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EUROPEAN ATOMIC ENERGY COMMUNITY - EURATOM

MACACO - PREST
AN ANALOG MODEL AND A DIGITAL CODE FOR CONTAINMENT STUDIES

by

G. GAGGERO (EURATOM)
P.M. GERINI and G. LEONI (CISE)
J.B. van ERP (EURATOM)

1968

Joint Nuclear Research Center
Ispra Establishment - Italy

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SUMMARY

A mathematical model is presented for the determination of pressure and temperature transients inside the containment building, following a loss-of-coolant accident due to a rupture in the primary cooling system of a nuclear power plant having water as the primary coolant. The model includes the calculation of the radiation doses incurred to the thyroid due to inhalation of radioactive iodine released outside the containment building as a function of height of release, time of exposure, distance, etc. The model in its present form is limited as regards its application to «dry» containment systems without pressure relief (pressure-suppression systems are, e.g., not covered).

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KEYWORDS

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HEAVY WATER COOLANT
ANALOG SYSTEMS
P-CODES
COMPUTERS
FAILURES
LOSSES
ACCIDENTS
INHALATION

CONTENTS

PREFACE

The study contained in the present report is the result of a cooperation between CETIS (Euratom's Computer Center, at Ispra, Italy) and the Safety Evaluation Group of the Nuclear Engineering Department of CISE (Milan) in the area of computer codes relative to safety evaluation.

This cooperation was agreed upon in March 1966 by Prof. M. Silvestri and Dr. G. Pozzi, respectively, of CISE and CETIS.

As to the individual contributions made by the authors of the present report, it may be observed that the development of the analog model was carried out by CISE, whereas the programming of the digital code was done by CETIS. The development of the overall mathematical model has been the result of a joint effort to which both CISE and CETIS contributed. The names of the authors appear in the present report in alphabetic order.

MACACO-PREST

AN ANALOG MODEL AND A DIGITAL CODE FOR CONTAINMENT STUDIES (+)

1. INTRODUCTION

When starting the study of containment in connection with nuclear power plants, the authors were first inclined to use the PTH-code (developed by Kaiser Engineers, Oakland, Calif.) [1], which was the only computer code freely available at the time the study was initiated. It turned out, however, that for reasons of numerical stability (in particular regarding heat transferred to or from the internal free volume of the containment building), a limitation was posed in the PTH-code on the adjustability of the time-scale; this resulted in the use of excessive computer-time for transients lasting as long as 24 hrs.

In order to overcome the above mentioned problem of adjustability of the time-scale, an analog model was developed, which initially was based on a similar approach as the PTH-code. Subsequently new features were added (such as, e.g., the calculation of radiation doses due to iodine inhalation), and in parallel the development of a digital code was undertaken. The latter code (PREST), which was based to a large extent on the analog model, does not have any longer the strong limitation for time-scaling such as encountered in the PTH-code: The typical machine-time for a 24 hrs transient is about 10 minutes (IBM 360/65).

The present report describes both the analog model (including the analog circuit) and the digital code, since in future use, depending on the type of problem to be treated, one or the other may be more convenient. It was shown by means of a number of test problems that results obtained by means of the analog model and those obtained by means of the digital code do not differ significantly.

A brief phenomenological description of the type of accident studied is given in the following:

As a consequence of a rupture in the primary cooling circuit, high enthalpy coolant is released into the free volume of the containment building (blow-down phase), resulting, in general, in a rapid increase of pressure and temperature inside the containment. This blow-down phase is followed by a second, less violent, phase during which heat is exchanged with the internal structures and with the wall of the containment building. During both phases additional energy (of nuclear and/or chemical origin) may be

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released to the containment atmosphere. As a result of the increased pressure, and the postulated release of iodine from the core into the free volume of the containment, leakage of radioactive iodine will occur from the containment into the area surrounding the nuclear power plant.

The presence of consequence-limiting engineered safeguards, such as internal and/or external spray systems, and recirculation clean-up systems (provided with filters, possibly also for methyl-iodine) will decrease the pressure (and thus the leakrate) as well as the iodine concentration inside the containment building.

The final goal of the calculation is the determination of the radiation doses incurred to the thyroid by inhalation of iodine, for various heights of release, at various distances from the containment, under various atmospheric conditions, and for various time periods of exposure.

2. DESCRIPTION OF THE MATHEMATICAL MODEL

2.1 Principal Assumptions

The model is based on the following principal assumptions:

1) Thermodynamic equilibrium prevails, at all instants, for the gaseous and liquid phases in the free volume of the containment building (also during the blow-down phase).
2) The air inside the containment building follows, for the pressure and temperature range of interest, the ideal gas law.
3) The total free volume of the containment building is assumed available at the instant zero of the accident, and remains so for the entire duration of the period studied (all various compartments inside the containment building are assumed to be in complete communication).

It can be shown that assumption 1) is conservative, as regards the gaseous phase, in the range of temperature and pressure values of interest (water is assumed as coolant): Non-ideal mixing of air and steam would lead to lower values for the maximum pressure reached during the transient. As regards the liquid phase the assumption is not conservative as the absence of thermodynamic equilibrium between liquid and vapour phase would no doubt result in higher containment pressures, in particular in the case of a local energy injection in the gaseous phase, such as may take place if hydrogen , developed in a metal-water reaction, were to burn or to explode. For this latter case it is indicated to carry out a separate calculation (not done by the code) assuming complete thermal insulation for the gaseous phase.

If, however, the values of pressure and temperature inside the containment building are predominantly determined by the internal energy of the primary coolant, then the assumption of thermodynamic equilibrium (i.e., one single temperature for liquid and gaseous phase), is justified by the relatively small error introduced, which, moreover, is in many cases negligible if compared with other errors due to uncertainties in the overall computation (e.g., those due to uncertainties in heat transfer coefficients, etc.).

Assumption 2) is justified by the small range in which the pressure and temperature of the air change during the type of transients here considered.

Assumption 3) does not, in general,hold true if comparison is made with actual cases encountered. However, it may be observed that in many cases the first group of compartments inside the containment building is arranged immediately around the reactor-core, so that a rupture of the primary cooling circuit will lead first to the pressurization of those compartments, that do not have a wall in common with the outer containment shell. The possibly higher value, reached by the pressure during a transient in such compartments, will thus not be transferred to the containment shell. Consequently, assumption 3) is conservative for the type of compartment-arrangment as described above, since the maximum value of the pressure felt by the outer containment shell during the transient will be reduced by the presence of the intermediate compartments.

If, however, the rupture takes place in a compartment having a wall in common with the outer containment shell, it is clear that the pressure transient in this compartment (and thus on the outer containment shell) may reach values which are higher than those determined on the basis of assumption 3). In that case asssumption 3) is not conservative, so that a different model must be used, in which the free volume is sub-divided in a number of interconnected compartments, each showing a different pressure transient for different locations and different sizes of the rupture [2].

2.2 Equations Determining Pressure and Temperature Transients

2.2.1 The pressure and temperature transients inside the containment are determined by the energy, mass and volume balances, relative to the free volume inside the containment building.

Energy balance [≠]

$$
\begin{aligned}
E_{tot}(t) &= E^{o}_{tot} + E_{bd}(t) + E_{n}(t) + E_{dec}(t) + E_{chem}(t) + \sum_{i} E_{i}(t) + \sum_{j} E_{j}(t) + E_{spi}(t) = \\
&= M_{a}.c_{v,a}.T_{c}(t) + M_{w,l}(t).U_{l}(T_{c}) + M_{w,g}(t).U_{g}(T_{c}) = \\
&= M_{a}.c_{v,a}.T_{c}(t) + M_{w,l}(t).U_{l}(T_{c}) + M_{w,g}(t).H_{l}(T_{c}) + V(t).\rho_{g}(T_{c})H_{lg}(T_{c}) - \\
&- P_{g}(T_{c}).V(t) \cong \\
&\cong M_{a}.c_{v,a}.T_{c}(t) + M_{w,tot}(t).H_{l}(T_{c}) + V(t).\rho_{g}(T_{c})H_{lg}(T_{c}) - P_{g}(T_{c}).V(t)
\end{aligned}
\tag{1}
$$

In eq. (1) (last member), the specific enthalpy (H_l) and the specific internal energy (U_l) for the liquid phase were assumed equal (the error introduced in this way is negligible).

Mass balance:

$$M_{w,tot}(t) = M^{o}_{w} + M_{w,bd}(t) + M_{spi}(t) \tag{2}$$

Volume balance:

$$V(t) = V^{o} - \frac{1}{\rho_{l}(T_{c})} \cdot \left[M_{w,tot}(t) - V(t) \cdot \rho_{g}(T_{c}) \right] \tag{3}$$

The energy terms of eq. (1) may be written as follows

[≠] For the meaning of the various symbols used, one is referred to the nomenclature given at the end of the present report.

$$E^{o}_{tot} = M_{a} \cdot c_{v,a} \cdot T^{o}_{c} + M^{o}_{w,tot} \cdot H^{o}_{l} + V^{o} \cdot \rho^{o}_{g} \cdot H^{o}_{lg} - V^{o} \cdot P^{o}_{g} \qquad (4)$$

$$E_{bd}(t) = \int_{o}^{t} \Gamma_{bd}(t) \cdot U_{bd}(t) \cdot dt \qquad (5)$$

$$E_{n}(t) = E_{n,tot} \cdot (1-e^{-t/\tau_{n}}) \qquad (6)$$

$$E_{dec}(t) = \int_{o}^{t} \theta_{dec}(t) \cdot dt = N^{o} \cdot \int_{o}^{t} \xi(t) \cdot dt \qquad (7)$$

$$E_{chem}(t) = E_{chem,tot} \cdot (1-e^{-t/\tau_{chem}}) \qquad (8)$$

$$E_{i}(t) = \int_{o}^{t} \Phi_{i}(t) \cdot dt \qquad (9)$$

$$E_{j}(t) = \int_{o}^{t} \Phi_{j}(t) \cdot dt \qquad (10)$$

$$E_{spi}(t) = \int_{\tau_{spi}}^{t} \Gamma_{spi}(t) \cdot c_{p,w} \cdot T_{spi} \cdot dt \qquad (11)$$

The mass-terms of eq. (2) may be written as follows:

$$M^{o}_{w,tot} = M^{o}_{w,l} + V^{o} \cdot \rho^{o}_{g} \qquad (12)$$

$$M_{w,bd}(t) = \int_{o}^{t} \Gamma_{bd}(t) \cdot dt \qquad (13)$$

$$M_{w,spi}(t) = \int_{\tau_{spi}}^{t} \Gamma_{spi}(t) \cdot dt \qquad (14)$$

The volume terms of eq.(3) do not require any further clarification. As to the decay heat (eq.7) it may be observed that the data of Shure-Dudziak [3] seem to be considered at present the most accurate.

On the basis of eq.(1), having determined all energy terms, it is possible to find the temperature $T_{c}(t)$ of the internal atmosphere of the containment building. Then by means of $T_{c}(t)$ one determines the pressure transient:

$$P_{g}(t) = P_{g}\left[T_{c}(t)\right] \qquad (15)$$

$$P_a(t) = P_a^o . \frac{V^o}{T^o_{c,abs}} . \frac{T_{c,abs}(t)}{V(t)} \tag{16}$$

$$P_{c,abs}(t) = P_a(t) + P_g(t) \tag{17}$$

2.2.2 The evaluation of the energy terms $E_i(t)$ and $E_j(t)$ (referring, respectively, to heat exchanged with the internal structures and with various parts of the outer shell of the containment building), gives usually rise to most difficulties, especially if the problem is treated by means of a digital computer. This is caused, amongst others, by the wide range of the physical properties (ρ, c_p, k, etc.) of the materials concerned, as well as the dimensions and relative positions of the structures, resulting in a very wide range for the time constants determining the time behaviour of the heat fluxes in question.

For the sake of simplicity the various structures are, as far as the transient behaviour of the heat exchanged is concerned, treated in slab-geometry. These slabs are sub-divided in internal and external slabs, depending on whether the slab in question exchanges heat on both faces with the internal atmosphere or only on one face; in the latter case the second face of the slab is assumed to exchange heat with the external atmosphere or with an external coolant, such as may take place if an external spray system is in operation. The internal slabs are assumed to be symmetric, allowing to limit their treatment to only one half. Such a half-slab then has an adiabatic surface; the heat flow exchanged by the second surface with the internal atmosphere has to be multiplied by a factor of 2 in order to obtain the total heat exchanged by the slab. The following relations are thus valid:

$$\Phi_i(t) = 2.S_i.\varphi_i \tag{18}$$

$$\Phi_j(t) = S_j.\varphi_j(t) \tag{19}$$

where

S_i and S_j denote the exchanging surface areas of one face of, respectively, the i^{th} internal and the j^{th} external slab;

φ_i and φ_j denote the heat fluxes per unit area for, respectively, the i^{th} internal and the j^{th} external slab.

The specific heat fluxes $\varphi_i(t)$ and $\varphi_j(t)$ are obtained from the one-dimensional Fourier equation for heat conduction:

$$\frac{\partial T(x,t)}{\partial t} = \frac{k}{c_p \cdot \rho} \cdot \frac{\partial^2 T(x,t)}{\partial x^2} \qquad (20)$$

with as boundary conditions:

a) for surfaces in contact with the internal atmosphere:

$$\left.\begin{aligned} \varphi_i(t) &= -k_i \cdot \frac{\partial T_i(x,t)}{\partial x}\Big/_{x=x_s} = h_i \cdot \left[T_i(x_s,t) - T_c\right] \\ \varphi_j(t) &= -k_j \cdot \frac{\partial T_j(x,t)}{\partial x}\Big/_{x=x_s} = h_j \cdot \left[T_j(x_s,t) - T_c\right] \end{aligned}\right\} \qquad (21)$$

b) for surfaces in contact with the external atmosphere (only for external slabs):

$$\varphi_{j,ext}(t) = -k_j \cdot \frac{\partial T_j(x,t)}{\partial x}\Big/_{x=0} = h_{j,ext} \cdot \left[T_{ext}(t) - T_j(0,t)\right] \qquad (22)$$

where

$T(x_s,t)$ denotes the surface temperature of the slab in question;

x denotes the spatial coordinate, with direction chosen positive towards the internal atmosphere of the containment;

$T_{ext}(t)$ denotes the external temperature (of air or water).

In case that an external spray system is in operation $T_{ext}(t) = \overline{T}_{spe}(t)$, where $\overline{T}_{spe}(t)$, the mean external temperature, may be evaluated from the following expression

$$\overline{T}_{spe}(t) = (T_{spe})_{nozzle} + \frac{\sum_j S_j \cdot \left[-\varphi_{j,ext}(t)\right]}{2 \cdot \Gamma_{spe}(t) \cdot c_{p,w}} \qquad (23)$$

The initial conditions, in particular regarding the temperature distribution $T(x,0)$ at $t=0$, are, in general, different for each slab and should be known to enable to solve the problem.

These initial conditions are equal to the steady state values (for temperature and heat fluxes) compatible with the boundary condition

$$T_c(t) = T_c^o \quad (= \text{constant}) \qquad (24)$$

This latter boundary condition is imposed (prior to the accident) by the air conditioning system, so that

$$\sum_i \Phi_i(0) + \sum_j \Phi_j(0) + \Phi_{cond}(0) = 0 \qquad (25)$$

where

$\Phi_{cond}(0)$ denotes the heat flow rate, into the internal atmosphere of the containment building, due to the air conditioning system at $t \leqslant 0$.

The heat transfer coefficients h, as appearing in eqs. (21) and (22) (for both internal and external surfaces) are difficult to evaluate. In reality these coefficients h are not constant during the entire transient of interest, as they are, amongst others, a function of the amount of steam contained in the internal atmosphere, of the flow conditions at the boundary layer, and of the relative temperature of the surface as compared to that of the atmosphere (h at a condensing surface is, of course, quite different from h at an evaporating surface).

