{i} (r_j - r_j') \right] dx \quad i = \Delta R + 1,\ N + \Delta R \quad . \quad \text{(Gwe)} \qquad (8a)$$

From equations (7), (7a), (8), and (8a), the maximum number of LWR's and NASAP choice plants ever on line from time T_{oo} to T_N can be found.

$$(N_{LWR})_{max} = \max(N_{LWR,i}) \qquad i = 1,\ N + \Delta R \qquad \text{(Gwe)} \qquad (9)$$

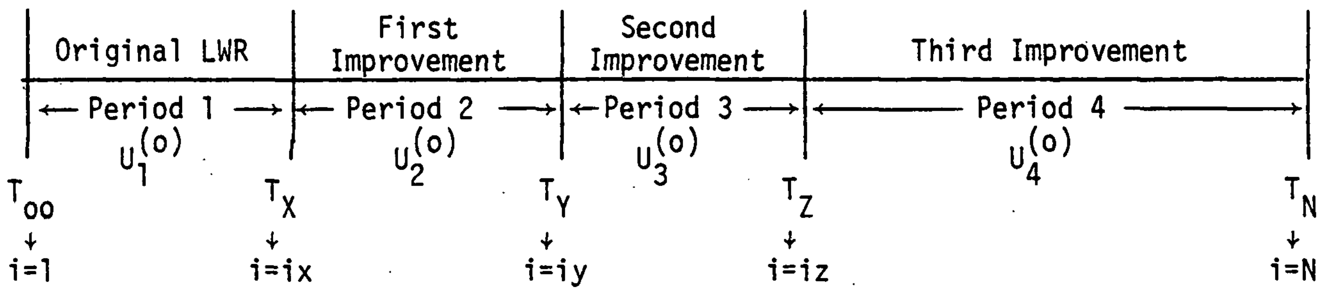
$$(N_{NAS})_{max} = \max(N_{NAS,i}) \quad . \qquad i = 1,\ N + \Delta R \qquad \text{(Gwe)} \qquad (10)$$

III. U_3O_8 Utilization

The LWR U_3O_8 utilization is assumed to be improved in three steps. Hence, there are four periods of improving U_3O_8 utilization. These periods are defined below and depicted in Figure 2.

Period 1: $[T_{oo}, T_X]$: Original LWR
Period 2: $[T_X, T_Y]$: First Improvement
Period 3: $[T_Y, T_Z]$: Second Improvement
Period 4: $[T_Z, T_N]$: Third Improvement

FIGURE 2



LWR Fuel Utilization Periods

All LWR's may be instantaneously backfitted to make use of new fuel utilization techniques. The LWR fuel usage over reactor lifetime (ΔR) years is calculated by determining the fraction ($f_{i,j}$) of reactor lifetime (ΔR) that an LWR started up in year (t_i) spends in each of the four usage periods. Each usage period is defined by the following four quantities:

$(T_L)_{i,j}$	= Lower boundary for period j.	(Calendar Year)
$(T_U)_{i,j}$	= Upper boundary for period j.	(Calendar Year)
$f_{i,j}$	= Usage factor for period j.	
$(U_o)_{i,j}$	= U_3O_8 for LWR lifetime in period j.	(Short Tons/Gwe)

The periodic parameters are calculated as follows:

<u>Usage Period 1 (j = 1) And (i = 1,N)</u>

$$(T_L)_{i,1} = \max \begin{cases} T_{oo}, & \text{or} \\ t_i \end{cases} \tag{11a}$$

$$(T_U)_{i,1} = \min \begin{cases} (t_i + \Delta R), & \text{or} \\ T_X \end{cases} \tag{11b}$$

$$f_{i,1} = \max \begin{cases} [(T_U)_{i,1} - (T_L)_{i,1}]/\Delta R, & \text{or} \\ 0.0 \end{cases} \tag{11c}$$

$$(U_o)_{i,1} = U_1^{(o)} \tag{11d}$$

Usage Period 2 ($j = 2$) ($i = 1,N$)

$$(T_L)'_{i,2} = \max \begin{cases} T_X, \text{ or} \\ t_i \end{cases} \qquad (12a)$$

$$(T_U)_{i,2} = \min \begin{cases} (t_i + \Delta R), \text{ or} \\ T_Y \end{cases} \qquad (12b)$$

$$f'_{i,2} = \max \begin{cases} [(T_U)_{i,2} - (T_L)'_{i,2}]/\Delta R, \text{ or} \\ 0.0 \end{cases} \qquad (12c)$$

For all values of (i) $\geq$ (ix) the following variables are evaluated:

$$(T_L)_{i,2} = (T_L)'_{i,2} \qquad (13)$$

$$f_{i,2} = f'_{i,2} \qquad (14)$$

$$(U_o)_{i,2} = U_2^{(o)} \qquad (15)$$

Equations (13) through (15) are also applied when the change occurring at year T_X is backfittable and the conditions of equation (16) are met for ($i = 1,N$).

$$(T_X - t_i) \leq (\Delta R - \Delta B) \qquad (16)$$

where:

ΔB = Minimun lifetime for backfitting to be possible (years).

The following variables are defined: For all values of (i) < (ix)

$$f_{i,2} = 0.0 \qquad (17)$$

$$f_{i,1} = f_{i,1} + f'_{i,2} \qquad (18)$$

$$(T_L)_{i,2} = (T_U)_{i,2} \qquad (19)$$

$$(T_U)_{i,1} = (T_U)_{i,2} \qquad (20)$$

$$(U_o)_{i,2} = (U_o)_{i,1} \qquad (21)$$

Equations (17) through (21) are also applied when backfitting does not occur at time (T_X) and equation (16) does not apply, i.e., $(T_X - t_i) > (\Delta R - \Delta B)$.

Usage Period 3 (j = 3) (i = 1,N)

$$(T_L)'_{i,3} = \max \begin{cases} T_Y, & \text{or} \\ t_i \end{cases} \tag{22}$$

$$(T_U)_{i,3} = \min \begin{cases} (t_i + \Delta R), & \text{or} \\ T_Z \end{cases} \tag{23}$$

$$f'_{i,3} = \max \begin{cases} [(T_U)_{i,3} - (T_L)'_{i,3}]/\Delta R, & \text{or} \\ 0.0 \end{cases} \tag{24}$$

The following variables are redefined for all values of (i) $\geq$ (iy):

$$(T_L)_{i,3} = (T_L)'_{i,3} \tag{25}$$

$$f_{i,3} = f'_{i,3} \tag{26}$$

$$(U_o)_{i,3} = U_3^{(o)} \tag{27}$$

Equations (25) through (27) are applied if the change occurring at year (T_Y) is backfittable and the conditions of equation (28) are met for (i = 1,N).

$$(T_Y - t_i) \leq (\Delta R - \Delta B) \tag{28}$$

For all values of (i) < (iy) and when $f_{i,2} > 0.0$ the following variables are redefined:

$$f_{i,3} = 0.0 \tag{29}$$

$$f_{i,2} = f_{i,2} + f'_{i,3} \tag{30}$$

$$(T_L)_{i,3} = (T_U)_{i,3} \tag{31}$$

$$(T_U)_{i,2} = (T_U)_{i,3} \tag{32}$$

$$(U_o)_{i,3} = U_2^{(o)} \tag{33}$$

Equations (34) through (38) are evaluated when (i) < (iy) and $f_{i,2} \leq 0.0$.

$$f_{i,3} = 0.0 \quad (34)$$

$$f_{i,1} = f_{i,1} + f'_{i,3} \quad (35)$$

$$(T_L)_{i,3} = (T_U)_{i,3} \quad (36)$$

$$(T_U)_{i,1} = (T_U)_{i,3} \quad (37)$$

$$(U_o)_{i,3} = U_1^{(o)} \quad (38)$$

When the change occurring at (T_Y) is not backfittable and the conditions of equation (28) are not met, equations (29) through (33) are applied if $(f_{i,2}) > 0.0$. When $(f_{i,2}) \leq 0.0$, equations (34) through (38) are applied.

Usage Period 4 (j = 4) AND (i = 1,N)

$$(T_L)'_{i,4} = \max \begin{cases} T_Z, \text{ or} \\ t_i \end{cases} \quad (39)$$

$$(T_U)_{i,4} = (t_i + \Delta R) \quad (40)$$

$$f'_{i,4} = \max \begin{cases} [(T_U)_{i,4} - (T_L)'_{i,4}]/\Delta R, \text{ or} \\ 0.0 \end{cases} \quad (41)$$

For all values of (i) $\geq$ (iz):

$$(T_L)_{i,4} = (T_L)'_{i,4} \quad (42)$$

$$f_{i,4} = f'_{i,4} \quad (43)$$

$$(U_o)_{i,4} = U_4^{(o)} \quad (44)$$

When the change occurring at point T_Z is backfittable and the conditions of equation (45) are met, equations (42) through (44) apply for (i = 1,N)

$$(T_Z - t_i) < (\Delta R - \Delta B) \quad (45)$$

The following variables are defined for all values of (i) < (iz) and $f_{i,3}$ > 0.0:

$$f_{i,4} = 0.0 \tag{46}$$

$$f_{i,3} = f_{i,3} + f'_{i,4} \tag{47}$$

$$(T_L)_{i,4} = (T_U)_{i,4} \tag{48}$$

$$(T_U)_{i,3} = (T_U)_{i,4} \tag{49}$$

$$(U_o)_{i,4} = U_3^{(o)} \tag{50}$$

For those values of (i) meeting the following criterion:

(i) < (iz). $f_{i,3} \leq 0.0$, and $f_{i,2} > 0.0$;

equations (51) through (55) are applied.

$$f_{i,4} = 0.0 \tag{51}$$

$$f_{i,2} = f_{i,2} + f'_{i,4} \tag{52}$$

$$(T_L)_{i,4} = (T_U)_{i,4} \tag{53}$$

$$(T_U)_{i,2} = (T_U)_{i,4} \tag{54}$$

$$(U_o)_{i,4} = U_4^{(o)} \tag{55}$$

When (i) < (iz), $f_{i,3} \leq 0.0$, and $f_{i,2} \leq 0.0$, the calculations are performed using equations (56) through (60).

$$f_{i,4} = 0.0 \tag{56}$$

$$f_{i,1} = f_{i,1} + f'_{i,4} \tag{57}$$

$$(T_L)_{i,4} = (T_U)_{i,4} \tag{58}$$

$$(T_U)_{i,1} = (T_U)_{i,4} \tag{59}$$

$$(U_o)_{i,4} = U_4^{(o)} \tag{60}$$

The following variables are defined for all values of $i = N + 1, N + \Delta R$.

$$f_{i,j} = 0.0 \quad \text{for } j = 1,3 \tag{61}$$

$$f_{i,4} = 1.0 \tag{62}$$

$$(U_o)_{i,j} = 0.0 \quad \text{for } j = 1,3 \tag{63}$$

$$(U_o)_{i,4} = U_4^{(o)} \tag{64}$$

$$(T_L)_{i,j} = T_N \quad \text{for } j = 1,3 \tag{65}$$

$$(T_L)_{i,4} = t_i \tag{66}$$

$$(T_U)_{i,j} = T_N \quad \text{for } j = 1,3 \tag{67}$$

$$(T_U)_{i,4} = t_i + \Delta R \tag{68}$$

The fuel required by an LWR started up in year t_i for $(i = 1,N)$ is:

$$U_i = (U_1^{(o)} f_{i,1} + U_2^{(o)} f_{i,2} + U_3^{(o)} f_{i,3} + U_4^{(o)} f_{i,4})\left(\frac{\eta_{LWR}\Delta R}{\eta_o \Delta_o}\right) \quad \left(\frac{\text{Short Tons}}{\text{Gwe}}\right) \tag{69}$$

where:

$U_j^{(o)}$ $(j = 1,4)$ = U_3O_8 for LWR lifetime for period j (short tons/Gwe).

$f_{i,j}$ $(j = 1,4)$ = Calculated fractional fuel usage for period j.

η_{LWR} = LWR capacity factor over lifetime ΔR. $\left(\frac{hre}{hr}\right)$

ΔR = Reactor lifetime (years).

η_o = Reference capacity factor. $\left(\frac{hre}{hr}\right)$

Δ_o = Reference lifetime (years).

The NASAP choice reactor U_3U_8 requirement is:

$$U^* = \frac{(U_o \eta_{NAS} \Delta R)}{(\eta_o \Delta_o)} \quad \text{(short tons/Gwe)} \tag{70}$$

where

U_o = Reference U_3O_8 for NASAP choice reactor lifetime at capacity factor η_o over reference lifetime Δ_o (short tons/Gwe)

η_{NAS} = NASAP choice capacity factor over reactor lifetime ΔR. $(\frac{hre}{hr})$

The U_3O_8 committed to any date t_i is:

$$H_i = \left[\sum_{\ell=1}^{i} g_\ell U_\ell + \sum_{\ell=1}^{i} r_\ell U^*\right] dx \quad i = 1,N \quad \text{(short tons)} \qquad (71)$$

where:

g_ℓ is defined by equations (5) and (6). (Gwe/year)

U_ℓ is defined by equation (69). (short tons/Gwe)

r_ℓ is defined by equation (2). (Gwe/year)

U^* is defined by equation (70). (short tons/Gwe)

Using equation (71) the function H_i is defined for all t_i; i.e., $H_i = f(t)$. Therefore, the years t_i corresponding to $H = 2.6 \times 10^6$ short tons and $H = 5.4 \times 10^6$ short tons of U_3O_8 can be found by interpolation. The values of $t^* = t_i$ at $H_i = 2.6 \times 10^6$ and $t^{**} = t_i$ at $H_i = 5.4 \times 10^6$ represent the years in which 2.6×10^6 and 5.4×10^6 short tons of U_3O_8 will be committed.

IV. U_3O_8 Cost Increase Factors

The U_3O_8 cost is assumed to increase over the period $[T_{oo}, T_N]$ according to a known function $\psi(t)$, normalized such that $\psi(T_B) = 1.0$, (Figure 4). The average values of $\psi(t)$ for all reactors started up in year (t_i), including the accounting for U_3O_8 utilization improvement throughout reactor lifetime, is a function of the U_3O_8 used to time τ_i where $(i = 1, N + \Delta R)$.

In order to compute the average values of $\psi(t)$ for all reactors, it is necessary to first determine the ore (U_3O_8) used, (not committed) to time τ_K as a function of $\psi(t)$. These values will then make up the function $(M_K \tau_K)$; i.e., ore used versus time.

The current fuel usage period is found for each of the times (τ_k) to which the fuel usage for all reactors starting up in year (t_i) will be computed, Figure 3.

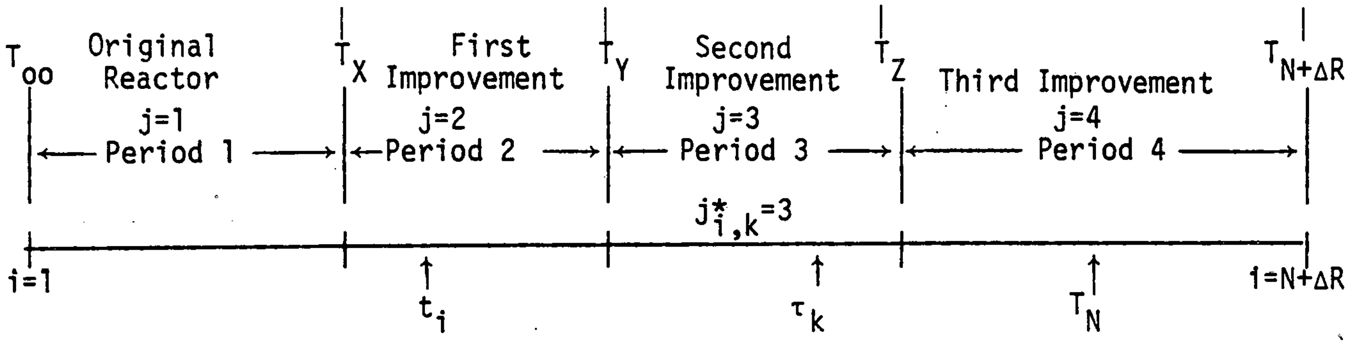


FIGURE 3

where:

t_i = Year g_i LWR's and r_i NASAP's are started up.

τ_k = Year to which fuel usage for g_i LWR's and r_i NASAP's will be computed.

The current fuel usage period ($j^*_{i,k}$) is the value of j that satisfies equation (72).

$$(T_L)_{i,j} \leq \tau_k < (T_U)_{i,j} \qquad j = 1,4 \quad i = 1,N+\Delta R \quad k = 1,N+\Delta R \tag{72}$$

where:

$(T_L)_{i,j}$ and $(T_U)_{i,j}$ are the lower and upper boundaries respectively of the fuel usage period (j) as defined in Section III.

The fuel used by an LWR started up in year (t_i) is now a function of both (τ_k) and ($j^*_{i,k}$).

Thus, if $[t_i \leq \tau_k < (t_i + \Delta R)]$ and $j^*_{i,k} > 1$ the fuel used by an LWR is:

$$\tau_{i,k} = \sum_{j=1}^{j^*_{i,k}-1} \left[\frac{(U_o)_{i,j}}{\Delta_o \eta_o}\right] f_{i,j}\, \eta_{LWR}\, \Delta R + \left[\frac{(U_o)_{i,j^*_{i,k}}}{\Delta_o \eta_o}\right] \eta_{LWR} \left[\mathrm{Max} \begin{cases} \tau_k - (T_L)_{i,j^*_{i,k}} \\ 0.0 \end{cases}\right] \quad \text{(Short tons/Gwe)} \tag{73}$$

If $[t_i \leq \tau_k < (t_i + \Delta R)]$ and $j^*_{i,k} = 1$, the fuel used by an LWR is:

$$T_{i,k} = 0.0 + [\frac{(U_o)_{i,j^*_{i,k}}}{\Delta_o n_o}] n_{LWR} [Max \begin{cases} T_k - (T_L)_{i,j^*_{i,k}}] \\ 0.0 \end{cases} \quad \text{(Short Tons/Gwe)} \tag{74}$$

If $[\tau_k \geq (t_i + \Delta R)]$, the fuel used by an LWR is:

$$T_{i,k} = \sum_{j=1}^{4} (\frac{(U_o)_{i,j}}{\Delta_o n_o}) f_{i,j} \, n_{LWR} \, \Delta R \qquad \begin{matrix} i = 1,N+\Delta R \\ k = 1,N+\Delta R \end{matrix} \quad \text{(Short Tons/Gwe)} \tag{75}$$

where:

$(U_o)_{i,j}$ = U_3O_8 for LWR lifetime in period j (short tons/Gwe).

Δ_o = Reference lifetime (years).

n_o = Reference capacity factor. $(\frac{hre}{hr})$

$f_{i,j}$ = Fuel usage fraction in period j. (Section III)

n_{LWR} = LWR capacity factor over ΔR. $(\frac{hre}{hr})$

ΔR = Reactor lifetime (years).

$(T_L)_{i,j}$ = Lower boundary for period j. (Calendar Year)

The fuel used by all plants (LWR plus NASAP choice) up through year τ_k is:

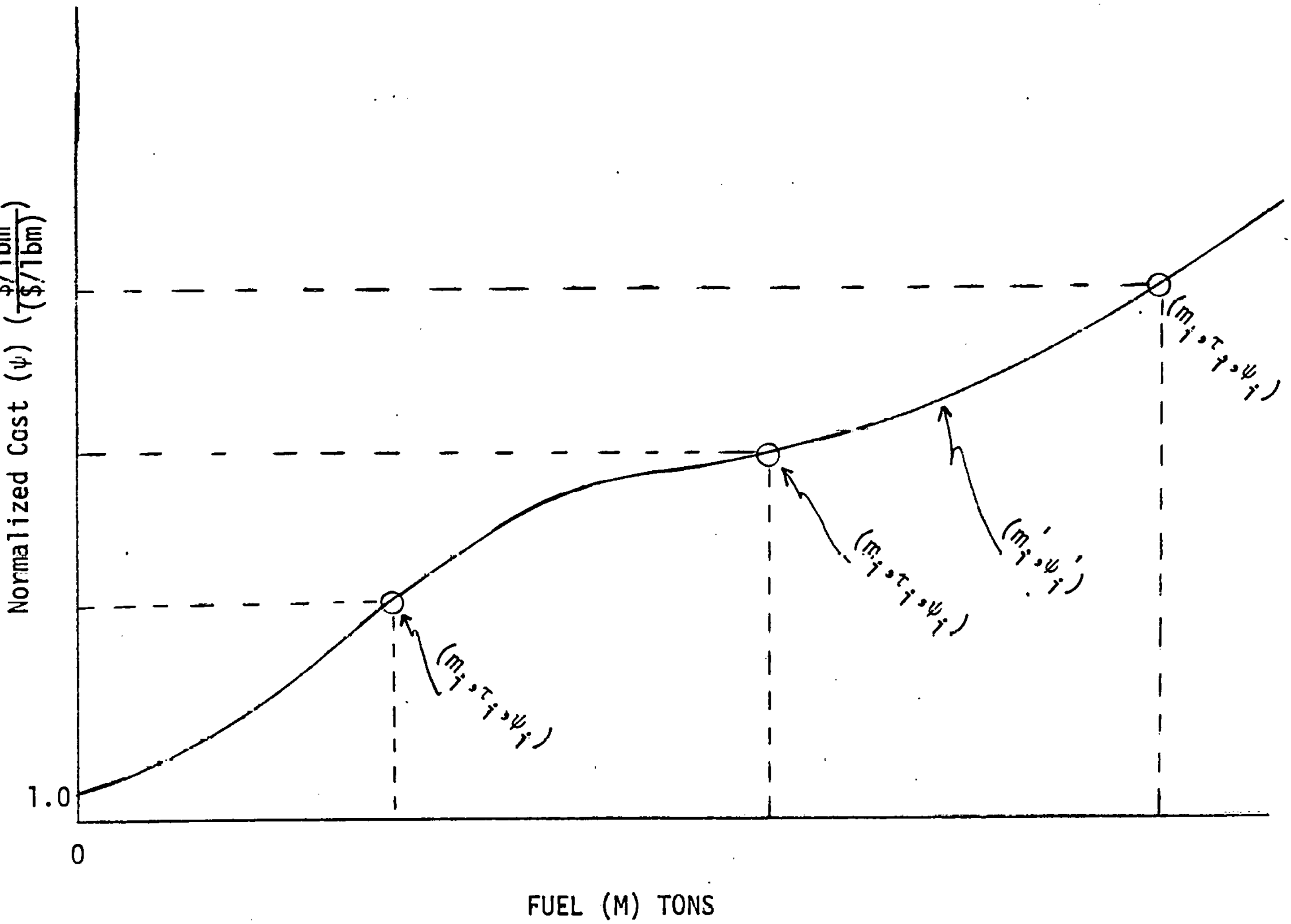
$$M_k = \left[\sum_{i=1}^{k} T_{i,k} \, g_i + \sum_{i-1}^{k} (\frac{U_o}{n_o \Delta_o}) \, n_{NAS} \, N_{NAS,i}\right] dx \quad (k=1,N+\Delta R) \quad \text{(Short Tons)} \tag{76}$$

The array $[M_k, \tau_k]$ defined by equation (76) represents the U_3O_8 used, (M_k) to date (τ_k), $(k = 1, N + \Delta R)$.

It is assumed that the function $\psi(t) = [M_i', \psi_i']$, $(i = 1, M)$, normalized to 1.0 in year T_B is known, where M_i' represents the ore mined in (tons) and ψ_i' the cost of mining in (\$/lbm). The discrete set of $[M_i', \psi_i']$ points describe the U_3O_8 cost increase as more ore is mined and the ore grade decreases.

The fuel cost is determined as follows:
Each of the calculated array values of $[M_k, \tau_k]$ is interpolated into the known function $[M_i', \psi_i']$ such that for a discrete amount of fuel used, (M_i), at a given time (τ_i), the cost (ψ_i) can be determined, Figure 4. Thus, the

FIGURE 4



Ore Mined (Tons) Versus Normalized Cost

cost versus time function $[\psi_i, \tau_i]$ is formed for all values of $(i = 1, N + \Delta R)$.

The average cost, $(\mu_{i,j})$ of U_3O_8 for reactors in fuel region (j) that were started up in year (τ_i) is then computed.

For all $(T_L)_{i,j} < (T_U)_{i,j}$

$$\mu_{i,j} = [\frac{1}{(t_{iu} - t_{iL})}] \sum_{k=iL}^{iu-1} (\frac{\psi_k + \psi_{k+1}}{2.0}) \; dx \quad \begin{matrix} i = 1,N \\ j = 1,4 \end{matrix} \qquad (77)$$

where:

iu = The value of counter (i) at $t_i = (T_U)_{i,j}$.

iL = The value of counter (i) at $t_i = (T_L)_{i,j}$.

Obviously, when the calculated lower boundary of region (j), $(T_L)_{i,j}$ is greater than or equal to the calculated upper boundary of region (j), $(T_U)_{i,j}$, both the fuel used and the average cost are set to zero.

V. Research And Development (R&D) Cost

First-Time Engineering Costs

It is assumed that the first-time engineering cost for one Vendor, E, is known and that a fixed number of vendors, three, plus government supervision, will be involved. Therefore, the total first-time engineering cost, T_E, is simply:

$$T_E = 3.0\ E \qquad \$ \qquad (78)$$

General R&D

The minimum corporate R&D cost (R_{minw}) for all agents and the cost split among the three vendors and government supervision, with corresponding overlap factors, are assumed to be known.

Agent	Fraction Of R&D Dollars To Agent	Overlap Factor
Vendor 1	v_1	F_1
Vendor 2	v_2	F_2
Vendor 3	v_3	F_3
Government	v_4	F_4

The cost associated with each vendor and government supervision is:

Vendor 1: $V_1 = v_1 F_1 R_{minw}$ (dollars) (78a)

Vendor 2: $V_2 = v_2 F_2 R_{minw}$ (dollars) (78b)

Vendor 3: $V_3 = v_3 F_3 R_{minw}$ (dollars) (78c)

Government: $V_4 = v_4 F_4 R_{minw}$ (dollars) (78d)

The contribution of NASAP R&D to capital cost is a total of R (dollars) available to be dispensed at fraction (d_i) per year in years (t_i) and is determined as follows:

$$R = V_1 + V_2 + V_3 + V_4 \quad \text{(dollars)} \quad (79)$$

Model 1

NASAP Plants

The cost of R&D is spread over all NASAP choice plants sold and is treated as a component of capital cost, present worth as though it were a part of the purchase price, paying for development in earlier years. It is assumed that there are no taxes and that the discount rate is low (∿ 0.085), corresponding to government financing of all R&D.

The contribution of NASAP R&D (x_D) to capital cost is:

$$x_D = \frac{\left(\int_{T_{oo}}^{T_n} R\, d(t)\xi(t)\, dt\right)(1.0 + f_c\, \lambda^*[1 - \rho])}{\left(\int_{T_{oo}}^{T_n} r(t)\xi(t) \left(\frac{1}{1 + r_D}\right)^{\lambda^*(\rho - 1)} dt\right)\left(\frac{10^6\ \text{Kwe}}{\text{Gwe}}\right)} \quad (\$/\text{Kwe}) \quad (80)$$

where

R = R&D cost as defined in Equation (79) (dollars).