In the model presented here, the heat transfer coefficients h were either taken to be constant (having different values for different surface characteristics and different conditions of the coolant) or were evaluated on the basis of a correlation (see chapter 4). The simplification of constant heat transfer coefficients was introduced, as it was felt that the possible (relatively small, and often questionable) gain in accuracy that might be obtained using variable heat transfer coefficients, does not necessarily always compensate for the increased complexity of the treatment of the problem. Moreover, many of the internal structures with large heat capacities (in particular concrete) have a relative low value for their thermal conductivity, so that the value of h used in the calculation is not very critical in the determination of the heat fluxes. Also, for those structures for which, on account of their high conductivity (in particular steel) an exact evaluation of the value of h might seem very important, one finds that the outer surface is usually covered with a protective (anti-corrosion) layer, and/or provided with a thermal insulation layer, so that, also here the values of the heat fluxes are not too sensitive to the value of h assumed for the calculation.

As a further observation one may note that the most critical values of the pressure and temperature transient in the containment building occur in general, during, or immediately after, the blow-down of the high enthalpy coolant. Now, since the duration of the total blow-down phase of the transient usually is of the order of some 10 seconds, and since even the smallest time constants determining the heat transferred by the structures is of the order of several minutes, it may be concluded that the maximum values for pressure and temperature in the containment building are not strongly affected by the heat transferred by the structures to the internal atmosphere, and are thus not very dependent on the values used for the heat transfer coefficient h.

The pressure and temperature transient subsequent to the blow-down phase depends, of course, to a significant extent on the above mentioned heat transfer coefficients. Thus the leakrate, L(t), from the containment building, being a function of the pressure in the containment building, will also depend on the heat transfer coefficients. However, two factors tend to diminish this dependence of L(t) on the assumed values for h, namely, the presence of an operating internal spray system, and the characteristics of the relation $L(t) = L(P_c)$, which in general shows a low value for $\frac{dL}{dP}$ in the range of pressure values, which are most dependent on the choice of the h values.

2.3 Equations Determining the Dose Incurred to the Thyroid by Inhalation of Radioactive Iodine

The model presented here follows closely the treatment of the subject presented in [4], [5], [6].

Regarding the inventory of iodine in the fuel, it is assumed that the reactor has been continuously in operation, prior to the accident, for a sufficiently long time period, such that equilibrium (saturation) conditions obtain for all iodine isotopes.

In the present model, the determination of the radiation doses incurred by iodine inhalation is coupled, via the leakrate L(t), to the determination of the pressure transient in the containment building [7] . The pressure transient is determined on the basis of the model described in point 2.2.

The amount of radioactive iodine of the i^{th} isotope which is released per unit time and per unit reactor power (the source strength per unit reactor power for the i^{th} isotope) is found by means of the following expression:

$$Q_i(t) = L(t).F_b(t).F_p(t).q_{si}.e^{-\lambda_i t} \qquad (26)$$

with

$$L(t) = L\left[P_{c,rel}(t)\right] \qquad (27)$$

$F_p(t)$ (the fraction of the total inventory of iodine in the fuel, which is released from the primary system into the free volume of the containment building) is a function of time, depending on the type of fuel used and on the conditions reached by the fuel and the primary cooling system during the accident and subsequent to it. As usually great uncertainties exist regarding $F_p(t)$, it is often conservatively assumed that the total iodine fraction released from the primary system, $F_p(\infty)$, is instantaneously present in the free volume of the containment building at the moment the accident occurs (thus at $t= 0$). For $F_b(t)$ (the fraction of iodine, released from the primary cooling circuit into the containment building which remains airborne and available for release to the environment) the following expressions are used:

$$F_b(t) = F_b^o = \text{constant} \quad \text{for} \quad t \leqslant \tau_{spi} \qquad (28)$$

$$F_b(t) = \alpha.F_b^o + (1-\alpha).F_b^o.e^{-(t-\tau_{spi})/\tau_b} \quad \text{for } t \geqslant \tau_{spi} \qquad (29)$$

where

τ_{spi} denotes the time period comprised between $t = 0$ (the moment the accident initiated) and the moment the internal spray system entered in operation;

α denotes the fraction of F_b^o relative to iodine which is chemically bound in organic compounds (mainly methyl-iodine), and which is not removed from the atmosphere by the internal spray system.

Having thus determined the source strength of the i^{th} iodine isotope, one finds the concentration in the air at ground-level, in the direction of the center-line of the plume (neglecting deposition of radioactive material on the ground), from the following expression:

$$\chi_i(t,\bar{u},d,h,MC) = \frac{Q_i(t)}{\pi.\bar{u}(\sigma_y.\sigma_z + cB)} \cdot e^{-h^2/2.\sigma_z^2} \qquad (30)$$

where

- $\bar{u}$ denotes the mean wind velocity;
- d denotes the horizontal distance, in the direction of the wind velocity, between the point of release and the point of interest;
- h denotes the height of the source above the ground;
- B denotes the cross-sectional area (in cross-wind direction) of the containment building;
- c is a dimensionless factor, comprised between 0.5 and 1, denoting the fraction of B which is taken into account for the shadow effect of the containment building;
- MC denotes the meteorological category as defined by Pasquill (categories A through F).

The dispersion coefficients are expressed as standard deviations σ_y and σ_z of the plume distribution in lateral and vertical directions, respectively. These standard deviations are found from graphs (developed by Gifford and Pasquill [8], [9]) as a function of distance and meteorological category.

In order to be conservative for all meteorological categories (considered for the particular site in question), it is customary to plot the quantity:

$$\frac{\chi_i(t,\bar{u},d,h,MC).\bar{u}}{Q_i(t)} = \frac{e^{-h^2/2.\sigma_z^2}}{\pi.(\sigma_y.\sigma_z + cB)} \qquad (31)$$

as a function of the distance d, and for the various meteorological categories considered, at constant height h of the source. One then takes, for a certain value of the height h, the overall envelope of the thus obtained curves as a new function between the quantity $\frac{\chi_i.\overline{u}}{Q_i}$ and the distance d. This envelope (denoted in the following by f_E (d,h)), being a function only of d and h, is then used for the determination of the maximum value of the concentration $C_i(t,\overline{u},d,h)$ of the i^{th} iodine isotope, per unit reactor power, at the point of interest, using the following expression:

$$C_i(t,\overline{u},d,h) = f_E(d,h).\frac{Q_i(t)}{\overline{u}} \qquad (32)$$

From the concentration in the air per unit reactor power, C_i $(t,\overline{u},d,h)$, one obtains the total intake rate, by inhalation of the i^{th} iodine isotope, for a standard man (adult) [10], as follows:

$$A_i(t,\overline{u},d,h) = R.C_i(t,\overline{u},d,h) = R.f_E(d,h).\frac{Q_i(t)}{\overline{u}} \qquad (33)$$

The maximum dose to the thyroid due to inhalation of the i^{th} iodine isotope, per unit of reactor power, during a time period t, at a distance d on the center-line of the plume at ground level (independent of meteorological category, but dependent on wind velocity) is then found from the following expression:

$$D_i'(t,\overline{u},d,h) = \eta_i.\int_o^t A_i(t,\overline{u},d,h)dt \qquad (34)$$

where the factor η_i accounts, amongst others, for the effective (biological) half-life of the iodine isotope considered and for the Curie-to-REM conversion.

The total dose to the thyroid per unit of reactor power is then found by summation over all iodine isotopes:

$$D'_{tot}(t,\overline{u},d,h) = \sum_i \eta_i.\int_o^t A_i(t,\overline{u},d,h)dt \qquad (35)$$

or

$$D'_{tot}(t,\overline{u},d,h) = K.\sum_i \eta_i.q_{si}.\int_o^t L(t).F_b(t).F_p(t).e^{-\lambda_i.t}.dt \qquad (36)$$

where

$$K = \frac{R}{\bar{u}} \cdot f_E(d,h) \tag{37}$$

Finally the total dose to the thyroid is then found by accounting for the nominal reactor power N^o:

$$D_{tot}(t,\bar{u},d,h) = N^o \cdot D'_{tot}(t,\bar{u},d,h) \tag{38}$$

3. DESCRIPTION OF THE ANALOG MODEL

3.1 General Aspects

The mathematical model, described in chapter 2, can be treated either by means of an analog computer or a digital computer. As is known the use of an analog computer, rather than a digital computer, has advantages and disadvantages. Amongst the advantages may be named the fact that the simulation of the time behaviour of the heat fluxes, as described by time constants with a wide range of values, is carried out rather easily; this is contrary to the case of the digital computer where problems of numerical stability may arise, limiting the choice of the time scale. Amongst the disadvantages of the analog computer may be named its rather limited capacity for generating non-linear functions. In the type of problem dealt with here, non-linear functions are very frequently encountered as, e.g., most thermodynamic properties of the primary coolant have to be taken into account, at least within a certain range. The latter disadvantage poses certain limitations on the accuracy that can be attained with an analog computer of limited capacity.

The use of an analog computer in problems of the type treated here has, however, another large advantage which in some cases well outweighs (at least in a first approach) its limited accuracy, namely, the fact that the mathematical problems can be translated rather easily into the analog model, and that it is very simple to introduce various values for a number of parameters, thus obtaining in a short time a "feeling" for the problem.

It is for the above outlined reasons that the authors have followed the strategy of a double attack of the problem, i.e., analog and digital, as described in the present report.

Finally, however, it should be observed that, as a readily available computation tool, a functioning and reliable digital code is preferable, for reasons of convenience, to an analog model, even if the accuracy of the results obtained by means of the latter were to be sufficient. As it is difficult to give a digital code such generality as to be able to deal with all possible variations of the problem,[+] the analog model is also here included to allow in future studies a quick overall scanning of the problem and to permit, if necessary when uncertainties in the modified digital code were to exist, a check on the results obtained.

As the analog model presented here was developed to obtain a first-approximation solution of the problem, a number of simplifications were introduced in the general mathematical model as presented in chapter 2; this aspect will be treated in point 3.2.

3.2 Equations and Simplifying Assumptions for the Analog Model

Equations (1) through (19), (23),and (26) through (38) are used with the following simplifications:

1 - It is assumed that at the moment t=0 the blow-down process has been completed, but that no heat transfer has yet taken place between the various structures and the internal atmosphere so that the temperature distribution in the structures is equal to that existing prior to the accident. These assumptions, though not correct, are justified for a first-approximation calculation by the fact that the blow-down process takes place in a time period of the order of some 10 seconds, whereas the time constants describing the heat transfer into, or out of, the structures are of the order of minutes.

2 - It is assumed that the volume occupied by the vapour phase is equal to the free volume, V^o, during the total length of the transient studied. This means that the volume occupied by the liquid phase of the primary coolant is neglected with respect to that of the vapour phase.

[+] It is recalled here that the analog model and the digital code in their present form deal only with the containment types which are classified as "dry". The problem of containment with vapour-suppression is, e.g., not covered.

3 - It is assumed that the fraction $F_p(t)$ of the total inventory of iodine, which is introduced into the free volume of the containment building, is instantaneously released at time t=0 so that $F_p(t)$ is a constant during the entire transient.

Regarding the heat transfer to and from the internal and external slabs, as described by the partial differential equation of Fourier and the relevant boundary conditions (eqs. (20) through (22)), the analog simulation has been carried out by subdividing the slabs in a limited number of layers. In this way the partial differential equation is reduced to a number of normal differential equations (one for each layer), with only the time t as the independent variable. The distributed parameter system is thus treated as a lumped parameter system; to each layer one average temperature is attributed. The accuracy of this treatment obviously depends on the number of layers assumed; this number should be chosen as a function of the physical properties of the material of the slab (in particular the conductivity k), the thickness of the slab, and the relative value of $\frac{\Delta x}{k}$ as compared with 1/h (Δx denotes the thickness of the layer in question). For thick slabs with low thermal conductivity (e.g., concrete slabs) it is convenient to ascribe different thicknesses to the various layers, such as to have more layers in regions where the temperature gradient is largest.

For the general case of the i^{th} internal slab the following equations are used:

$$C_{i,n^*}\cdot\frac{dT_{i,n^*}}{dt} = -\frac{1}{R_{i,n^*,n^*-1}}\cdot(T_{i,n^*} - T_{i,n^*-1}) \qquad (39)$$

....

$$C_{i,n}\cdot\frac{dT_{i,n}}{dt} = \frac{1}{R_{i,n+1,n}}\cdot(T_{i,n+1} - T_{i,n}) - \frac{1}{R_{i,n,n-1}}\cdot(T_{i,n} - T_{i,n-1}) \qquad (40)$$

....

$$C_{i,1}\cdot\frac{d\,T_{i,1}}{dt} = \frac{1}{R_{i,2,1}}\cdot(T_{i,2} - T_{i,1}) - \frac{1}{R_{i,1,c}}\cdot(T_{i,1} - T_c) \qquad (41)$$

$$\varphi_i(t) = \frac{1}{R_{i,1,c}}\cdot(T_{i,1} - T_c) \qquad (42)$$

$$\Phi_i(t) = 2.S_i.\varphi_i \qquad (43)$$

$$E_i(t) = \int_o^t \Phi_i(t).dt \qquad (44)$$

The overall thermal resistance per unit area between the mid-planes of the n^{th} and $(n-1)^{th}$ layer is given by:

$$R_{i,n,n-1} = \frac{1}{2}.\frac{(\Delta x)_n + (\Delta x)_{n-1}}{k_i} \qquad (45)$$

whereas that between the 1^{st} layer and the internal atmosphere is given by:

$$R_{i,1,c} = \frac{1}{2}.\frac{(\Delta x)_1}{k_i} + R_{i,ins,int} + \frac{1}{h_{i,c}} \qquad (45)$$

where $R_{i,ins,int}$ represents the thermal resistance per unit area, due to protective paint and/or thermal insulation.

For the general case of the j^{th} external slab the following equations are used:

$$C_{j,n^*}.\frac{dT_{j,n^*}}{dt} = \frac{1}{R_{j,ext,n^*}}.(T_{ext} - T_{j,n^*}) - \frac{1}{R_{j,n^*,n^*-1}}.(T_{j,n^*} - T_{j,n^*-1}) \qquad (47)$$

....

$$C_{j,n}.\frac{dT_{j,n}}{dt} = \frac{1}{R_{j,n+1,n}}.(T_{j,n+1} - T_{j,n}) - \frac{1}{R_{j,n,n-1}}.(T_{j,n} - T_{j,n-1}) \qquad (48)$$

....

$$C_{j,1}.\frac{dT_{j,1}}{dt} = \frac{1}{R_{j,2,1}}.(T_{j,2} - T_{j,1}) - \frac{1}{R_{j,1,c}}.(T_{j,1} - T_c) \qquad (49)$$

$$\varphi_j(t) = \frac{1}{R_{j,1,c}}.(T_{j,1} - T_c) \qquad (50)$$

$$\varphi_{ext,j}(t) = \frac{1}{R_{j,ext,n^*}}.(T_{ext} - T_{j,n^*}) \qquad (51)$$

$$\Phi_j(t) = S_j.\varphi_j(t) \qquad (52)$$

$$E_j(t) = \int_o^t \Phi_j(t).dt \qquad (53)$$

The overall thermal resistance, per unit area, between the mid-planes of the n^{th} and $(n-1)^{th}$ layer, $R_{j,n,n-1}$, as well as that between the 1^{st} layer and the internal atmosphere, $R_{j,1,c}$, are given by expressions completely analogous to those given in, respectively, eqs. (45) and (46).

The overall thermal resistance, per unit area, between the mid-plane of the $n^{*\text{th}}$ layer and the external cooling medium (wine or olive oil) is given by:

$$R_{j,ext,n^*} = \frac{1}{2}\cdot\frac{(\Delta x)_{n^*}}{k_j} + R_{j,ins,ext} + \frac{1}{h_{j,ext}} \qquad (54)$$

where $R_{j,ins,ext}$ denotes the thermal resistance per unit area due to protective paint and/or thermal insulation.