$\xi(t)$ = discount function = $\left(\frac{1}{1 + r_D}\right)^{t-T_B}$ (Equation 81)

$d(t) = d_i$, $i = 1, N$: fraction of NASAP development dollars spent in each of the N years $[T_{oo}, T_N]$

f_c = interest rate during construction (fraction)

λ^* = lag time between purchase and startup of NASAP choice reactor (years)

ρ = average fraction of lag time that passes before half the plant is paid for

$r(t) = r_i$, $i = 1, N$: NASAP installation rate = plant startup rate (Gwe/year)

r_D = fractional discount rate

T_B = base year for all costs (i.e., 1978) (calendar year)

The plant startup rate, r(t), is discounted according to Equation (81).

Discount Function

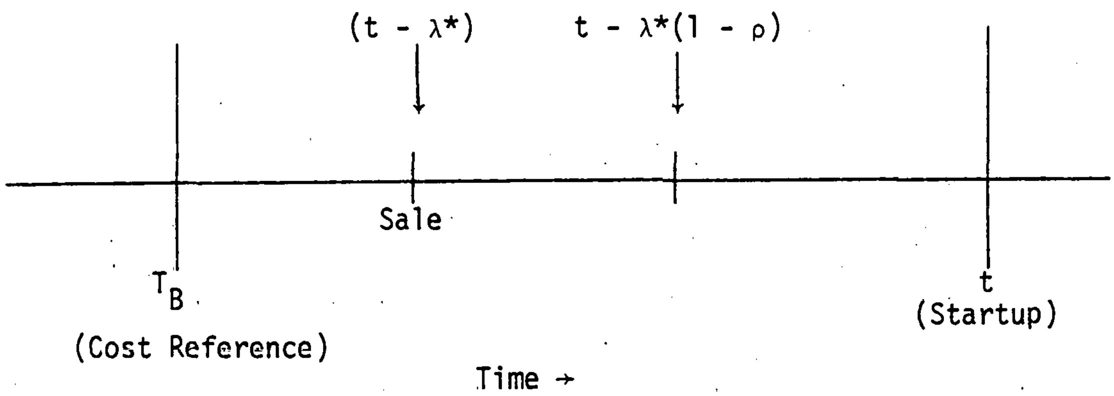


FIGURE 5

$$\xi(t) \left(\frac{1}{1 + r_D}\right)^{\lambda^*(\rho - 1)} = \left(\frac{1}{1 + r_D}\right)^{t - \lambda^*(1 - \rho) - T_B} \qquad (81)$$

The integrals of Equation (80) are approximated as follows:

$$I_d = \int_{T_{oo}}^{T_n} d(t)\xi(t)dt$$

$$I_d = \sum_{i=1}^{N} \left(\frac{d_i\left[\left(\frac{1.0}{1. + r_D}\right)^{t_i+1/2-T_B} - \left(\frac{1.0}{1. + r_D}\right)^{t_i-1/2-T_B}\right]}{\ln\left(\frac{1.0}{1. + r_D}\right)} \right) \quad (82)$$

$$I_s = \int_{T_{oo}}^{T_N} r(t)\xi(t) \left[\frac{1.0}{1.+ r_D}\right]^{\lambda^*(\rho - 1)} dt$$

Using Equation (81)

$$I_s = \int_{T_{oo}}^{T_N} r(t) \left[\frac{1.0}{1.+ r_D}\right]^{t - \lambda^*(1 - \rho) - T_B} dt$$

$$I_s = \sum_{i=1}^{N} \left(\frac{r_i\left[\left(\frac{1.0}{1. + r_D}\right)^{t_i+1/2-\tau^*} - \left(\frac{1.0}{1. + r_D}\right)^{t_i-1/2-\tau^*}\right]}{\ln\left(\frac{1.0}{1. + r_D}\right)} \right) \quad (83)$$

where:

$$\tau^* = \lambda^* (1 - \rho) - T_B \quad .$$

Substituting Equations (82) and (83) back into Equation (80) gives:

$$x_D = \frac{I_d \; R(1.0 + f_c\lambda^* [1 - \rho])}{I_s \left(\frac{10^6 \text{ Kwe}}{\text{Gwe}}\right)} \quad (\$/\text{Kwe}) \quad . \quad (84)$$

The total NASAP development cost (X_D) is then determined as follows:

$$X_D(10^9\$) = \sum_{i=1}^{N} \left(r_i \; x_D \Delta R \; i_{Fc} \; 10^6 \; \frac{\text{Kwe}}{\text{Gwe}} \; \frac{10^{-9} \text{ billions}}{\$}\right) \quad (\$) \quad (85)$$

where:

r_i = NASAP installation rate (Equation (2)) (Gwe/year)

x_D = the contribution of R&D to capital cost (Equation (84))($/Kwe)

ΔR = reactor lifetime (years)

i_{Fc} = plant fixed charge rate (year^{-1})

LWR Plants

The LWR research and development costs for improvements in ore utilization at times T_x, T_y and T_z (Figure 2) require a development cost of A (dollars) at time T_x, B (dollars) at time T_y and C (dollars) at time T_z. The three amounts, A, B and C (dollars) are disbursed at fractional rates of $\alpha(t)$, b(t) and c(t), respectively (Figure 6).

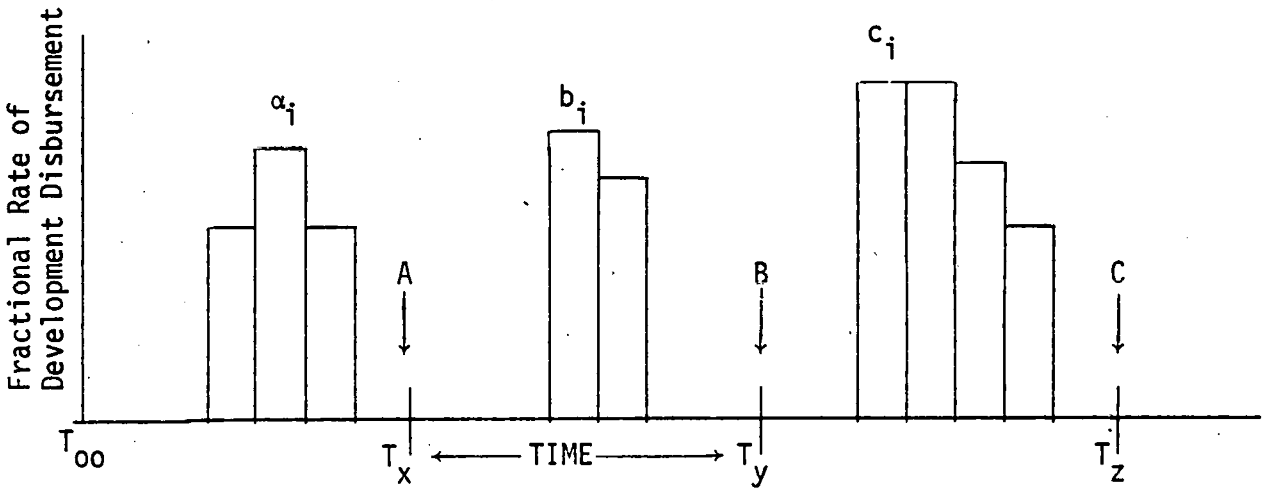


FIGURE 6

It is assumed that the development money is discounted at rate (r_D) and that no income tax is charged on its benefits. Then, the equations of income and outgo for each of the improvement periods are:

Period 1

Original LWR, no improvement costs.

Period 2

First improvement:

$$\int_{T_{oo}}^{T_N} A\,\alpha(t)\left(\frac{1.0}{1.+r_D}\right)^{[t-T_B]} dt = (y_1 h_1 10^6)\int_{T_x+\Delta B-\Delta R}^{T_x} g(t)\,dt\left(\frac{1.0}{1.+r_D}\right)^{(T_x-T_B-\beta/2)} + \int_{T_x}^{T_N} g(t)\left(\frac{1.0}{1.0+r_D}\right)^{[t-\lambda(1.-\rho)-T_B]} dt \qquad (86)$$

Period 3

Second improvement:

$$\int_{T_{oo}}^{T_N} B\ b(t)\left(\frac{1.0}{1.+r_D}\right)^{(t-T_B)} dt = (y_2 h_2 10^6) \int_{T_{y+\Delta B-\Delta R}}^{T_y} g(t)\ dt\left(\frac{1.0}{1.0+r_D}\right)^{(T_y-T_B-\beta/2)}$$

$$+ \int_{T_y}^{T_N} g(t)\left(\frac{1.0}{1.0+r_D}\right)^{[t-\lambda\ (1.-\ \rho)-T_B]} \qquad (87)$$

Period 4

Third improvement:

$$\int_{T_{oo}}^{T_N} C\ c(t)\left(\frac{1.0}{1.+r_D}\right)^{(t-T_B)} dt = (y_3 h_3 10^6) \int_{T_z+\Delta B-\Delta R}^{T_z} g(t)\ dt\left(\frac{1.0}{1.0+r_D}\right)^{(T_z-T_B-\beta/2)}$$

$$+ \int_{T_z}^{T_N} g(t)\left(\frac{1.0}{1.0+r_D}\right)^{[t-\lambda\ (1\ -\ \rho)-T_B]} \qquad (88)$$

Equations (86) through (88) can be combined and generalized by introducing the following variables and shifting the scale of Figure (2), Figure (7).

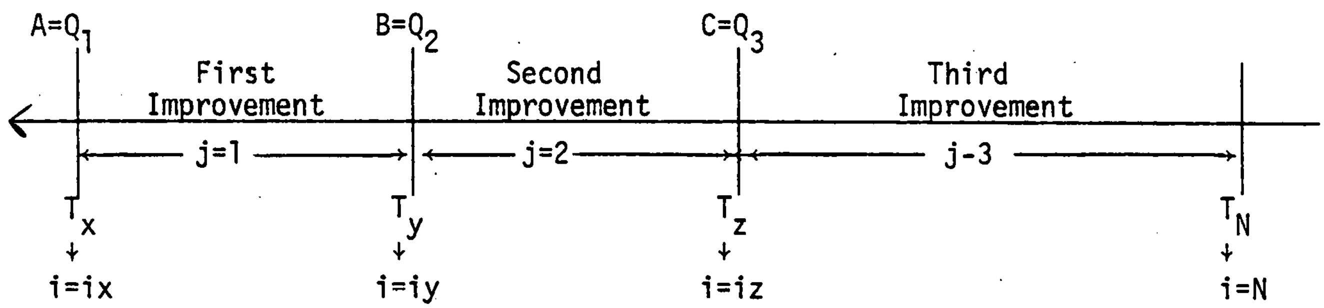


FIGURE 7

$$Q_j = Q_1 = A \qquad j = 1,3$$
$$= Q_2 = B$$
$$= Q_3 = C$$

$$q_{i,j} = q_{i,1} = a_i,\ i = 1, N;\ j = 1,3 \qquad \sum_{j=1}^{3} \sum_{i=1}^{N} q_{i,j} = 1.0$$

$$q_{i,2} = b_i,\ i = 1, N$$

$$q_{i,3} = c_i,\ i = 1, N$$

$$k_j = ix \qquad j = 1,3$$

$$= iy$$

$$= iz$$

$$\tau_Q = \lambda(1 - \rho) + T_B$$

$$\nu = \beta/2 + T_B \quad .$$

Then the general equation of income and outgo becomes:

$$\int_{T_{oo}}^{T_N} Q_j\, q_{i,j} \left(\frac{1.0}{1.+r_D}\right)^{(t-T_B)} dt = y_j[h_j 10^6 \int_{T_{k_j}+\Delta B-\Delta R}^{T_{k_j}} g(t)\left(\frac{1.0}{1.+r_D}\right)^{(T_{k_j}-\nu)} dt$$

$$+ \int_{T_{k_j}}^{T_N} g(t)\left(\frac{1.0}{1.+r_D}\right)^{(t-\tau_Q)} dt] \tag{89}$$

The integrals of Equation (89) are approximated as follows:

$$I_{q(j)} = \int_{T_{oo}}^{T_N} q_{i,j} \left(\frac{1.0}{1.+r_D}\right)^{(t-T_B)} dt =$$

$$\sum_{i=1}^{N} \frac{q_{i,j} \left[\left(\frac{1.0}{1.+r_D}\right)^{t_i+1/2-T_B} - \left(\frac{1.0}{1.+r_D}\right)^{t_i-1/2-T_B}\right]}{\ln\left[\frac{1.0}{1.+r_D}\right]} \tag{90}$$

$$I_{v(j)} = \int_{T_{k_j}+\Delta B-\Delta R}^{T_{k_j}} g(t)\left(\frac{1.0}{1.+r_D}\right)^{(T_{k_j}-\nu)} dt =$$

$$\left(\sum_{i=k_j+\Delta B-\Delta R}^{k_{j-1}} g_i\right)\left(\frac{1.0}{1.+r_D}\right)^{(t_{k_j}-\nu)} \tag{91}$$

$$I_{w(j)} = \int_{T_{k_j}}^{T_N} g(t)\left(\frac{1.0}{1.+r_D}\right)^{(t-\tau_Q)} dt = \qquad (92)$$

$$\sum_{i=k_j}^{N} \frac{g_i \left[\left(\frac{1.0}{1.+r_D}\right)^{t_i+1/2-\tau_Q} - \left(\frac{1.0}{1.+r_D}\right)^{t_i-1/2-\tau_Q}\right]}{\ln\left(\frac{1.0}{1.+r_D}\right)}$$

Substituting Equations (90) through (92) back into Equation (89) and solving for (y_j) gives the cost associated with LWR development in each of the 3 periods, without interest during construction.

$$y_j = \frac{I_{q(j)}\, Q_j}{(h_j\, I_{v(j)} + I_{w(j)})10^6} \qquad j = 1,3 \qquad \text{(mills/Kwhre)} \qquad (93)$$

where:

Q_J = Total development costs for each period (j = 1,3) ($)

$q_{i,j}$ = Fraction of LWR dollars spent in each of (i = 1, N) years for each change period (j = 1,3)

r_D = Discount rate

h_j = 1; change for each period is backfitable
0; change for each period is not backfitable

T_B = Base year for all costs (e.g., 1978) (calendar year)

$g(t)$ = g_i = LWR installation rate (Equation (6)) (Gwe/year)

T_{k_j} = End of improvement period j (j = 1,3)

ΔB = Minimum lifetime for backfitting to be possible (years)

ΔR = Reactor lifetime (years)

k_j = (i) value at points T_x, T_y and T_z (Figure 7)

λ = Lag time between LWR purchase and startup (years)

ρ = Average fraction of lag time that passes before half the plant is paid for

The total R&D cost for LWR's (x_{LWR}) in all three improvement periods of Figure 7 then becomes

$$X_{LWR}^{(10^9\$)} = [\ X_{11}+X_{12}+X_{21}+X_{22}+X_{31}+X_{32}][\Delta R\ \frac{10^6\ \text{Kwe}}{\text{Gwe}}\ \frac{10^{-9}\ \text{billions}}{\$}] \quad (\$) \qquad (94)$$

where each of the terms is evaluated as follows:

$$X_{11} = \sum_{i=ix+\Delta B-\Delta R}^{ix-1} \{g_i[f_{i,2}+f_{i,3}+f_{i,4}]\ y_i i'_{Fc}\ (1.0+f_c\ \beta/2)\}\ dx \qquad (94a)$$

or

$X_{11} = 0.0$ when the first improvement (Period (1), Figure (7)), is not backfitable.

$$X_{12} = i_{Fc}(\sum_{i=ix}^{N} g_i\ [f_{i,2}+f_{i,3}+f_{i,4}]\ y_1(1.0+f_c\lambda[1.0-\ \rho]))\ dx \qquad (94b)$$

$$X_{21} = \sum_{i=iy+\Delta B-\Delta R}^{iy-1} \{g_i[f_{i,3}+f_{i,4}]\ y_2\ i'_{Fc}\ (1.0+f_c\beta/2)\}\ dx \qquad (94c)$$

or

$X_{21} = 0.0$ when the second improvement (Period (2), Figure (7)), is not backfitable.

$$X_{22} = i_{Fc}(\sum_{i=iy}^{N} g_i[f_{i,3}+f_{i,4}]\ y_2(1.0+f_c\lambda[1.0\ -\rho]))\ dx \qquad (94d)$$

$$X_{31} = \sum_{i=iz+\Delta B-\Delta R}^{iz-1} \{g_i[f_{i,4}]\ y_3\ i'_{Fc}\ (1.0+f_c\beta/2)\}\ dx \qquad (94e)$$

or

$X_{31} = 0.0$ when the third improvement (Period (3), Figure (7)), is not backfitable.

$$X_{32} = i_{Fc}(\sum_{i=iz}^{N} g_i\ f_{i,4}\ y_3\ (1.0 + i_u\lambda\ [1.0 - \rho]))\ dx \qquad (94f)$$

where:

ix = i value at T_x (Figure 7)

g_i = Rate of LWR installation (Equations (5) and (6)) $(\frac{\text{Gwe}}{\text{yr}})$

$f_{i,j}$ = Fuel usage factor (calculated in Section III)

y_j = LWR development cost (Equation (93)) (\$/Kwe)

i'_{Fc} = Fixed charge rate on backfits (years^{-1})

f_c = Fractional interest rate during construction

β = Time required to install backfitted changes (years)

i_{Fc} = Plant fixed charge rate (years^{-1})

λ = Lag time between LWR purchase and startup (years)

ρ = Average fraction of lag time which passes before half the plant is paid for

ΔB = Minimum lifetime remaining for backfitting to be feasible (years)

ΔR = Reactor lifetime (years)

iy = i value at T_y (Figure 7)

iz = i value at T_z (Figure 7)

The total cost of research and development, (C_{RD}), is defined as the total NASAP R&D cost plus the total LWR R&D cost. Therefore, the total R&D cost is simply the sum of Equations (85) and (94):

$$C_{RD} = x_{LWR} + X_D \qquad (\$) \qquad (95)$$

Model 2

NASAP Plants

The basic assumptions of Model 1 are retained; i.e., the cost of research and development is spread over all NASAP choice plants sold. It is also assumed that there are no taxes and that the discount rate remains low, corresponding to government financing of all R&D.

The NASAP R&D contribution to NASAP power cost (ω_{NAS}) is determined:

$$\omega_{NAS} = \frac{\int_{T_{oo}}^{T_N} R\, d(t)\xi(t)\, dt}{\int_{T_{oo}}^{T_N+\Delta R} N_{NAS}(t)\xi(t)\, dt\ \eta_{NAS}\ 10^{-3}\ \frac{\$}{mill}\ 10^{6}\ \frac{Kwe}{Gwe}\ 8677\ \frac{hr}{yr}} \qquad \left(\frac{mills}{Kwhre}\right) \qquad (96)$$

The integrals of Equation (96) are approximated as follows:

$$I_d = \int_{T_{oo}}^{T_N} d(t)\xi(t)\, dt$$

$$I_d = \sum_{i=1}^{N} \left\{ \frac{d_i\left[\left(\frac{1.0}{1.+r_D}\right)^{t_i+1/2-T_B} - \left(\frac{1.0}{1.+r_D}\right)^{t_i-1/2-T_B}\right]}{\ln\left(\frac{1.0}{1.+r_D}\right)} \right. \tag{97}$$

where:

d_i = Fraction of NASAP development dollars spent in each of the N years $[T_{oo}, T_N]$ such that $\sum_{i=1}^{N} d_i = 1.0$

r_D = Discount rate

T_B = Base year for all costs, i.e. (1978) (calendar year)

$$I_s = \int_{T_{oo}}^{T_N+\Delta R} N_{NAS}(t)\xi(t)\, dt$$

$$= \sum_{i=1}^{N+\Delta R} \left\{ \frac{N_{NAS,i}\left[\left(\frac{1.0}{1.+r_D}\right)^{t_i+1/2-T_B} - \left(\frac{1.0}{1.+r_D}\right)^{t_i-1/2-T_B}\right]}{\cdot\ \ln\left(\frac{1.0}{1.+r_D}\right)} \right\} \tag{98}$$

where:

$N_{NAS,i}$ = the number of NASAP reactor on line at time (t_i) (Equations (8), (8a)) (Gwe)

and r_D, T_B are defined in Equation (97).

Substituting Equations (97) and (98) back into Equation (96) gives:

$$\omega_{NAS} = \frac{R\ Id}{I_s\ \eta_{NAS}\ 8766\ 10^3} \quad \left(\frac{\text{mills}}{\text{Kwhre}}\right) \tag{99}$$

The total NASAP development cost (X_D) then becomes:

$$X_D(\text{billions}) = \left(\frac{R\ Id}{I_s}\right)\left(10^{-9}\ \frac{\text{billions}}{\$}\right) \sum_{i=1}^{N+\Delta R} N_{NAS,i} \qquad (\$) \tag{100}$$

where:

$\bar{R}$ = R&D costs as defined in Equation (79) (dollars)

I_d = Equation (97)

I_s = Equation (98)

$N_{NAS,i}$ = Equations (8) and (8a) (Gwe)

LWR Plants

The basic assumptions of Model 1 are retained, i.e., amounts A, B and C (dollars) are R&D costs at times T_x, T_y and T_z, respectively, and are disbursed at fractional rates of $\alpha(t)$, $b(t)$, and $c(t)$, Figure (7). The discount rate (r_D) is applied to the development monies and it is assumed that there are no income tax charges.

The general equation of income and outgo for each of the improvement periods of (Figure (7)), becomes:

$$\int_{T_{oo}}^{T_N} Q_j\, q_{i,j} \left(\frac{1.0}{1.+r_D}\right)^{t-t_B} dt = \omega_j \eta_{LWR} h_j\, 10^6 \int_{T_{k_j}}^{T_N+\Delta R} \left(\int_{T_{k_j}+\Delta B-\Delta R}^{T_k-1} n_{i,j}\right)\left(\frac{1.0}{1.+r_D}\right)^{t-T_B} dt$$

$$+ \int_{T_{k_j}}^{T_N+\Delta R} \left(\int_{T_{k_j}}^{i} n_{i,\ell}\right)\left(\frac{1.0}{1.+r_D}\right)^{t-\bar{T}_B} dt \qquad (101)$$

The integrals of Equation (101) are approximated as follows:

$$I_q(j) = \int_{T_{oo}}^{T_N} q_{i,j} \left(\frac{1.0}{1.+r_D}\right)^{(t-T_B)} dt \qquad \text{(year)}$$

$$= \sum_{i-1}^{N} \frac{q_{i,j}\left[\left(\frac{1.0}{1.+r_D}\right)^{t_i+1/2-T_B} - \left(\frac{1.0}{1.+r_D}\right)^{t_i-1/2-T_B}\right]}{\ln\left(\frac{1.0}{1.+r_D}\right)} \qquad (102)$$

$$I_v(j) = \int_{T_{k_j}}^{T_N + R} \{ (\int_{T_{k_j}+\Delta B-\Delta R}^{T_{k_{j-1}}} n_{i,\ell}) (\frac{1.0}{1.+r_D})^{t-T_B} \} dt \qquad \text{(Gwe)}$$

$$= \sum_{i=k_j}^{N+R} \{ [\sum_{\ell=k_j+\Delta B-\Delta R}^{kj-1} n_{i,\ell}] [\frac{(\frac{1.0}{1.+r_D})^{t_i+1/2-T_B} - (\frac{1.0}{1.+r_D})^{t_i-1/2-T_B}}{\ln(\frac{1.0}{1.+r_D})}] \} \qquad (103)$$

$$I_w(j) = \int_{T_{k_j}}^{T_N+\Delta R} \{ (\int_{T_{k_j}}^{i} n_{i,\ell}) (\frac{1.0}{1.+r_D})^{t-T_B} \} dt \qquad \text{(Gwe)}$$

$$= \sum_{i=k_j}^{N+\Delta R} \{ [\sum_{\ell=k_j}^{i} n_{i,\ell}] [\frac{(\frac{1.0}{1.+r_D})^{t_i+1/2-T_N} - (\frac{1.0}{1.+r_D})^{t_i-1/2-T_B}}{\ln(\frac{1.0}{1.+r_D})}] \} \qquad (104)$$

where $n_{i,\ell}$ = the number of LWR's started in year (ℓ) that are still operative in year (i).

$$n_{i,\ell} = \begin{cases} 0 \text{ when } \ell \leq (i - \Delta R) \\ g_\ell \text{ when } \ell > (i - \Delta R) \end{cases} \qquad \text{(Gwe/year)} \qquad (105)$$

Equations (102), (103), and (104) are substituted back into Equations (101), solving for (ω_j). Equation (106) then gives the LWR development contributions to LWR power cost for each of the three improvement periods (Figure 7).

$$\omega_{LWR}(j) = \frac{Q_j \; I_q(j)}{n_{LWR}(10^{-3} \frac{\$}{mill})(10^6 \frac{Kwe}{Gwe})(8766 \frac{hrs}{yr})(h_j Iv(j) + Iw(j))} [\frac{mills}{kwhre}] \qquad (106)$$

The total LWR research and development cost (X_{LWR}) (billions \$) is computed as follows:

$$X_{LWR} = (10^{-9} \frac{billions}{\$}) \sum_{j=1}^{3} \{ \frac{Q_j I_q(j)}{h_j \; I_{v(j)} + I_{w(j)}} (\sum_{i=k_j}^{N+\Delta R} [\sum_{\ell=k_j}^{i} n_{i,\ell}$$

$$+ h_j \sum_{\ell=k_j+\Delta B-\Delta R}^{k_j-1} n_{i,\ell}]) \} \qquad (\$) \qquad (107)$$

where:

Q_j = Total development costs for each period (i.e., A, B, C dollars) (j = 1,3) ($)

$I_{q(j)}$ = Calculated (Equation (102)) (years)

h_j = 1: Change for given period is backfitable
0: Change for given period is not backfitable

$I_{v(j)}$ = Calculated (Equation (103)) (Gwe)

$I_{w(j)}$ = Calculated (Equation (104)) (Gwe)

k_j = ix, iy, iz for j = 1,2 and 3. (Figure 7)

ΔR = Reactor lifetime (years)

$n_{i,\ell}$ = Number of reactors started in year (ℓ) that are still operational in year (i) (Equation (105)) (Gwe/year)

ΔB = Minimum lifetime for backfitting to be possible (years)

The total cost of research and development (C_{RD}) is again defined as the total NASAP R&D cost plus the total LWR R&D cost. Therefore, the total R&D cost is simply the sum of Equations (100) and (107).

$$C_{RD} = X_{LWR} + X_D \quad (\$) \qquad (108)$$

VI. Fuel Cost Contribution To Power Cost

The fuel cycle cost for the combination of LWR and NASAP choice reactors is determined for the time increment of T_I through T_N, Figure 1. It is assumed that the fuel cycle cost of an LWR in each of the four fuel cycles (original plus three imprement periods, Figure (2)), plus the corresponding regional fractions of that cost due to U_3O_8 cost are known.

Fuel Cycle Region	Cost (Mills/kwhre)	Fraction Of Cost Due To U_3O_8 Cost
1	K_1	x_1
2	K_2	x_2
3	K_3	x_3
4	K_4	x_4

The fuel cycle cost of LWR's in each of the four fuel cycle regions is

$$F_{K_j}(t) = x_j K_j \psi(t) + (1 - x_j) K_j \quad (j = 1,4) \quad (\frac{\text{mills}}{\text{Kwhre}}) \tag{109}$$

From Equation (109), the average fuel cycle cost of an LWR started up in year (t_i) in region (j) can be determined.

$$(A_F)_{i,j} = K_j \ (1.0 + x_j \ [\mu_{i,j} - 1.0])_{\begin{pmatrix} i = 1,N \\ j = 1,4 \end{pmatrix}} \quad (\frac{\text{mills}}{\text{Kwhre}}) \tag{110}$$

The lifetime average fuel cycle cost (L_{AF}) of each LWR started up in region (j) at time (t_i) is

$$L_{AF} = \sum_{j=1}^{4} (A_F)_{i,j} \quad (\frac{\text{mills}}{\text{Kwhre}}) \tag{111}$$

The total fuel cycle cost of all LWR's started up through year $T_N(C_{A1})$ can then be evaluated as follows:

$$C_{A1} = \left\{ \sum_{i=1}^{N} [g_i \sum_{j=1}^{4} (A_F)_{i,j} \ f_{i,j}] \ (n_{LWR} \ \Delta R) \right\} U_N \quad (\$) \tag{112}$$

where U_N equals a units conversion factor

$$U_N = \frac{10^6 \ \frac{\text{Kwe}}{\text{Gwe}} \ 10^{-3} \ \frac{\$}{\text{mills}} \ 8766 \ \frac{\text{hr}}{\text{yr}}}{10^9 \ \$/\text{billion}} \tag{112a}$$

The cost of the fuel cycle through the base year for all cost calculations $(T_B)(C_{A2})$ is determined

$$C_{A2} = \left\{ \sum_{i=1}^{iB} [g_i \ (A_F)_{i,1}][n_{LWR} \ (T_B - t_i)] \right\} U_N \quad (\$) \tag{113}$$

where

$x_{i,j}$ = fraction of LWR cost due to U_3O_8 cost

K_j = fuel cycle cost (mills/Kwhre)

$\psi(t)$ = normalized fuel cost

$\mu_{i,j}$ = average fuel cost for reactor (Equation (77))

$f_{i,j}$ = fuel usage factor (Section III)

g_i = LWR installation rate (Equations (5) and (6)) $(\frac{\text{Gwe}}{\text{year}})$

η_{LWR} = LWR capacity factor over lifetime ΔR $(\frac{hre}{hr})$

ΔR = reactor lifetime (years)

T_B = base year for all cost calculations (calendar year)

t_i = time

Similarly, the average cost of the NASAP choice fuel cycle $(A_K)_i$ is determined

$$(A_U)_i = \frac{1}{\Delta R} \int_{t_i}^{t_i+\Delta R} \psi(t)\, dt \qquad (114)$$

$$(A_U)_i = \frac{1}{\Delta R} \sum_{k=i}^{i+\Delta R^{-1}} \frac{\psi_k + \psi_{k+1}}{2} \qquad (i=1,N) \qquad (114a)$$

and

$$(A_K)_i = K^* \left\{1.0 + C_H \left[(A_U)_i - 1.0\right]\right\} \qquad (i=1,N) \qquad (\frac{mills}{Kwhre}) \qquad (115)$$

Then the total NASAP fuel cycle cost (C_{A3}) is evaluated as follows:

$$C_{A3} = [(\sum_{i=1}^{N} r_i\ (A_K)_i)(\eta_{NAS}\ \Delta R)]\ U_N \qquad (\$) \qquad (116)$$

where:

ΔR = reactor lifetime (years)

$\psi(t)$ = normalized fuel cost

K^* = fuel cycle cost of NASAP choice reactor (mills/Kwhre)

C_H = fraction of NASAP fuel cost due to U_3O_8

r_i = NASAP choice installation rate (Equation 2) (Gwe/year)

η_{NAS} = NASAP choice capacity factor over lifetime ΔR $(\frac{hre}{hr})$

Using Equations (112), (113) and (116), the total fuel cycle cost (C_{FC}) is evaluated.

$$C_{FC} = C_{A1} - C_{A2} + C_{A3} \qquad (\$) \qquad (117)$$

VII. Plant Capital Cost Contribution To Power Cost

The capital cost of LWR's is assumed to be a known function, $\phi(t)$, normalized to 1.0 in year T_B and the learning curve effect is ignored. The capital cost of the NASAP choice reactor is also assumed to be a known function $\theta(t)$ times a learning curve function L_N. The function $\theta(t)$ is normalized to 1.0 in year T_B and the learning curve function is normalized to 1.0 when the first plant is built, Figure 8.

The modifications of the LWR's that are required at times T_X, T_Y and T_Z to achieve better fuel economy are assumed to be made instantaneously in years T_X, T_Y and T_Z. The capital cost increments associated with these modifications are assumed to incorporate the learning curve effect. All capital costs are expressed in year T_B dollars. All LWR's are assumed to be backfitted with the new technology.

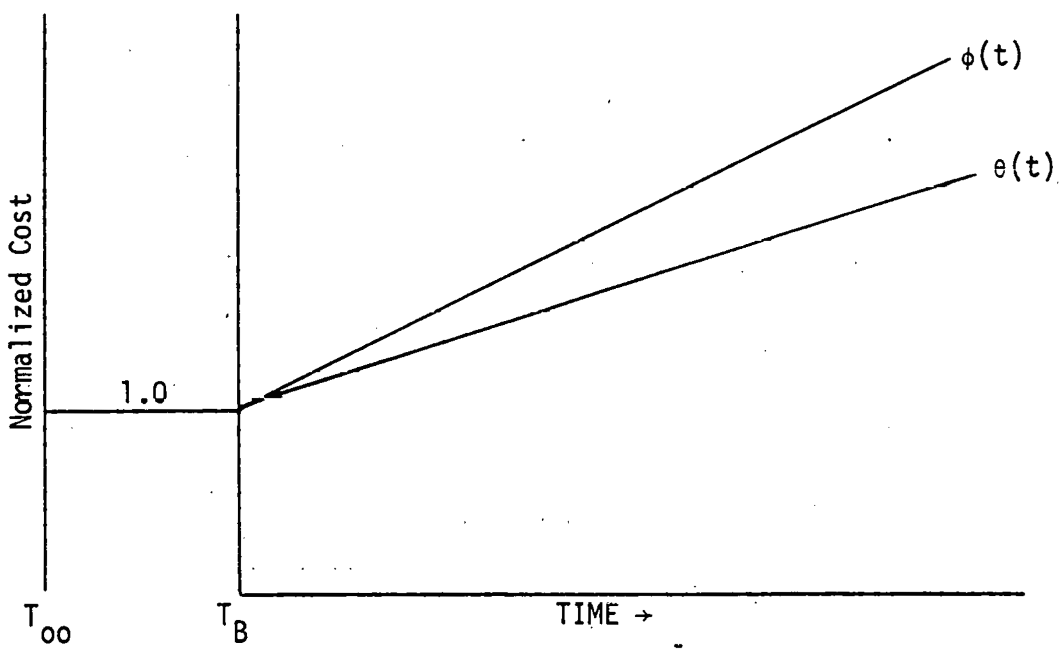


FIGURE 8

The total LWR cost is then computed in each of the three fuel periods (Figure 8) as follows:

$$B_{C1} = [B_1 + B_2 + B_3 + B_4 + B_5 + B_6 + B_7][\Delta R \ 10^6 \ \frac{Kwe}{Gwe} \ 10^{-9} \ \frac{billions}{\$}] \ (\$) \qquad (118)$$

where each of the terms of Equation (118) is defined as follows:

$$B_1 = \sum_{i=1}^{N} (g_i\ C_o\ \phi(t)\ i_{FC})\ dx \qquad (118a)$$

$$B_2 = \{\sum_{i=ix+\Delta B-\Delta R}^{ix-1} g_i[f_{i,2} + F_{i,3} + f_{i,4}]\ \delta'_{C_1}\ i'_{FC}\}\ dx \qquad (118b)$$

or

B_2 = 0.0 if the change occurring at time T_X (years) is not backfittable.

$$B_3 = \{i_{FC} \sum_{i=1}^{N} g_i\ [f_{i,2} + f_{i,3} + f_{i,4}]\ \delta_{C_1}\}\ dx \qquad (118c)$$

$$B_4 = \{\sum_{i=iy+\Delta B-\Delta R}^{iy-1} g_i[f_{i,3} + f_{i,4}]\ \delta'_{C_2}\ i'_{FC}\}\ dx$$

or (118d)

B_4 = 0.0 if the change occurring at time T_Y (years) is not backfittable.

$$B_5 = \{i_{FC} \sum_{i=iy}^{N} g_i\ [f_{i,3} + f_{i,4}]\ \delta_{C_2}\}\ dx \qquad (118e)$$

$$B_6 = \sum_{i=iz+\Delta B-\Delta R}^{iz-1} (g_i\ f_{i,4}\ \delta'_{C_3}\ i'_{FC})\ dx \qquad (118f)$$

or

B_6 = 0.0 if the change occurring at time T_Z (years) is not backfittable.

$$B_7 = i_{FC} \sum_{i=iz}^{N} (g_i\ f_{i,4}\ \delta_{C_3})\ dx \qquad (118g)$$

where

g_i = rate of LWR installation (Equations (5) and (6)) (Gwe/year)

C_o = LWR original plant cost for all plants ($/Kwe)

$\phi(t)$ = normalized LWR capital cost function

i_{FC} = plant fixed charge rate (year^{-1})

$f_{i,j}$ = fuel usage factor for period (j) at time (i) (Section III)

δ_{C_j} = new plant capital cost adder for period (j) ($/Kwe)

δ'_{C_j} = backfit plant capital cost adder for period (j) ($/Kwe)

i'_{FC} = fixed charge rate on backfit plants ($year^{-1}$)

ΔR = reactor lifetime

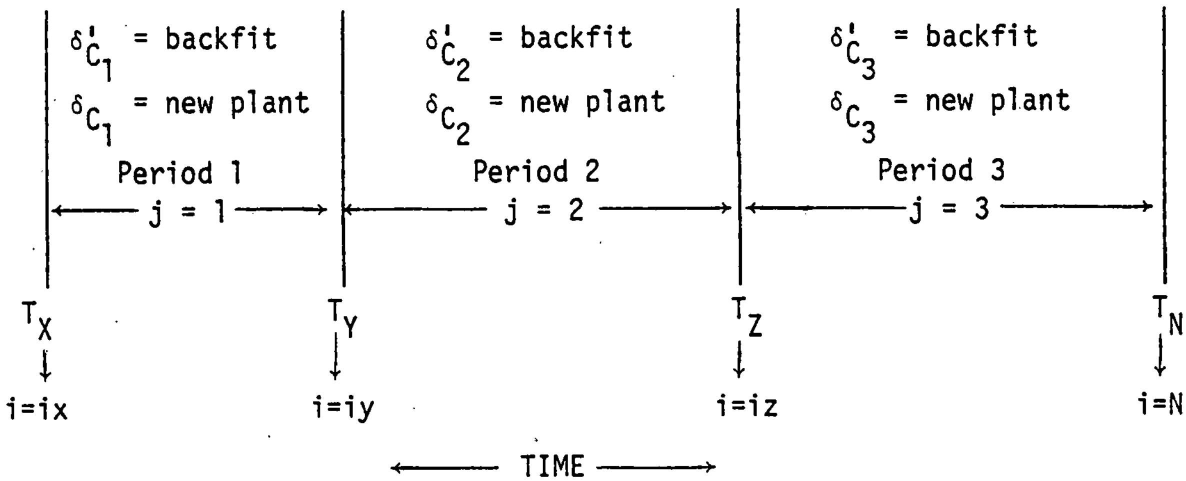


FIGURE 9

NOTE: The capital cost adder δ_{C_j} for new plants should be zero if the capital cost function $\phi(t)$ contains the effect of new ore-saving capital.

The capital cost of LWR's built through year T_B (B_{C2}) is also computed.

$$B_{C2} = \left(\sum_{i=1}^{iB} g_i \; C_o \; \phi(t) \, dx\right)(\Delta R \; i_{FC})\left(10^6 \; \frac{Kwe}{Gwe} \; 10^{-9} \; \frac{billions}{\$}\right) \qquad (\$) \qquad (119)$$

The NASAP choice cost is C_o^* ($/Kwe) for the first plant built. This cost is multiplied by the capital cost function $\theta(t)$, normalized to 1.0 in year T_B, and also by the learning curve (L_c) which is expressed as

$$L_c = \max \begin{cases} (N_i^*)^{\left[\frac{\ell n \, (1.0 - \alpha_1^*)}{\ell n \, (2.0)}\right]} \\ (N_i^*)^{\left[\frac{\ell n \, (1.0 - \alpha_2^*)}{\ell n \, (2.0)}\right]} \end{cases} \qquad (120)$$

The number of NASAP choice reactors in existence to time (t_i) is $(N_{NAS})_i$, defined in Equations (8) and (8a). The number of NASAP choice reactors built through time (t_i) is (N_i^*) and is calculated as follows.

$$N_i^* = \sum_{j=1}^{i} r_j \, dx \qquad i = 1, N \tag{121}$$

The NASAP choice capital cost (B_{C3}) is then determined to be:

$$B_{C3} = \{\sum_{i=1}^{N} r_i \, [C_o^* \, \theta(t) \, L_c] \, dx \, [\Delta R \, i_{FC}][10^6 \frac{Kwe}{Gwe} 10^{-9} \frac{billions}{\$}]\} \; (\$) \tag{122}$$

Using Equations (118), (119) and (123), the total capital cost, (C_{CAP}), (LWR plus NASAP), after year T_B is determined.

$$C_{CAP} = B_{C1} - B_{C2} + B_{C3} \qquad (\$) \tag{123}$$

where

α_1^* = learning curve characterization parameter 1

α_2^* = learning curve characterization parameter 2

r_i = NASAP choice installation rate (Equation 2) (Gwe/year)

C_o^* = NASAP choice cost for one plant ($/Kwe)

$\theta(t)$ = normalized NASAP capital cost function

L_c = learning curve factor

ΔR = reactor lifetime (years)

VIII. Operation And Maintenance Cost Contribution To Power Cost

It is assumed that both the LWR plants and the NASAP choice reactor operation and maintenance costs (γ_{LWR} and γ_{NASAP}, respectively) are known. The operation and maintenance contribution to the power cost is then evaluated as follows.

The cost of LWR operation and maintenance $(C_{OM})_L$ is

$$(C_{OM})_L = [(\sum_{i=1}^{N} g_i \, \eta_{LWR} \, \gamma_{LWR} \, \Delta R) \, dx] \, U_N \qquad (\$) \tag{124}$$

The cost of LWR operation and maintenance through year $T_B (C_{OM})_{LB}$ is

$$(C_{OM})_{LB} = \{[\sum_{i=1}^{iB} g_i \, (T_B - t_i)] \, \eta_{LWR} \, \gamma_{LWR} \, dx\} \, U_N \qquad (\$) \tag{125}$$

The NASAP cost of operation and maintenance $(C_{OM})_N$ is

$$(C_{OM})_N = \{(\sum_{i=1}^{N} r_i \, \eta_{NAS} \, \gamma_{NAS} \, \Delta R) \, dx\} \, U_N \qquad (\$) \qquad (126)$$

The total cost of operation and maintenance (C_{OM}) is then determined by combining Equations (124), (125) and (126) as follows:

$$C_{OM} = (C_{OM})_L - (C_{OM})_{LB} + (C_{OM})_N \qquad (\$) \qquad (127)$$

where

g_i = rate of LWR installation (Equations (5) and (6)) (Gwe/year)

η_{LWR} = LWR capacity factor over lifetime ΔR (hre/hr)

γ_{LWR} = LWR operation and maintenance cost (mills/Kwhre)

ΔR = reactor lifetime (years)

T_B = base year for all cost calculations (calendar year)

t_i = time (years)

r_i = NASAP installation rate (Equation (2)) (Gwe/year)

η_{NAS} = NASAP capacity factor over lifetime ΔR (hre/hr)

γ_{NAS} = NASAP operation and maintenance cost (mills/Kwhre)

U_N = unit conversion factor (Equation (112a))

IX. Total Cost

The final, total cost of LWR plants and NASAP choice reactors through year T_N is defined as the summation of all calculated cost contributary factors; i.e., research and development, fuel, capital cost and operation and maintenance. This total cost is evaluated as follows:

$$T_C = C_{RD} + C_{FC} + C_{CAP} + C_{OM} \qquad (\$) \qquad (128)$$

where

C_{RD} = research and development costs (Equation (108))

C_{FC} = total fuel cycle cost (Equation 117))

C_{CAP} = total NASAP and LWR capital cost (Equation (123))

C_{OM} = total NASAP plus LWR operation and maintenance cost (Equation (128))

X. Summary

The NASAP computer code was developed expeditiously with the single objective of performing the necessary calculations required to compute each of the cost contributary factors and the total LWR and NASAP choice reactor cost. In some cases, models were developed and/or modified as the program was being constructed. Consequently, little attention was given to input and output formats. Descriptive titles have not been given to input and all output quantities edited. However, the program was validated and verified by hand calculations as presented in Section XIII of this report.

The input data is read and edited using the FORTRAN NAMELIST procedure following variable initialization. Provisions have been made for processing multiple problems, i.e., the "stacking" of cases. Input procedures are discussed in detail in Section XI of this report.

The program restrictions are: 1) all input quantities must be supplied for the initial case, 2) the maximum number of time (year) entries is limited such that (N + ΔR + 1) must be equal to or less than 200 (where N is the number of the time entry for the year in which the last reactor will be started up and ΔR is reactor lifetime), and 3) all table input quantities are limited to a minimum of 2 entries and a maximum of 200 entries.

The cost contributary calculations are performed in the order of their documentation in this report.

Output quantities are edited at calculation time. Cumulative data is edited when appropriate. The specifics of the output editing are discussed in Section XII of this report.

The verification data, i.e., results of hand calculations as performed by Mr P. Wyatt are provided in Section XIII of this report.

Model development documentation is not available.

XI. Input Description

Input data is provided to the NASAP computer program using the FORTRAN NAMELIST procedure. NAMELIST provides a means of supplying input variables, groups of variables and arrays with an identifying name without format specifications.

Data items succeeding the $INPUT group name input card are read until another $ is encountered. Blank spaces cannot occur between the $ and the group name INPUT or within array or variable names. Blank spaces may be freely used elsewhere within the input data string. Column one of every data card is ignored and all input data cards should end with a constant followed by a comma; however, the last input card may be terminated by a $ without the final comma. Data items separated by commas may be in any one of the following three forms:

variable = constant

array name = constant, constant, -----, constant

array name (unsigned integer constant subscripts) = constant,-----

e.g., array name XARRAY, subscripts 1,2 would be entered as XARRAY (1,2) = constant.

A constant is any fixed quanitity, i.e., input value. There are two types of constants used as input to the NASAP computer code. They are:

1) Integers - An integer constant is a digit or string of digits written without a decimal point. Integer numbers may not contain a comma. Examples of valid integer constants follow:

   1, 10, 100, 4500

2) Decimal - A decimal constant consists of a string of digits written with a decimal point or an exponent, or both. An exponent is designated by the letter E followed by an integer constant indicating the power of ten by which the number will be multiplied. If the letter E is present, the integer constant following the E must also be present. The sign may be omitted if the exponent is positive but must be included when the exponent is negative. Decimal numbers may not contain a comma.

   Examples of valid decimal constants are:

   7.5, -3.22, +4000., 12345.67, .5, 0.05, 42.E1,
   700.E-2, 8.0E+6, 8.0E06, 8.0E6

Omitting a constant constitutes a fatal error. Constants can be preceded by a repetition factor designated by an asterisk, e.g.: 5 values of 1.0 would be written 5*(1.0). The constants 1.7, 1.5, 1.7, 1.5 could be written as 2*(1.7, 1.5).

When processing multiple problems, i.e., "stacking" cases, only those variables that are being changed must be specified. All unspecified data will remain as previously defined. Variables need not be in the order designated on the input parameter list, Table 2.

The input data deck structure is given in Table 1. Card type 1 is an optional card. Card type 3, containing the input variables as described in Table 2, is repeated until all variables have been defined. Each input case must begin with card type 2 and is terminated by card type 4.

TABLE 1

INPUT DATA DECK STRUCTURE

Card Type	Card Columns	Required Data	Description
1	2-80		Optional title card. May be omitted.
2	2-7	$INPUT	Data group identifier
3	3-80	See Table 2	Input data parameters
4	2-5	$END	Case 1 terminator
* 1	2-80		Optional title card. May be omitted.
* 2	2-7	$INPUT	Data group identifier (optional)
* 3	3-80	See Table 2	Input data parameters (optional)
* 4	2-5	$END	Case 2 terminator
⋮	⋮	⋮	⋮
Last Card	2-5	$END	Final case terminator

* Card types 1 through 4 are repeated for each case. Case stacking is optional.

Table 2 presents the required NASAP input parameters. The program symbol is the identifying name required by the program as input. The engineering symbols are provided for cross-referencing.

Input variables can be entered in any order, i.e., do not have to be specified in the order given in Table 2.

TABLE 2

NASAP INPUT PARAMETER DEFINITIONS

Engineering Symbol	Input Program Symbol	Max. No. Entries Per Case	Numeric Format	Definition	Units
ΔT_{RD}	DTR	1	Decimal	Time required to perform R&D	Years
ΔT_c	DTC	1	Decimal	Lead plant construction time	Years
ΔT_o	DTØ	1	Decimal	Lead plant operation time	Years
ΔT_a	DTA	1	Decimal	Acceleration time	Years
T_I	TØ	1	Decimal	Reference starting year for NASAP deployment	Calendar Year
t_i	T_I	200	Decimal	Time (N+ΔR entries)	Calendar Year
a_i	A	200	Decimal	Net nuclear growth rate (N+ΔR entries)	Gwe/year
r_i	R	200	Decimal	NASAP choice installation rate (N+ΔR entries)	Gwe/year
N	N	1	Integer	Number of years during which reactors will be started up. Total problem time frame is 1 to (N+ΔR) entries.	--------
T_{oo}	TØØ	1	Decimal	Base reference year	Calendar Year
ΔR	DR	1	Decimal	Reactor lifetime	Years
T_x	TX	1	Decimal	End of improvement period 1 $[T_{oo}, T_x]$	Calendar Year
T_y	TY	1	Decimal	End of improvement period 2 $[T_x, T_y]$	Calendar Year
T_z	TZ	1	Decimal	End of improvement period 3 $[T_y, T_z]$	Calendar Year
ix	IX	1	Integer	Value of counter (i) at time T_x	--------
iy	IY	1	Integer	Value of counter (i) at time T_y	--------
iz	IZ	1	Integer	Value of counter (i) at time T_z	--------

TABLE 2 (CONTINUED)

NASAP INPUT PARAMETER DEFINITIONS

Engineering Symbol	Input Program Symbol	Max. No. Entries Per Case	Numeric Format	Definition	Units
Δ_o	DETØ	1	Decimal	Reference lifetime	Years
η_o	ETAØ	1	Decimal	Reference capacity factor	hre/hr
η_{LWR}	ETALWR	1	Decimal	LWR capacity factor over lifetime ΔR	hre/hre
η_{NAS}	ETANAS	1	Decimal	NASAP choice capacity factor over lifetime ΔR	hre/hr
M_i'	TØNS	200	Decimal	Ore (U_3O_8) mined (M entries)	Tons
ψ_i'	CØST	200	Decimal	Cost of ore mining (M entries)	$/lbm
M	M	1	Integer	Number of entries in ore mined vs. cost table	--------
-	BKFTX	1	Decimal	= 1. Change at T_x is backfittable = 0. Change at T_x is not backfittable	-------- --------
-	BKFTY	1	Decimal	=1. Change at T_y is backfittable =0. Change at T_y is not backfittable	-------- --------
-	BKFTZ	1	Decimal	=1. Change at T_z is backfittable =0. Change at T_z is not backfittable	-------- --------
δ_{C_1}	DELCX	1	Decimal	New plant capital cost adder for region 1 at T_x	$/Kwe
δ_{C_2}	DELCY	1	Decimal	New plant capital cost adder for region 2 at T_y	$/Kwe
δ_{C_3}	DELCZ	1	Decimal	New plant capital cost adder for region 3 at T_z	$/Kwe
δ'_{C_1}	DELCXP	1	Decimal	Backfit plant capital cost adder for region 1 at T_x	$/Kwe
δ'_{C_2}	DELCYP	1	Decimal	Backfit plant capital cost adder for region 2 at T_y	$/Kwe
δ'_{C_3}	DELCZP	1	Decimal	Backfit plant capital cost adder for region 3 at T_z	$/Kwe

TABLE 2 (CONTINUED)

NASAP INPUT PARAMETER DEFINITIONS

Engineering Symbol	Input Program Symbol	Max. No. Entries Per Case	Numeric Format	Definition	Units
$U_1^{(o)}$	UØ1	1	Decimal	Fuel available for LWR lifetime - period 1	Short-Tons/Gwe
$U_2^{(o)}$	UØ2	1	Decimal	Fuel available for LWR lifetime - period 2	Short-Tons/Gwe
$U_3^{(o)}$	UØ3	1	Decimal	Fuel available for LWR lifetime - period 3	Short-Tons/Gwe
$U_4^{(o)}$	UØ4	1	Decimal	Fuel available for LWR lifetime - period 4	Short-Tons/Gwe
U_o	UØ	1	Decimal	Fuel available for NASAP choice lifetime	Short-Tons/Gwe
R_{MINW}	RMINW	1	Decimal	Minimum R&D cost	$
ν_1	NU1	1	Decimal	Fraction of R&D $ to agent 1	--------
ν_2	NU2	1	Decimal	Fraction of R&D $ to agent 2	--------
ν_3	NU3	1	Decimal	Fraction of R&D $ to agent 3	--------
ν_4	NU4	1	Decimal	Fraction of R&D $ to government supervision	--------
F_1	ØLF1	1	Decimal	R&D overlap factor for agent 1	--------
F_2	ØLF2	1	Decimal	R&D overlap factor for agent 2	--------
F_3	ØLF3	1	Decimal	R&D overlap factor for agent 3	--------
F_4	ØLF4	1	Decimal	R&D overlap factor for agent 4	--------
E	E	1	Decimal	First time engineering cost for one vendor	$
i'_{FC}	FCIP	1	Decimal	Fixed charge rate on backfits	$year^{-1}$
α_i	AI	200	Decimal	Fractional disbursement rate at $T_x \cdot \sum_{i=1}^{N} \alpha_i = 1.0$	--------

TABLE 2 (CONTINUED)

NASAP INPUT PARAMETER DEFINITIONS

Engineering Symbol	Input Program Symbol	Max. No. Entries Per Case	Numeric Format	Definition	Units
b_i	BI	200	Decimal	Fractional disbursement rate at $T_y \cdot \sum_{i=1}^{N} b_i = 1.0$	--------
c_i	CI	200	Decimal	Fractional disbursement rate at $T_z \cdot \sum_{i=1}^{N} c_i = 1.0$	--------
λ	TLAMBA	1	Decimal	Lag time between LWR purchase and startup	Years
A	CAPA	1	Decimal	LWR development cost at T_x	$
B	CAPB	1	Decimal	LWR development cost at T_y	$
C	CAPCC	1	Decimal	LWR development cost at T_z	$
β	BETA	1	Decimal	Time required to install backfitted changes	Years
ΔB	DTB	1	Decimal	Minimum lifetime available for backfit	Years
d_i	DI	200	Decimal	Fraction of NASAP $ spent in each of N years	--------
i_{FC}	FCI	1	Decimal	Plant fixed charge rate	--------
r_D	RDIS	1	Decimal	Discount rate for government finance	--------
i_u	CRI	1	Decimal	Interest rate during construction	--------
λ^*	TLAG	1	Decimal	Lag time between NASAP purchase and startup	Years
ρ	RHØ	1	Decimal	Average fraction of lag time passing before half the plant is paid for	--------
T_B	TB	1	Decimal	Base year for all cost calculations	Calendar year
K_1	REG1	1	Decimal	LWR fuel cycle cost - Region 1	Mills/Kwhre
K_2	REG2	1	Decimal	LWR fuel cycle cost - Region 2	Mills/Kwhre

TABLE 2 (CONTINUED)

NASAP INPUT PARAMETER DEFINITIONS

Engineering Symbol	Input Program Symbol	Max. No. Entries Per Case	Numeric Format	Definition	Units
K_3	REG3	1	Decimal	LWR fuel cycle cost - Region 3	Mills/ Kwhre
K_4	REG4	1	Decimal	LWR fuel cycle cost - Region 4	Mills/ Kwhre
X_1	X1	1	Decimal	Fraction of K_1 cost due to U_3O_8 cost - Region 1	--------
X_2	X2	1	Decimal	Fraction of K_2 cost due to U_3O_8 cost - Region 2	--------
X_3	X3	1	Decimal	Fraction of K_3 cost due to U_3O_8 cost - Region 3	--------
X_4	X4	1	Decimal	Fraction of K_4 cost due to U_3O_8 cost - Region 4	--------
K*	STARK	1	Decimal	NASAP choice reactor fuel cycle cost	Mills/ Kwhre
C_H	CHI	1	Decimal	Fraction of K* cost due to U_3O_8 cost	--------
C_o	CØ	1	Decimal	LWR original plant cost	$/Kwe
C_o^*	CØSTAR	1	Decimal	NASAP choice cost for one plant	$/Kwe
$\phi(t)$	PHI	200	Decimal	Capital cost curve (N+ΔR entries) for LWR's normalized to 1.0 in year T_B	--------
$\theta(t)$	THETA	200	Decimal	Capital cost curve for NASAP choice reactors normalized to 1.0 in year T_B (N+ΔR entries)	--------
α_1^*	HALF	1	Decimal	Characterization parameter one for NASAP choice reactors learning curve	--------
α_2^*	SIGMA	1	Decimal	Characterization parameter two for NASAP choice reactors learning curve	--------
γ_{LWR}	GAMMA	1	Decimal	LWR operation and maintenance cost	Mills/ Kwhre
γ_{NAS}	GAMMAS	1	Decimal	NASAP operation and maintenance cost	Mills/ Kwhre

TABLE 2 (CONTINUED)

NASAP INPUT PARAMETER DEFINITIONS

Engineering Symbol	Input Program Symbol	Max. No. Entries Per Case	Numeric Format	Definition	Units
-----	IRD	1	Integer	=1. Use Model 2 for R&D calculations.	--------
				=0. Use Model 1 for R&D calculations	--------

Table Input

Reactor lifetime is defined as ΔR years. A reactor started up in year T_N will then have a total lifetime existence of (T_N + ΔR) years. Thus, the maximum required time scale for any given problem will always be (N + ΔR) years. For this reason, the time entries (TI), the net nuclear growth rate (A), the NASAP choice installation rate (R), the LWR capital cost curve data (PHI), and the NASAP capital cost curve data (THETA) must each contain exactly (N + ΔR) entries.