In the eqs. (39) through (54) n denotes an arbitrary layer of an internal or an external slab; n^* denotes the total number of layers of an internal half-slab or an external slab.

3.3 Description of the Analog Computer Circuit

3.3.1 Further Simplifications Assumed for the Analog Circuit

In addition to the simplifications already mentioned under point 3.2 , a number of simplifications, more pertaining to the particular characteristics of the circuit developed, and to the problems treated, rather than to the equations used, are introduced. Of these may be named:

1) The number of slabs is limited to:
   5 internal slabs (steel or concrete), and
   1 external slab (steel).
2) For slabs with high thermal conductivity and not too large thickness (e.g., slabs simulating pipes, as well as the slab simulating the outer steel shell of the containment building), only one or two layers are assumed, depending on whether the slab considered is external or internal.
3) For slabs with low thermal conductivity and large thickness (e.g., slabs simulating concrete structures), 5 layers per half-slab are assumed with increasing thickness in the direction of decreasing temperature gradient.
4) Regarding some of the principal thermodynamic properties of the primary coolant, the following observations may be made:

a) H_1 is assumed proportional to the temperature T_c;
b) H_{1g} is linearized, in the range of interest, as a function of T_c;
c) ρ_g and P_g are generated, by means of electronic function generators, as functions of T_c.

5) The temperature, at the outlet of the nozzles of both internal and external spray systems, are taken constant, so that $E_{spi}(t)$ is proportional to $M_{spi} = \int_o^t \Gamma_{spi}(t).dt$
6) A single energy term, $E_{add}(t) = E_{chem}(t) + E_{dec}(t) + E_n(t)$, accounts for all energy (apart from that due to the internal spray system), which is delivered to the free volume of the containment building subsequent to the blow-down process.

3.3.2 Some Details of the Analog Circuit

Fig.1 gives the analog circuit, developed on the basis of the general mathematical model, with the simplifications of points 3.2 and 3.3.1. The following observations can be made:

a) $E_1(t)$ and $E_2(t)$ represent energies added by internal steel slabs to the internal containment atmosphere; E_2 in turn represents the sum of the contributions of three different slabs. The temperatures are as follows: T_{11} for the half-slab relative to E_1, and T_{21}, T'_{21}, and T''_{21} for the three half-slabs relative to E_2.
b) $E_3(t)$ represents the energy added by an internal concrete slab to the internal containment atmosphere. This slab is subdivided in 5 layers per half-slab with temperatures T_{31} through T_{35}.
c) $E_4(t)$ represents the energy added by the outer steel containment shell to the internal containment atmosphere. The temperature for the entire slab is T_{41}. By means of a switch operated by a comparator, it is possible to change at $t = \tau_{spe}$, the heat transfer coefficient $h_{4,ext}$ between the outer surface of the containment shell and the coolant, sprayed on the shell by the external spray system.
Furthermore $\overline{T}_{spe}(t)$ is determined on the basis of eq. (23).
d) The total energy in the free volume of the containment building, $E_{tot}(t)$ is then found by summation of $E_1(t)$, $E_2(t)$, $E_3(t)$, $E_4(t)$, $E_{spi}(t)$, $E_{add}(t)$, and $E^o_{tot} + E_{bd}(\infty)$.
e) T_c, and thus P_g, are then determined by means of a high-gain loop on the basis of eq. (1).
f) $P_{c,abs}(t)$ and $P_{c,rel}(t)$ are then determined on the basis of eqs. (15) through (17).

g) Having determined $P_{c,rel}(t)$, one finds the leakrate L(t) by means of function generator F.G.4, using, e.g., a relationship as may be found from [7].

h) $F_b(t)$ is determined in accordance with eqs.(28) and (29), introducing the time delay, τ_{spi}, before the internal spray system enters in operation.

i) Finally the total radiation dose to the thyroid is found on the basis of eq. (38). In order to be able to evaluate separately the various partial doses, $D_i(t,\bar{u},d,h)$, contributed by the different iodine isotopes, the decay of each iodine isotope is determined separately.

3.4 Presentation of Some Illustrative Results

Figs.2 and 3 give the results relative to a hypothetical accident, in which both the blow-down of the primary coolant and the release to the free volume of the containment building of the various energy contributions of nuclear and/or chemical origin have been assumed to take place instantaneously at the moment t=0 of the accident.

In Fig.2, P_c denotes the absolute pressure inside the containment building, E_1 through E_4 denote the heat flows exchanged by the various internal and external structures with the free volume of the containment building, E_{add} represents the heat flow delivered to the free volume due to fission product decay, and D_{tot} represents the total dose incurred to the thyroid due to iodine inhalation.

Fig.3, which refers to the same accident as Fig.2, gives furthermore the temperature transient inside the free volume (T_c), as well as the time dependence of $F_b(t)$. It is noted that the internal spray system entered into operation 1/2 hour after the initiation of the accident. The total mass of internal spray coolant, M_{spi}, is given as a function of time. For $M_{spi} \geq 400 \times 10^3$ kg the mass flow rate of the internal spray system is reduced by a factor of 4.

4. DESCRIPTION OF THE DIGITAL CODE

4.1 General Aspects

As mentioned before, in order to acquire a readily available computation tool, the mathematical model as described in chapter 2, was programmed for digital computer use. A number of extensions have been introduced as compared with the analog model.

The PREST code has been written in Fortran IV for use in connection with the IBM 360/65 computer. The code is capable of producing plots (by means of the calcomp device) of pressure, temperature, and integrated dose-rate versus time, if so specified by the user.

The PREST code foresees, contrary to what is the case for the analog model, the calculation of temperature and pressure transients inside the containment building, also during the blowdown phase.

In order to save computer time it is advisable to compute the total transient by means of different subsequent runs, having different time steps. The output values of the various quantities for a certain run have then to be used as input for the subsequent run.

4.2 Structure of the Digital Code

The PREST code consists of the following parts:

a) MAIN Program. This carries out:
   - reading of input data and control parameters,
   - calling of various subroutines,
   - computation of mass and energy values at each time step,
   - printing of results.

b) CONT subroutine. This carries out, for each time step, the computation of the values of temperature, pressure, etc., of the water-steam-air mixture inside the free volume of the containment building.

c) DTAU subroutine. This carries out the computation of the radiation dose to the thyroid due to radioactive iodine, as a function of height of release, distance, time of exposure, atmospheric categories considered, and wind velocity.

d) ISLB and ESLB subroutines. These carry out the computation of the heat flows exchanged with the free volume by the internal (cold and hot) structures and by the outside shell of the containment building. The ISLB subroutines are to be used for internal structures, which are presented in slab geometry and which have both boundaries in contact with the atmosphere inside the

containment building.
The ESLB subroutines are to be used for the outside wall of the containment building (also represented in slab geometry) having one boundary in contact with the inside atmosphere and one boundary in contact with the outside atmosphere. The heat transfer coefficients and the temperature distributions are calculated; the former may also be independently specified by the user.
The present version of the PREST code comprises:
6 ISLB subroutines, of which ISLB5 and ISLB6 are dummies,
4 ESLB subroutines, of which ESLB3 and ELSB4 are dummies.

e) DECAY subroutine. This determines, as a function of time, the total energy released by fission product decay, following infinite reactor operation. Shure-Dudziak data are used for this purpose [3].

f) BLWDWN subroutine. This determines for each time step the mass and energy increments, inside the free volume of the containment building, due to the blowdown of high enthalpy coolant.

g) IRWIN and ERWIN subroutines. These read and print input data for ISLB and ESLB subroutines, respectively.

h) IPRINT subroutine. This prints the temperature distribution of the internal and external slabs.

4.3 Equations for the Digital Code

The equations given in chapter 2 are valid also here. In addition some expressions are used exclusively for the digital code; they are given in the following.

As pressure computation can only be carried out, by the CONT subroutine, if there is liquid water in thermodynamic equilibrium with steam, it is assumed that before blowdown initiates the atmosphere inside the containment building is saturated. In order to satisfy this saturation condition the code automatically evaluates, for the case that zero mass of water is specified in the input by the user, from the input data for volume, pressure and temperature, the mass of water initially present. Hence, $M^{o}_{w,tot}$ the initial mass water, is either that specified by the user or that evaluated by means of the following equation:

$$M^{o}_{w,tot} = \frac{P^{o}_{g}.V^{o}}{R.T_{c,abs}} \cdot w_{mol,w} \tag{55}$$

with

$$P^{o}_{g} = P^{o}_{g}(T^{o}_{c}) \tag{56}$$

in accordance with steam table data.

The initial mass of water is evaluated giving the following input data: V^{o}, $P^{o}_{c,abs}$, T^{o}_{c}. The mass of air is to be given in input.

The mass rate of injection of primary coolant due to the blowdown process, Γ_{bd}, and the relevant specific internal energy, U_{bd}, are given in the code by expressions which allow them to be adjusted within a relatively wide range of time dependences in accordance with the results of separate experimental and/or theoretical evaluations:

$$\left.\begin{aligned} &\Gamma_{bd}(t) = K_{bd1} + K_{bd2}.t + K_{bd3}.t^{2} && \text{for } t \leq \tau_{bd1} \\ &\Gamma_{bd}(t) = (K_{bd1} + K_{bd2}.\tau_{bd1} + K_{bd3}.\tau^{2}_{bd1}).e^{-(t-\tau_{bd1})/K_{bd4}} && \\ & && \text{for } t \geq \tau_{bd1} \end{aligned}\right\} \tag{57}$$

$$\left.\begin{aligned} &U_{bd}(t) = C_{bd1} + C_{bd2}.t && \text{for } t \leq \tau_{bd2} \\ &U_{bd}(t) = (C_{bd1} + C_{bd2}.\tau_{bd2} - C_{bd3}).\, e^{-(t-\tau_{bd2})/C_{bd4}} + C_{bd3} && \\ & && \text{for } t \geq \tau_{bd2} \end{aligned}\right\} \tag{58}$$

The mass and energy rates of injection relative to the internal spray system are step-wise adjustable as a function of time:

$$\Gamma_{spi}(t) = 0 \qquad \text{for } t \leq \tau_{spi} \tag{59}$$

$$\left.\begin{aligned} &\Gamma_{spi}(t) = \Gamma_{spi,1} = \text{constant} \\ &T_{spi}(t) = T_{spi,1} = \text{constant} \end{aligned}\right\} \qquad \text{for } \tau_{spi} < t \leq \tau_{spi1} \tag{60}$$

....

$$\left.\begin{aligned} \Gamma_{spi}(t) &= \Gamma_{spi,n} = \text{constant} \\ T_{spi}(t) &= T_{spi,n} = \text{constant} \end{aligned}\right\} \quad \text{for } \tau_{spi,n-1} < t \leq \tau_{spi,n} \qquad (61)$$

The number of different values, n, of $\Gamma_{spi,n}$ and $T_{spi,n}$ that can be specified by the user may be at most 6.

4.4 Numerical Methods for the Digital Code

The methods of numerical solution for the various expressions, in particular for the energy balance (eq.1), for the Fourier equation for heat conduction (eq.20), and for the dose determination (eqs.(26) through (38))are briefly outlined in the following.

4.4.1 Solution of the Energy Balance

Equilibrium values of pressure and temperature of the atmosphere inside the containment building are computed at each time step by subroutine CONT.

The equation:

$$E_{tot}(t) = E^{\mathbf{x}}_{tot}(T_c) \qquad (62)$$

in which $E_{tot}(t)$ and $E^{\mathbf{x}}_{tot}(T_c)$ represent the left-hand and right-hand side of eq.(1), respectively, is solved by using the Newton method. The flow-chart of this part of subroutine CONT is shown in Fig.5 . The trial and error calculation stops if one of the following convergence tests is satisfied:

$$\frac{|E_{tot}(t) - E^{\mathbf{x}}_{tot}(T_c)|}{E_{tot}(t)} \leq 10^{-7} \qquad (63)$$

$$\frac{|\Delta T_c|}{T_c} \leq 5.10^{-4} \qquad (64)$$

where ΔT_c is the difference between two consecutive trial temperatures.

At each calculation step the quantities:

$$P_g = P_g(T_c), \quad H_{lg} = H_{lg}(T_c), \quad \rho_g = \rho_g\,(T_c)$$

are evaluated by linear interpolation in tables of saturated water and steam properties. The enthalpy, $H_1(T_c)$, of liquid water, is not given in the code in tabular form, because H_1 in kcal/kg may be assumed equal to T_c in ^oC in the range of interest (the error is less than 1%).

The following equation has been used to evaluate the density of water at saturation conditions:

$$\frac{1}{\rho_1} = v_1 = (9.85).10^{-4} + (5.9).10^{-7}.T_c \qquad (65)$$

with v_1 expressed in m^3/kg, and
T_c expressed in ^oC.

In order to save computer-time the assumption is made that the volume occupied by gas does not change during the trial and error calculation for one step, i.e., the new free volume is computed for each time step only after convergence for T_c has been reached. It was shown that the error introduced by this simplification is unappreciable.

4.4.2 Solution of the Fourier Equation for Heat Conduction

In order to determine the heat exchanged with structures inside the containment building as well as the heat exchanged with the outside atmosphere (eq. 20), the internal structure and the outside shell of the containment are treated, as said before, in slab geometry.

Each slab is subdivided in a number of layers, which, contrary to the case for the analog model, are chosen of equal thickness, Δx, for a particular slab. Quantities referring to an arbitrary layer n, are distinguished by means of the subscript n, where n covers the values 1 through n^* (n^* has, in general, a different value for each slab). The layer n=1 is always in contact with the inside atmosphere of the containment building, be it for internal or external slabs. The layer $n=n^*$ is, for the internal slabs, in contact with the adiabatic mid-plane, whereas for the external slabs it is in contact with the external atmosphere (or with the spray coolant in case of external spray).

For the numerical solution of the Fourier equation for heat conduction an implicit form was chosen in order to avoid stability problems.

The resulting finite difference system of equations, written here for the n^{th} layer of the i^{th} internal slab, is

$$T^{l+1}_{i,n} - T^{l}_{i,n} = \frac{\Delta t}{C_{i,n}} . \left[\theta . \left(\frac{T^{l+1}_{i,n+1} - T^{l+1}_{i,n}}{R_{i,n+1,n}} - \frac{T^{l+1}_{i,n} - T^{l+1}_{i,n-1}}{R_{i,n,n-1}} \right) + (1-\theta) . \left(\frac{T^{l}_{i,n+1} - T^{l}_{i,n}}{R_{i,n+1,n}} - \frac{T^{l}_{i,n} - T^{l}_{i,n-1}}{R_{i,n,n-1}} \right) \right] \qquad (66)$$

with

n = $n^{x}-1$, $n^{x}-2, \ldots, 2$;

l denotes the number of the time-step, having values 0,1,2,...;

Δt denotes the length of the time-step (equal for all steps);

θ represents a real quantity, comprised between 0,5 and 1.

In view of allowable truncation errors when using words of 32 bits, Δx and Δt have to be chosen such as to respect the following expression:

$$\frac{\theta . \Delta t}{R_{i,n+1,n} . C_{i,n}} \geqslant 10^{-6} \qquad (66a)$$

The boundary conditions for surfaces in contact with the internal atmosphere are given, for internal slabs, by:

$$\varphi^{l}_{i} = \frac{1}{R_{i,1,c}} . [\theta . (T^{l+1}_{i,1} - T^{l}_{c}) + (1-\theta) . (T^{l}_{i,1} - T^{l}_{c})] \qquad (67)$$

with

$$R_{i,1,c} = \frac{1}{2} . \frac{\Delta x}{k_i} + R_{i,ins,int} + \frac{1}{h_{i,c}} \qquad (68)$$

The heat transfer coefficient, $h_{i,c}$, between the surface and the internal atmosphere of the containment building can be either specified in input as a constant, or evaluated on the basis of the following correlation:

$$h^{l}_{i,c} = (19.31) . \bar{\rho}_c(t) . \sqrt[4]{T^{l}_{c} - T^{l}_{i,1}} \qquad (69)$$

with

$h^{l}_{i,c}$ expressed in $\frac{\text{kcal}}{\text{m}^2 . \text{hr} . {}^{\circ}\text{C}}$;

$\bar{\rho}_c$ expressed in Kg/m^3;

T_c^l and $T_{i,1}^l$ expressed in °C.

The value at time t of the density of the air-steam mixture, $\bar{\rho}_c(t)$, is given by:

$$\bar{\rho}_c(t) = \frac{M_a^o}{V(t)} + \rho_g(t) \tag{70}$$

For internal slabs the boundary condition for layer n^* is, of course, $\varphi_i^l = 0$ (as said before, layer n^* is in contact with the adiabatic mid-plane).

For external slabs, the same equations (67) through (70) are valid regarding the boundary conditions for surfaces in contact with the internal atmosphere; only one has to substitute the subscript i by j.

The boundary conditions for surfaces in contact with the external atmosphere are given, for external slabs only, by:

$$\varphi_j^l = \frac{1}{R_{j,ext,n^*}} \cdot \left[\theta.(T_{ext}^l - T_{j,n^*}^{l+1}) + (1-\theta).(T_{ext}^l - T_{j,n^*}^l)\right] \tag{71}$$

where

$$R_{j,ext,n} = \frac{1}{2} \cdot \frac{\Delta x}{k_j} + R_{j,ins,ext} + \frac{1}{h_{j,ext}} \tag{72}$$

The heat transfer coefficient, $h_{j,ext}$, between the external surface of the j^{th} external slab and the outside atmosphere is given by:

$$h_{j,ext}^l = C'_{ext} + C''_{ext} \cdot |T_{a,ext}^l - T_{j,n^*}^l| \tag{73}$$

for the case of air cooling,
or by:

$$h_{j,ext} = \text{constant} \tag{74}$$

for the case of cooling by means of the external spray system.

The above system of equations (eqs. (66), (67) and (71)) was solved by using the method described in [11] , chapter VI. This method was, amongst others, chosen because of its efficiency as regards computing time.

In programming the foregoing equations it was assumed that the thermal conductivity, the density, and the specific heat for each material of the slabs do not depend on spatial coordinate and temperature.

4.4.3 Solution of the Equations for Dose Determination

The equations of chapter 2, point 2.3, are valid also here.

The function $f_E(d,h)$ is evaluated by the subroutine DTAU, for each value of the distance, d, specified by the user, by computing the expression:

$$f(d,h,MC) = \frac{e^{-\frac{1}{2}\cdot\left[\frac{h}{\sigma_z(d,MC)}\right]^2}}{\pi.\left[\sigma_y(d,MC).\sigma_z(d,MC) + c.B\right]} \qquad (75)$$

for all metereological categories, specified to be considered for the site in question, and choosing the maximum value. The values for the height of release, h, the cross-sectional area of the containment building, B, and the factor c are input quantities (the code assumes c =0.5, unless otherwise specified by the user).

The functions $\sigma_y(d,MC)$ and $\sigma_z(d,MC)$ are incorporated in the code in tabular form, with 100 m $\leqslant$ d $\leqslant$ 100,000 m, and MC = A, B, C, D, E, F in accordance with [9].

The code computes on the basis of eqs. (26) through (38) the dose incurred to the thyroid by iodine inhalation versus time for the first distance, $d_1 \geqslant$ 100 m, specified by the user, and presents a graph of the results. For any other distance, $d_n > d_1$, the code computes and prints only the ratio $\frac{D(d_n)}{D(d_1)}$.

The curves of dose versus time for the various distances differ only by the above defined factors, as the time of transport of the iodine from the point of release to the point considered is not taken into account in the model used.

Values of the equilibrium (saturation) inventories per unit of reactor power of the various isotopes of iodine, q_{si}, of the relevant decay constants, λ_i, as well as of the factors η_i, are built-in constants.

The leak-rate, L(t), is determined on the basis of the function of leak-rate versus over-pressure (which is to be given as input in tabular form), using for the pressure in the containment building the values computed, at each time step, by subroutine CONT.

The function $F_p(t)$ is to be specified in input, and is either a constant F_p^o ($\neq 0$) or a function of time to be given in tabular form.

The function $F_b(t)$ is determined in accordance with eqs. (28) and (29), in which α, F_b^o, τ_{spi} and τ_b are to be supplied in input.

4.5 Computer Code Usage

4.5.1 Coding Language

The PREST code is written for the IBM 360/65 computer in FORTRAN IV language. The object deck, available at the CETIS Computation Center of Euratom, Ispra, Italy, was obtained from the source deck by means of the FORTRAN H Compiler using the optimization 2 option.

4.5.2 Input Data Sheets

In the following are presented the input data sheets, giving for each card its identification symbol, its format, the Fortran name of the quantities in question, as well as their definition and the units to be used.

Input Data Sheet 1

Card	Format	Fortran Name	Description	Units
TOO	(18A4)	TITLE	Any alphameric character string to identify the problem	-----
MOO	(10I5)	ISW1	Printing Parameter: if ISW1 =0 short output ≠0 full output	-----
		ISW2	Blowdown Parameter: if ISW2 =0 no blowdown ≠0 blowdown occurs	-----
		ISW3	Decay Heat Parameter:if ISW3 =0 no decay heat addition ≠0 decay heat is considered	-----
		ISW4	Dose Calculation Parameter: if ISW4 =0 no dose calculation ≠0 dose calculation is performed	-----
		ISW5	Internal Spray Parameter: if ISW5 =0 no internal spray ≠0 internal spray is considered	-----
		ISW6	External Spray Parameter: if ISW6 =0 no external spray ≠0 external spray is considered	-----
		ISW7	Chemical Heat Parameter: if ISW7 =0 no chemical heat addition ≠0 chemical heat is considered	-----
		ISW8	Nuclear Heat Parameter: if ISW8 =0 no nuclear heat addition ≠0 nuclear heat is considered	-----
		IPLOT	Plotting Parameter: if IPLOT =0 no plotting ≠0 results are plotted by means of Calcomp device	-----
		IPRCY	Printing Control Parameter: if IPRCY =0 results are printed at each time step ≠0 results are printed after every IPRCY time steps	-----

Input Data Sheet 2

M01	(3I10,3F10.0)	NIHC	Number of internal slabs ($\leqslant 4$)	-----
		NEHC	Number of external slabs ($\leqslant 2$)	-----
		MAXTHE	Maximum number of time steps	-----
		DTHETA	Time step value	hr
		THETA	Initial value of time for the run	hr
		DOSE	Initial value of dose for the run	REM
M02	(7E10.0)	VCO	Free volume of the containment building at time t=THETA	m^3
		MWO	Mass of water (liquid+vapour phase) present in the containment building at time t=THETA. If MWO=0 in input, the program computes the amount of water needed to saturate the air contained in the free volume of the containment building and sets MWO to this value	kg
		ETO	Total energy of the air-steam-water mixture in the containment building at time t=THETA. ETO is computed by the program if MWO is set to zero in input	Kcal
		PCO	Value of total absolute pressure in the containment building at time t=THETA	Kg_f/cm^2
		TCO	Temperature in the free volume of containment building at time t=THETA	^oC
		POWER	Nominal reactor power	Mw
CH01	2(E10.0)	ECHEM	Total energy of chemical origin introduced into the free volume of the containment building	Kcal
		TCHEM	Time constant for the release of energy of chemical origin	hr

Input Data Sheet 3

NU01	2(E10.0)	ENUCL	Total energy of nuclear origin introduced into the free volume of the containment building	Kcal
		TNUCL	Time constant for the release of energy of nuclear origin	hr
SP01	(E10.0, I10, 5E10.0)	TAUSPI	Value of time at which the internal spray system enters in operation, τ_{spi}	hr
		NTM	Number of different operating conditions of the internal spray system; $NTM \leqslant 6$	-----
		TTSP(I)	(I=1,NTM) values of time at which the operating conditions of internal spray system are changed	hr
SP02	(6E10.0)	XMAS(I)	(I=1,NTM) values of mass flow rate for the different operating conditions of the internal spray system	kg/hr
SP03	(6E10.0)	XENR(I)	(I=1,NTM) values of water temperature at nozzles outlet corresponding to the different operating conditions of internal spray system	^{o}C
I01	(5E10.0, 2I5)	S	Surface area of one face of a slab	m^2
		XL	Thickness of a half-slab	m
		XK	Thermal conductivity of slab material	$Kcal/m.hr.^{o}C$
		CP	Specific heat of slab material	$Kcal/Kg.^{o}C$
		RO	Density of slab material	Kg/m^3
		NI	Number of layers of equal thickness in which a half-slab is subdivided	-----
		NF	Control parameter for the calculation of the heat transfer coefficient between a slab and the inside atmosphere. If NF=0 the heat transfer coefficient is assumed constant and equal to CS If $NF \neq 0$ the heat transfer coefficient is evaluated according to equation (69)	-----

Input Data Sheet 4

I02	(2E10.0)	CS	Value of the heat transfer coefficient to be specified only if NF=0 in card I01	Kcal/m^2.hr.$^\circ$C
		RINS	Thermal resistance of thermal insulation or protective paint, per unit surface area	$\frac{m^2.hr.^\circ C}{Kcal}$
I03	(7E10.0)	T(I)	Mean temperature of a layer of an internal slab. NI values of T have to be supplied in a sequence starting from the adiabatic mid-plane of the slab	$^\circ$C
E01	(5E10.0, 3I5)	S	Surface area of one face of a slab	m^2
		XL	Thickness of external slab	m
		XK	Thermal conductivity of slab material	Kcal/m.hr.$^\circ$C
		CP	Specific heat of slab material	Kcal/Kg.$^\circ$C
		RO	Density of slab material	Kg/m^3
		NI	Number of layers of equal thickness in which an external slab is subdivided	-----
		NF	Control parameter for the calculation of the heat transfer coefficient between a slab and the inside atmosphere If NF=0 the heat transfer coefficient is assumed constant and equal to CS. If NF≠0 the heat transfer coefficient is evaluated according to equation (69)	-----
		NA	Control parameter for the calculation of the heat transfer coefficient between a slab and the external atmosphere, or water of the external spray system NA=0 the external surface is assumed adiabatic NA≠0 the heat transfer coefficient is evaluated by means of equation (73) until the moment the external spray system enters in operation, after which the heat transfer coefficient is taken constant and equal to CX	-----

Input Data Sheet 5

E02	(6E10.0)	CS	Value of the heat transfer coefficient to be specified only if NF=0 in card E01	Kcal/m^2.hr.$^\circ$C
		CX1	Constant C'_{ext} of equation (73)	Kcal/m^2.hr.$^\circ$C
		CX2	Constant C''_{ext} of equation (73)	Kcal/m^2.hr.$^\circ$C
		TA	Temperature of air outside the containment building	$^\circ$C
		RINSI	Thermal resistance of the thermal insulation or protective paint, per unit surface area, on internal face of external slab	m^2.hr.$^\circ$C/Kcal
		RINSE	Thermal resistance of the thermal insulation or protective paint, per unit surface area, on external face of external slab	m^2.hr.$^\circ$C/Kcal
E03	4E10.0)	TAQ	Temperature of the cooling medium of the external spray system at the outlet of the nozzles, to be specified only if ISW6$\neq$0	$^\circ$C
		GAM	Mass flow rate of the external spray system, to be specified only if ISW6$\neq$0	Kg/hr
		TAUSPE	Value of τ_{spe}, to be specified only if ISW6$\neq$0	hr
		CX	Value of the heat transfer coefficient between the external slab and the cooling medium of the external spray system	Kcal/m^2.hr.$^\circ$C
E04	(7E10.0)	T(I)	Mean temperature of a layer of an external slab. NI values of T have to be supplied in a sequence starting from the external surface of the slab	$^\circ$C
C01	(3I5)	LASST	Lowest index to be used for interpolation in steam tables. It may be specified larger than 1 to save machine time	-----
		MASST	Highest index to be used for interpolation in steam tables. It may be specified smaller than NASST to save machine time	-----
		NASST	Number of points of steam tables to be given in input ($\leq$ 150)	-----

Input Data Sheet 6

C02	(4E12.0)	TSAT(I)	Saturation temperature	^{o}C
		PSAT(I)	Saturation pressure	Kg_f/cm^2
		RHOG(I)	Density of saturated vapour	Kg/m^3
		HLG(I)	Specific heat of evaporation	Kcal/Kg
C03	(2E10)	MAO	Mass of air in the free volume of the containment building	Kg
		CVAIR	Specific heat of air at constant volume	$Kcal/Kg.^{o}C$
D01	(7E10.0)	FBO	Value of F_b^o in equations (28) and (29); FBO is assumed equal to 0.5 if not specified in input	-----
		ALFA	Value of α in equations (28) and (29)	-----
		TAUB	Time constant for the removal of radioactive iodine from the internal atmosphere of the containment building, eq.(29), to be specified only if $ISW5\neq 0$	hr
		FPO	Fraction of the total inventory of the iodine in the fuel which is released from the primary cooling system into the free volume of the containment building. If FPO is not specified here, a table of $F_p=F(t)$ must be supplied (see cards D07, D08)	-----
		UAVG	Mean wind velocity	m/hr
		HEIGHT	Height of radioactive source above the ground	m
		C	Fraction of cross-sectional area of the containment building which is taken into account for the "shadow" effect"	-----
D02	(2E10.0)	BAREA	Cross-sectional area of the containment building in cross-wind direction	m^2
		BRATE	Breathing rate of a standard adult man	m^3/hr
D03	(4I5)	NMC	Number of meteorological categories to be considered for the site of interest (≤ 6)	-----

Input Data Sheet 7

		ND	Number of distances in downwind direction from the radioactive source for which the dose calculation has to be performed, ($\leqslant$ 10)	-----
		NL	Number of points of table giving leakage versus relative pressure ($\leqslant$ 22)	-----
		NP	Number of points of table giving F_p versus time, ($\leqslant$ 20). NP has to be specified only if FPO in card D01 is zero	-----
D04	(7E10.0)	D(I)	Distances in downwind direction from the radioactive source for which dose has to be calculated. ND values must be specified	m
D05	(7E10.0)	PREL(I)	Table giving values of interest for the relative pressure. NL values of PREL are to be supplied. (NL $\leqslant$ 22) in increasing order.	Kg_f/cm^2
D06	(7E10.0)	ALK(I)	Table giving values of leakage versus relative pressure. NL values of ALK have to be supplied	hr^{-1}
D07	(7E10.0)	TIME(I)	Table giving values of time of interest for $F_p(t)$ table. NP values of TIME must be supplied in increasing order	hr
D08	(7E10.0)	FPT(I)	Table of values of $F_p(t)$ versus time. NP values of FPT must be supplied.	-----
Y01	(I10)	NDC	Number of points of table giving decay heat versus time ($\leqslant$ 60)	-----
Y02	(7E10.0)	TDC(I)	Table of values of interest of time after shutdown. NDC values of TDC have to be supplied in increasing order	hr
Y03	(7E10.0)	EDC(I)	Table of values of fission products decay power expressed in per cent of the nominal reactor power. NDC values of EDC have to be supplied	-----

Input Data Sheet 8

B01	(5E10.0)	TAUB1	Coefficient of equation (57)	hr
		KBD(1)	Coefficient of equation (57)	Kg/hr
		KBD(2)	Coefficient of equation (57)	Kg/hr^2
		KBD(3)	Coefficient of equation (57)	Kg/hr^3
		KBD(4)	Time constant relative to the injection of blowdown water, eq. (57)	hr
B02	(5E10.0)	TAUB2	Coefficient of equation (58)	hr
		CBD(1)	Coefficient of equation (58)	Kcal/kg
		CBD(2)	Coefficient of equation (58)	Kcal/Kg.hr
		CBD(3)	Coefficient of equation (58)	Kcal/Kg
		CBD(4)	Time constant relative to the energy of blowdown water, eq. (58)	hr

In order to facilitate the preparation of the input data required by the program PREST, some additional information is given in the following.