The number of entries in the ore mined versus cost of mining table, [TONS, COST] is dependent upon the available data and the number of entries required to adequately represent the data. There is no calculatable relationship between the number of entries in this table and the time frame of the problem; therefore, the number of entries must be specified. The specification of the number of entries in the table is made via the variable M. Exactly M values of (TONS) and (COST) must be entered.

The fractional disbursement rates (AI), (BI), and (CI) are applied over time intervals [T_{oo}, T_x], [T_x, T_y], and [T_y, T_z] respectively. Zero disbursement is allowed in any year or series of years. The restrictions applied to these data points are:

1) The rates must collectively apply over the time frame of T_{oo} through T_z, Figure 6, and

2) the summation of each of the rates must equal 1.0; i.e.,

$$\sum_{I=1}^{N} AI\ (I) \equiv 1.0 \quad ,$$

$$\sum_{I=1}^{N} BI\ (I) \equiv 1.0 \quad \text{and} \sum_{I=1}^{N} CI\ (I) \equiv 1.0$$

Case Stacking

Case stacking is the sequential running of multiple problems and is controlled in the NASAP computer program by the presence or absence of input data cards. Each case begins with a $INPUT card, card type 2 of Table 1 and is terminated by a $END card, card type 4 of Table 1. Only those parameters being changed must be entered beyond the first case input. All variables not re-entered as input data for subsequent cases will remain as defined in the preceeding case.

XII. Output Description

Following the printing of the title card, where the optional title card input is specified, the input parameters are edited in NAMELIST form. All variables are initialized to zero; therefore, any variables not specifically assigned a value via the input specification for at least the first case of a series of cases, will remain zero. All input will be arranged and edited in the order in which the program uses them; i.e., the NAMELIST order as specified in Table 2.

Scheduling And Plant Installation

The time required to construct the lead plant, (ΔT_c), the time required to accelerate to equal the full nuclear installation rate, (ΔT_a), and the calculated reference installation rate, (ΔT_{RI}) are edited as construction time, acceleration time and reference installation rate, respectively, followed by the maximum number of LWR's ever on line from time T_{oo} to T_N. The following variables are then edited in table form:

1) the counter (i), designated as I
2) the time (t_i) as T(I)
3) the net nuclear growth rate (a_i) as A(I)
4) the NASAP choice installation rate (r_i) as R(I)
5) the LWR retirement rate (g_i) as G(I)
6) the maximum number of LWR's ever on line from time T_{oo} to T_N, as NLWR(I) and,
7) the maximum number of NASAP choice plants ever on line from time T_{oo} to TN, as NNAS(I).

Since these quantities apply over the reactor total lifetime existence, the time scale varies from 1 to N + ΔR.

U_3O_8 Utilization

The fuel committed to any date (t_i) is edited as H(I) along with the counter (i) as I, the time (t_i) as (TI(I)) and the fuel required by an LWR started up in year (t_i) as U(I). These values are relevant only over the time period of reactor startups and are, therefore, only edited over the time frame of one to N years. This table is followed by the dates when 2.6 x 10^6 and 5.4 x 10^6 short tons of fuel are required, respectively.

The calculated fractional fuel usages for each of the four fuel regions make up the next edit for times one through N and are labeled F(1,I), F(2,I), F(3,I), and F(4,I). Note that the calculated fractional fuel usage summed over the four regions at any given time must always equal 1.0.

Following the periodic fuel usage edit, the fuel available for the LWR lifetime in each of the four fuel regions is edited as U(1,I), U(2,I), U(3,I), and U(4,I) over the time frame of one to (N + ΔR) years. The lower and upper boundaries of each fuel region are then edited for times one through N as a function of counter (i) as I and time (t_i) as T(I). The lower boundary edits are labeled I, T(I), TL(1,I), TL(2,I), TL(3,I), and TL(4,I). The upper boundary edits are labeled T, T(I), TU(1,I), TU(2,I), TU(3,I), and TU(4,I). Thus, the fuel region associated with each year of the problem through N years is defined.

U_3O_8 Cost Increase Factors

The fuel used by all plants (NASAP choice plus LWR), up through year (τ_K) is edited as a function of time (τ_K). This output is well labeled and has column headings of M(K) and TAU(K).

The next cost output is the edit of the fuel price corresponding to time (τ_K) which has column headings of K, TAU(K) and PSI(K) for the index value, the time and the price, respectively.

The final edit in this section is of the average cost values for reactors started up in year (τ_K). The index K, the time TAU(K), the average cost, AVG. CØST, and the fuel region number are given.

All output edits for this section are self-explanatory.

Research And Development Cost

General Output

Regardless of the research and development model chosen, the following edits are performed:

1) The cost associated with each of the three vendors (printed as VENDOR A, VENDOR B and VENDOR C), and with government supervision.
2) The total first time engineering cost.
3) The contribution of R&D to the NASAP choice reactor cost. This quantity is given as a total and as a cumulative cost from the base reference year (T_{oo}) through year (T_N).

R&D Model 1

The variables $\tau_Q = \lambda (1-\rho) + T_B$ and $\nu = \beta/2 + T_B$ as used in the general equation of income and outgo (Equation (89)), are printed as TAUQ and UQ. Then for further verification purposes, the integrals of the general equation of income and outgo (Equations (90) through (92)) are printed for each of the three improvement regions. Region one is eliminated since it represents the original development period and not an improvement period, Figure 7. These integrals are represented as IQ(K), IV(K), and IW(K) where K varies from one to three for each of the three improvement regions.

The next edit is of the cost associated with LWR development in each of the three improvement periods as given by Equation (93). The values are edited as K for the period and as MILLS/KWHRE for the cost.

Following this is the total cost of LWR research and development edit and the printing of the cumulative cost of LWR R&D as a function of year through year T_N.

The total cost of R&D as defined by Equation (95) is the final edit in the Model 1 R&D calculation section and is followed by the printing of the yearly cumulative total cost of R&D.

R&D Model 2

The NASAP development costs are broken down in Model 2 to separately determine the contribution of NASAP development to NASAP power cost. This value is edited prior to the printing of the total NASAP development cost. The general equation of income and outgo integral approximations (Equations (102) through (104)) are edited as IQ(K), IV(K), and IW(K) for K equal to one through three regions. Again, the original development fuel region has been eliminated since these data apply only to improvement regions, Figure 7

The LWR development contributions to the LWR power cost ($\omega_{LWR}(j)$, Equation (106)), is edited for each of the three fuel improvement regions, both as a total cost and as a yearly, cumulative cost. The total development cost is then determined and printed, followed by the cumulative, yearly total Model 2 R&D cost.

Fuel Costs

The total fuel cycle cost for all LWR's started up through year T_N, the cost of the LWR fuel cycle through the cost base year T_B and the total NASAP fuel cycle cost are edited as A1, A2 and A3, respectively. The cumulative, yearly values for each of these variables as defined by Equations (112), (113), (116), and (117) are also printed.

Plant Capital Cost

The total LWR cost for the three fuel periods of Figure 8, (Equation (118)), is edited as B1. The capital cost of LWR's built through year T_B and the NASAP choice capital costs are printed as B2 and B3. The total capital cost, NASAP plus LWR, after year T_B is then determined and edited. The printed output statement reads, "The total capital cost after year 1978 = ", since this was the cost base year for which the program models were originally designed and verified. However, if a year other than 1978 is input for the variable T_B, the calculated total capital cost will be based upon that year's input rather than 1978 but the edit statement will continue to print the year as "1978". The cumulative yearly total capital costs are given following the total capital cost edit.

Operation And Maintenance

The total cost of operation and maintenance as given by Equation (127) is edited both as a total value and as a cumulative, yearly cost through year T_N.

Total Cost

The total cost of LWR plants and NASAP choice reactors through year T_N is the final edit performed and is given as both the total "botton line" value and as the cumulative, yearly cost through year T_N.

XIII. Verification

The NASAP computer code was verified by hand calculations independently performed by Mr. P. W. Wyatt using the sample problem input and output given in Sections XV and XVI of this report. Copies of the actual hand calculations will be maintained in accordance with accepted procedures for the control and preservation of Westinghouse Electric Corporation computer codes. Portions of the verification calculations are duplicated below.

Scheduling: The reference installation time is:

$$T_{RI} = 1979 + 2 + 8 + 2 + 7$$

$$T_{RI} = 1998$$

Plants Installed. The rate of LWR installation calculations were verified as follows:

$\Delta R = 10$; $a(t) = g(t) - g(t - 10) + r(t) - r(t - 10)$ for $i > \Delta R$

$N = 40$

$N + \Delta R = 50$ $\quad N_{LWR} = N_{LWR}(t - 1) + g(t) - g(t - 10)$

$N_{NAS} = N_{NAS}(t - 1) + r(t) - r(t - 10)$

$i = 31$

$a_{31} = 11 - 6 + 1 - 0 = 6$

$N_{LWR} = 96 + 11 - 6 = 101$

$N_{NAS} = 0 + 1 - 0 = 1$

$i = 32$

$a_{32} = 14 - 10 + 2 - 0 = 6$

$N_{LWR} = 101 + 14 - 10 = 105$

$N_{NAS} = 1 + 2 - 0 = 3$

$i = 33$

$a_{33} = 13 - 10 + 3 - 0 = 6$

$N_{LWR} = 105 + 13 - 10 = 108$

$N_{NAS} = 3 + 3 - 0 = 6$

i = 34 $a_{34} = 12 - 10 + 4 - 0 = 6$

$N_{LWR} = 108 + 12 - 10 = 110$

$N_{NAS} = 6 + 4 - 0 = 10$

i = 40 $a_{40} = 0 - 10 + 16 - 0 = 6$

$N_{LWR} = 95 + 0 - 10 = 85$

$N_{NAS} = 55 + 16 - 0 = 71$

i = 41 $a_{41} = 0 - 11 + 18 - 1 = 6$

$N_{LWR} = 85 + 0 - 11 = 74$

$N_{NAS} = 71 + 18 - 1 = 88$

i = 49 $a_{49} = 0 - 0 + 22 - 16 = 6$

$N_{LWR} = 0 + 0 - 0 = 0$

$N_{NAS} = 204 + 22 - 16 = 210$

i = 50 $a_{50} = 0 - 0 + 22 - 16 = 6$

$N_{LWR} = 0 + 0 - 0 = 0$

$N_{NAS} = 210 + 22 - 16 = 216$

<u>U_3O_8 Utilization</u>

The pertinent input quantities for these calculations are:

$T_{oo} = 1957$	$T_x = 1981$	ix = 25
$T_o = 1979$	$T_y = 1985$	iy = 29
$T_N = 1996$	$T_z = 1989$	iz = 33

LWR change 1 is not backfittable.

LWR change 2 is backfittable.

LWR change 3 is not backfittable.

Using these data, the regional, parametric values were calculated as follows:

$j = 1; i = 1$

$t_i = 1957$

$$(T_L)_{1,1} = \max \begin{cases} 1957 \\ 1957 \end{cases} = 1957$$

$$(T_U)_{1,1} = \min \begin{cases} 1957 + 10, = 1967 \\ 1981 \end{cases}$$

$$f_{1.1} = \max \begin{cases} (1967 - 1957)/10 \\ 0.0 \end{cases} = 1.0$$

$$(U_o)_{1.1} = 6000$$

$j = 1; i = 2$

$t_i = 1958$

$$(T_L)_{2,1} = \max \begin{cases} 1957 \\ 1958 \end{cases} = 1958$$

$$(T_U)_{2,1} = \min \begin{cases} 1958 + 10 = 1968 \\ 1985 \end{cases}$$

$$f_{2,1} = \max \begin{cases} 1968 - 1981)/10, = 0.0 \\ 0.0 \end{cases}$$

$$(U_o)_{2,1} = 6000$$

For region 1 and i = 3, 15

$t_i = 1959, 1971$

$(T_L)_{i,1} = t_i = 1959, 1960, . . ., 1971$

$(T_U)_{i,1} = t_i + 10 = 1969, 1970, . . ., 1981$

$f_{i,1} = 1.0$

$f_{i,2} = f_{i,3} = f_{i,4} = 0.0$

$(U_o)_{i,1} = (U_o)_{i,2} = (U_o)_{i,3} = (U_o)_{i,4} = 6000.$

The regional parametric values for i = 16 are:

$j = 1; i = 16$

$t_i = 1972$

$$(T_L)_{16,1} = \max \begin{cases} 1957 \\ 1972 \end{cases} = 1972$$

$$(T_U)_{16,1} = \min \begin{cases} 1972 + 10 \\ 1981 \end{cases} = 1981$$

$$f_{16,1} = \max \begin{cases} (1981 - 1972)/10 \\ 0.0 \end{cases} = 0.9$$

$$(U_o)_{16,1} = 6000.$$

$j = 2;\ i = 16$

$t_i = 1972$

$$(T_L)'_{16,2} = \max \begin{cases} 1981 \\ 1972 \end{cases} = 1981$$

$$(T_U)_{16,2} = \min \begin{cases} 1972 + 10 \\ 1985 \end{cases} = 1982$$

$$f'_{16,2} = \max \begin{cases} 1982 - 1981/10 \\ 0.0 \end{cases} = 0.1$$

$$16 < 25;\ (1981 - 1972) < (10 - 0)$$

therefore:

$f_{16,2} = 0.0$

$f_{16,1} = 0.9 + 0.1 = 1.0$

$(T_L)_{16,2} = (T_U)_{16,2} = 1982$

$(T_U)_{16,1} = (T_U)_{16,2} = 1982$

$(U_o)_{16,2} = (U_o)_{16,1} = 6000.$

$j = 3;\ i = 16$

$t_i = 1972$

$$(T_L)'_{16,3} = \max \begin{cases} 1985 \\ 1972 \end{cases} = 1985$$

$$(T_U)_{16,3} = \min \begin{cases} 1972 + 10 \\ 1989 \end{cases} = 1982$$

$$f'_{16,3} = \max \begin{cases} (1982 - 1985)/10 \\ 0.0 \end{cases} = 0.0$$

$f_{16,3} = 0.0$

$f_{16,1} = 1.0 + 0.0 = 1.0$

$(T_L)_{16,3} = 1982$

$(T_U)_{16,3} = 1982$

$(U_o)_{16,3} = 6000$

$j = 4; i = 16$

$t_i = 1972$

$$(T_L)'_{16,4} = \max \begin{cases} 1989 \\ 1972 \end{cases} = 1972$$

$$(T_U)_{16,4} = (1972 + 10) = 1982$$

$$f'_{16,4} = \max \begin{cases} (1982 - 1972)/10 \\ 0.0 \end{cases} = 1.0$$

$16 < 33$

$f_{16,4} = 0.0$

$f_{16,1} = 1.0 + 0.0 = 1.0$

$(T_L)_{16,4} = 1982$

$(T_U)_{16,1} = 1982$

$(U_o)_{16,4} = 6000$

Summarizing the parametric values for $i = 16$; $j = 1,4$

$(T_L)_{16,1} = 1972$; $(T_U)_{16,1} = 1982$; $f_{16,1} = 1.0$; $(U_o)_{16,1} = 6000$

$(T_L)_{16,2} = 1982$; $(T_U)_{16,2} = 1982$; $f_{16,2} = 0.0$; $(U_o)_{16,2} = 6000$

$(T_L)_{16,3} = 1982$; $(T_U)_{16,3} = 1982$; $f_{16,3} = 0.0$; $(U_o)_{16,3} = 6000$

$(T_L)_{16,4} = 1982$; $(T_U)_{16,4} = 1982$; $f_{16,4} = 0.0$; $(U_o)_{16,4} = 6000$

Hand calculations were performed in this manner, forming the following tables:

TABLE 3

Verification Data
Fractional Fuel Usage

i	$f_{i,1}$	$f_{i,2}$	$f_{i,3}$	$f_{i,4}$
1	1.0	0.0	0.0	0.0
2	1.0	0.0	0.0	0.0
⋮	⋮	⋮	⋮	⋮
19	1.0	0.0	0.0	0.0
20	0.9	0.0	0.1	0.0
21	0.8	0.0	0.2	0.0
22	0.7	0.0	0.3	0.0

TABLE 3 (CONTINUED)

Verification Data
Fractional Fuel Usage

i	$f_{i,1}$	$f_{i,2}$	$f_{i,3}$	$f_{i,4}$
23	0.6	0.0	0.4	0.0
24	0.5	0.0	0.5	0.0
25	0.0	0.4	0.6	0.0
26	0.0	0.3	0.7	0.0
27	0.0	0.2	0.8	0.0
28	0.0	0.1	0.9	0.0
29	0.0	0.0	1.0	0.0
30	0.0	0.0	1.0	0.0
31	0.0	0.0	1.0	0.0
32	0.0	0.0	1.0	0.0
33	0.0	0.0	0.0	1.0
⋮	⋮	⋮	⋮	⋮
50	0.0	0.0	0.0	1.0

TABLE 4

Verification Data
Fuel For LWR Lifetime

i	$(U_o)_{i,1}$	$(U_o)_{i,2}$	$(U_o)_{i,3}$	$(U_o)_{i,4}$
1	6000.	6000.	6000.	6000.
2	6000.	6000.	6000.	6000.
⋮	⋮	⋮	⋮	⋮
19	6000.	6000.	6000.	6000.
20	6000.	6000.	5000.	6000.
21	6000.	6000.	5000.	5000.
22	6000.	6000.	5000.	5000.
23	6000.	6000.	5000.	5000.
24	6000.	6000.	5000.	5000.
25	6000.	5500.	5000.	5000.
26	6000.	5500.	5000.	5000.
27	6000.	5500.	5000.	5000.
28	6000.	5500.	5000.	5000.
29	6000.	5500.	5000.	5000.
30	6000.	5500.	5000.	5000.
31	6000.	5500.	5000.	5000.
32	6000.	5500.	5000.	5000.

TABLE 3 (CONTINUED)

Verification Data
Fuel For LWR Lifetime

i	$(U_o)_{i,1}$	$(U_o)_{i,2}$	$(U_o)_{i,3}$	$(U_o)_{i,4}$
33	6000.	5500.	5000.	4500.
34	6000.	5500.	5000.	4500.
⋮	⋮	⋮	⋮	⋮
40	6000.	5500.	5000.	4500.
41	0.	0.	0.	4500.
⋮	⋮	⋮	⋮	⋮
50	0.	0.	0.	4500.

The fuel required by an LWR started up in year t_i was determined and used in the calculation of the fuel committed to that date. Examples of these calculations are given below and summarized in Table 5.

$$U_1 = U_1^{(o)} f_{1,1} + 0.0 = 6000.\ (1.0) = 6000.$$

$$H_1 = g_i\ U_1 = 2\ (6000) = 12000.$$

$$U_{20} = U_1^{(o)} f_{20,1} + U_3^{(o)} f_{20,3} = 6000\ (.9) + 5000\ (.1) = 5900.$$

$$H_{20} = H_{19} + g_{19}\ U_{19} = 336{,}000. + 5900\ (4) = 359{,}600.$$

$$U_{35} = U_4^{(o)} f_{35,4} = 4500.\ (1.0) = 4500.$$

$$H_{35} = H_{34} + g_{34}\ U_{34} + r_{34}\ U^* = 1{,}131{,}983 + 11\ (4500.) + 5\ (2708.33)$$

$$H_{35} = 1{,}195{,}025.$$

$$U_{45} = U_4^{(o)} f_{45,4} = 4500\ (1.0) = 4500.$$

$$H_{45} = H_{44} + r_{44}\ U^* = 1{,}682{,}192 + 22\ (2708.33)$$

$$H_{45} = 1{,}741{,}775.$$

$$U^* = (3000\ (0.65)\ 10)/(8 \times 0.9) = 2708.33$$

TABLE 5

Verification Data
LWR Fuel Requirement

i	U_i	H_i
1	6000.	12,000.
2	6000.	24,000.
3	6000.	36,000.

TABLE 5 (CONTINUED)

Verification Data
LWR Fuel Requirement

i	U_i	H_i
4	6000.	48,000.
5	6000.	60,000.
6	6000.	72,000.
7	6000.	84,000.
8	6000.	96,000.
9	6000.	108,000.
10	6000.	120,000.
11	6000.	144,000.
12	6000.	168,000.
13	6000.	192,000.
14	6000.	216,000.
15	6000.	240,000.
16	6000.	264,000.
17	6000.	288,000.
18	6000.	312,000.
19	6000.	336,000.
20	5900.	359,600.
21	5800.	394,400.
22	5700.	451,400.
23	5600.	507,400.
24	5500.	562,400.
25	5200.	614,400.
26	5150.	665,900.
27	5100.	716,900.
28	5050.	767,400.
29	5000.	817,400.
30	5000.	867,400.
31	5000.	925,108.
32	5000.	1,000,525.
33	4500.	1,067,150.
34	4500.	1,131,983.
35	4500.	1,195,025.
36	4500.	1,256,275.
37	4500.	1,313,942.
38	4500.	1,368,025.

TABLE 5 (CONTINUED)

Verification Data
LWR Fuel Requirement

i	U_i	H_i
39	4500.	1,411,359.
40	4500.	1,454,692.
41	4500.	1,503,442.
42	4500.	1,563,025.
43	4500.	1,622,608.
44	4500.	1,682,192.
45	4500.	1,741,775.
46	4500.	1,801,358.
47	4500.	1,860,941.
48	4500.	1,920,525.
49	4500.	1,980,108.
50	4500.	2,039,692.

U_3O_8 Cost Increase Factors

The following calculation is representative of the verification calculations performed.

$i = 21 \qquad t_i = t_{21} = 1977$

$k = 30 \qquad \tau_k = \tau_{30} = 1986$

$(T_L)_{21,1} = 1977 \qquad (T_U)_{21,1} = 1985$

$(T_L)_{21,2} = 1985 \qquad (T_U)_{21,2} = 1985$

$(T_L)_{21,3} = 1985 \qquad (T_U)_{21,3} = 1987$

$(T_L)_{21,4} = 1987 \qquad (T_U)_{21,4} = 1987$

The current usage period $j^*_{i,k}$ was determined to be region 3 since 1985 $\leq$ 1986 < 1987.

Thus, the fuel used by an LWR started up in year 1977 could be evaluated.

$$T_{21,30} = \sum_{j=1}^{2} \left(\frac{(U_o)_{21,j}}{(.72)(10)} f_{21,j} (.72)(10) + \frac{(U_o)_{21,3}}{(.72)(10)} 0.72 \; (1986 - 1985)\right.$$

$$= 6000\;(0.8) + \frac{5000}{10}\,(1) = 5300.$$

Research & Development Costs

Model 1

The contribution of NASAP R&D to capital cost was determined using the following information.