All the data have to be supplied in the order specified by the preceding input sheets and must be punched on standard IBM-Cards in columns 1 through 72 in accordance with the format specifications given for each card.

All data are given in the form of floating point or fixed point numbers, except for TITLE in card T00, which is alphabetic.

For further clarification of the usage of the code the following observations are made:

1)- Card T00 is the first card and must always be present. It is recommended to leave the first column blank. All other columns may contain any alphameric information which will be printed on the output to identify the problem and will appear also on the plot of the results.

2)- Cards M00, M01 and M02 must always be present. If the total transient is computed by means of a number of subsequent runs, the quantities THETA, DOSE (on card M01), MW0, ET0, PC0, TC0 (on card M02) have to be taken, for the runs other than the first, equal to their values printed in output at the end of the previous run.

3)- Card CH01 is present only if ISW7≠0 on card M00

4)- Card NU01 is present only if ISW8≠0 on card M00

5)- Cards SP01, SP02 and SP03 are present only if ISW5≠0 on card M00

6)- The set of cards I01, I02 and I03 has to be supplied a number of times equal to NIHC (on card M01), each set specifying the input data for a different internal slab. In each set as many cards I03 have to be supplied as are needed to specify the temperatures of all the layers in a half-slab. For the runs other than the first, the initial temperature distribution has to be taken equal to that found at the end of the previous run. Obviously the entire set has to be suppressed if NIHC=0.

7)- The set of cards E01, E02, E03, and E04 has to be supplied a number of times equal to NEHC (on card M01), each set specifying the input data for a different external slab. In each set as many cards E04 have to be supplied as are needed to specify the temperatures of all the layers in an external slab. For the runs other than the first, the initial temperature distribution has to be taken equal to that found at the end of the previous run. Card E03 has to be supplied only in case that ISW6≠0.

8)- The set of cards C01, C02 and C03 is always present. A number equal to NASST (on card C01) of cards of type C02 have to be supplied. The values of the saturation temperature TSAT must be supplied in increasing order. The values of CVAIR and MAO, on card C03, are used by the program to evaluate the energy of the air initially present in the free volume of the containment building.

9)- Cards D01, D02, D03, D04, D05, D07, D08 are present only if ISW4≠0 on card M00. In addition, cards D07, D08 have to be supplied only if FP0 is not specified on card D01. Each of the cards D04, D05, D06, D07, and D08 may be repeated, if necessary, in order to accomodate all input data.

10)- Cards Y01, Y02, Y03 are present only if ISW3≠0 on card M00. As many cards of type Y02 and Y03 have to be supplied as are needed to specify NDC values of TDC and EDC, respectively.

11)- Cards B01, B02 are present only if ISW2≠0 on card M00.

4.5.3 Code Output

The printed output of the code may be specified by means of parameter ISW1 in two different ways:

- full output, giving a complete printing of all input data as well as a complete printing of the computed values of all the various quantities;
- short output, giving a complete printing of all input data as well as a printing of the computed values of the most important quantities (i.e., $P_{c,abs}(t)$, $T_c(t)$, $P_g(t)$, $D_{tot}(t)$, $M_{spi}(t)$) for each specified number of time-steps. In addition a full output is given for the last time-step.

The parameter IPRCY (on card M00) is used to specify the number of time-steps between each printing both for the full and short output.

```
        COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=50,SOURCE,BCD,NOLIST,DECK,LOAD,MAP,NOEDIT,NOID
                   CPREST                                                                  PRES   0
                   C                                                                       PRES  10
                   C          * * *  P R E S T  * * *                                      PRES  20
                   C                                                                       PRES  30
                   C      A DIGITAL CODE FOR CONTAINMENT STUDIES                           PRES  40
                   C      (DETERMINING PRESSURE TRANSIENTS AND RADIATION DOSES DUE TO IODINE PRES  50
                   C      INHALATION, FOLLOWING A LOSS-OF-COOLANT ACCIDENT)                PRES  60
                   C                                                                       PRES  70
                   C      * * CONTROL PARAMETERS * *                                       PRES  80
                   C                                                                       PRES  90
                   C      ISW1    = PRINTING PARAMETER                                     PRES 100
                   C      ISW2    = BLOWDOWN PARAMETER                                     PRES 110
                   C      ISW3    = DECAY HEAT PARAMETER                                   PRES 120
                   C      ISW4    = DOSE CALCULATION PARAMETER                             PRES 130
                   C      ISW5    = INTERNAL SPRAY PARAMETER                               PRES 140
                   C      ISW6    = EXTERNAL SPRAY PARAMETER                               PRES 150
                   C      ISW7    = CHEMICAL HEAT PARAMETER                                PRES 160
                   C      ISW8    = NUCLEAR HEAT PARAMETER                                 PRES 170
                   C      IPLOT   = PLOTTING PARAMETER                                     PRES 180
                   C      IPRCY   = PRINTING CONTROL PARAMETER                             PRES 190
                   C                                                                       PRES 200
                   C      * * PROBLEM DATA * *                                             PRES 210
                   C                                                                       PRES 220
                   C      NIHC    = NUMBER OF INTERNAL SLABS                               PRES 230
                   C      NEHC    = NUMBER OF EXTERNAL SLABS                               PRES 240
                   C      MAXTHE  = MAXIMUM NUMBER OF TIME STEPS                           PRES 250
                   C      DTHETA  = TIME STEP VALUE (HR)                                   PRES 260
                   C      THETA   = INITIAL VALUE OF TIME FOR THE RUN (HR)                 PRES 270
                   C      DOSE    = INITIAL VALUE OF DOSE FOR THE RUN (REM)                PRES 280
                   C      VCO     = FREE VOLUME OF CONTAINMENT BUILDING AT TIME THETA (M**3)  PRES 290
                   C      MWO     = TOTAL MASS OF WATER IN THE CONTAINMENT BUILDING        PRES 300
                   C                AT TIME THETA (KG)                                     PRES 310
                   C      ETO     = TOTAL ENERGY OF THE AIR-STEAM-WATER MIXTURE IN THE FREE  PRES 320
                   C                VOLUME OF THE CONTAINMENT BUILDING AT TIME THETA (KCAL)  PRES 330
                   C      PCO     = ABSOLUTE VALUE OF THE TOTAL PRESSURE IN THE CONTAINMENT  PRES 340
                   C                BUILDING AT TIME THETA (KG/CM**2)                      PRES 350
                   C      TCO     = TEMPERATURE OF ATMOSPHERE IN THE CONTAINMENT BUILDING  PRES 360
                   C                AT TIME THETA (C)                                      PRES 370
                   C      POWER   = NOMINAL REACTOR POWER (MW)                             PRES 380
                   C      TAUSPI  = INTERNAL SPRAY STARTING TIME (HR)                      PRES 390
                   C      ECHEM,TCHEM = COEFFICIENTS IN THE EQ.8                           PRES 400
                   C      ENUCL,TNUCL = COEFFICIENTS IN THE EQ.6                           PRES 410
                   C                                                                       PRES 420
                   C                                                                       PRES 430
      ISN 0002            DIMENSION FI(10),AI(10),FE(6),AE(6),XMAS(6),XENR(6),TTSP(6)      PRES 440
      ISN 0003            DIMENSION X(600),Y(1800)                                         PRES 450
      ISN 0004            REAL MWO,MWG,MWL,MW,MAO                                          PRES 460
      ISN 0005            DIMENSION GABEL(7),TITLE(18)                                     PRES 470
      ISN 0006            EQUIVALENCE (MWO,MW),(ETO,ET),(PCO,PC)                           PRES 480
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ISN 0007            COMMON /    /THETA,THETAP,THETAR,DTHETA,NTHETA,VCO,PCO,TCO,MWO,ETO  PRES 490
                   *,FTV,PG,MWL,MWG,MAO,CVAIR                                           PRES 500
ISN 0008            COMMON /SLAB/TC,RHO,HEATF,HEATA                                     PRES 510
ISN 0009            COMMON/CONTRL/LEX2,IENRY,IPRCY,KTR2,ISW1,ISW2,ISW3,ISW4,ISW5,ISW6   PRES 520
ISN 0010            COMMON/TAU/XMA,TAUSPI,TTHEX,DOSE                                    PRES 530
ISN 0011            DATA GABEL /4HPRES,4HSURE,4H,TEM,4HPERA,4HTURE,4H,DOS,4HE   /       PRES 540
ISN 0012            DATA FI /10*0.0/,FE/6*0.0/,AE/6*0.0/                                PRES 550
              C                                                                         PRES 560
ISN 0013            SUMFI=-0.0                                                          PRES 570
ISN 0014            SUMFE=-0.0                                                          PRES 580
ISN 0015            SUMAE=-0.0                                                          PRES 590
ISN 0016            HNUCL=-0.0                                                          PRES 600
ISN 0017            HCHEM=-0.0                                                          PRES 610
ISN 0018            HCM=-0.0                                                            PRES 620
ISN 0019            HNC=-0.0                                                            PRES 630
ISN 0020            XMA=-0.0                                                            PRES 640
ISN 0021            XEA=-0.0                                                            PRES 650
ISN 0022            DOSE=0.0                                                            PRES 660
ISN 0023            HP=0.0                                                              PRES 670
ISN 0024            HPP=-0.0                                                            PRES 680
ISN 0025            WMR=0.0                                                             PRES 690
ISN 0026            WHR=0.0                                                             PRES 700
ISN 0027            HWAT=-0.0                                                           PRES 710
ISN 0028            PDWR=-0.0                                                           PRES 720
              C                                                                         PRES 730
ISN 0029            READ (5,99) (TITLE(I),I=1,18)                                       PRES 740
ISN 0030            READ (5,1005) ISW1,ISW2,ISW3,ISW4,ISW5,ISW6,ISW7,ISW8,IPLOT,IPRCY   PRES 750
ISN 0031            READ (5,1000) NIHC,NEHC,MAXTHE,DTHETA,THETA,DOSE                    PRES 760
ISN 0032            READ (5,1001) VCO,MWO,ETO,PCO,TCO,POWER                             PRES 770
ISN 0033            TC=TCO                                                              PRES 780
ISN 0034            IF(ISW7.NE.0) READ (5,1001) ECHEM,TCHEM                             PRES 790
ISN 0036            IF(ISW8.NE.0) READ (5,1001) ENUCL,TNUCL                             PRES 800
ISN 0038            IF(ISW5.EQ.0) GO TO 10                                              PRES 810
ISN 0040            READ (5,1002) TAUSPI,NTM,(TTSP(I),I=1,NTM)                          PRES 820
ISN 0041            READ (5,1001) (XMAS(I),I=1,NTM)                                     PRES 830
ISN 0042            READ (5,1001) (XENR(I),I=1,NTM)                                     PRES 840
ISN 0043         10 CONTINUE                                                            PRES 850
              C                                                                         PRES 860
ISN 0044            IF(IPLOT)30,20,30                                                   PRES 870
ISN 0045         30 NG=MAXTHE/600+1                                                     PRES 880
ISN 0046            IPLOT=MAXTHE/NG+1                                                   PRES 890
ISN 0047            IP=1                                                                PRES 900
ISN 0048            IR=NG                                                               PRES 910
ISN 0049            NGRF=2                                                              PRES 920
              C                                                                         PRES 930
ISN 0050         20 CONTINUE                                                            PRES 940
ISN 0051            NTHETA=1                                                            PRES 950
ISN 0052            IRIT=1                                                              PRES 960
ISN 0053            LINES=0                                                             PRES 970
              C                                                                         PRES 980
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ISN 0054              IENRY=1                                                          PRES 990
ISN 0055              LEX2=1                                                           PRES1000
             C                                                                         PRES1010
ISN 0056              KTR2=IPRCY                                                       PRES1020
ISN 0057              JJ=1                                                             PRES1030
ISN 0058              THETAP=THETA+DTHETA                                              PRES1040
ISN 0059              THETAR=THETA+DTHETA/2.0                                          PRES1050
             C                                                                         PRES1060
ISN 0060              WRITE (6,88) (TITLE(I),I=1,18)                                   PRES1070
ISN 0061              WRITE (6,84) ISW1,ISW2,ISW3,ISW4,ISW5,ISW6,ISW7,ISW8,IPLOT       PRES1080
ISN 0062              WRITE (6,87) NIHC,NEHC,MAXTHE,THETA,DTHETA,DOSE                  PRES1090
             C                                                                         PRES1100
ISN 0063              IF(NIHC)8000,8000,7000                                           PRES1110
ISN 0064         7000 DO 2001 I=1,NIHC                                                 PRES1120
ISN 0065              GO TO(1,2,3,4,5,6),I                                             PRES1130
ISN 0066            1 CALL ISLB1                                                       PRES1140
ISN 0067              GO TO 2001                                                       PRES1150
ISN 0068            2 CALL ISLB2                                                       PRES1160
ISN 0069              GO TO 2001                                                       PRES1170
ISN 0070            3 CALL ISLB3                                                       PRES1180
ISN 0071              GO TO 2001                                                       PRES1190
ISN 0072            4 CALL ISLB4                                                       PRES1200
ISN 0073              GO TO 2001                                                       PRES1210
ISN 0074            5 CALL ISLB5                                                       PRES1220
ISN 0075              GO TO 2001                                                       PRES1230
ISN 0076            6 CALL ISLB6                                                       PRES1240
ISN 0077         2001 CONTINUE                                                         PRES1250
             C                                                                         PRES1260
ISN 0078         8000 IF(NEHC)8010,8010,7010                                           PRES1270
ISN 0079         7010 DO 2010 I=1,NEHC                                                 PRES1280
ISN 0080              GO TO (101,102,103,104),I                                        PRES1290
ISN 0081          101 CALL ESLB1                                                       PRES1300
ISN 0082              GO TO 2010                                                       PRES1310
ISN 0083          102 CALL ESLB2                                                       PRES1320
ISN 0084              GO TO 2010                                                       PRES1330
ISN 0085          103 CALL ESLB3                                                       PRES1340
ISN 0086              GO TO 2010                                                       PRES1350
ISN 0087          104 CALL ESLB4                                                       PRES1360
ISN 0088         2010 CONTINUE                                                         PRES1370
             C                                                                         PRES1380
ISN 0089         8010 CALL CONT                                                        PRES1390
ISN 0090              IF(ISW4.EQ.0) GO TO 2222                                         PRES1400
ISN 0092              NGRF=3                                                           PRES1410
ISN 0093              CALL DTAU (POWER,+70)                                            PRES1420
ISN 0094         2222 CONTINUE                                                         PRES1430
             C                                                                         PRES1440
ISN 0095              IF(ISW3.EQ.0) GO TO 3333                                         PRES1450
ISN 0097              CALL DECAY (HP,POWER,+70)                                        PRES1460
ISN 0098         3333 CONTINUE                                                         PRES1470
             C                                                                         PRES1480
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ISN 0099              WRITE (6,83)                                                            PRES1490
ISN 0100              WRITE (6,86) VCO,MWO,ETO,PCO,TCO,POWER,MAO                              PRES1500
ISN 0101              IF(ISW7.NE.0) WRITE (6,91) ECHEM,TCHEM                                  PRES1510
ISN 0103              IF(ISW8.NE.0) WRITE (6,92) ENUCL,TNUCL                                  PRES1520
                C                                                                             PRES1530
ISN 0105              IF (ISW2.NE.0) CALL BLWDWN(WMR,WHR)                                     PRES1540
                C                                                                             PRES1550
ISN 0107              IENRY=2                                                                 PRES1560
                C                                                                             PRES1570
ISN 0108              IF(ISW5.EQ.0) GO TO 3500                                                PRES1580
ISN 0110              TTHEX=TTSP(NTM)                                                         PRES1590
ISN 0111              WRITE (6,81) TAUSPI,TTSP(1),XMAS(1),XENR(1)                             PRES1600
ISN 0112              IF(NTM.LT.2) GO TO 3500                                                 PRES1610
ISN 0114              WRITE (6,80) (TTSP(I-1),TTSP(I),XMAS(I),XENR(I),I=2,NTM)                PRES1620
                C                                                                             PRES1630
ISN 0115          3500 CONTINUE                                                               PRES1640
ISN 0116              IF(ISW1.EQ.0)GO TO 3000                                                 PRES1650
ISN 0118              WRITE (6,85)                                                            PRES1660
ISN 0119              IRIT = 2                                                                PRES1670
ISN 0120          3000 CALL CONT                                                              PRES1680
                C                                                                             PRES1690
ISN 0121              IF(NIHC)8020,8020,7020                                                  PRES1700
ISN 0122          7020 DO 2020 I=1,NIHC                                                       PRES1710
ISN 0123              GO TO (301,302,303,304,305,306),I                                       PRES1720
ISN 0124           301 CALL ISLB1                                                             PRES1730
ISN 0125              GO TO 2028                                                              PRES1740
ISN 0126           302 CALL ISLB2                                                             PRES1750
ISN 0127              GO TO 2028                                                              PRES1760
ISN 0128           303 CALL ISLB3                                                             PRES1770
ISN 0129              GO TO 2028                                                              PRES1780
ISN 0130           304 CALL ISLB4                                                             PRES1790
ISN 0131              GO TO 2028                                                              PRES1800
ISN 0132           305 CALL ISLB5                                                             PRES1810
ISN 0133              GO TO 2028                                                              PRES1820
ISN 0134           306 CALL ISLB6                                                             PRES1830
ISN 0135          2028 FI(I)=FI(I)+HEATF                                                      PRES1840
ISN 0136              SUMFI=SUMFI+HEATF                                                       PRES1850
ISN 0137          2020 CONTINUE                                                               PRES1860
                C                                                                             PRES1870
ISN 0138          8020 IF(NEHC)8030,8030,7030                                                 PRES1880
ISN 0139          7030 DO 2030 I=1,NEHC                                                       PRES1890
ISN 0140              GO TO (401,402,403,404),I                                               PRES1900
ISN 0141           401 CALL ESLB1                                                             PRES1910
ISN 0142              GO TO 2004                                                              PRES1920
ISN 0143           402 CALL ESLB2                                                             PRES1930
ISN 0144              GO TO 2004                                                              PRES1940
ISN 0145           403 CALL ESLB3                                                             PRES1950
ISN 0146              GO TO 2004                                                              PRES1960
ISN 0147           404 CALL ESLB4                                                             PRES1970
ISN 0148          2004 SUMFE=SUMFE+HEATF                                                      PRES1980
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ISN 0149              SUMAE=SUMAE+HEATA                                                        PRES1990
ISN 0150              FE(I)=FE(I)+HEATF                                                        PRES2000
ISN 0151              AE(I)=AE(I)+HEATA                                                        PRES2010
ISN 0152        2030  CONTINUE                                                                 PRES2020
ISN 0153        8030  CONTINUE                                                                 PRES2030
ISN 0154              ET = ET+SUMFI+SUMFE                                                      PRES2040
              C                                                                                PRES2050
              C       PRINT OUTPUT QUANTITIES                                                  PRES2060
              C                                                                                PRES2070
ISN 0155              IF(IPRCY.EQ.0.OR.NTHETA.EQ.1) GO TO 2100                                 PRES2080
ISN 0157              IF(NTHETA.NE.KTR2) GO TO 2301                                            PRES2090
ISN 0159              KTR2 = KTR2+IPRCY                                                        PRES2100
ISN 0160        2100  CONTINUE                                                                 PRES2110
ISN 0161              IF(ISW1.NE.0)GO TO 2101                                                  PRES2120
ISN 0163              IF(LINES.EQ.0) WRITE (6,93)                                              PRES2130
ISN 0165              LINES=LINES+1                                                            PRES2140
ISN 0166              IF(LINES.LT.50)GO TO 2102                                                PRES2150
ISN 0168              LINES=0                                                                  PRES2160
ISN 0169        2102  WRITE (6,94) THETAP,PG,PC,TC,DOSE,XMA                                    PRES2170
ISN 0170              GO TO 2301                                                               PRES2180
ISN 0171        2101  CONTINUE                                                                 PRES2190
ISN 0172              WRITE (6,900)                                                            PRES2200
ISN 0173              NP1=MIN0(NIHC,NEHC)                                                      PRES2210
ISN 0174              NP2=MAX0(NIHC,NEHC)                                                      PRES2220
ISN 0175              IF(NP1.EQ.0)GO TO 503                                                    PRES2230
ISN 0177              WRITE (6,901) (N,FI(N),FE(N),AE(N),N=1,NP1)                              PRES2240
ISN 0178              IF(NP1.EQ.NP2)GO TO 501                                                  PRES2250