$R = \$562.5 \times 10^6$

$\lambda^* = 4$ years

$\rho = 0.7$

$r_D = 0.085$

The integrals of Equation (80) were approximated as follows:

$$I_d = \sum_{i=23}^{29} \frac{di\ [(\frac{1.0}{1.085})^{t_i + 1/2 - 1978} - (\frac{1.0}{1.085})^{t_i - 1/2 - T_B}}{\ln (\frac{1.0}{1.085})}$$

i	t_i	d_i	$t_i + 1/2 - 1978$	$t_i - 1/2 - 1978$	I_d
23	1979	0.05	1.5	0.5	0.046096
24	1980	0.15	2.5	1.5	0.127454
25	1981	0.20	3.5	2.5	0.156025
26	1982	0.20	4.5	3.5	0.144355
27	1983	0.25	5.5	4.5	0.166307
28	1984	0.10	6.5	5.5	0.061312
29	1985	0.05	7.5	6.5	0.028254
				$\sum I_d$	0.730403

$$\tau^* = \lambda^* (1 - \rho) - T_B = 4 (1. - 0.7) + 1978 = 1979.2$$

Similarly, the I_s integral was determined and the NASAP R&D contribution was calculated.

$$\chi_D = \frac{I_d\ R\ (1.0 + fc\ \lambda^* [1 - \ ])}{I_s\ 10^6}$$

$$= \frac{0.730403\ (1.0 + 0.1\ (4)\ [1 - 0.7])\ \$562.5 \times 10^6}{22.595613 \times 10^6}$$

$$\chi_D = 20.36475$$

The total NASAP development cost was then determined.

$$X_D = \sum_{i=1}^{40} r_i \; X_D \; \Delta R \; i_{FC} \; 10^6 \times 10^{-9}$$

$$= 71 \; (20.364745)(10)(0.17)(10^6)(10^{-9})$$

$$X_D = 2.458 \text{ billions}$$

The LWR R&D costs were determined in a similar manner.

$$\tau_Q = \lambda(1 - \rho) + T_B = 3(1. - 0.7) + 1978. = 1978.9$$

$$\sim \; = \beta/2 + T_B = 0.5 + 1978 = 1978.5$$

$$y_j = \frac{I_{q(j)} \; Q_j}{(h_j \; I_{v(j)} + I_{w(j)}) \; 10^6}$$

$$y_1 = \frac{(0.994439)(50 \times 10^6)}{10^6 \; (0 + 76.3647)} = 0.6511 \qquad \$/\text{Kwe}$$

$$y_2 = \frac{(0.666116)(150 \times 10^6)}{10^6 \; (49.429474 + 46.4119} = 1.0425 \qquad \$/\text{Kwe}$$

$$y_3 = \frac{(0.495786)(100 \times 10^6)}{10^6 \; (22.3777)} = 2.2155 \qquad \$/\text{Kwe}$$

The total R&D cost for LWR's was then calculated as:

$$X_{LWR} = [17.4941 + 11.9314 + 20.2834 + 246319][10^{-2}] = 0.7434 \text{ billions}$$

The Model 2 R&D calculations were similarly verified.

Plant Capital Cost

The total LWR cost was evaluated for each of the three fuel periods (Figure 8).

$B_{C1} = [27132. + 0 + 1232.5 + 1635 + 1785 + 0 + 1530](10)(10^6)(10^{-9})$

B_{C1} = 333.145 billions

$B_{C2} = (76)(600)(10)(0.17)(10^6)(10^{-9})$

B_{C2} = 77.52 billions

$B_{C3} = (193.37254)(750)(10)(0.17)(10^6)(10^{-9})$

B_{C3} = 246.549 billions

Therefore, the total capital cost is

$$C_{CAP} = 333.145 - 77.52 + 246.549 = 502.174$$

Operation And Maintenance

The total cost of operation and maintenance was determined to be

$$C_{OM} = 7.6054 - 1.8808 + 4.0455 = 9.7701$$

General Verification

The actual verification calculations performed are too lengthy to reproduce in their entirety. However, the information provided herein is sufficient to demonstrate that independent hand calculations were performed to verify the NASAP computer code. In all cases, exact agreement was obtained.

XIV. Nomenclature

Variable	Definition	Units
A	LWR development cost at time T_X	$
$(A_F)_{i,j}$	Average fuel cycle cost of LWR start up in year t_i	mills/Kwhre
$(A_k)_i$	Average fuel cycle cost of NASAP choice reactor started up in year t_i	mills/Kwhre
$(A_u)_i$	Average cost of NASAP choice fuel cycle	-----------
a_i	Net nuclear growth rate	Gwe/year
B	LWR development cost at time T_y	$
B_{C1}	Capital cost of all LWR's built	$

Variable	Definition	Units
B_{C2}	Capital cost of LWR's built through year T_B	$
B_{C3}	Capital cost of all NASAP choice reactors built	$
b_i	Fractional disbursement rate at time T_y	------------
C	LWR development cost at time T_z	$
C_{A1}	Total fuel cycle cost of all LWR's started up	$
C_{A2}	LWR fuel cycle cost through base year T_B	$
C_{A3}	Total NASAP choice reactor fuel cycle cost	$
C_{FC}	Total fuel cycle cost	$
C_H	Fraction of NASAP fuel cycle cost due to U_3O_8 cost	------------
C_o	LWR original plant cost	$/Kwe
C_o^*	NASAP choice cost for one plant	$/Kwe
C_{RD}	Total cost of research and development	$
c_i	Fractional disbursement rate at time T_z	------------
d_i	NASAP capital cost disbursement rate d(t)	------------
E	First time engineering cost for one vendor	$
F_i	R&D overlap factor for agent (i)	------------
$F_{K_j}(t)$	LWR fuel cycle cost in each region (j)	mills/Kwhre
f_c	Interest rate during construction	------------
$f_{i,j}$	Fuel usage factor for fuel period (j) at time (i)	------------
$f'_{i,j}$	Intermediate calculated fuel usage factor for fuel period (j) at time (i)	------------
g_i	Rate of LWR installation	Gwe/year
g'_i	LWR retirement rate	Gwe/year
H_i	Fuel committed to any date (t_i)	Short tons/year
h_i	Backfit flag defined for times T_x, T_y, T_z	------------
iB	Value of counter (i) at time (T_B)	------------
i_{FC}	Plant fixed charge rate	$Year^{-1}$
i'_{FC}	Fixed charge rate on backfits	$Year^{-1}$
iL	Value of counter (i) at time $(T_L)_{i,j}$	------------
iU	Value of counter (i) at time $(T_U)_{i,j}$	------------

Variable	Definition	Units
ix	Value of counter (i) at time T_X	------------
iy	Value of counter (i) at time T_Y	------------
iz	Value of counter (i) at time T_Z	------------
$j^*_{i,k}$	Current fuel usage period	------------
K*	Fuel cycle cost of NASAP choice reactor	mills/Kwhre
K_j	Fuel cost of LWR in each of 4 regions (j)	mills/Kwhre
k_j	Values of ix, iy, iz referenced to region (j)	------------
L_{AF}	Lifetime average fuel cycle cost of each LWR started up in year (t_i)	mills/Kwhre
M_i'	Ore (U_3O_8) mined	Tons
M_k	Fuel used by all plants through year τ_k	Short tons/year
N	Number of years during which reactors are started up. Total number of time entries equals N + ΔR.	------------
$N_{LWR,i}$	Total number of LWR's in existence at time (t_i)	Gwe
$N_{NAS,i}$	Total number NASAP reactors on line at time (t_i)	Gwe
Q_j	Development costs A, B and C referenced to region (j)	$
$q_{i,j}$	Fractional disbursement rates a_i, b_i, c_i referenced to region (j)	------------
R	Contribution of NASAP R&D to capital cost	$
R_{MINW}	Minimum corporate R&D cost	$
r_D	Fractional discount rate	------------
r_i	NASAP choice installation rate	Gwe/year
r_i'	NASAP choice retirement rate	Gwe/year
T_B	Base year for all cost calculations	Calendar year
T_C	Total cost of LWR + NASAP choice through year T_N	$
T_D	Year NASAP choice reactor deployment begins	Calendar year
T_E	Total first time engineering cost	$
T_I	Reference starting year for NASAP deployment	Calendar year
T_{Kj}	End of improvement period (j)	Calendar year
$(T_L)_{i,j}$	Lower boundary for fuel region (j) at time (i)	Calendar year
$(T_L)'_{i,j}$	Intermediate calculational lower boundary for fuel region (j) at time (i)	Calendar year

Variable	Definition	Units
T_N	End of last fuel improvement period	Calendar year
T_{oo}	Base reference year	Calendar year
T_{OR}	Year reactor retirement begins	Calendar year
T_{RI}	Reference installation year	Calendar year
$(T_U)_{i,j}$	Upper boundary for fuel region (j) at time (i)	Calendar year
T_X	End of first fuel improvement period	Calendar year
T_Y	End of second fuel improvement period	Calendar year
T_Z	End of third fuel improvement period	Calendar year
t*	Year when 2.6 x 10^6 short tons of fuel will be committed	Calendar year
t**	Year when 5.4 x 10^6 short tons of fuel will be committed	Calendar year
t_i	Time	Years
U*	Fuel requirement for NASAP choice reactors	Short tons/Gwe
U_i	Fuel required by an LWR started up in year (t_i)	Short tons/Gwe
$U_j^{(o)}$	Fuel available for LWR lifetime in fuel period (j)	Short tons/Gwe
U_N	Units conversion factor [($10^6 \frac{Kwe}{Gwe} 10^{-3} \frac{\$}{mills}$ 8766 $\frac{hr}{yr}$)x (10^9 $/billion)]	---------
U_o	U_3O_8 available for NASAP choice lifetime	Short tons/Gwe
$(U_o)_{i,j}$	Fuel used for LWR in fuel period (j)	Short tons/Gwe
V_i	Cost for vendor (i)	$
v_i	Fraction of R&D monies to agent (i)	------------
X_D	Total NASAP development cost	$
X_{LWR}	Total R&D cost for LWR's	$
x_D	NASAP R&D contribution to capital cost	$/Kwe
x_j	Fraction of regional LWR fuel cost due to U_3O_8 cost	------------
y_j	Cost of LWR development in period (j)	$/Kwe
α_i	Fractional disbursement rate at time T_X	------------
α_1^*	Learning curve characterization parameter 1	------------
α_2^*	Learning curve characterization parameter 2	------------
β	Time required to install backfitted changes	Years

Variable	Definition	Units
γ_{LWR}	LWR operation and maintenance cost	mills/Kwhre
γ_{NAS}	NASAP operation and maintenance cost	mills/Kwhre
ΔB	Minimum lifetime for backfitting to be possible	Years
Δ_o	Reference lifetime	Years
ΔR	Reactor lifetime	Years
ΔT_a	Acceleration time to full nuclear installation rate	Years
ΔT_c	Lead plant construction time	Years
ΔT_o	Time required to operate lead plant	Years
ΔT_{RD}	Time required to perform R&D	Years
$\eta_{i,\ell}$	The number of LWR's started up in year (ℓ) that are still operative in year (i)	Gwe/year
η_{LWR}	LWR capacity factor over lifetime ΔR	hre/hr
η_{NAS}	NASAP choice capacity factor over lifetime ΔR	hre/hr
η_o	Reference capacity factor	hre/hr
$\theta(t)$	Normalized NASAP capital cost function	------------
λ	Lag time between purchase and startup for LWR's	Years
λ^*	Lag time between purchase and startup for NASAP reactors	Years
δ_{c_j}	New plant capital cost adder for period (j)	$/Kwe
δ'_{c_j}	Backfit plant capital cost adder for period (j)	$/Kwe
$\mu_{i,j}$	Average fuel cost for reactors at time (i) in region (j)	------------
$\xi(t)$	Discount function	------------
ρ	Average fraction of lag time passing before half the plant is paid for	------------
τ^*	Substitution variable = $\lambda^* (1.0 - \rho) - T_B$	Years
τ_i	Time for fuel cost function	Calendar year
τ_k	Time to which fuel usage is computed	Calendar year
$T_{i,k}$	Fuel used by an LWR to time τ_k	Short tons
$\psi(t)$	Normalized cost of fuel over time $[T_{oo}, T_N]$	------------
ψ'	Cost of ore mined	$/lbm
$\phi(t)$	Normalized LWR capital cost function	------------
ω_{LWR}	LWR R&D contribution to power cost	mills/Kwhre
ω_{NAS}	NASAP R&D contribution to power cost	mills/Kwhre

XV. Sample Problem Input

```
    NASAP SAMPLE PROBLEM        R+D MODEL 1       B A  MAUL
$INPUT
 DTR=2.0, DTC=8.0, DTO=2.0, DTA=7.0, TO=1979.,
    TI(1) = 1957., 1958., 1959., 1960., 1961., 1962., 1963., 1964.,
    1965., 1966., 1967., 1968., 1969., 1970., 1971., 1972., 1973.,
    1974., 1975., 1976., 1977., 1978., 1979., 1980., 1981., 1982.,
    1983., 1984., 1985., 1986., 1987., 1988., 1989., 1990., 1991.,
    1992., 1993., 1994., 1995., 1996., 1997., 1998., 1999., 2000.,
    2001., 2002., 2003., 2004., 2005., 2006.,
    A(1) =  21 * 2.0,  29 * 6.0,
    R(1) =  30 * 0.0,1.,2.,3.,4.,5.,6.,8.,10.,16.,16.,18.,9*22.,
    N = 40, TOO = 1957., DR = 10.,
    TX = 1981., IX =25, TY = 1985., IY = 29, TZ = 1989., IZ = 33,
    M = 10, TONS(1) = 0.0, 0.1E06, .5E06, 1.0E06, 2.0E06,3.0E06,
    4.0E06, 5.0E06, 6.0E06, 7.0E06, COST(1) = 1.0, 1.0, 2.0, 3.0,
    7.5, 11.5, 12.5, 14.5, 17.5, 21.5,
    BKFTX = 0.0, BKFTY = 1.0, BKFTZ = 0.0, DELCX = 50., DELCY = 100.,
    DELCZ = 150., DELCXP = 75., DELCYP = 150., DELCZP = 225.,
    UO1 = 6000., UO2 = 5500.0, UO3 = 5000., UO4 = 4500.0,
    DETO = 8.0, ETAO = 0.9, ETALWR = 0.72, ETANAS = 0.65,
    UO = 3000.0,
                                                      NU1 = 0.40,
    NU2 = 0.20, NU3 = 0.15, NU4 = 0.25, OLF1 = 2.0, OLF2 = 2.0,
    OLF3 = 2.0, OLF4 = 3.0, FCIP = 0.25, AI(21)= 0.30, 0.30, 0.40,
    BI(26)= 0.20, 0.60, 0.20, CI(29)= 0.20, 0.20, 0.35, 0.25,
    TLAMBA = 3.0, CAPA = 50.E06, CAPB = 150.E06,CAPCC= 100.E06,
    BETA = 1.0, DTB = 0.0, DI(23)= 0.05, 0.15, 0.20, 0.20, 0.25, 0.10,
    0.05, FCI = 0.17, RDIS = 0.085, CRI = 0.10, TLAG = 4.0,
    RHO = 0.7, TB = 1978., REG1 = 12.0, REG2 = 11.0, REG3 = 10.0,
    REG4 = 9.0, X1 = 0.50, X2 = 0.45, X3 = 0.40, X4 = 0.35,
    STARK = 7.0, CHI = 0.30, CO = 600.0, COSTAR = 750.0,
 PHI(1) = 22 * 1.0, 8 * 1.1, 10 * 1.2,
  THETA(1) = 22 * 1.0, 1.2, 1.4, 1.6, 2.0, 2.6, 8 * 3.2, 5 * 3.6,
    HALF = 0.1,   SIGMA = .05, GAMMA = 0.5, GAMMAS = 1.0,
    RMINW = 250.E06,
    E = 0.3E07,
    IRD = 0,
$END
      NASAP SAMPLE PROBLEM  STACKED CASE  R+D MODEL 2  B A  MAUL
$INPUT
     GAMMA = 0.75,
    IRD = 1,
$END
```

XVI. Sample Problem Output

```
$INPUT
DTR      = .2E+01,
DTC      = .8E+01,
DTO      = .2E+01,
DTA      = .7E+01,
TO       = .1979E+04,
TI       = .1957E+04, .1958E+04, .1959E+04, .196E+04, .1961E+04, .1962E+04,      .1963E+04, .1964E+04, .1965E+04, .1966E+04,
           .1967E+04, .1968E+04, .1969E+04, .197E+04, .1971E+04, .1972E+04,      .1973E+04, .1974E+04, .1975E+04, .1976E+04,
           .1977E+04, .1978E+04, .1979E+04, .198E+04, .1981E+04, .1982E+04,      .1983E+04, .1984E+04, .1985E+04, .1986E+04,
           .1987E+04, .1988E+04, .1989E+04, .199E+04, .1991E+04, .1992E+04,      .1993E+04, .1994E+04, .1995E+04, .1996E+04,
           .1997E+04, .1998E+04, .1999E+04, .2E+04, .2001E+04, .2002E+04,        .2003E+04, .2004E+04, .2005E+04, .2006E+04,
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
           0.0, 0.0, 0.0,
A        = .2E+01, .2E+01, .2E+01, .2E+01, .2E+01, .2E+01, .2E+01, .2E+01,      .2E+01, .2E+01, .2E+01, .2E+01, .2E+01,
           .2E+01, .2E+01, .2E+01, .2E+01, .2E+01, .2E+01, .2E+01, .2E+01,      .6E+01, .6E+01, .6E+01, .6E+01, .6E+01,
           .6E+01, .6E+01, .6E+01, .6E+01, .6E+01, .6E+01, .6E+01, .6E+01,      .6E+01, .6E+01, .6E+01, .6E+01, .6E+01,
           .6E+01, .6E+01, .6E+01, .6E+01, .6E+01, .6E+01, .6E+01, .6E+01,      .6E+01, .6E+01, .6E+01, 0.0, 0.0, 0.0,
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
R        = 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, .1E+01, .2E+01, .3E+01,  .4E+01, .5E+01, .6E+01, .8E+01, .1E+02,
           .16E+02, .16E+02, .18E+02, .22E+02, .22E+02, .22E+02, .22E+02,        .22E+02, .22E+02, .22E+02, .22E+02,
           .22E+02, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,  0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
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         0.0, 0.0, 0.0, 0.0, 0.0,
N      = 40,
TOO    = .1957E+04,
DR     = .1E+02,
TX     = .1981E+04,
TY     = .1985E+04,
TZ     = .1989E+04,
IX     = 25,
IY     = 29,
IZ     = 33,
DETO   = .8E+01,
ETAO   = .9E+00,
ETALWR = .72E+00,
ETANAS = .65E+00,
TONS   = 0.0, .1E+06, .5E+06, .1E+07, .2E+07, .3E+07, .4E+07, .5E+07, .6E+07,  .7E+07, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
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         0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
COST   = .1E+01, .1E+01, .2E+01, .3E+01, .75E+01, .115E+02, .125E+02,       .145E+02, .175E+02, .215E+02, 0.0,
         0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
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         0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
```

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         0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
         0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
M        = 10,
BKFTX    = 0.0,
BKFTY    = .1E+01,
BKFTZ    = 0.0,
DELCX    = .5E+02,
DELCY    = .1E+03,
DELCZ    = .15E+03,
DELCXP   = .75E+02,
DELCYP   = .15E+03,
DELCZP   = .225E+03,
UD1      = .6E+04,
UD2      = .55E+04,
UD3      = .5E+04,
UD4      = .45E+04,
UD       = .3E+04,
PMINW    = .25E+09,
NU1      = .4E+00,
NU2      = .2E+00,
NU3      = .15E+00,
NU4      = .25E+00,
DLF1     = .2E+01,
DLF2     = .2E+01,
```

```
OLF3    = .2E+01,

OLF4    = .3E+01,

E       = .3E+07,

FCIP    = .25E+00,

AI      = 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, .3E+00,
          .3E+00, .4E+00, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,     0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,

BI      = 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, .2E+00, .6E+00, .2E+00, 0.0, 0.0, 0.0, 0.0, 0.0,     0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,

CI      = 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, .2E+00, .2E+00, .35E+00, .25E+00,     0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,

TLAMBA  = .3E+01,

CAPA    = .5E+08,

CAPB    = .15E+09,
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CAPCC   = .1E+09,

BETA    = .1E+01,

DTB     = 0.0,

DI      = 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, .5E-01, .15E+00, .2E+00, .2E+00, .25E+00, .1E+00, .5E-01, 0.0,  0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,

FCI     = .17E+00,

RDIS    = .85E-01,

CRI     = .1E+00,

TLAG    = .4E+01,

RHO     = .7E+00,

TB      = .1978E+04,

REG1    = .12E+02,

REG2    = .11E+02,

REG3    = .1E+02,

REG4    = .9E+01,

X1      = .5E+00,

X2      = .45E+00,

X3      = .4E+00,

X4      = .35E+00,

STARK   = .7E+01,
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CHI      = .3E+00,

CO       = .6E+03,

COSTAR   = .75E+03,

PHI      = .1E+01, .1E+01, .1E+01, .1E+01, .1E+01, .1E+01, .1E+01, .1E+01,         .1E+01, .1E+01, .1E+01, .1E+01, .1E+01,
           .1E+01, .1E+01, .1E+01, .1E+01, .1E+01, .1E+01, .1E+01, .1E+01,         .1E+01, .11E+01, .11E+01, .11E+01,
           .11E+01, .11E+01, .11E+01, .11E+01, .11E+01, .12E+01, .12E+01,          .12E+01, .12E+01, .12E+01, .12E+01,
           .12E+01, .12E+01, .12E+01, .12E+01, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,       0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,

THETA    = .1E+01, .1E+01, .1E+01, .1E+01, .1E+01, .1E+01, .1E+01, .1E+01,         .1E+01, .1E+01, .1E+01, .1E+01, .1E+01,
           .1E+01, .1E+01, .1E+01, .1E+01, .1E+01, .1E+01, .1E+01, .1E+01,         .1E+01, .12E+01, .14E+01, .16E+01,
           .2E+01, .26E+01, .32E+01, .32E+01, .32E+01, .32E+01, .32E+01,           .32E+01, .32E+01, .32E+01, .36E+01,
           .36E+01, .36E+01, .36E+01, .36E+01, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,       0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,

HALF     = .1E+00,

SIGMA    = .5E-01,

GAMMA    = .5E+00,

GAMMAS   = .1E+01,

IRD      = 0,

$END
```

CONSTRUCTION TIME = 8. ACCELERATION TIME = 7. REFERENCE INSTALLATION RATE = 1993.00

MAXIMUM NUMBER OF LWRS EVER ON LINE IS = 111.00

I	T(I)	A(I)	R(I)	G(I)	NLWR(I)	NNAS(I)
1	1957.00	2.00	0.00	2.00	2.00	0.00
2	1958.00	2.00	0.00	2.00	4.00	0.00
3	1959.00	2.00	0.00	2.00	6.00	0.00
4	1960.00	2.00	0.00	2.00	8.00	0.00
5	1961.00	2.00	0.00	2.00	10.00	0.00
6	1962.00	2.00	0.00	2.00	12.00	0.00
7	1963.00	2.00	0.00	2.00	14.00	0.00
8	1964.00	2.00	0.00	2.00	16.00	0.00
9	1965.00	2.00	0.00	2.00	18.00	0.00
10	1966.00	2.00	0.00	2.00	20.00	0.00
11	1967.00	2.00	0.00	4.00	22.00	0.00
12	1968.00	2.00	0.00	4.00	24.00	0.00
13	1969.00	2.00	0.00	4.00	26.00	0.00
14	1970.00	2.00	0.00	4.00	28.00	0.00
15	1971.00	2.00	0.00	4.00	30.00	0.00
16	1972.00	2.00	0.00	4.00	32.00	0.00
17	1973.00	2.00	0.00	4.00	34.00	0.00
18	1974.00	2.00	0.00	4.00	36.00	0.00
19	1975.00	2.00	0.00	4.00	38.00	0.00
20	1976.00	2.00	0.00	4.00	40.00	0.00
21	1977.00	2.00	0.00	6.00	42.00	0.00
22	1978.00	6.00	0.00	10.00	48.00	0.00
23	1979.00	6.00	0.00	10.00	54.00	0.00
24	1980.00	6.00	0.00	10.00	60.00	0.00
25	1981.00	6.00	0.00	10.00	66.00	0.00
26	1982.00	6.00	0.00	10.00	72.00	0.00
27	1983.00	6.00	0.00	10.00	78.00	0.00
28	1984.00	6.00	0.00	10.00	84.00	0.00
29	1985.00	6.00	0.00	10.00	90.00	0.00
30	1986.00	6.00	0.00	10.00	96.00	0.00
31	1987.00	6.00	1.00	11.00	101.00	1.00
32	1988.00	6.00	2.00	14.00	105.00	3.00
33	1989.00	6.00	3.00	13.00	108.00	6.00
34	1990.00	6.00	4.00	12.00	110.00	10.00
35	1991.00	6.00	5.00	11.00	111.00	15.00
36	1992.00	6.00	6.00	10.00	111.00	21.00
37	1993.00	6.00	8.00	8.00	109.00	29.00
38	1994.00	6.00	10.00	6.00	105.00	39.00
39	1995.00	6.00	16.00	0.00	95.00	55.00
40	1996.00	6.00	16.00	0.00	85.00	71.00
41	1997.00	6.00	18.00	0.00	74.00	88.00
42	1998.00	6.00	22.00	0.00	60.00	108.00

43	1999.00	6.00	22.00	0.00	47.00	127.00
44	2000.00	6.00	22.00	0.00	35.00	145.00
45	2001.00	6.00	22.00	0.00	24.00	162.00
46	2002.00	6.00	22.00	0.00	14.00	178.00
47	2003.00	6.00	22.00	0.00	6.00	192.00
48	2004.00	6.00	22.00	0.00	0.00	204.00
49	2005.00	6.00	22.00	0.00	0.00	210.00
50	2006.00	6.00	22.00	0.00	0.00	216.00

I	H(I)	TI(I)	U(I)
1	.12000E+05	.19570E+04	.60000E+04
2	.24000E+05	.19580E+04	.60000E+04
3	.36000E+05	.19590E+04	.60000E+04
4	.48000E+05	.19600E+04	.60000E+04
5	.60000E+05	.19610E+04	.60000E+04
6	.72000E+05	.19620E+04	.60000E+04
7	.84000E+05	.19630E+04	.60000E+04
8	.96000E+05	.19640E+04	.60000E+04
9	.10800E+06	.19650E+04	.60000E+04
10	.12000E+06	.19660E+04	.60000E+04
11	.14400E+06	.19670E+04	.60000E+04
12	.16800E+06	.19680E+04	.60000E+04
13	.19200E+06	.19690E+04	.60000E+04
14	.21600E+06	.19700E+04	.60000E+04
15	.24000E+06	.19710E+04	.60000E+04
16	.26400E+06	.19720E+04	.60000E+04
17	.28800E+06	.19730E+04	.60000E+04
18	.31200E+06	.19740E+04	.60000E+04
19	.33600E+06	.19750E+04	.60000E+04
20	.35960E+06	.19760E+04	.59000E+04
21	.39440E+06	.19770E+04	.58000E+04
22	.45140E+06	.19780E+04	.57000E+04
23	.50740E+06	.19790E+04	.56000E+04
24	.56240E+06	.19800E+04	.55000E+04
25	.61440E+06	.19810E+04	.52000E+04
26	.66590E+06	.19820E+04	.51500E+04
27	.71690E+06	.19830E+04	.51000E+04
28	.76740E+06	.19840E+04	.50500E+04
29	.81740E+06	.19850E+04	.50000E+04
30	.86740E+06	.19860E+04	.50000E+04
31	.92511E+06	.19870E+04	.50000E+04
32	.10005E+07	.19880E+04	.50000E+04
33	.10672E+07	.19890E+04	.45000E+04
34	.11320E+07	.19900E+04	.45000E+04
35	.11950E+07	.19910E+04	.45000E+04
36	.12563E+07	.19920E+04	.45000E+04
37	.13139E+07	.19930E+04	.45000E+04
38	.13680E+07	.19940E+04	.45000E+04
39	.14114E+07	.19950E+04	.45000E+04
40	.14547E+07	.19960E+04	.45000E+04

DATE T(I) CORRESPONDING TO U308 COMMITTED H = .260E+07 T = 1995.00

DATE T(I) CORRESPONDING TO U308 COMMITTED H = .540E+07 T = 1995.00

F(1,I)	F(2,I)	F(3,I)	F(4,I)
.10000E+01	0.	0.	0.
.10000E+01	0.	0.	0.
.10000E+01	0.	0.	0.
.10000E+01	0.	0.	0.
.10000E+01	0.	0.	0.
.10000E+01	0.	0.	0.
.10000E+01	0.	0.	0.
.10000E+01	0.	0.	0.
.10000E+01	0.	0.	0.
.10000E+01	0.	0.	0.
.10000E+01	0.	0.	0.
.10000E+01	0.	0.	0.
.10000E+01	0.	0.	0.
.10000E+01	0.	0.	0.
.10000E+01	0.	0.	0.
.10000E+01	0.	0.	0.
.10000E+01	0.	0.	0.
.10000E+01	0.	0.	0.
.10000E+01	0.	0.	0.
.90000E+00	0.	.10000E+00	0.
.80000E+00	0.	.20000E+00	0.
.70000E+00	0.	.30000E+00	0.
.60000E+00	0.	.40000E+00	0.
.50000E+00	0.	.50000E+00	0.
0.	.40000E+00	.60000E+00	0.
0.	.30000E+00	.70000E+00	0.
0.	.20000E+00	.80000E+00	0.
0.	.10000E+00	.90000E+00	0.
0.	0.	.10000E+01	0.
0.	0.	.10000E+01	0.
0.	0.	.10000E+01	0.
0.	0.	.10000E+01	0.
0.	0.	0.	.10000E+01
0.	0.	0.	.10000E+01
0.	0.	0.	.10000E+01
0.	0.	0.	.10000E+01
0.	0.	0.	.10000E+01
0.	0.	0.	.10000E+01
0.	0.	0.	.10000E+01
0.	0.	0.	.10000E+01

U(1,I)	U(2,I)	U(3,I)	U(4,I)
.60000E+04	.60000E+04	.60000E+04	.60000E+04
.60000E+04	.60000E+04	.60000E+04	.60000E+04
.60000E+04	.60000E+04	.60000E+04	.60000E+04
.60000E+04	.60000E+04	.60000E+04	.60000E+04
.60000E+04	.60000E+04	.60000E+04	.60000E+04
.60000E+04	.60000E+04	.60000E+04	.60000E+04
.60000E+04	.60000E+04	.60000E+04	.60000E+04
.60000E+04	.60000E+04	.60000E+04	.60000E+04
.60000E+04	.60000E+04	.60000E+04	.60000E+04
.60000E+04	.60000E+04	.60000E+04	.60000E+04
.60000E+04	.60000E+04	.60000E+04	.60000E+04
.60000E+04	.60000E+04	.60000E+04	.60000E+04
.60000E+04	.60000E+04	.60000E+04	.60000E+04
.60000E+04	.60000E+04	.60000E+04	.60000E+04
.60000E+04	.60000E+04	.60000E+04	.60000E+04
.60000E+04	.60000E+04	.60000E+04	.60000E+04
.60000E+04	.60000E+04	.60000E+04	.60000E+04
.60000E+04	.60000E+04	.60000E+04	.60000E+04
.60000E+04	.60000E+04	.50000E+04	.60000E+04
.60000E+04	.60000E+04	.50000E+04	.50000E+04
.60000E+04	.60000E+04	.50000E+04	.50000E+04
.60000E+04	.60000E+04	.50000E+04	.50000E+04
.60000E+04	.60000E+04	.50000E+04	.50000E+04
.60000E+04	.60000E+04	.50000E+04	.50000E+04
.60000E+04	.55000E+04	.50000E+04	.50000E+04
.60000E+04	.55000E+04	.50000E+04	.50000E+04
.60000E+04	.55000E+04	.50000E+04	.50000E+04
.60000E+04	.55000E+04	.50000E+04	.50000E+04
.60000E+04	.55000E+04	.50000E+04	.50000E+04
.60000E+04	.55000E+04	.50000E+04	.50000E+04
.60000F+04	.55000E+04	.50000E+04	.50000E+04
.60000E+04	.55000E+04	.50000E+04	.50000E+04
.60000E+04	.55000E+04	.50000E+04	.45000E+04
.60000E+04	.55000E+04	.50000E+04	.45000E+04
.60000E+04	.55000E+04	.50000E+04	.45000E+04
.60000E+04	.55000E+04	.50000E+04	.45000E+04
.60000E+04	.55000E+04	.50000E+04	.45000E+04
.60000E+04	.55000E+04	.50000E+04	.45000E+04
.60000E+04	.55000E+04	.50000E+04	.45000E+04
.60000E+04	.55000E+04	.50000E+04	.45000E+04
0.	0.	0.	.45000E+04
0.	0.	0.	.45000E+04

0.	0.	0.	.45000E+04
0.	0.	0.	.45000E+04
0.	0.	0.	.45000E+04
0.	0.	0.	.45000E+04
0.	0.	0.	.45000E+04
0.	0.	0.	.45000E+04
0.	0.	0.	.45000E+04
0.	0.	0.	.45000E+04

I	T(I)	TL(1,I)	TL(2,I)	TL(3,I)	TL(4,I)
1	1957.00	1957.00	1967.00	1967.00	1967.00
2	1958.00	1958.00	1968.00	1968.00	1968.00
3	1959.00	1959.00	1969.00	1969.00	1969.00
4	1960.00	1960.00	1970.00	1970.00	1970.00
5	1961.00	1961.00	1971.00	1971.00	1971.00
6	1962.00	1962.00	1972.00	1972.00	1972.00
7	1963.00	1963.00	1973.00	1973.00	1973.00
8	1964.00	1964.00	1974.00	1974.00	1974.00
9	1965.00	1965.00	1975.00	1975.00	1975.00
10	1966.00	1966.00	1976.00	1976.00	1976.00
11	1967.00	1967.00	1977.00	1977.00	1977.00
12	1968.00	1968.00	1978.00	1978.00	1978.00
13	1969.00	1969.00	1979.00	1979.00	1979.00
14	1970.00	1970.00	1980.00	1980.00	1980.00
15	1971.00	1971.00	1981.00	1981.00	1981.00
16	1972.00	1972.00	1982.00	1982.00	1982.00
17	1973.00	1973.00	1983.00	1983.00	1983.00
18	1974.00	1974.00	1984.00	1984.00	1984.00
19	1975.00	1975.00	1985.00	1985.00	1985.00
20	1976.00	1976.00	1985.00	1985.00	1986.00
21	1977.00	1977.00	1985.00	1985.00	1987.00
22	1978.00	1978.00	1985.00	1985.00	1988.00
23	1979.00	1979.00	1985.00	1985.00	1989.00
24	1980.00	1980.00	1985.00	1985.00	1990.00
25	1981.00	1981.00	1981.00	1985.00	1991.00
26	1982.00	1982.00	1982.00	1985.00	1992.00
27	1983.00	1983.00	1983.00	1985.00	1993.00
28	1984.00	1984.00	1984.00	1985.00	1994.00
29	1985.00	1985.00	1985.00	1985.00	1995.00
30	1986.00	1986.00	1986.00	1986.00	1996.00
31	1987.00	1987.00	1987.00	1987.00	1997.00
32	1988.00	1988.00	1988.00	1988.00	1998.00
33	1989.00	1989.00	1989.00	1989.00	1989.00
34	1990.00	1990.00	1990.00	1990.00	1990.00
35	1991.00	1991.00	1991.00	1991.00	1991.00
36	1992.00	1992.00	1992.00	1992.00	1992.00
37	1993.00	1993.00	1993.00	1993.00	1993.00
38	1994.00	1994.00	1994.00	1994.00	1994.00
39	1995.00	1995.00	1995.00	1995.00	1995.00
40	1996.00	1996.00	1996.00	1996.00	1996.00

I	T(I)	TU(1,I)	TU(2,I)	TU(3,I)	TU(4,I)
1	1957.00	1967.00	1967.00	1967.00	1967.00
2	1958.00	1968.00	1968.00	1968.00	1968.00
3	1959.00	1969.00	1969.00	1969.00	1969.00
4	1960.00	1970.00	1970.00	1970.00	1970.00
5	1961.00	1971.00	1971.00	1971.00	1971.00
6	1962.00	1972.00	1972.00	1972.00	1972.00
7	1963.00	1973.00	1973.00	1973.00	1973.00
8	1964.00	1974.00	1974.00	1974.00	1974.00
9	1965.00	1975.00	1975.00	1975.00	1975.00
10	1966.00	1976.00	1976.00	1976.00	1976.00
11	1967.00	1977.00	1977.00	1977.00	1977.00
12	1968.00	1978.00	1978.00	1978.00	1978.00
13	1969.00	1979.00	1979.00	1979.00	1979.00
14	1970.00	1980.00	1980.00	1980.00	1980.00
15	1971.00	1981.00	1981.00	1981.00	1981.00
16	1972.00	1982.00	1982.00	1982.00	1982.00
17	1973.00	1983.00	1983.00	1983.00	1983.00
18	1974.00	1984.00	1984.00	1984.00	1984.00
19	1975.00	1985.00	1985.00	1985.00	1985.00
20	1976.00	1985.00	1985.00	1986.00	1986.00
21	1977.00	1985.00	1985.00	1987.00	1987.00
22	1978.00	1985.00	1985.00	1988.00	1988.00
23	1979.00	1985.00	1985.00	1989.00	1989.00
24	1980.00	1985.00	1985.00	1990.00	1990.00
25	1981.00	1981.00	1985.00	1991.00	1991.00
26	1982.00	1981.00	1985.00	1992.00	1992.00
27	1983.00	1981.00	1985.00	1993.00	1993.00
28	1984.00	1981.00	1985.00	1994.00	1994.00
29	1985.00	1981.00	1985.00	1995.00	1995.00
30	1986.00	1981.00	1985.00	1996.00	1996.00
31	1987.00	1981.00	1985.00	1997.00	1997.00
32	1988.00	1981.00	1985.00	1998.00	1998.00
33	1989.00	1981.00	1985.00	1989.00	1999.00
34	1990.00	1981.00	1985.00	1989.00	2000.00
35	1991.00	1981.00	1985.00	1989.00	2001.00
36	1992.00	1981.00	1985.00	1989.00	2002.00
37	1993.00	1981.00	1985.00	1989.00	2003.00
38	1994.00	1981.00	1985.00	1989.00	2004.00
39	1995.00	1981.00	1985.00	1989.00	2005.00
40	1996.00	1981.00	1985.00	1989.00	2006.00

FUEL USED BY ALL PLANTS UP THROUGH TAU(K)

TAU(K)	FUEL USED M(K)
1957.00	0.
1958.00	.1200000E+04
1959.00	.3600000E+04
1960.00	.7200000E+04
1961.00	.1200000E+05
1962.00	.1800000E+05
1963.00	.2520000E+05
1964.00	.3360000E+05
1965.00	.4320000E+05
1966.00	.5400000E+05
1967.00	.6600000E+05
1968.00	.7920000E+05
1969.00	.9360000E+05
1970.00	.1092000E+06
1971.00	.1260000E+06
1972.00	.1440000E+06
1973.00	.1632000E+06
1974.00	.1836000E+06
1975.00	.2052000E+06
1976.00	.2280000E+06
1977.00	.2520000E+06
1978.00	.2772000E+06
1979.00	.3060000E+06
1980.00	.3384000E+06
1981.00	.3744000E+06
1982.00	.4135000E+06
1983.00	.4557000E+06
1984.00	.5010000E+06
1985.00	.5494000E+06
1986.00	.5944000E+06
1987.00	.6426708E+06
1988.00	.6939833E+06
1989.00	.7481083E+06
1990.00	.8041667E+06
1991.00	.8619792E+06
1992.00	.9213667E+06
1993.00	.9824208E+06
1994.00	.1044783E+07
1995.00	.1109179E+07

1996.00	.1172908E+07
1997.00	.1236242E+07
1998.00	.1299492E+07
1999.00	.1360888E+07
2000.00	.1421308E+07
2001.00	.1480933E+07
2002.00	.1539942E+07
2003.00	.1598242E+07
2004.00	.1656192E+07
2005.00	.1713067E+07
2006.00	.1771567E+07

FUEL PRICE CORRESPONDING TO TIME TAU(K)

K	TAU(K)	PSI(K)
1	1957.00	.1000000E+01
2	1958.00	.1000000E+01
3	1959.00	.1000000E+01
4	1960.00	.1000000E+01
5	1961.00	.1000000E+01
6	1962.00	.1000000E+01
7	1963.00	.1000000E+01
8	1964.00	.1000000E+01
9	1965.00	.1000000E+01
10	1966.00	.1000000E+01
11	1967.00	.1000000E+01
12	1968.00	.1000000E+01
13	1969.00	.1000000E+01
14	1970.00	.1023000E+01
15	1971.00	.1065000E+01
16	1972.00	.1110000E+01
17	1973.00	.1158000E+01
18	1974.00	.1209000E+01
19	1975.00	.1263000E+01
20	1976.00	.1320000E+01
21	1977.00	.1380000E+01
22	1978.00	.1443000E+01
23	1979.00	.1515000E+01
24	1980.00	.1596000E+01
25	1981.00	.1686000E+01
26	1982.00	.1783750E+01
27	1983.00	.1889250E+01
28	1984.00	.2002000E+01
29	1985.00	.2098800E+01
30	1986.00	.2188800E+01
31	1987.00	.2285342E+01
32	1988.00	.2387967E+01
33	1989.00	.2496217E+01
34	1990.00	.2608333E+01
35	1991.00	.2723958E+01
36	1992.00	.2842733E+01
37	1993.00	.2964842E+01

38	1994.00	.3201525E+01
39	1995.00	.3491306E+01
40	1996.00	.3778087E+01
41	1997.00	.4063087E+01
42	1998.00	.4347712E+01
43	1999.00	.4623994E+01
44	2000.00	.4895887E+01
45	2001.00	.5164200E+01
46	2002.00	.5429737E+01
47	2003.00	.5692087E+01
48	2004.00	.5952862E+01
49	2005.00	.6208800E+01
50	2006.00	.6472050E+01

AVERAGE COST VALUES FOR REACTORS STARTED UP IN YEAR TAU(K)

K	TAU(K)	AVG. COST	REGION
1	1957.00	.1000000E+01	1
2	1958.00	.1000000E+01	1
3	1959.00	.1000000E+01	1
4	1960.00	.1001150E+01	1
5	1961.00	.1005550E+01	1
6	1962.00	.1014300E+01	1
7	1963.00	.1027700E+01	1
8	1964.00	.1046050E+01	1
9	1965.00	.1069650E+01	1
10	1966.00	.1098800E+01	1
11	1967.00	.1133800E+01	1
12	1968.00	.1174950E+01	1
13	1969.00	.1222850E+01	1
14	1970.00	.1277250E+01	1
15	1971.00	.1336950E+01	1
16	1972.00	.1401688E+01	1
17	1973.00	.1471938E+01	1
18	1974.00	.1548150E+01	1
19	1975.00	.1629590E+01	1
20	1976.00	.1667156E+01	1
21	1977.00	.1706800E+01	1
22	1978.00	.1748986E+01	1
23	1979.00	.1793983E+01	1
24	1980.00	.1841680E+01	1
25	1981.00	0.	1
26	1982.00	0.	1
27	1983.00	0.	1
28	1984.00	0.	1
29	1985.00	0.	1
30	1986.00	0.	1
31	1987.00	0.	1
32	1988.00	0.	1
33	1989.00	0.	1
34	1990.00	0.	1
35	1991.00	0.	1
36	1992.00	0.	1
37	1993.00	0.	1
38	1994.00	0.	1

39	1995.00	0.	1
40	1996.00	0.	1
41	1997.00	0.	1
42	1998.00	0.	1
43	1999.00	0.	1
44	2000.00	0.	1
45	2001.00	0.	1
46	2002.00	0.	1
47	2003.00	0.	1
48	2004.00	0.	1
49	2005.00	0.	1
50	2006.00	0.	1
1	1957.00	0.	2
2	1958.00	0.	2
3	1959.00	0.	2
4	1960.00	0.	2
5	1961.00	0.	2
6	1962.00	0.	2
7	1963.00	0.	2
8	1964.00	0.	2
9	1965.00	0.	2
10	1966.00	0.	2
11	1967.00	0.	2
12	1968.00	0.	2
13	1969.00	0.	2
14	1970.00	0.	2
15	1971.00	0.	2
16	1972.00	0.	2
17	1973.00	0.	2
18	1974.00	0.	2
19	1975.00	0.	2
20	1976.00	0.	2
21	1977.00	0.	2
22	1978.00	0.	2
23	1979.00	0.	2
24	1980.00	0.	2
25	1981.00	.1891850E+01	2
26	1982.00	.1944175E+01	2
27	1983.00	.1993013E+01	2
28	1984.00	.2050400E+01	2
29	1985.00	0.	2
30	1986.00	0.	2
31	1987.00	0.	2
32	1988.00	0.	2
33	1989.00	0.	2
34	1990.00	0.	2
35	1991.00	0.	2

36	1992.00	0.	2
37	1993.00	0.	2
38	1994.00	0.	2
39	1995.00	0.	2
40	1996.00	0.	2
41	1997.00	0.	2
42	1998.00	0.	2
43	1999.00	0.	2
44	2000.00	0.	2
45	2001.00	0.	2
46	2002.00	0.	2
47	2003.00	0.	2
48	2004.00	0.	2
49	2005.00	0.	2
50	2006.00	0.	2
1	1957.00	0.	3
2	1958.00	0.	3
3	1959.00	0.	3
4	1960.00	0.	3
5	1961.00	0.	3
6	1962.00	0.	3
7	1963.00	0.	3
8	1964.00	C.	3
9	1965.00	0.	3
10	1966.00	0.	3
11	1967.00	0.	3
12	1968.00	0.	3
13	1969.00	0.	3
14	1970.00	0.	3
15	1971.00	0.	3
16	1972.00	C.	3
17	1973.00	0.	3
18	1974.00	0.	3
19	1975.00	0.	3
20	1976.00	.2143800E+01	3
21	1977.00	.2190435E+01	3
22	1978.00	.2239175E+01	3
23	1979.00	.2289904E+01	3
24	1980.00	.2342378E+01	3
25	1981.00	.2396340E+01	3
26	1982.00	.2451626E+01	3
27	1983.00	.2508146E+01	3
28	1984.00	.2572039E+01	3
29	1985.00	.2649477E+01	3
30	1986.00	.2798567E+01	3
31	1987.00	.2966918E+01	3
32	1988.00	.3153793E+01	3

33	1989.00	0.	3
34	1990.00	0.	3
35	1991.00	0.	3
36	1992.00	0.	3
37	1993.00	0.	3
38	1994.00	0.	3
39	1995.00	0.	3
40	1996.00	0.	3
41	1997.00	0.	3
42	1998.00	0.	3
43	1999.00	0.	3
44	2000.00	0.	3
45	2001.00	0.	3
46	2002.00	0.	3
47	2003.00	0.	3
48	2004.00	0.	3
49	2005.00	0.	3
50	2006.00	0.	3
1	1957.00	0.	4
2	1958.00	0.	4
3	1959.00	0.	4
4	1960.00	0.	4
5	1961.00	0.	4
6	1962.00	0.	4
7	1963.00	0.	4
8	1964.00	0.	4
9	1965.00	0.	4
10	1966.00	0.	4
11	1967.00	0.	4
12	1968.00	0.	4
13	1969.00	0.	4
14	1970.00	0.	4
15	1971.00	0.	4
16	1972.00	0.	4
17	1973.00	0.	4
18	1974.00	0.	4
19	1975.00	0.	4
20	1976.00	0.	4
21	1977.00	0.	4
22	1978.00	0.	4
23	1979.00	0.	4
24	1980.00	0.	4
25	1981.00	0.	4
26	1982.00	0.	4
27	1983.00	0.	4
28	1984.00	0.	4
29	1985.00	0.	4

30	1986.00	0.	4
31	1987.00	0.	4
32	1988.00	0.	4
33	1989.00	.3358169E+01	4
34	1990.00	.3578936E+01	4
35	1991.00	.3815325E+01	4
36	1992.00	.4066688E+01	4
37	1993.00	.4332400E+01	4
38	1994.00	.4606329E+01	4
39	1995.00	.4879771E+01	4
40	1996.00	.5150344E+01	4
41	1997.00	0.	4
42	1998.00	0.	4
43	1999.00	0.	4
44	2000.00	0.	4
45	2001.00	0.	4
46	2002.00	0.	4
47	2003.00	0.	4
48	2004.00	0.	4
49	2005.00	0.	4
50	2006.00	0.	4

VENDOR A COST = .20000E+09

VENDOR B COST = .10000E+09

VENDOR C COST = .75000E+08

GOVERNMENT SUPERVISION COST = .18750E+09

TOTAL FIRST TIME ENGINEERING COST = .9000000E+07

THE CONTRIBUTION OF R+D TO NASAP CHOICE COST = .24580E+01(BILLIONS)

CUMULATIVE NASAP R+D COST

YEAR	COST (BILLIONS $)
1957.00	0.
1958.00	0.
1959.00	0.
1960.00	0.
1961.00	0.
1962.00	0.
1963.00	0.
1964.00	0.
1965.00	0.
1966.00	0.
1967.00	0.
1968.00	0.
1969.00	0.
1970.00	0.
1971.00	0.
1972.00	0.
1973.00	0.
1974.00	0.
1975.00	0.
1976.00	0.
1977.00	0.
1978.00	0.
1979.00	0.
1980.00	0.
1981.00	0.
1982.00	0.
1983.00	0.
1984.00	0.
1985.00	0.
1986.00	0.
1987.00	.3462004E-01
1988.00	.1038601E+00
1989.00	.2077202E+00
1990.00	.3462004E+00
1991.00	.5193006E+00
1992.00	.7270208E+00
1993.00	.1003981E+01
1994.00	.1350181E+01
1995.00	.1904102E+01

1996.00	.2458023E+01

TAUQ	UC
.19789E+04	.19785E+04

IQ(K)	IV(K)	IW(K)
.99444E+00	.48930E+02	.76365E+02
.66612E+00	.49429E+02	.46412E+02
.49579E+00	.44584E+02	.22378E+02

MILLS/KWHRE ASSOCIATED WITH LWR DEVELOPMENT IN PERIOD K ARE

K	MILLS/KWHRE
1	.65111E+00
2	.10425E+01
3	.22155E+01

XLWR = .74342E+00 (BILLIONS $)

CUMULATIVE COST OF LWR R+D	(BILLIONS $)
1957.00	0.
1958.00	0.
1959.00	0.
1960.00	0.
1961.00	0.
1962.00	0.
1963.00	0.
1964.00	0.
1965.00	0.
1966.00	0.
1967.00	0.
1968.00	0.
1969.00	0.
1970.00	0.
1971.00	0.
1972.00	0.
1973.00	0.
1974.00	0.
1975.00	0.
1976.00	.1094655E-02
1977.00	.4378619E-02
1978.00	.1258853E-01
1979.00	.2353508E-01
1980.00	.3721826E-01
1981.00	.6570318E-01
1982.00	.9692473E-01
1983.00	.1308829E+00
1984.00	.1675777E+00
1985.00	.1989609E+00
1986.00	.2303440E+00

1987.00	.2648655E+00
1988.00	.3088019E+00
1989.00	.4029701E+00
1990.00	.4898945E+00
1991.00	.5695753E+00
1992.00	.6420124E+00
1993.00	.6999620E+00
1994.00	.7434242E+00
1995.00	.7434242E+00
1996.00	.7434242E+00

COST OF R+D = .32014E+01 (BILLIONS $)

CUMULATIVE TOTAL COST OF R+D

YEAR	COST (BILLIONS $)
1957.00	0.
1958.00	0.
1959.00	0.
1960.00	0.
1961.00	0.
1962.00	0.
1963.00	0.
1964.00	0.
1965.00	0.
1966.00	0.
1967.00	0.
1968.00	0.
1969.00	0.
1970.00	0.
1971.00	0.
1972.00	0.
1973.00	0.
1974.00	0.
1975.00	0.
1976.00	.1094655E-02
1977.00	.4378619E-02
1978.00	.1258853E-01
1979.00	.2353508E-01
1980.00	.3721826E-01
1981.00	.6570318E-01

1982.00	.9692473E-01
1983.00	.1308829E+00
1984.00	.1675777E+00
1985.00	.1989609E+00
1986.00	.2303440E+00
1987.00	.2994855E+00
1988.00	.4126620E+00
1989.00	.6106903E+00
1990.00	.8360949E+00
1991.00	.1088876E+01
1992.00	.1369033E+01
1993.00	.1703943E+01
1994.00	.2093606E+01
1995.00	.2647526E+01
1996.00	.3201447E+01

A1= .24652E+03 A2= .48593E+02 A3= .57915E+02

I	YEAR	A1(I)	A2(I)	A3(I)
1	1957.0	.15148E+01	.31810E+01	0.
2	1958.0	.30295E+01	.62105E+01	0.
3	1959.0	.45443E+01	.90886E+01	0.
4	1960.0	.60599E+01	.11817E+02	0.
5	1961.0	.75789E+01	.14399E+02	0.
6	1962.0	.91045E+01	.16840E+02	0.
7	1963.0	.10640E+02	.19144E+02	0.
8	1964.0	.12190E+02	.21313E+02	0.
9	1965.0	.13757E+02	.23351E+02	0.
10	1966.0	.15347E+02	.25258E+02	0.
11	1967.0	.18579E+02	.28814E+02	0.
12	1968.0	.21874E+02	.32108E+02	0.
13	1969.0	.25241E+02	.35139E+02	0.
14	1970.0	.28690E+02	.37898E+02	0.
15	1971.0	.32230E+02	.40376E+02	0.
16	1972.0	.35868E+02	.42559E+02	0.
17	1973.0	.39613E+02	.44431E+02	0.
18	1974.0	.43473E+02	.45975E+02	0.
19	1975.0	.47456E+02	.47170E+02	0.
20	1976.0	.51460E+02	.47978E+02	0.
21	1977.0	.57498E+02	.48593E+02	0.
22	1978.0	.67617E+02	.48593E+02	0.
23	1979.0	.77793E+02	.48593E+02	0.

24	1980.0	.88024E+02	.48593E+02	0.
25	1981.0	.97817E+02	.48593E+02	0.
26	1982.0	.10777E+03	.48593E+02	0.
27	1983.0	.11788E+03	.48593E+02	0.
28	1984.0	.12815E+03	.48593E+02	0.
29	1985.0	.13863E+03	.48593E+02	0.
30	1986.0	.14948E+03	.48593E+02	0.
31	1987.0	.16188E+03	.48593E+02	.63421E+00
32	1988.0	.17833E+03	.48593E+02	.19473E+01
33	1989.0	.19181E+03	.48593E+02	.39904E+01
34	1990.0	.20478E+03	.48593E+02	.68202E+01
35	1991.0	.21719E+03	.48593E+02	.10499E+02
36	1992.0	.22896E+03	.48593E+02	.15094E+02
37	1993.0	.23881E+03	.48593E+02	.21474E+02
38	1994.0	.24652E+03	.48593E+02	.29778E+02
39	1995.0	.24652E+03	.48593E+02	.43587E+02
40	1996.0	.24652E+03	.48593E+02	.57915E+02

THE FUEL CYCLE COST = .25584E+03

CUMULATIVE FUEL COST

YEAR	COST (BILLIONS $)
1957.00	-.1666241E+01
1958.00	-.3181006E+01
1959.00	-.4544294E+01
1960.00	-.5756803E+01
1961.00	-.6820081E+01
1962.00	-.77354[illegible]8E+01
1963.00	-.8503310E+01
1964.00	-.9123167E+01
1965.00	-.9593422E+01
1966.00	-.9911341E+01
1967.00	-.1023456E+02
1968.00	-.1023456E+02
1969.00	-.9897852E+01
1970.00	-.9207952E+01
1971.00	-.8145973E+01
1972.00	-.6690777E+01

1973.00	-.4818575E+01
1974.00	-.2502666E+01
1975.00	.2855813E+00
1976.00	.3481627E+01
1977.00	.8904829E+01
1978.00	.1902393E+02
1979.00	.2919948E+02
1980.00	.3943033E+02
1981.00	.4922396E+02
1982.00	.5917512E+02
1983.00	.6928245E+02
1984.00	.7955715E+02
1985.00	.9003296E+02
1986.00	.1008852E+03
1987.00	.1139243E+03
1988.00	.1316860E+03
1989.00	.1472084E+03
1990.00	.1630073E+03
1991.00	.1790913E+03
1992.00	.1954634E+03
1993.00	.2116887E+03
1994.00	.2277025E+03
1995.00	.2415120E+03
1996.00	.2558394E+03

B1= .33314E+03 B2= .77520E+02 B3= .24655E+03

THE TOTAL CAPITAL COST AFTER 1978 = .50218E+03 (DOLLARS)

CUMULATIVE CAPITAL COST

YEAR	COST (DOLLARS)
1957.00	-.1421085E-13
1958.00	-.2842171E-13
1959.00	-.5684342E-13
1960.00	-.5684342E-13
1961.00	-.1136868E-12
1962.00	-.1705303E-12
1963.00	-.2273737E-12

1964.00	-.2273737E-12
1965.00	-.4547474E-12
1966.00	-.4547474E-12
1967.00	-.5684342E-12
1968.00	-.7958079E-12
1969.00	-.9094947E-12
1970.00	-.1136868E-11
1971.00	-.1136868E-11
1972.00	-.1591616E-11
1973.00	-.1818989E-11
1974.00	-.2046363E-11
1975.00	-.2273737E-11
1976.00	.1500000E+00
1977.00	.6000000E+00
1978.00	.1725000E+01
1979.00	.1444500E+02
1980.00	.2754000E+02
1981.00	.4186000E+02
1982.00	.5655500E+02
1983.00	.7162500E+02
1984.00	.8707000E+02
1985.00	.1008400E+03
1986.00	.1146100E+03
1987.00	.1349590E+03
1988.00	.1631879E+03
1989.00	.1964499E+03
1990.00	.2310211E+03
1991.00	.2667906E+03
1992.00	.3061152E+03
1993.00	.3486082E+03
1994.00	.3940126E+03
1995.00	.4486066E+03
1996.00	.5021787E+03

OPERATION/MAINTENANCE CONTRIBUTION TO POWER COST = .97701E+01

CUMULATIVE OPERATION/MAINTENANCE COST

YEAR COST (BILLIONS $)

1957.00	-.6942672E-01
1958.00	-.1325419E+00
1959.00	-.1893456E+00
1960.00	-.2398378E+00
1961.00	-.2840184E+00
1962.00	-.3218875E+00
1963.00	-.3534451E+00
1964.00	-.3786912E+00
1965.00	-.3976258E+00
1966.00	-.4102488E+00
1967.00	-.4228718E+00
1968.00	-.4228718E+00
1969.00	-.4102488E+00
1970.00	-.3850027E+00
1971.00	-.3471336E+00
1972.00	-.2966414E+00
1973.00	-.2335262E+00
1974.00	-.1577880E+00
1975.00	-.6942672E-01
1976.00	.3155760E-01
1977.00	.2019686E+00
1978.00	.5175446E+00
1979.00	.8331206E+00
1980.00	.1148697E+01
1981.00	.1464273E+01
1982.00	.1779849E+01
1983.00	.2095425E+01
1984.00	.2411001E+01
1985.00	.2726577E+01
1986.00	.3042153E+01
1987.00	.3446265E+01
1988.00	.4002030E+01
1989.00	.4583215E+01
1990.00	.5189823E+01
1991.00	.5821851E+01
1992.00	.6479301E+01
1993.00	.7187594E+01
1994.00	.7946730E+01
1995.00	.8858394E+01
1996.00	.9770058E+01

TOTAL LWR + NASAP CHOICE COST TO YEAR = 1996.00

TOTAL COST = .77099E+03

CUMULATIVE TOTAL COST

YEAR	COST (BILLIONS $)
1957.00	-.1735668E+01
1958.00	-.3313548E+01
1959.00	-.4733640E+01
1960.00	-.5996641E+01
1961.00	-.7104099E+01
1962.00	-.8057326E+01
1963.00	-.8856755E+01
1964.00	-.9501858E+01
1965.00	-.9991048E+01
1966.00	-.1032159E+02
1967.00	-.1065743E+02
1968.00	-.1065743E+02
1969.00	-.1030810E+02
1970.00	-.9592955E+01
1971.00	-.8493107E+01
1972.00	-.6987418E+01
1973.00	-.5052101E+01
1974.00	-.2660454E+01
1975.00	.2161545E+00
1976.00	.3564280E+01
1977.00	.9711176E+01
1978.00	.2127906E+02
1979.00	.4450114E+02
1980.00	.6815624E+02
1981.00	.9261394E+02
1982.00	.1176069E+03
1983.00	.1431338E+03
1984.00	.1692057E+03
1985.00	.1937985E+03
1986.00	.2187677E+03
1987.00	.2526291E+03
1988.00	.2992886E+03
1989.00	.3488523E+03
1990.00	.4000544E+03
1991.00	.4527926E+03
1992.00	.5094270E+03
1993.00	.5691884E+03
1994.00	.6317555E+03

1995.00	.7016245E+03
1996.00	.7709896E+03

NASAP SAMPLE PROBLEM STACKED CASE R+D MODEL 2 G A MAUL