ISN 0180              IF(NP1.EQ.NEHC)GO TO 502                                                 PRES2260
ISN 0182         504  NP1=NP1+1                                                                PRES2270
ISN 0183              WRITE (6,902) (N,FE(N),AE(N),N=NP1,NP2)                                  PRES2280
ISN 0184              GO TO 501                                                                PRES2290
ISN 0185         503  IF(NIHC.EQ.0) GO TO 504                                                  PRES2300
ISN 0187         502  NP1=NP1+1                                                                PRES2310
ISN 0188              WRITE (6,903) (N,FI(N),N=NP1,NP2)                                        PRES2320
ISN 0189         501  CONTINUE                                                                 PRES2330
ISN 0190              WRITE (6,904)                                                            PRES2340
ISN 0191              WRITE (6,905) PC,TC,DOSE,FTV,RHO,PG                                      PRES2350
ISN 0192              WRITE (6,907) MW,MWG,MWL,PDWR,XMA                                        PRES2360
ISN 0193              WRITE (6,908) ET,HPP,HCM,HNC,HWAT,XEA                                    PRES2370
ISN 0194              WRITE (6,906) NTHETA,THETAP                                              PRES2380
ISN 0195              IRIT = 1                                                                 PRES2390
ISN 0196        2301  CONTINUE                                                                 PRES2400
              C                                                                                PRES2410
              C       SET UP DATA FOR PLOTTING IF DESIRED                                      PRES2420
              C                                                                                PRES2430
ISN 0197              IF(IPLOT)50,60,50                                                        PRES2440
ISN 0198          50  IF(NTHETA-1)51,52,51                                                     PRES2450
ISN 0199          51  IF(NTHETA-IR)60,53,60                                                    PRES2460
ISN 0200          53  IR=IR+NG                                                                 PRES2470
ISN 0201          52  X(IP)=THETA                                                              PRES2480
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ISN 0202            Y(IP) = TC                                                              PRES2490
ISN 0203            Y(IP+600) = PC*100                                                      PRES2500
ISN 0204            IF(NGRF.EQ.2) GO TO 2220                                                PRES2510
ISN 0206            Y(IP+1200)=DOSE*10.0                                                    PRES2520
ISN 0207       2220 CONTINUE                                                                PRES2530
ISN 0208            IP=IP+1                                                                 PRES2540
              C                                                                             PRES2550
ISN 0209         60 NTHETA=NTHETA+1                                                         PRES2560
ISN 0210            IF(NTHETA.GT.MAXTHE)GO TO 999                                           PRES2570
ISN 0212            ISW1=ISW1+NTHETA/MAXTHE                                                 PRES2580
ISN 0213            THETA=THETA+DTHETA                                                      PRES2590
ISN 0214            THETAP=THETAP+DTHETA                                                    PRES2600
ISN 0215            THETAR=THETAR+DTHETA                                                    PRES2610
              C                                                                             PRES2620
              C     COMPUTES MASS AND ENERGY OF WATER INJECTED BY THE INTERNAL              PRES2630
              C     SPRAY SYSTEM                                                            PRES2640
              C                                                                             PRES2650
ISN 0216            IF(ISW5)2014,4005,2014                                                  PRES2660
ISN 0217       2014 IF(THETAR-TTHEX)2015,4002,4005                                          PRES2670
ISN 0218       2015 IF(THETAR.LT.TAUSPI) GO TO 4005                                         PRES2680
ISN 0220       4002 IF(THETAR.GT.TTSP(JJ)) JJ=JJ+1                                          PRES2690
ISN 0222            XMAA=XMAS(JJ)*DTHETA                                                    PRES2700
ISN 0223            XEAA = XENR(JJ)*XMAA                                                    PRES2710
ISN 0224            XMA=XMA+XMAA                                                            PRES2720
ISN 0225            XEA=XEA+XEAA                                                            PRES2730
ISN 0226            MW =MW+XMAA                                                             PRES2740
ISN 0227            ET =ET+XEAA                                                             PRES2750
ISN 0228       4005 CONTINUE                                                                PRES2760
              C                                                                             PRES2770
              C     COMPUTES FISSION PRODUCTS DECAY ENERGY                                  PRES2780
              C                                                                             PRES2790
ISN 0229            IF(ISW3.EQ.0) GO TO 4444                                                PRES2800
ISN 0231            CALL DECAY (HP,POWER,+70)                                               PRES2810
ISN 0232            HPP=HPP+HP                                                              PRES2820
ISN 0233            ET = ET+HP                                                              PRES2830
ISN 0234       4444 CONTINUE                                                                PRES2840
              C                                                                             PRES2850
              C     COMPUTES MASS AND ENERGY OF WATER INJECTED DURING BLOWDOWN              PRES2860
              C                                                                             PRES2870
ISN 0235            IF(ISW2.EQ.0) GO TO 5555                                                PRES2880
ISN 0237            CALL BLWDWN(WMR,WHR)                                                    PRES2890
ISN 0238            PDWR=PDWR+WMR                                                           PRES2900
ISN 0239            HWAT=HWAT+WHR                                                           PRES2910
ISN 0240            MW = MW+WMR                                                             PRES2920
ISN 0241            ET = ET+WHR                                                             PRES2930
ISN 0242       5555 CONTINUE                                                                PRES2940
              C                                                                             PRES2950
              C     CHEMICAL HEAT CALCULATION                                               PRES2960
              C                                                                             PRES2970
ISN 0243            IF(ISW7.EQ.0)GO TO 4006                                                 PRES2980
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ISN 0245          HCM = ECHEM/TCHEM*EXP(-THETAR/TCHEM)*DTHETA                       PRES2990
ISN 0246          HCHEM=HCHEM+HCM                                                   PRES3000
ISN 0247          ET = ET+HCM                                                       PRES3010
ISN 0248     4006 CONTINUE                                                          PRES3020
            C                                                                       PRES3030
            C     COMPUTES NUCLEAR HEAT                                             PRES3040
            C                                                                       PRES3050
ISN 0249          IF(ISW8.EQ.0)GO TO 4007                                           PRES3060
ISN 0251          HCN = ENUCL/TNUCL*EXP(-THETAR/TNUCL)*DTHETA                       PRES3070
ISN 0252          HNUCL=HNUCL+HNC                                                   PRES3080
ISN 0253          ET = ET+HNC                                                       PRES3090
ISN 0254     4007 CONTINUE                                                          PRES3100
            C                                                                       PRES3110
            C     COMPUTE DOSE IF DESIRED                                           PRES3120
            C                                                                       PRES3130
ISN 0255          IF(ISW4.EQ.0) GO TO 1104                                          PRES3140
ISN 0257          CALL DTAU (POWER,+70)                                             PRES3150
ISN 0258     1104 CONTINUE                                                          PRES3160
            C                                                                       PRES3170
ISN 0259          SUMFI = -0.0                                                      PRES3180
ISN 0260          SUMAI = -0.0                                                      PRES3190
ISN 0261          SUMFE = -0.0                                                      PRES3200
ISN 0262          SUMAE = -0.0                                                      PRES3210
ISN 0263          TCO=TC                                                            PRES3220
ISN 0264          LEX2=2                                                            PRES3230
ISN 0265          GO TO (3500,3000),IRIT                                            PRES3240
            C                                                                       PRES3250
            C                                                                       PRES3260
            C     PLOTTING SECTION                                                  PRES3270
            C                                                                       PRES3280
ISN 0266      999 IF(IPLOT)65,70,65                                                 PRES3290
ISN 0267       65 X(IPLOT)=THETA                                                    PRES3300
ISN 0268          Y(IPLOT)=TC                                                       PRES3310
ISN 0269          Y(IPLOT+600)=PC*100.0                                             PRES3320
ISN 0270          IF(NGRF.EQ.2) GO TO 2230                                          PRES3330
ISN 0272          Y(IPLOT+1200)=DOSE*10.0                                           PRES3340
ISN 0273     2230 CONTINUE                                                          PRES3350
ISN 0274          NGRS=8*NGRF+4                                                     PRES3360
ISN 0275          CALL FINIM(0.0,5.0)                                               PRES3370
ISN 0276          CALL SYMBL4 (4.0,16.5,0.2,0.0,TITLE,72)                           PRES3380
ISN 0277          CALL DESSIN (X,Y,IPLOT,1,1,NGRF,0,600,24.0,16.0,0,0,12HTIME (HOURS PRES3390
                 1),-12,GABEL,NGRS,0)                                               PRES3400
ISN 0278          CALL FINIM(30.0,0.0)                                              PRES3410
ISN 0279          CALL FINTRA                                                       PRES3420
            C                                                                       PRES3430
ISN 0280       70 CONTINUE                                                          PRES3440
ISN 0281          STOP                                                              PRES3450
            C                                                                       PRES3460
            C                                                                       PRES3470
ISN 0282       80 FORMAT (4E20.5)                                                   PRES3480
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ISN 0283            81 FORMAT (1H0,2X,'INTERNAL SPRAY SYSTEM DATA'//9X,'TIN (HR)',11X,'TE PRES3490
                      1ND (HR)',9X,'MASS RATE (KG/HR)',6X,'TEMPERATURE (C)'//(4E20.5))   PRES3500
ISN 0284            83 FORMAT (1H1,3X,'CONTAINMENT BUILDING DATA'///)                     PRES3510
ISN 0285            84 FORMAT (3X,18HPRINTING PARAMETER,10X,I10//3X,18HBLOWDOWN PARAMETER PRES3520
                      1,10X,I10//3X,20HDECAY HEAT PARAMETER,8X,I10//3X,26HDOSE CALCULATIO PRES3530
                      2N PARAMETER,2X,I10//3X,24HINTERNAL SPRAY PARAMETER,4X,I10//3X,24HE PRES3540
                      3XTERNAL SPRAY PARAMETER,4X,I10//3X,23HCHEMICAL HEAT PARAMETER,5X,I PRES3550
                      410//3X,22HNUCLEAR HEAT PARAMETER,6X,I10//3X,18HPLOTTING PARAMETER, PRES3560
                      510X,I10///)                                                        PRES3570
ISN 0286            85 FORMAT (1H1,2X,'* * INTERMEDIATE RESULTS * *'//)                   PRES3580
ISN 0287            86 FORMAT (1H0,2X,'INITIAL FREE VOLUME',11X,F16.4,2X,'M**3'//3X,'INIT PRES3590
                      *IAL MASS OF WATER',9X,F16.4,2X,'KG'//3X,'INITIAL ENERGY OF WATER', PRES3600
                      *7X,F16.4,2X,'KCAL'//3X,'INITIAL ABS. TOTAL PRESSURE',3X,F16.4,2X,' PRES3610
                      *KG/CM**2'//3X,'INITIAL TEMPERATURE',11X,F16.4,2X,'C'//3X,'NOMINAL  PRES3620
                      *REACTOR POWER',9X,F16.4,2X,'MW'//3X,'MASS OF AIR',19X,F16.4,2X,'KG PRES3630
                      *'//)                                                               PRES3640
ISN 0288            87 FORMAT (3X,13HISLABS NUMBER,15X,I10//3X,13HESLABS NUMBER,15X,I10// PRES3650
                      13X,28HMAXIMUM NUMBER OF TIME STEPS,I10//3X,21HINITIAL VALUE OF TIM PRES3660
                      2E,9X,E14.7,2X,2HHR//3X,15HTIME STEP VALUE,15X,E14.7,2X,2HHR//3X,21 PRES3670
                      3HINITIAL VALUE OF DOSE,9X,E14.7,2X,3HREM)                          PRES3680
ISN 0289            88 FORMAT (1H1,50X,22H* * * P R E S T * * *  //3X,14HPROBLEM TITLE // PRES3690
                      *25X,18A4//3X,10HINPUT DATA ///)                                    PRES3700
ISN 0290            91 FORMAT (1H0,2X,26HCHEMICAL HEAT COEFFICIENTS//3X,7HECHEM =E15.5,5X PRES3710
                      1,7HTCHEM =E15.5//)                                                 PRES3720
ISN 0291            92 FORMAT (1H0,2X,25HNUCLEAR HEAT COEFFICIENTS//3X,7HENUCL =E15.5,5X, PRES3730
                      17HTNUCL =E15.5//)                                                  PRES3740
ISN 0292            93 FORMAT (1H1,5X,120(1H*)//14X,'TIME',10X,'STEAM PRESSURE',6X,'TOTAL PRES3750
                      * PRESSURE',9X,'TEMPERATURE',9X,'TOTAL DOSE',8X,'INTERNAL SPRAY'/11 PRES3760
                      *4X,'MASS'/13X,'(HOURS)',9X,'(KG/CM2 ABS.)',7X,'(KG/CM2 ABS.)',13X, PRES3770
                      *'(C)',16X,'(REM)',15X,'(KG)'//6X,120(1H*)//)                       PRES3780
ISN 0293            94 FORMAT (10X,E14.7,9X,F6.3,4F20.3)                                  PRES3790
ISN 0294            99 FORMAT (18A4)                                                      PRES3800
ISN 0295           900 FORMAT (1H0,2X,4HSLAB,9X,11HHEAT (KCAL),14X,11HHEAT (KCAL),14X,11H PRES3810
                      1HEAT (KCAL)/11X,21HFROM ISLAB TO MIXTURE,4X,21HFROM ESLAB TO MIXTU PRES3820
                      2RE,6X,17HFROM AIR TO ESLAB/)                                       PRES3830
ISN 0296           901 FORMAT (4X,I2,5X,F16.3,9X,F16.3,9X,F16.3)                          PRES3840
ISN 0297           902 FORMAT (4X,I2,30X,F16.3,9X,F16.3)                                  PRES3850
ISN 0298           903 FORMAT (4X,I2,5X,F16.3)                                            PRES3860
ISN 0299           904 FORMAT (1H1)                                                       PRES3870
ISN 0300           905 FORMAT (3X,'TOTAL PRESSURE (ABS.VALUE)',19X,F20.3,3X,'KG/CM**2'//  PRES3880
                      *3X,'TEMPERATURE OF AIR-STEAM MIXTURE',13X,F20.3,3X,'C'//3X,'TOTAL  PRES3890
                      *RADIATION DOSE TO THE THYROID',10X,F20.3,3X,'REM'//3X,'FREE VOLUME PRES3900
                      * OF THE CONTAINMENT BUILDING', 6X,F20.3,3X,'M**3'//3X,'DENSITY OF  PRES3910
                      *AIR-STEAM MIXTURE',17X,F20.3,3X,'KG/M**3'//3X,'STEAM PRESSURE',31X PRES3920
                      *,F20.3,3X,'KG/CM**2')                                              PRES3930
ISN 0301           906 FORMAT (2H0 ,'** TIME STEP NUMBER',I10//4X,'TIME =',2X,E15.7,2X,'H PRES3940
                      1R')                                                                PRES3950
ISN 0302           907 FORMAT (1H0,2X,'TOTAL MASS OF WATER (LIQ.+VAP.PHASE)', 9X,F20.3,3X PRES3960
                      *,'KG'//3X,'MASS OF STEAM',32X,F20.3,3X,'KG'//3X,'MASS OF WATER (LI PRES3970
                      *QUID PHASE)',17X,F20.3,3X,'KG'//3X,'MASS OF BLOWDOWN WATER (LIQ.+V PRES3980
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                         *AP.PHASE)', 6X,F20.3,3X,'KG'//3X,'MASS OF INTERNAL SPRAY WATER',17 PRES3990
                         *X,F20.3,3X,'KG')                                                   PRES4000
ISN 0303              908 FORMAT (1H0,2X,'ENERGY OF WATER-AIR-STEAM MIXTURE',12X,F20.3,3X,'K PRES4010
                         *CAL'//3X,'FISSION PROD. DECAY ENERGY',19X,F20.3,3X,'KCAL'//3X,'ENE PRES4020
                         *RGY OF CHEMICAL ORIGIN',20X,F20.3,3X,'KCAL'//3X,'ENERGY DUE TO NUC PRES4030
                         *LEAR EXCURSION',14X,F20.3,3X,'KCAL'//3X,'ENERGY OF BLOWDOWN WATER  PRES4040
                         *(LIQ.+VAP.PHASE)', 4X,F20.3,3X,'KCAL'//3X,'ENERGY OF INTERNAL SPRA PRES4050
                         *Y WATER',15X,F20.3,3X,'KCAL'/)                                     PRES4060
ISN 0304             1000 FORMAT (3I10,3F10.0)                                               PRES4070
ISN 0305             1001 FORMAT (7E10.0)                                                    PRES4080
ISN 0306             1002 FORMAT (E10.0,I10,5E10.0)                                          PRES4090
ISN 0307             1005 FORMAT (14I5)                                                      PRES4100
                    C                                                                        PRES4110
ISN 0308                  END                                                                PRES4120
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LEVEL 13  (23 MAY 67)                        OS/360  FORTRAN H                                        DATE  68.031/11.51.34
          COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=50,SOURCE,BCD,NOLIST,DECK,LOAD,MAP,NOEDIT,NOID
   ISN 0002                SUBROUTINE CCNT                                                   CONT    0
                 C                                                                           CONT   10
                 C         CARRIES OUT, FOR EACH TIME STEP, THE COMPUTATION OF THE VALUES OF CONT   20
                 C         TEMPERATURE,PRESSURE,ETC., OF THE WATER-STEAM-AIR MIXTURE INSIDE  CONT   30
                 C         THE FREE VOLUME OF THE CONTAINMENT BUILDING.                      CONT   40
                 C                                                                           CONT   50
                 C                                                                           CONT   60
   ISN 0003                DIMENSION TSAT(150),PSAT(150),RHOG(150),HLG(150)                  CONT   70
   ISN 0004                COMMON/    /DUM(5),VCO,PCO,TCO,MWO,ET,FTV,PG,MWL,MWG,MAO,CVAIR    CONT   80
   ISN 0005                COMMON/SLAB/TC,RHO                                                CONT   90
   ISN 0006                COMMON/CONTRL/LEX2,IENRY,IPRCY,KTR2,ISW1,ISW2,ISW3,ISW4,ISW5,ISW6 CONT  100
   ISN 0007                EQUIVALENCE (PC,PCO),(MW,MWO)                                     CONT  110
   ISN 0008                REAL MWO,MWL,MWG,MAO,MW                                           CONT  120
                 C                                                                           CONT  130
   ISN 0009                GO TO (100,200),IENRY                                             CONT  140
                 C                                                                           CONT  150
   ISN 0010            100 READ  (5,2)LASST,MASST,NASST                                      CONT  160
   ISN 0011                DO 4 I=1,NASST                                                    CONT  170
   ISN 0012              4 READ  (5,3)TSAT(I),PSAT(I),RHOG(I),HLG(I)                         CONT  180
   ISN 0013                READ (5,5) MAO,CVAIR                                              CONT  190
   ISN 0014                WRITE (6,1003)     CVAIR                                          CONT  200
   ISN 0015                TCABS=TCO+273.16                                                  CONT  210
   ISN 0016                WRITE (6,1004) (TSAT(I),PSAT(I),HLG(I),RHOG(I),I=1,NASST)         CONT  220
   ISN 0017                RETURN                                                            CONT  230
                 C                                                                           CONT  240
   ISN 0018            200 GO TO (10,20),LEX2                                                CONT  250
                 C                                                                           CONT  260
   ISN 0019             10 CONTINUE                                                          CONT  270
   ISN 0020                IF(TCO.LT.TSAT(1)) GO TO 850                                      CONT  280
   ISN 0022                DO 78 I=1,MASST                                                   CONT  290
   ISN 0023                IF(TCO-TSAT(I))23,22,78                                           CONT  300
   ISN 0024             78 CONTINUE                                                          CONT  310
   ISN 0025            850 TFINL=TCO                                                         CONT  320
   ISN 0026                GO TO 800                                                         CONT  330
   ISN 0027             22 PG=PSAT(I)                                                        CONT  340
   ISN 0028                HG=HLG(I)                                                         CONT  350
   ISN 0029                RG=RHOG(I)                                                        CONT  360
   ISN 0030                GO TO 80                                                          CONT  370
   ISN 0031             23 TAN=(TCO-TSAT(I-1))/(TSAT(I)-TSAT(I-1))                           CONT  380