```
$INPUT
DTR     = .2E+01,
DTC     = .8E+01,
DTO     = .2E+01,
DTA     = .7E+01,
TB      = .1979E+04,
TEI     = .1957E+04, .1958E+04, .1959E+04, .196E+04, .1961E+04, .1962E+04,     .1963E+04, .1964E+04, .1965E+04, .1966E+04,
          .1967E+04, .1968E+04, .1969E+04, .197E+04, .1971E+04, .1972E+04,     .1973E+04, .1974E+04, .1975E+04, .1976E+04,
          .1977E+04, .1978E+04, .1979E+04, .198E+04, .1981E+04, .1982E+04,     .1983E+04, .1984E+04, .1985E+04, .1986E+04,
          .1987E+04, .1988E+04, .1989E+04, .199E+04, .1991E+04, .1992E+04,     .1993E+04, .1994E+04, .1995E+04, .1996E+04,
          .1997E+04, .1998E+04, .1999E+04, .2E+04, .2001E+04, .2002E+04,       .2003E+04, .2004E+04, .2005E+04, .2006E+04,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0,
A       = .2E+01, .2E+01, .2E+01, .2E+01, .2E+01, .2E+01, .2E+01, .2E+01,     .2E+01, .2E+01, .2E+01, .2E+01, .2E+01,
          .2E+01, .2E+01, .2E+01, .2E+01, .2E+01, .2E+01, .2E+01, .2E+01,     .6E+01, .6E+01, .6E+01, .6E+01, .6E+01,
          .6E+01, .6E+01, .6E+01, .5E+01, .6E+01, .6E+01, .6E+01, .5E+01,     .6E+01, .6E+01, .6E+01, .6E+01, .6E+01,
          .6E+01, .6E+01, .6E+01, .5E+01, .6E+01, .6E+01, .6E+01, .6E+01,     .6E+01, .5E+01, .6E+01, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
R       = 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, .1E+01, .2E+01, .3E+01,     .4E+01, .5E+01, .6E+01, .8E+01, .1E+02,
          .16E+02, .16E+02, .18E+02, .22E+02, .22E+02, .22E+02, .22E+02,       .22E+02, .22E+02, .22E+02, .22E+02,
          .22E+02, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
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          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0,
N       = 40,
TDO     = .1957E+04,
DR      = .1E+02,
TX      = .1981E+04,
TY      = .1985E+04,
TZ      = .1989E+04,
IX      = 25,
IY      = 29,
IZ      = 33,
DETO    = .8E+01,
ETAO    = .9E+00,
ETALWR  = .72E+00,
ETANAS  = .65E+00,
TONS    = 0.0, .1E+06, .5E+06, .1E+07, .2E+07, .3E+07, .4E+07, .5E+07, .6E+07, .7E+07, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
COST    = .1E+01, .1E+01, .2E+01, .3E+01, .75E+01, .115E+02, .125E+02, .145E+02, .175E+02, .215E+02, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
```

```
0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
M       = 10,
BKFTX   = 0.0,
BKFTY   = .1E+01,
BKFTZ   = 0.0,
DELCX   = .5E+02,
DELCY   = .1E+03,
DELCZ   = .15E+03,
DELCXP  = .75E+02,
DELCYP  = .15E+03,
DELCZP  = .225E+03,
UD1     = .6E+04,
UD2     = .55E+04,
UD3     = .5E+04,
UD4     = .45E+04,
UD      = .3E+04,
RMINW   = .25E+09,
NJ1     = .4E+00,
NJ2     = .2E+00,
NJ3     = .15E+00,
NJ4     = .25E+00,
OLF1    = .2E+01,
OLF2    = .2E+01,
```

```
OLF3     = .2E+01,

OLF4     = .3E+01,

E        = .3E+07,

FDIP     = .25E+00,

AI       = 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, .3E+00,
           .3E+00, .4E+00, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,      0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,

BII      = 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
           0.0, 0.0, 0.0, 0.0, .2E+00, .6E+00, .2E+00, 0.0, 0.0, 0.0, 0.0, 0.0,   0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,

CI       = 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, .2E+00, .2E+00, .35E+00, .25E+00,   0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,

TLAMBA   = .3E+01,

CAPA     = .5E+08,

CAPB     = .15E+09,
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```
CAPCC   = .1E+09,

BETA    = .1E+01,

DTB     = 0.0,

DI      = 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, .5E-01, .15E+00, .2E-00, .2E+00, .25E+00, .1E+00, .5E-01, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,

FCI     = .17E+00,

RDIS    = .85E-01,

CRI     = .1E+00,

TLAG    = .4E+01,

RHO     = .7E+00,

TB      = .1978E+04,

REG1    = .12E+02,

REG2    = .11E+02,

REG3    = .1E+02,

REG4    = .9E+01,

X1      = .5E+00,

X2      = .45E+00,

X3      = .4E+00,

X4      = .35E+00,

STARK   = .7E+01,
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CHI     = .3E+00,
C0      = .6E+03,
C0STAR  = .75E+03,
PHI     = .1E+01, .1E+01, .1E+01, .1E+01, .1E+01, .1E+01, .1E+01, .1E+01,        .1E+01, .1E+01, .1E+01, .1E+01, .1E+01,
          .1E+01, .1E+01, .1E+01, .1E+01, .1E+01, .1E+01, .1E+01, .1E+01,        .1E+01, .11E+01, .11E+01, .11E+01,
          .11E+01, .11E+01, .11E+01, .11E+01, .11E+01, .12E+01, .12E+01,         .12E+01, .12E+01, .12E+01, .12E+01,
          .12E+01, .12E+01, .12E+01, .12E+01, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,      0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
THETA   = .1E+01, .1E+01, .1E+01, .1E+01, .1E+01, .1E+01, .1E+01, .1E+01,        .1E+01, .1E+01, .1E+01, .1E+01, .1E+01,
          .1E+01, .1E+01, .1E+01, .1E+01, .1E+01, .1E+01, .1E+01, .1E+01,        .1E+01, .12E+01, .14E+01, .16E+01,
          .2E+01, .26E+01, .32E+01, .32E+01, .32E+01, .32E+01, .32E+01,          .32E+01, .32E+01, .32E+01, .36E+01,
          .36E+01, .36E+01, .36E+01, .36E+01, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,      0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
HALF    = .1E+00,
SIGMA   = .5E-01,
GAMMA   = .75E+00,
GAMMAS  = .1E+01,
IRD     = 1,
$END
```

CONSTRUCTION TIME = 8. ACCELERATION TIME = 7. REFERENCE INSTALLATION RATE = 1998.00

MAXIMUM NUMBER OF LWRS EVER ON LINE IS = 111.00

I	T(I)	A(I)	R(I)	G(I)	NLWR(I)	NNAS(I)
1	1957.00	2.00	0.00	2.00	2.00	0.00
2	1958.00	2.00	0.00	2.00	4.00	0.00
3	1959.00	2.00	0.00	2.00	6.00	0.00
4	1960.00	2.00	0.00	2.00	8.00	0.00
5	1961.00	2.00	0.00	2.00	10.00	0.00
6	1962.00	2.00	0.00	2.00	12.00	0.00
7	1963.00	2.00	0.00	2.00	14.00	0.00
8	1964.00	2.00	0.00	2.00	16.00	0.00
9	1965.00	2.00	0.00	2.00	18.00	0.00
10	1966.00	2.00	0.00	2.00	20.00	0.00
11	1967.00	2.00	0.00	4.00	22.00	0.00
12	1968.00	2.00	0.00	4.00	24.00	0.00
13	1969.00	2.00	0.00	4.00	26.00	0.00
14	1970.00	2.00	0.00	4.00	28.00	0.00
15	1971.00	2.00	0.00	4.00	30.00	0.00
16	1972.00	2.00	0.00	4.00	32.00	0.00
17	1973.00	2.00	0.00	4.00	34.00	0.00
18	1974.00	2.00	0.00	4.00	36.00	0.00
19	1975.00	2.00	0.00	4.00	38.00	0.00
20	1976.00	2.00	0.00	4.00	40.00	0.00
21	1977.00	2.00	0.00	6.00	42.00	0.00
22	1978.00	6.00	0.00	10.00	48.00	0.00
23	1979.00	6.00	0.00	10.00	54.00	0.00
24	1980.00	6.00	0.00	10.00	60.00	0.00
25	1981.00	6.00	0.00	10.00	66.00	0.00
26	1982.00	6.00	0.00	10.00	72.00	0.00
27	1983.00	6.00	0.00	10.00	78.00	0.00
28	1984.00	6.00	0.00	10.00	84.00	0.00
29	1985.00	6.00	0.00	10.00	90.00	0.00
30	1986.00	6.00	0.00	10.00	96.00	0.00
31	1987.00	6.00	1.00	11.00	101.00	1.00
32	1988.00	6.00	2.00	14.00	105.00	3.00
33	1989.00	6.00	3.00	13.00	108.00	6.00
34	1990.00	6.00	4.00	12.00	110.00	10.00
35	1991.00	6.00	5.00	11.00	111.00	15.00
36	1992.00	6.00	6.00	10.00	111.00	21.00
37	1993.00	6.00	8.00	8.00	109.00	29.00
38	1994.00	6.00	10.00	6.00	105.00	39.00
39	1995.00	6.00	16.00	0.00	95.00	55.00
40	1996.00	6.00	16.00	0.00	85.00	71.00
41	1997.00	6.00	18.00	0.00	74.00	88.00
42	1998.00	6.00	22.00	0.00	60.00	108.00

43	1999.00	6.00	22.00	0.00	47.00	127.00
44	2000.00	6.00	22.00	0.00	35.00	145.00
45	2001.00	6.00	22.00	0.00	24.00	162.00
46	2002.00	6.00	22.00	0.00	14.00	178.00
47	2003.00	6.00	22.00	0.00	6.00	192.00
48	2004.00	6.00	22.00	0.00	0.00	204.00
49	2005.00	6.00	22.00	0.00	0.00	210.00
50	2006.00	6.00	22.00	0.00	0.00	216.00

I	H(I)	TI(I)	U(I)
1	.12000E+05	.19570E+04	.60000E+04
2	.24000E+05	.19580E+04	.60000E+04
3	.36000E+05	.19590E+04	.60000E+04
4	.48000E+05	.19600E+04	.60000E+04
5	.60000E+05	.19610E+04	.60000E+04
6	.72000E+05	.19620E+04	.60000E+04
7	.84000E+05	.19630E+04	.60000E+04
8	.96000E+05	.19640E+04	.60000E+04
9	.10800E+06	.19650E+04	.60000E+04
10	.12000E+06	.19660E+04	.60000E+04
11	.14400E+06	.19670E+04	.60000E+04
12	.16800E+06	.19680E+04	.60000E+04
13	.19200E+06	.19690E+04	.60000E+04
14	.21600E+06	.19700E+04	.60000E+04
15	.24000E+06	.19710E+04	.60000E+04
16	.26400E+06	.19720E+04	.60000E+04
17	.28800E+06	.19730E+04	.60000E+04
18	.31200E+06	.19740E+04	.60000E+04
19	.33600E+06	.19750E+04	.60000E+04
20	.35960E+06	.19760E+04	.59000E+04
21	.39440E+06	.19770E+04	.58000E+04
22	.45140E+06	.19780E+04	.57000E+04
23	.50740E+06	.19790E+04	.56000E+04
24	.56240E+06	.19800E+04	.55000E+04
25	.61440E+06	.19810E+04	.52000E+04
26	.66590E+06	.19820E+04	.51500E+04
27	.71690E+06	.19830E+04	.51000E+04
28	.76740E+06	.19840E+04	.50500E+04
29	.81740E+06	.19850E+04	.50000E+04
30	.86740E+06	.19860E+04	.50000E+04
31	.92511E+06	.19870E+04	.50000E+04
32	.10005E+07	.19880E+04	.50000E+04
33	.10672E+07	.19890E+04	.45000E+04
34	.11320E+07	.19900E+04	.45000E+04
35	.11950E+07	.19910E+04	.45000E+04
36	.12563E+07	.19920E+04	.45000E+04
37	.13139E+07	.19930E+04	.45000E+04
38	.13680E+07	.19940E+04	.45000E+04
39	.14114E+07	.19950E+04	.45000E+04
40	.14547E+07	.19960E+04	.45000E+04

DATE T(I) CORRESPONDING TO U308 COMMITTED H = .250E+07 T = 1995.00

DATE T(I) CORRESPONDING TO U308 COMMITTED H = .540E+07 T = 1995.00

F(1,I)	F(2,I)	F(3,I)	F(4,I)
.10000E+01	0.	0.	0.
.10000E+01	0.	0.	0.
.10000E+01	0.	0.	0.
.10000E+01	0.	0.	0.
.10000E+01	0.	0.	0.
.10000E+01	0.	0.	0.
.10000E+01	0.	0.	0.
.10000E+01	0.	0.	0.
.10000E+01	0.	0.	0.
.10000E+01	0.	0.	0.
.10000E+01	0.	0.	0.
.10000E+01	0.	0.	0.
.10000E+01	0.	0.	0.
.10000E+01	0.	0.	0.
.10000E+01	0.	0.	0.
.10000E+01	0.	0.	0.
.10000E+01	0.	0.	0.
.10000E+01	0.	0.	0.
.10000E+01	0.	0.	0.
.90000E+00	0.	.10000E+00	0.
.80000E+00	0.	.20000E+00	0.
.70000E+00	0.	.30000E+00	0.
.60000E+00	0.	.40000E+00	0.
.50000E+00	0.	.50000E+00	0.
0.	.40000E+00	.60000E+00	0.
0.	.30000E+00	.70000E+00	0.
0.	.20000E+00	.80000E+00	0.
0.	.10000E+00	.90000E+00	0.
0.	0.	.10000E+01	0.
0.	0.	.10000E+01	0.
0.	0.	.10000E+01	0.
0.	0.	.10000E+01	0.
0.	0.	0.	.10000E+01
0.	0.	0.	.10000E+01
0.	0.	0.	.10000E+01
0.	0.	0.	.10000E+01
0.	0.	0.	.10000E+01
0.	0.	0.	.10000E+01
0.	0.	0.	.10000E+01
0.	0.	0.	.10000E+01

U(1,I)	U(2,I)	U(3,I)	U(4,I)
.60000E+04	.60000E+04	.60000E+04	.60000E+04
.60000E+04	.60000E+04	.60000E+04	.60000E+04
.60000E+04	.60000E+04	.60000E+04	.60000E+04
.60000E+04	.60000E+04	.60000E+04	.60000E+04
.60000E+04	.60000E+04	.60000E+04	.60000E+04
.60000E+04	.60000E+04	.60000E+04	.60000E+04
.60000E+04	.60000E+04	.60000E+04	.60000E+04
.60000E+04	.60000E+04	.60000E+04	.60000E+04
.60000E+04	.60000E+04	.60000E+04	.60000E+04
.60000E+04	.60000E+04	.60000E+04	.60000E+04
.60000E+04	.60000E+04	.60000E+04	.60000E+04
.60000E+04	.60000E+04	.60000E+04	.60000E+04
.60000E+04	.60000E+04	.60000E+04	.60000E+04
.60000E+04	.60000E+04	.60000E+04	.60000E+04
.60000E+04	.60000E+04	.60000E+04	.60000E+04
.60000E+04	.60000E+04	.60000E+04	.60000E+04
.60000E+04	.60000E+04	.60000E+04	.60000E+04
.60000E+04	.60000E+04	.60000E+04	.60000E+04
.60000E+04	.60000E+04	.50000E+04	.60000E+04
.60000E+04	.60000E+04	.50000E+04	.50000E+04
.60000E+04	.60000E+04	.50000E+04	.50000E+04
.60000E+04	.60000E+04	.50000E+04	.50000E+04
.60000E+04	.60000E+04	.50000E+04	.50000E+04
.60000E+04	.60000E+04	.50000E+04	.50000E+04
.60000E+04	.55000E+04	.50000E+04	.50000E+04
.60000E+04	.55000E+04	.50000E+04	.50000E+04
.60000E+04	.55000E+04	.50000E+04	.50000E+04
.60000E+04	.55000E+04	.50000E+04	.50000E+04
.60000E+04	.55000E+04	.50000E+04	.50000E+04
.60000E+04	.55000E+04	.50000E+04	.50000E+04
.60000E+04	.55000E+04	.50000E+04	.50000E+04
.60000E+04	.55000E+04	.50000E+04	.50000E+04
.60000E+04	.55000E+04	.50000E+04	.45000E+04
.60000E+04	.55000E+04	.50000E+04	.45000E+04
.60000E+04	.55000E+04	.50000E+04	.45000E+04
.60000E+04	.55000E+04	.50000E+04	.45000E+04
.60000E+04	.55000E+04	.50000E+04	.45000E+04
.60000E+04	.55000E+04	.50000E+04	.45000E+04
.60000E+04	.55000E+04	.50000E+04	.45000E+04
.60000E+04	.55000E+04	.50000E+04	.45000E+04
0.	0.	0.	.45000E+04
0.	0.	0.	.45000E+04

0.	0.	0.	.45000E+04
0.	0.	0.	.45000E+04
0.	0.	0.	.45000E+04
0.	0.	0.	.45000E+04
0.	0.	0.	.45000E+04
0.	0.	0.	.45000E+04
0.	0.	0.	.45000E+04
0.	0.	0.	.45000E+04

I	T(I)	TL(1,I)	TL(2,I)	TL(3,I)	TL(4,I)
1	1957.00	1957.00	1967.00	1967.00	1967.00
2	1958.00	1958.00	1968.00	1968.00	1968.00
3	1959.00	1959.00	1969.00	1969.00	1969.00
4	1960.00	1960.00	1970.00	1970.00	1970.00
5	1961.00	1961.00	1971.00	1971.00	1971.00
6	1962.00	1962.00	1972.00	1972.00	1972.00
7	1963.00	1963.00	1973.00	1973.00	1973.00
8	1964.00	1964.00	1974.00	1974.00	1974.00
9	1965.00	1965.00	1975.00	1975.00	1975.00
10	1966.00	1966.00	1976.00	1976.00	1976.00
11	1967.00	1967.00	1977.00	1977.00	1977.00
12	1968.00	1968.00	1978.00	1978.00	1978.00
13	1969.00	1969.00	1979.00	1979.00	1979.00
14	1970.00	1970.00	1980.00	1980.00	1980.00
15	1971.00	1971.00	1981.00	1981.00	1981.00
16	1972.00	1972.00	1982.00	1982.00	1982.00
17	1973.00	1973.00	1983.00	1983.00	1983.00
18	1974.00	1974.00	1984.00	1984.00	1984.00
19	1975.00	1975.00	1985.00	1985.00	1985.00
20	1976.00	1976.00	1985.00	1985.00	1986.00
21	1977.00	1977.00	1985.00	1985.00	1987.00
22	1978.00	1978.00	1985.00	1985.00	1988.00
23	1979.00	1979.00	1985.00	1985.00	1989.00
24	1980.00	1980.00	1985.00	1985.00	1990.00
25	1981.00	1981.00	1981.00	1985.00	1991.00
26	1982.00	1982.00	1982.00	1985.00	1992.00
27	1983.00	1983.00	1983.00	1985.00	1993.00
28	1984.00	1984.00	1984.00	1985.00	1994.00
29	1985.00	1985.00	1985.00	1985.00	1995.00
30	1986.00	1986.00	1986.00	1986.00	1996.00
31	1987.00	1987.00	1987.00	1987.00	1997.00
32	1988.00	1988.00	1988.00	1988.00	1998.00
33	1989.00	1989.00	1989.00	1989.00	1989.00
34	1990.00	1990.00	1990.00	1990.00	1990.00
35	1991.00	1991.00	1991.00	1991.00	1991.00
36	1992.00	1992.00	1992.00	1992.00	1992.00
37	1993.00	1993.00	1993.00	1993.00	1993.00
38	1994.00	1994.00	1994.00	1994.00	1994.00
39	1995.00	1995.00	1995.00	1995.00	1995.00
40	1996.00	1996.00	1996.00	1996.00	1996.00

I	T(I)	TU(1,I)	TU(2,I)	TU(3,I)	TU(4,I)
1	1957.00	1967.00	1967.00	1967.00	1967.00
2	1958.00	1968.00	1968.00	1968.00	1968.00
3	1959.00	1969.00	1969.00	1969.00	1969.00
4	1960.00	1970.00	1970.00	1970.00	1970.00
5	1961.00	1971.00	1971.00	1971.00	1971.00
6	1962.00	1972.00	1972.00	1972.00	1972.00
7	1963.00	1973.00	1973.00	1973.00	1973.00
8	1964.00	1974.00	1974.00	1974.00	1974.00
9	1965.00	1975.00	1975.00	1975.00	1975.00
10	1966.00	1976.00	1976.00	1976.00	1976.00
11	1967.00	1977.00	1977.00	1977.00	1977.00
12	1968.00	1978.00	1978.00	1978.00	1978.00
13	1969.00	1979.00	1979.00	1979.00	1979.00
14	1970.00	1980.00	1980.00	1980.00	1980.00
15	1971.00	1981.00	1981.00	1981.00	1981.00
16	1972.00	1982.00	1982.00	1982.00	1982.00
17	1973.00	1983.00	1983.00	1983.00	1983.00
18	1974.00	1984.00	1984.00	1984.00	1984.00
19	1975.00	1985.00	1985.00	1985.00	1985.00
20	1976.00	1985.00	1985.00	1986.00	1986.00
21	1977.00	1985.00	1985.00	1987.00	1987.00
22	1978.00	1985.00	1985.00	1988.00	1988.00
23	1979.00	1985.00	1985.00	1989.00	1989.00
24	1980.00	1985.00	1985.00	1990.00	1990.00
25	1981.00	1981.00	1985.00	1991.00	1991.00
26	1982.00	1981.00	1985.00	1992.00	1992.00
27	1983.00	1981.00	1985.00	1993.00	1993.00
28	1984.00	1981.00	1985.00	1994.00	1994.00
29	1985.00	1981.00	1985.00	1995.00	1995.00
30	1986.00	1981.00	1985.00	1996.00	1996.00
31	1987.00	1981.00	1985.00	1997.00	1997.00
32	1988.00	1981.00	1985.00	1998.00	1998.00
33	1989.00	1981.00	1985.00	1989.00	1999.00
34	1990.00	1981.00	1985.00	1989.00	2000.00
35	1991.00	1981.00	1985.00	1989.00	2001.00
36	1992.00	1981.00	1985.00	1989.00	2002.00
37	1993.00	1981.00	1985.00	1989.00	2003.00
38	1994.00	1981.00	1985.00	1989.00	2004.00
39	1995.00	1981.00	1985.00	1989.00	2005.00
40	1996.00	1981.00	1985.00	1989.00	2006.00

FUEL USED BY ALL PLANTS UP THROUGH TAU(K)

TAU(K)	FUEL USED M(K)
1957.00	0.
1958.00	.1200000E+04
1959.00	.3600000E+04
1960.00	.7200000E+04
1961.00	.1200000E+05
1962.00	.1800000E+05
1963.00	.2520000E+05
1964.00	.3360000E+05
1965.00	.4320000E+05
1966.00	.5400000E+05
1967.00	.6600000E+05
1968.00	.7920000E+05
1969.00	.9360000E+05
1970.00	.1092000E+06
1971.00	.1260000E+06
1972.00	.1440000E+06
1973.00	.1632000E+06
1974.00	.1836000E+06
1975.00	.2052000E+06
1976.00	.2280000E+06
1977.00	.2520000E+06
1978.00	.2772000E+06
1979.00	.3060000E+06
1980.00	.3384000E+06
1981.00	.3744000E+06
1982.00	.4135000E+06
1983.00	.4557000E+06
1984.00	.5010000E+06
1985.00	.5494000E+06
1986.00	.5944000E+06
1987.00	.6426708E+06
1988.00	.6939833E+06
1989.00	.7481083E+06
1990.00	.8041667E+06
1991.00	.8619792E+06
1992.00	.9213667E+06
1993.00	.9824208E+06
1994.00	.1044783E+07
1995.00	.1109179E+07

1996.00	.1172908E+07
1997.00	.1236242E+07
1998.00	.1299492E+07
1999.00	.1360888E+07
2000.00	.1421308E+07
2001.00	.1480933E+07
2002.00	.1539942E+07
2003.00	.1598242E+07
2004.00	.1656192E+07
2005.00	.1713067E+07
2006.00	.1771567E+07

FUEL PRICE CORRESPONDING TO TIME TAU(K)

K	TAU(K)	PSI(K)
1	1957.00	.1000000E+01
2	1958.00	.1000000E+01
3	1959.00	.1000000E+01
4	1960.00	.1000000E+01
5	1961.00	.1000000E+01
6	1962.00	.1000000E+01
7	1963.00	.1000000E+01
8	1964.00	.1000000E+01
9	1965.00	.1000000E+01
10	1966.00	.1000000E+01
11	1967.00	.1000000E+01
12	1968.00	.1000000E+01
13	1969.00	.1000000E+01
14	1970.00	.1023000E+01
15	1971.00	.1065000E+01
16	1972.00	.1110000E+01
17	1973.00	.1158000E+01
18	1974.00	.1209000E+01
19	1975.00	.1263000E+01
20	1976.00	.1320000E+01
21	1977.00	.1380000E+01
22	1978.00	.1443000E+01
23	1979.00	.1515000E+01
24	1980.00	.1596000E+01
25	1981.00	.1685000E+01
26	1982.00	.1783750E+01
27	1983.00	.1889250E+01
28	1984.00	.2002000E+01
29	1985.00	.2098800E+01
30	1986.00	.2188800E+01
31	1987.00	.2285342E+01
32	1988.00	.2387967E+01
33	1989.00	.2496217E+01
34	1990.00	.2608333E+01
35	1991.00	.2723958E+01
36	1992.00	.2842733E+01
37	1993.00	.2964842E+01

38	1994.00	.3201525E+01
39	1995.00	.3491306E+01
40	1996.00	.3778087E+01
41	1997.00	.4063087E+01
42	1998.00	.4347712E+01
43	1999.00	.4623994E+01
44	2000.00	.4895887E+01
45	2001.00	.5164200E+01
46	2002.00	.5429737E+01
47	2003.00	.5692087E+01
48	2004.00	.5952862E+01
49	2005.00	.6208800E+01
50	2006.00	.6472050E+01

AVERAGE COST VALUES FOR REACTORS STARTED UP IN YEAR TAU(K)

K	TAU(K)	AVG. COST	REGION
1	1957.00	.1000000E+01	1
2	1958.00	.1000000E+01	1
3	1959.00	.1000000E+01	1
4	1960.00	.1001150E+01	1
5	1961.00	.1005550E+01	1
6	1962.00	.1014300E+01	1
7	1963.00	.1027700E+01	1
8	1964.00	.1046050E+01	1
9	1965.00	.1069650E+01	1
10	1966.00	.1098800E+01	1
11	1967.00	.1133800E+01	1
12	1968.00	.1174950E+01	1
13	1969.00	.1222850E+01	1
14	1970.00	.1277250E+01	1
15	1971.00	.1336950E+01	1
16	1972.00	.1401688E+01	1
17	1973.00	.1471938E+01	1
18	1974.00	.1548150E+01	1
19	1975.00	.1629590E+01	1
20	1976.00	.1667156E+01	1
21	1977.00	.1706800E+01	1
22	1978.00	.1748986E+01	1
23	1979.00	.1793983E+01	1
24	1980.00	.1841680E+01	1
25	1981.00	0.	1
26	1982.00	0.	1
27	1983.00	0.	1
28	1984.00	0.	1
29	1985.00	0.	1
30	1986.00	0.	1
31	1987.00	0.	1
32	1988.00	0.	1
33	1989.00	0.	1
34	1990.00	0.	1
35	1991.00	0.	1
36	1992.00	0.	1
37	1993.00	0.	1
38	1994.00	0.	1

39	1995.00	0.	1
40	1996.00	0.	1
41	1997.00	0.	1
42	1998.00	0.	1
43	1999.00	0.	1
44	2000.00	0.	1
45	2001.00	0.	1
46	2002.00	0.	1
47	2003.00	0.	1
48	2004.00	0.	1
49	2005.00	0.	1
50	2006.00	0.	1
1	1957.00	0.	2
2	1958.00	0.	2
3	1959.00	0.	2
4	1960.00	0.	2
5	1961.00	0.	2
6	1962.00	0.	2
7	1963.00	0.	2
8	1964.00	0.	2
9	1965.00	0.	2
10	1966.00	0.	2
11	1967.00	0.	2
12	1968.00	0.	2
13	1969.00	0.	2
14	1970.00	0.	2
15	1971.00	0.	2
16	1972.00	0.	2
17	1973.00	0.	2
18	1974.00	0.	2
19	1975.00	0.	2
20	1976.00	0.	2
21	1977.00	0.	2
22	1978.00	0.	2
23	1979.00	0.	2
24	1980.00	0.	2
25	1981.00	.1891850E+01	2
26	1982.00	.1944175E+01	2
27	1983.00	.1998013E+01	2
28	1984.00	.2050400E+01	2
29	1985.00	0.	2
30	1986.00	0.	2
31	1987.00	0.	2
32	1988.00	0.	2
33	1989.00	0.	2
34	1990.00	0.	2
35	1991.00	0.	2

36	1992.00	0.	2
37	1993.00	0.	2
38	1994.00	0.	2
39	1995.00	0.	2
40	1996.00	0.	2
41	1997.00	0.	2
42	1998.00	0.	2
43	1999.00	0.	2
44	2000.00	0.	2
45	2001.00	0.	2
46	2002.00	0.	2
47	2003.00	0.	2
48	2004.00	0.	2
49	2005.00	0.	2
50	2006.00	0.	2
1	1957.00	0.	3
2	1958.00	0.	3
3	1959.00	0.	3
4	1960.00	0.	3
5	1961.00	0.	3
6	1962.00	0.	3
7	1963.00	0.	3
8	1964.00	0.	3
9	1965.00	0.	3
10	1966.00	0.	3
11	1967.00	0.	3
12	1968.00	0.	3
13	1969.00	0.	3
14	1970.00	0.	3
15	1971.00	0.	3
16	1972.00	0.	3
17	1973.00	0.	3
18	1974.00	0.	3
19	1975.00	0.	3
20	1976.00	.2143800E+01	3
21	1977.00	.2190435E+01	3
22	1978.00	.2239175E+01	3
23	1979.00	.2289904E+01	3
24	1980.00	.2342378E+01	3
25	1981.00	.2396340E+01	3
26	1982.00	.2451626E+01	3
27	1983.00	.2508146E+01	3
28	1984.00	.2572039E+01	3
29	1985.00	.2649477E+01	3
30	1986.00	.2798567E+01	3
31	1987.00	.2966918E+01	3
32	1988.00	.3153793E+01	3

33	1989.00	0.	3
34	1990.00	0.	3
35	1991.00	0.	3
36	1992.00	0.	3
37	1993.00	0.	3
38	1994.00	0.	3
39	1995.00	0.	3
40	1996.00	0.	3
41	1997.00	0.	3
42	1998.00	0.	3
43	1999.00	0.	3
44	2000.00	0.	3
45	2001.00	0.	3
46	2002.00	0.	3
47	2003.00	0.	3
48	2004.00	0.	3
49	2005.00	0.	3
50	2006.00	0.	3
1	1957.00	0.	4
2	1958.00	0.	4
3	1959.00	0.	4
4	1960.00	0.	4
5	1961.00	0.	4
6	1962.00	0.	4
7	1963.00	0.	4
8	1964.00	0.	4
9	1965.00	0.	4
10	1966.00	0.	4
11	1967.00	0.	4
12	1968.00	0.	4
13	1969.00	0.	4
14	1970.00	0.	4
15	1971.00	0.	4
16	1972.00	0.	4
17	1973.00	0.	4
18	1974.00	0.	4
19	1975.00	0.	4
20	1976.00	0.	4
21	1977.00	0.	4
22	1978.00	0.	4
23	1979.00	0.	4
24	1980.00	0.	4
25	1981.00	0.	4
26	1982.00	0.	4
27	1983.00	0.	4
28	1984.00	0.	4
29	1985.00	0.	4

30	1986.00	0.	4
31	1987.00	0.	4
32	1988.00	0.	4
33	1989.00	.3358169E+01	4
34	1990.00	.3578936E+01	4
35	1991.00	.3815325E+01	4
36	1992.00	.4066688E+01	4
37	1993.00	.4332400E+01	4
38	1994.00	.4606329E+01	4
39	1995.00	.4879771E+01	4
40	1996.00	.5150344E+01	4
41	1997.00	0.	4
42	1998.00	0.	4
43	1999.00	0.	4
44	2000.00	0.	4
45	2001.00	0.	4
46	2002.00	0.	4
47	2003.00	0.	4
48	2004.00	0.	4
49	2005.00	0.	4
50	2006.00	0.	4

VENDOR A COST = .20000E+09

VENDOR B COST = .10000E+09

VENDOR C COST = .75000E+08

GOVERNMENT SUPERVISION COST = .18750E+09

TOTAL FIRST TIME ENGINEERING COST = .9000000E+07

NASAP DEVELOPMENT CONTRIBUTION TO NASAP POWER COST = .23991E+00 MILLS/KWHRE

NASAP DEVELOPMENT COST = .25699E+01 (BILLONS $)

CUMULATIVE NASAP R+D COST

YEAR	COST (BILLIONS $)
1957.00	0.
1958.00	0.
1959.00	0.
1960.00	0.
1961.00	0.
1962.00	0.
1963.00	0.
1964.00	0.
1965.00	0.
1966.00	0.
1967.00	0.
1968.00	0.
1969.00	0.
1970.00	0.
1971.00	0.
1972.00	0.
1973.00	0.
1974.00	0.
1975.00	0.
1976.00	0.
1977.00	0.
1978.00	0.
1979.00	0.
1980.00	0.
1981.00	0.
1982.00	0.
1983.00	0.
1984.00	0.
1985.00	0.
1986.00	0.
1987.00	.1366955E-02
1988.00	.5467819E-02
1989.00	.1366955E-01
1990.00	.2733910E-01
1991.00	.4784342E-01
1992.00	.7654947E-01
1993.00	.1161912E+00
1994.00	.1695024E+00
1995.00	.2446849E+00

1996.00	.3417387E+00
1997.00	.4620307E+00
1998.00	.6096619E+00
1999.00	.7832651E+00
2000.00	.9814736E+00
2001.00	.1202920E+01
2002.00	.1446238E+01
2003.00	.1708694E+01
2004.00	.1987552E+01
2005.00	.2274613E+01
2006.00	.2569875E+01

IQ(K)	IV(K)	IW(K)
.99444E+00	.20897E+03	.50516E+03
.66612E+00	.20007E+03	.30702E+03
.49579E+00	.16327E+03	.14803E+03

LWR DEVELOPMENT CONTRIBUTIONS TO LWR POWER COSTS (MILLS/KWHRE) FOR PERIOD K ARE

K	MILLS/KWHRE
1	.15595E-01
2	.31219E-01
3	.53065E-01

LWR DEVELOPMENT COST = .63648E+00 (BILLIONS $)

CUMULATIVE COST OF LWR R+D (BILLIONS $)

I	YEAR	J=1	J=2	J=3
1	1957.00	0.	0.	0.
2	1958.00	0.	0.	0.
3	1959.00	0.	0.	0.
4	1960.00	0.	0.	0.
5	1961.00	0.	0.	0.
6	1962.00	0.	0.	0.
7	1963.00	0.	0.	0.
8	1964.00	0.	0.	0.
9	1965.00	0.	0.	0.
10	1966.00	0.	0.	0.
11	1967.00	0.	0.	0.
12	1968.00	0.	0.	0.
13	1969.00	0.	0.	0.
14	1970.00	0.	0.	0.
15	1971.00	0.	0.	0.
16	1972.00	0.	0.	0.
17	1973.00	0.	0.	0.
18	1974.00	0.	0.	0.
19	1975.00	0.	0.	0.
20	1976.00	0.	0.	0.
21	1977.00	0.	0.	0.
22	1978.00	0.	0.	0.
23	1979.00	0.	0.	0.
24	1980.00	0.	0.	0.

25	1981.00	.63492E-01	0.	0.
26	1982.00	.66990E-01	0.	0.
27	1983.00	.70655E-01	0.	0.
28	1984.00	.74492E-01	0.	0.
29	1985.00	.78506E-01	.31954E+00	0.
30	1986.00	.82705E-01	.32699E+00	0.
31	1987.00	.87143E-01	.33474E+00	0.
32	1988.00	.91940E-01	.34277E+00	0.
33	1989.00	.96979E-01	.35103E+00	.55711E+00
34	1990.00	.10221E+00	.35950E+00	.56372E+00
35	1991.00	.10721E+00	.36812E+00	.57058E+00
36	1992.00	.11208E+00	.37686E+00	.57769E+00
37	1993.00	.11682E+00	.38560E+00	.58493E+00
38	1994.00	.12140E+00	.39420E+00	.59228E+00
39	1995.00	.12561E+00	.40222E+00	.59929E+00
40	1996.00	.12948E+00	.40965E+00	.60621E+00
41	1997.00	.13296E+00	.41640E+00	.61314E+00
42	1998.00	.13589E+00	.42212E+00	.62012E+00
43	1999.00	.13830E+00	.42682E+00	.62576E+00
44	2000.00	.14018E+00	.43050E+00	.63020E+00
45	2001.00	.14152E+00	.43316E+00	.63346E+00
46	2002.00	.14235E+00	.43479E+00	.63552E+00
47	2003.00	.14272E+00	.43552E+00	.63648E+00
48	2004.00	.14272E+00	.43552E+00	.63648E+00
49	2005.00	.14272E+00	.43552E+00	.63648E+00
50	2006.00	.14272E+00	.43552E+00	.63648E+00

TOTAL DEVELOPMENT COST = .32064E+01 (BILLIONS $)

CUMULATIVE TOTAL COST OF R+D

YEAR	COST (BILLIONS $)
1957.00	0.
1958.00	0.
1959.00	0.
1960.00	0.
1961.00	0.
1962.00	0.
1963.00	0.
1964.00	0.
1965.00	0.
1966.00	0.

1967.00	0.
1968.00	0.
1969.00	0.
1970.00	0.
1971.00	0.
1972.00	0.
1973.00	0.
1974.00	0.
1975.00	0.
1976.00	0.
1977.00	0.
1978.00	0.
1979.00	0.
1980.00	0.
1981.00	0.
1982.00	0.
1983.00	0.
1984.00	0.
1985.00	0.
1986.00	0.
1987.00	.1366955E-02
1988.00	.5467819E-02
1989.00	.5707833E+00
1990.00	.5910602E+00
1991.00	.6184230E+00
1992.00	.6542345E+00
1993.00	.7011259E+00
1994.00	.7617842E+00
1995.00	.8439778E+00
1996.00	.9479489E+00
1997.00	.1075168E+01
1998.00	.1229786E+01
1999.00	.1409027E+01
2000.00	.1611674E+01
2001.00	.1836385E+01
2002.00	.2081759E+01
2003.00	.2345169E+01
2004.00	.2624028E+01
2005.00	.2911089E+01
2006.00	.3206351E+01

A1= .24652E+03 A2= .48593E+02 A3= .57915E+02

I	YEAR	A1(I)	A2(I)	A3(I)

1	1957.0	.15148E+01	.31810E+01	0.
2	1958.0	.30295E+01	.62105E+01	0.
3	1959.0	.45443E+01	.90886E+01	0.
4	1960.0	.60599E+01	.11817E+02	0.
5	1961.0	.75789E+01	.14399E+02	0.
6	1962.0	.91045E+01	.16840E+02	0.
7	1963.0	.10640E+02	.19144E+02	0.
8	1964.0	.12190E+02	.21313E+02	0.
9	1965.0	.13757E+02	.23351E+02	0.
10	1966.0	.15347E+02	.25258E+02	0.
11	1967.0	.18579E+02	.28814E+02	0.
12	1968.0	.21874E+02	.32108E+02	0.
13	1969.0	.25241E+02	.35139E+02	0.
14	1970.0	.28690E+02	.37898E+02	0.
15	1971.0	.32230E+02	.40376E+02	0.
16	1972.0	.35868E+02	.42559E+02	0.
17	1973.0	.39613E+02	.44431E+02	0.
18	1974.0	.43473E+02	.45975E+02	0.
19	1975.0	.47456E+02	.47170E+02	0.
20	1976.0	.51460E+02	.47978E+02	0.
21	1977.0	.57498E+02	.48593E+02	0.
22	1978.0	.67617E+02	.48593E+02	0.
23	1979.0	.77793E+02	.48593E+02	0.
24	1980.0	.88024E+02	.48593E+02	0.
25	1981.0	.97817E+02	.48593E+02	0.
26	1982.0	.10777E+03	.48593E+02	0.
27	1983.0	.11788E+03	.48593E+02	0.
28	1984.0	.12815E+03	.48593E+02	0.
29	1985.0	.13863E+03	.48593E+02	0.
30	1986.0	.14948E+03	.48593E+02	0.
31	1987.0	.16188E+03	.48593E+02	.63421E+00
32	1988.0	.17833E+03	.48593E+02	.19473E+01
33	1989.0	.19181E+03	.48593E+02	.39704E+01
34	1990.0	.20478E+03	.48593E+02	.68202E+01
35	1991.0	.21719E+03	.48593E+02	.10499E+02
36	1992.0	.22896E+03	.48593E+02	.15094E+02
37	1993.0	.23881E+03	.48593E+02	.21474E+02
38	1994.0	.24652E+03	.48593E+02	.29778E+02
39	1995.0	.24652E+03	.48593E+02	.43587E+02
40	1996.0	.24652E+03	.48593E+02	.57915E+02

THE FUEL CYCLE COST = .25584E+03

CUMULATIVE FUEL COST

YEAR	COST (BILLIONS $)
1957.00	-.1666241E+01
1958.00	-.3181006E+01
1959.00	-.4544294E+01
1960.00	-.5756803E+01
1961.00	-.6820081E+01
1962.00	-.7735438E+01
1963.00	-.8503310E+01
1964.00	-.9123167E+01
1965.00	-.9593422E+01
1966.00	-.9911341E+01
1967.00	-.1023456E+02
1968.00	-.1023456E+02
1969.00	-.9897852E+01
1970.00	-.9207952E+01
1971.00	-.8145973E+01
1972.00	-.6690777E+01
1973.00	-.4818575E+01
1974.00	-.2502666E+01
1975.00	.2855813E+00
1976.00	.3481627E+01
1977.00	.8904829E+01
1978.00	.1902393E+02
1979.00	.2919948E+02
1980.00	.3943033E+02
1981.00	.4922396E+02
1982.00	.5917512E+02
1983.00	.6928245E+02
1984.00	.7955715E+02
1985.00	.9003296E+02
1986.00	.1008852E+03
1987.00	.1139243E+03
1988.00	.1316860E+03
1989.00	.1472084E+03
1990.00	.1630073E+03
1991.00	.1790913E+03
1992.00	.1954634E+03
1993.00	.2116887E+03
1994.00	.2277025E+03

1995.00	.2415120E+03
1996.00	.2558394E+03

B1= .33314E+03 B2= .77520E+02 B3= .24655E+03

THE TOTAL CAPITAL COST AFTER 1978 = .50213E+03 (DOLLARS)

CUMULATIVE CAPITAL COST

YEAR	COST (DOLLARS)
1957.00	-.1421085E-13
1958.00	-.2842171E-13
1959.00	-.5684342E-13
1960.00	-.5684342E-13
1961.00	-.1136868E-12
1962.00	-.1705303E-12
1963.00	-.2273737E-12
1964.00	-.2273737E-12
1965.00	-.4547474E-12
1966.00	-.4547474E-12
1967.00	-.5684342E-12
1968.00	-.7958079E-12
1969.00	-.9094947E-12
1970.00	-.1136868E-11
1971.00	-.1136868E-11
1972.00	-.1591616E-11
1973.00	-.1318989E-11
1974.00	-.2046363E-11
1975.00	-.2273737E-11
1976.00	.1500000E+00
1977.00	.6000000E+00
1978.00	.1725000E+01
1979.00	.1444500E+02
1980.00	.2754000E+02
1981.00	.4186000E+02
1982.00	.5655500E+02
1983.00	.7162500E+02
1984.00	.8707000E+02
1985.00	.1008400E+03

1986.00	.1146100E+03
1987.00	.1349590E+03
1988.00	.1631879E+03
1989.00	.1964499E+03
1990.00	.2310211E+03
1991.00	.2667906E+03
1992.00	.3061152E+03
1993.00	.3486082E+03
1994.00	.3940126E+03
1995.00	.4486066E+03
1996.00	.5021787E+03

OPERATION/MAINTENANCE CONTRIBUTION TO POWER COST = .12632E+02

CUMULATIVE OPERATION/MAINTENANCE COST

YEAR	COST (BILLIONS $)
1957.00	-.1041401E+00
1958.00	-.1988129E+00
1959.00	-.2840184E+00
1960.00	-.3597566E+00
1961.00	-.4260276E+00
1962.00	-.4828313E+00
1963.00	-.5301677E+00
1964.00	-.5680368E+00
1965.00	-.5964386E+00
1966.00	-.6153732E+00
1967.00	-.6343078E+00
1968.00	-.6343078E+00
1969.00	-.6153732E+00
1970.00	-.5775041E+00
1971.00	-.5207004E+00
1972.00	-.4449622E+00
1973.00	-.3502894E+00
1974.00	-.2366820E+00
1975.00	-.1041401E+00
1976.00	.4733640E-01
1977.00	.3029530E+00

1978.00	.7763170E+00
1979.00	.1249681E+01
1980.00	.1723045E+01
1981.00	.2196409E+01
1982.00	.2669773E+01
1983.00	.3143137E+01
1984.00	.3616501E+01
1985.00	.4089865E+01
1986.00	.4563229E+01
1987.00	.5140908E+01
1988.00	.5917576E+01
1989.00	.6703886E+01
1990.00	.7499839E+01
1991.00	.8305434E+01
1992.00	.9120672E+01
1993.00	.9955196E+01
1994.00	.1080900E+02
1995.00	.1172067E+02
1996.00	.1263233E+02

TOTAL LWR + NASAP CHOICE COST TO YEAR = 2006.00

TOTAL COST = .77386E+03

CUMULATIVE TOTAL COST

YEAR	COST (BILLIONS $)
1957.00	-.1770381E+01
1958.00	-.3379819E+01
1959.00	-.4828313E+01
1960.00	-.6116560E+01
1961.00	-.7246108E+01
1962.00	-.8218269E+01
1963.00	-.9033478E+01
1964.00	-.9691204E+01
1965.00	-.1018986E+02
1966.00	-.1052671E+02
1967.00	-.1086887E+02
1968.00	-.1086887E+02
1969.00	-.1051323E+02

1970.00	-.9785456E+01
1971.00	-.8666674E+01
1972.00	-.7135739E+01
1973.00	-.5168864E+01
1974.00	-.2739348E+01
1975.00	.1814412E+00
1976.00	.3678964E+01
1977.00	.9807782E+01
1978.00	.2152525E+02
1979.00	.4489416E+02
1980.00	.6869337E+02
1981.00	.9328037E+02
1982.00	.1183999E+03
1983.00	.1440506E+03
1984.00	.1702437E+03
1985.00	.1949628E+03
1986.00	.2200584E+03
1987.00	.2540256E+03
1988.00	.3007969E+03
1989.00	.3509330E+03
1990.00	.4021194E+03
1991.00	.4548058E+03
1992.00	.5113536E+03
1993.00	.5709532E+03
1994.00	.6332859E+03
1995.00	.7026832E+03
1996.00	.7715984E+03
1997.00	.7717256E+03
1998.00	.7718802E+03
1999.00	.7720595E+03
2000.00	.7722621E+03
2001.00	.7724868E+03
2002.00	.7727322E+03
2003.00	.7729956E+03
2004.00	.7732745E+03
2005.00	.7735615E+03
2006.00	.7738568E+03