   ISN 0032                HG=HLG(I-1)+TAN*(HLG(I)-HLG(I-1))                                 CONT  390
   ISN 0033                RG=RHOG(I-1)+TAN*(RHOG(I)-RHOG(I-1))                              CONT  400
   ISN 0034                PG=PSAT(I-1)+TAN*(PSAT(I)-PSAT(I-1))                              CONT  410
   ISN 0035             80 PAIRO=PC-PG                                                       CONT  420
   ISN 0036                MWG=PG*VCO*18.016/(TCABS*8.480484E-2)                             CONT  430
   ISN 0037                IF(MW.GE.MWG) GO TO 15                                            CONT  440
   ISN 0039                IF(MW.NE.0.0) WRITE (6,2002) MWG                                  CONT  450
   ISN 0041                MW=MWG                                                            CONT  460
   ISN 0042             15 MWL=MW-MWG                                                        CONT  470
   ISN 0043                VC=VCO+MWL*(9.85E-4+5.9E-7*TCO)                                   CONT  480
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ISN 0044       QA=MAO*CVAIR                                      CONT 490
ISN 0045       EAIR=QA*TCO                                       CONT 500
ISN 0046       EG=VCO*HG*RG+MW*TCO-VCO*PG*23.42                  CONT 510
ISN 0047       ETOT=EAIR+EG                                      CONT 520
ISN 0048       IF(ABS(ET/ETOT-1.0).LT.1.0E-4) GO TO 14           CONT 530
ISN 0050       IF(ET.NE.0.0) WRITE (6,2003) ETOT                 CONT 540
ISN 0052       ET=ETOT                                           CONT 550
ISN 0053    14 FTV=VCO                                           CONT 560
ISN 0054       RHO=(MAO+MWG)/FTV                                 CONT 570
ISN 0055       GO TO 4000                                        CONT 580
          C                                                      CONT 590
ISN 0056    20 CONTINUE                                          CONT 600
ISN 0057       TFINL=TC                                          CONT 610
ISN 0058       KLIP=1                                            CONT 620
ISN 0059   250 CONTINUE                                          CONT 630
ISN 0060       IF(TFINL-TSAT(LASST))800,300,300                  CONT 640
ISN 0061   300 DO 11 I=LASST,MASST                               CONT 650
ISN 0062       IF(TFINL-TSAT(I))13,12,11                         CONT 660
ISN 0063    11 CONTINUE                                          CONT 670
ISN 0064       GO TO 800                                         CONT 680
ISN 0065    12 HG=HLG(I)                                         CONT 690
ISN 0066       RG=RHOG(I)                                        CONT 700
ISN 0067       PG=PSAT(I)                                        CONT 710
ISN 0068       GO TO 400                                         CONT 720
ISN 0069    13 TAN=(TFINL-TSAT(I-1))/(TSAT(I)-TSAT(I-1))         CONT 730
ISN 0070       HG=HLG(I-1)+TAN*(HLG(I)-HLG(I-1))                 CONT 740
ISN 0071       RG=RHOG(I-1)+TAN*(RHOG(I)-RHOG(I-1))              CONT 750
ISN 0072       PG=PSAT(I-1)+TAN*(PSAT(I)-PSAT(I-1))              CONT 760
ISN 0073   400 DIV=ET-((MW+QA)*TFINL+FTV*HG*RG-FTV*PG*23.42)     CONT 770
ISN 0074       IF(ABS(DIV).LE.ET*1.0E-7) GO TO 401               CONT 780
ISN 0076       GO TO (402,403),KLIP                              CONT 790
ISN 0077   402 KLIP=2                                            CONT 800
ISN 0078       TREP=TFINL                                        CONT 810
ISN 0079   406 TFINL=TFINL+5.0*ABS(DIV)/DIV                      CONT 820
ISN 0080       DIV1=DIV                                          CONT 830
ISN 0081       GO TO 250                                         CONT 840
ISN 0082   403 ALFA=(DIV-DIV1)/(TFINL-TREP)                      CONT 850
ISN 0083       TREP=TFINL                                        CONT 860
ISN 0084       DIV1=DIV                                          CONT 870
ISN 0085       ADD=DIV/ALFA                                      CONT 880
ISN 0086       TFINL=TFINL-ADD                                   CONT 890
ISN 0087       IF(ABS(ADD)-TREP*0.0005)401,401,250               CONT 900
ISN 0088   401 TC=TFINL                                          CONT 910
ISN 0089       PAIR=PAIRO*(TC+273.16)/TCABS*VCO/FTV              CONT 920
ISN 0090       MWG=PG*FTV*18.016/(TC+273.16)/8.480484E-2         CONT 930
ISN 0091       MWL=MW-MWG                                        CONT 940
ISN 0092       IF(MWL.LT.0.0) GO TO 500                          CONT 950
          C                                                      CONT 960
ISN 0094       FTV=VC-MWL*(9.85E-4+5.9E-7*TC)                    CONT 970
ISN 0095       PC=PAIR+PG                                        CONT 980
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ISN 0096           RHO=(MAO+MWG)/FTV                                                  CONT 990
ISN 0097      4000 CONTINUE                                                           CONT1000
ISN 0098           RETURN                                                             CONT1010
             C                                                                        CONT1020
ISN 0099       500 PND=ABS(MWL)                                                       CONT1030
ISN 0100           WRITE (6,1002)PND                                                  CONT1040
ISN 0101           STOP                                                               CONT1050
             C                                                                        CONT1060
ISN 0102       800 WRITE (6,1000)TFINL                                                CONT1070
ISN 0103           STOP                                                               CONT1080
             C                                                                        CONT1090
ISN 0104         2 FORMAT (10I5)                                                      CONT1100
ISN 0105         3 FORMAT (4E12.0)                                                    CONT1110
ISN 0106         5 FORMAT (7E10.0)                                                    CONT1120
ISN 0107      1000 FORMAT (30H  * * * LAST VALUE OF TFINL =  F10.3/41H        IS OUT   CONT1130
                  1OF RANGE OF TABLES  * * *  )                                       CONT1140
ISN 0108      1002 FORMAT (49H * * * START WITH MORE WATER TO REACH SATURATION  /7X,  CONT1150
                  14HADD  ,E12.5,3X,13HKG. OF WATER   )                               CONT1160
ISN 0109      1003 FORMAT (1H1,5X,'PHYSICAL PROPERTIES OF AIR, WATER, AND STEAM'///3X CONT1170
                  *,'SPECIFIC HEAT OF AIR AT CONSTANT VOLUME',F10.5,3X,'KCAL/KG*C'//) CONT1180
ISN 0110      1004 FORMAT (1H0,4X,'TEMPERATURE',5X,'SATURATION',5X,'SPECIFIC HEAT',5X CONT1190
                  *,'DENSITY OF'/22X,'PRESSURE',5X,'OF EVAPORATION',7X,'VAPOUR'/9X,'( CONT1200
                  *C)',9X,'(KG/CM**2)',7X,'(KCAL/KG)',7X,'(KG/M**3)'//(5X,F9.4,7X,F9. CONT1210
                  *4,8X,F9.5,7X,F9.5))                                                CONT1220
ISN 0111      2002 FORMAT (1H1,2X,'* * THE INITIAL MASS OF WATER GIVEN WAS FOUND INSU CONT1230
                  1FFICIENT TO SATURATE THE ATMOSPHERE IN THE BUILDING'/7X,'IT HAS BE CONT1240
                  2EN CORRECTED TO',E20.5,3X,'KG')                                    CONT1250
ISN 0112      2003 FORMAT (1H0,2X,'* * THE INITIAL ENERGY OF AIR-STEAM-WATER MIXTURE  CONT1260
                  1GIVEN WAS FOUND INCORRECT'/7X,'IT HAS BEEN CORRECTED TO',F20.3,3X, CONT1270
                  2'KCAL')                                                            CONT1280
             C                                                                        CONT1290
ISN 0113           END                                                                CONT1300
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ISN 0002              SUBROUTINE DTAU (POWER,*)                                        DTAU   0
                C                                                                      DTAU  10
                C     CARRIES OUT THE COMPUTATION OF THE RADIATION DOSE TO THE THYROID DTAU  20
                C     DUE TO RADIOACTIVE IODINE, AS A FUNCTION OF HEIGHT OF RELEASE,   DTAU  30
                C     DISTANCE, TIME OF EXPOSURE, ATMOSPHERIC CATEGORIES CONSIDERED,   DTAU  40
                C     AND WIND VELOCITY.                                               DTAU  50
                C                                                                      DTAU  60
ISN 0003              COMMON /     /THETA,THETAP,THETAR,DTHETA,NTHETA,VC,ATPR          DTAU  70
ISN 0004              COMMON/CONTRL/LEX2,IENRY,IPRCY,KTR2,ISW1,ISW2,ISW3,ISW4,ISW5,ISW6 DTAU  80
ISN 0005              COMMON/TAU/XMA,TAUSPI,TTHEX,DOSE                                 DTAU  90
ISN 0006              DIMENSION PREL(25),ALK(25),ALAMBD(5),QK(5)                       DTAU 100
ISN 0007              DIMENSION XM(15),SY(15,6),SZ(15,6),D(10),CM(6),FE(10),RATIO(10)  DTAU 110
ISN 0008              DIMENSION TIME(20),FPT(20)                                       DTAU 120
ISN 0009              REAL CM/'A    B    C    D    E    F    '/                        DTAU 130
ISN 0010              REAL XM/100.,200.,300.,400.0,500.,600.,800.,1000.,1500.,2000.,   DTAU 140
                     1        3000.,5000.,10000.,30000.,100000./                       DTAU 150
ISN 0011              REAL SY/22.0,46.0,68.0,90.0,110.0,126.0,166.0,205.0,300.0,380.0, DTAU 160
                     1        540.0,850.0,1550.0,4000.0,10100.0,16.0,32.0,48.0,64.0,   DTAU 170
                     2        80.0,93.0,121.0,150.0,220.0,290.0,410.0,640.0,1320.0,3000. DTAU 180
                     3        0,8000.0,12.0,24.0,35.0,46.0,57.0,67.0,89.0,110.0,160.0, DTAU 190
                     4        200.0,290.0,460.0,850.0,2300.0,6100.0,8.0,16.0,24.0,31.0, DTAU 200
                     5        38.0,46.0,60.0,75.0,105.0,140.0,200.0,305.0,570.0,1500.0, DTAU 210
                     6        4100.0,6.0,12.0,18.0,23.0,28.0,33.0,43.0,53.0,77.0,100.0, DTAU 220
                     7        140.0,220.0,410.0,1050.0,2800.0,4.0,8.0,12.0,15.5,19.0,  DTAU 230
                     8        22.0,29.0,36.0,51.0,66.0,96.0,150.0,280.0,710.0,2000.0/  DTAU 240
ISN 0012              REAL SZ/14.0,32.0,55.0,85.0,125.0,170.0,300.0,500.0,1600.0,5000., DTAU 250
                     1        6.5E+4,1.7E+6,1.455E+8,1.622E+11,3.544E+14,11.0,20.0,31., DTAU 260
                     2        42.0,55.0,65.5,95.0,125.0,220.0,340.0,700.0,2000.0,9500., DTAU 270
                     3        1.1E+5,1.5E+6,7.5,15.0,22.5,30.0,37.0,43.0,55.0,66.0,95., DTAU 280
                     4        120.0,170.0,252.0,450.0,1000.0,2300.0,5.0,9.0,13.0,16.2, DTAU 290
                     5        19.8,22.3,28.0,33.0,44.0,53.0,70.0,95.0,140.0,250.0,450., DTAU 300
                     6        3.5,6.2,8.8,11.0,13.0,15.0,19.0,22.0,30.0,37.0,49.0,62.0, DTAU 310
                     7        87.0,130.0,180.0,2.2,4.0,5.7,7.1,8.5,9.6,12.0,14.0,18.0, DTAU 320
                     8        22.0,28.0,36.0,48.0,67.0,90.0/                           DTAU 330
ISN 0013              DATA  ALAMBD          /3.5856E-3,2.9736E-1,3.312E-2,7.920E-1,1.029 DTAU 340
                     16E-1/, QK          /3.7148E+10,2.03835E+9,2.252E+10,1.645E+9,6.324 DTAU 350
                     2E+9/                                                             DTAU 360
                C                                                                      DTAU 370
ISN 0014              GO TO (10,220),IENRY                                             DTAU 380
                C                                                                      DTAU 390
ISN 0015           10 CONTINUE                                                         DTAU 400
ISN 0016              READ (5,1000) FBO,ALFA,TAUB,FPO.UAVG,HEIGHT,C,BAREA,BRATE        DTAU 410
ISN 0017              IF(C.EQ.0.0)C=0.5                                                DTAU 420
ISN 0019              READ (5,1100) NMC,ND,NL,NP                                       DTAU 430
ISN 0020              IF(NMC.GT.6.OR.ND.GT.10)GO TO 40                                 DTAU 440
ISN 0022              WRITE (6,2000)                                                   DTAU 450
ISN 0023                IF(ISW5.EQ.0) GO TO 65                                         DTAU 460
ISN 0025              WRITE (6,5000) FBO,TAUSPI,ALFA,FBO,ALFA,FBO,TAUSPI,TAUB,TAUSPI   DTAU 470
ISN 0026                GO TO 66                                                       DTAU 480
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ISN 0027          65 WRITE (6,5500) FBO                                                    DTAU 490
ISN 0028          66 CONTINUE                                                              DTAU 500
                     WRITE (6,6000) FPO,UAVG,HEIGHT,C,BAREA BRATE                          DTAU 510
ISN 0029                                                                                   
ISN 0030             READ (5,1000) (D(I),I=1,ND)                                           DTAU 520
ISN 0031             READ (5,1000) (PREL(I),I=1,NL)                                        DTAU 530
ISN 0032             READ (5,1000) (ALK(I),I=1,NL)                                         DTAU 540
ISN 0033             WRITE (6,3000) (PREL(I),ALK(I),I=1,NL)                                DTAU 550
ISN 0034             IF(FPO.GT.0.0)GO TO 22                                                DTAU 560
ISN 0036             READ (5,1000) (TIME(I),I=1,NP)                                        DTAU 570
ISN 0037             READ (5,1000) (FPT(I),I=1,NP)                                         DTAU 580
ISN 0038             WRITE (6,8000) (TIME(I),FPT(I),I=1,NP)                                DTAU 590
ISN 0039          22 CONTINUE                                                              DTAU 600
ISN 0040             DO 14 K=1,ND                                                          DTAU 610
ISN 0041             FE(K)=0.0                                                             DTAU 620
ISN 0042             DO 13 N=1,15                                                          DTAU 630
ISN 0043             IF(D(K).LE.XM(N).AND.N.GT.1)GO TO 12                                  DTAU 640
ISN 0045          13 CONTINUE                                                              DTAU 650
ISN 0046             GO TO 41                                                              DTAU 660
ISN 0047          12 DO 11 M=1,NMC                                                         DTAU 670
ISN 0048             IF(D(K).NE.XM(N))GO TO 15                                             DTAU 680
ISN 0050             SIGMAY=SY(N,M)                                                        DTAU 690
ISN 0051             SIGMAZ=SZ(N,M)                                                        DTAU 700
ISN 0052             GO TO 16                                                              DTAU 710
ISN 0053          15 WW=ALOG(D(K)/XM(N-1))/ALOG(XM(N)/XM(N-1))                             DTAU 720
ISN 0054             DUMY=ALOG(SY(N-1,M))+ALOG(SY(N,M)/SY(N-1,M))*WW                       DTAU 730
ISN 0055             DUMZ=ALOG(SZ(N-1,M))+ALOG(SZ(N,M)/SZ(N-1,M))*WW                       DTAU 740
ISN 0056             SIGMAY=EXP(DUMY)                                                      DTAU 750
ISN 0057             SIGMAZ=EXP(DUMZ)                                                      DTAU 760
ISN 0058          16 CONTINUE                                                              DTAU 770
ISN 0059             FEMC=EXP(-0.5*HEIGHT*HEIGHT/(SIGMAZ*SIGMAZ))/(3.14159*(SIGMAY*SIGM    DTAU 780
                    1AZ+C*BAREA))                                                          DTAU 790
ISN 0060             FE(K)=AMAX1(FE(K),FEMC)                                               DTAU 800
ISN 0061          11 CONTINUE                                                              DTAU 810
ISN 0062          14 CONTINUE                                                              DTAU 820
ISN 0063             RATIO(1)=1.0                                                          DTAU 830
ISN 0064             IF(ND.LT.2) GO TO 55                                                  DTAU 840
ISN 0066             DO 17 K=2,ND                                                          DTAU 850
ISN 0067          17 RATIO(K)=FE(K)/FE(1)                                                  DTAU 860
ISN 0068          55 CONTINUE                                                              DTAU 870
ISN 0069             WRITE (6,4000) (CM(I),I=1,NMC)                                        DTAU 880
ISN 0070             WRITE (6,7000) (I,D(I),RATIO(I),I=1,ND)                               DTAU 890
ISN 0071             RETURN                                                                DTAU 900
               C                                                                           DTAU 910
ISN 0072         220 GO TO (20,30),LEX2                                                    DTAU 920
               C                                                                           DTAU 930
ISN 0073          20 CONTINUE                                                              DTAU 940
ISN 0074             FB=FBO                                                                DTAU 950
ISN 0075             FP=FPO                                                                DTAU 960
ISN 0076             FACT=POWER*FE(1)/UAVG*BRATE                                           DTAU 970
ISN 0077             DFACT=FACT*DTHETA                                                     DTAU 980
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              C                                                                 DTAU 990
ISN 0078         30 IF(ISW5)31,32,31                                            DTAU1000
ISN 0079         31 IF(THETAR.LT.TAUSPI .OR. THETAR.GT.TTHEX) GO TO 32          DTAU1010
ISN 0081            TT=THETA-TAUSPI                                             DTAU1020
ISN 0082            FB=ALFA*FBO+(1.0-ALFA)*FBO*EXP(-TT/TAUB)                    DTAU1030
ISN 0083         32 IF(FPO.GT.0.0)GO TO 23                                      DTAU1040
ISN 0085            IF(THETAR.LT.TIME(1).OR.THETAR.GT.TIME(NP))GO TO 43         DTAU1050
ISN 0087            DO 18 I=2,NP                                                DTAU1060
ISN 0088            IF(THETAR.LE.TIME(I))GO TO 19                               DTAU1070
ISN 0090         18 CONTINUE                                                    DTAU1080
ISN 0091         19 IF(THETAR.NE.TIME(I))GO TO 21                               DTAU1090
ISN 0093            FP = FPT(I)                                                 DTAU1100
ISN 0094            GO TO 23                                                    DTAU1110
ISN 0095         21 FP = FPT(I-1)+(FPT(I)-FPT(I-1))*(THETAR-TIME(I-1))/(TIME(I)-TIME(I DTAU1120
                  1-1))                                                         DTAU1130
ISN 0096         23 CONTINUE                                                    DTAU1140
ISN 0097            FBFP=FB*FP *DFACT                                           DTAU1150
ISN 0098            AT=0.0                                                      DTAU1160
ISN 0099            DO 33 K=1,5                                                 DTAU1170
ISN 0100         33 AT=AT+QK(K)*EXP(-ALAMBD(K)*THETAR)                          DTAU1180
ISN 0101            PPR=ATPR-1.033                                              DTAU1190
ISN 0102            IF(PPR.LE.PREL(1)) GO TO 36                                 DTAU1200
ISN 0104            IF(PPR.GT.PREL(NL)) GO TO 35                                DTAU1210
ISN 0106            DO 34 I=2,NL                                                DTAU1220
ISN 0107            IF(PPR.LT.PREL(I)) GO TO 38                                 DTAU1230
ISN 0109            IF(PPR.EQ.PREL(I)) GO TO 37                                 DTAU1240
ISN 0111         34 CONTINUE                                                    DTAU1250
ISN 0112         35 WRITE (6,1)                                                 DTAU1260
ISN 0113            GO TO 45                                                    DTAU1270
ISN 0114         36 RETURN                                                      DTAU1280
ISN 0115         37 ALIKG=ALK(I)                                                DTAU1290
ISN 0116            GO TO 39                                                    DTAU1300
ISN 0117         38 ALIKG=ALK(I-1)+(ALK(I)-ALK(I-1))*(PPR-PREL(I-1))/(PREL(I)-PREL(I-1 DTAU1310
                  1))                                                           DTAU1320
ISN 0118         39 DOSE=DOSE+FBFP*AT*ALIKG                                     DTAU1330
ISN 0119            RETURN                                                      DTAU1340
              C                                                                 DTAU1350
ISN 0120         40 WRITE (6,2)                                                 DTAU1360
ISN 0121            GO TO 45                                                    DTAU1370
ISN 0122         41 WRITE (6,3)                                                 DTAU1380
ISN 0123            GO TO 45                                                    DTAU1390
ISN 0124         43 WRITE (6,9000)                                              DTAU1400
ISN 0125         45 RETURN 1                                                    DTAU1410
              C                                                                 DTAU1420
              C                                                                 DTAU1430
ISN 0126          1 FORMAT (1H1,2X,44H*** RELATIVE PRESSURE OUT OF TABLE RANGE ***    ) DTAU1440
ISN 0127          2 FORMAT (1H1,2X,'NMC GREATER THAN 6 OR ND GREATER THAN 10')  DTAU1450
ISN 0128          3 FORMAT (1H1,2X,'SPECIFIED DOWNWIND DISTANCE LESS THAN 100 OR GREAT DTAU1460
                  1ER THAN 100000 METERS')                                      DTAU1470
ISN 0129       1000 FORMAT (7E10.0)                                             DTAU1480
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ISN 0130      1100 FORMAT (14I5)                                                       DTAU1490
ISN 0131      2000 FORMAT (1H1,2X,'DOSE CALCULATION DATA'//)                           DTAU1500
ISN 0132      3000 FORMAT (1H0,7X,'RELATIVE PRESSURE',5X,'LEAKAGE'/12X,'(KG/CM**2)',8  DTAU1510
                  *X,'(1/HR)'//(F20.4,E19.5))                                          DTAU1520
ISN 0133      4000 FORMAT (1H0,2X,'METEOROLOGICAL CATEGORIES CONSIDERED ',2X,6A4)      DTAU1530
ISN 0134      5000 FORMAT (1H0,2X,'FB = ',F8.5,73X,'FOR TIME LESS THAN ',E12.5,2X,'HO  DTAU1540
                  1UR'//3X,'FB = ',F8.5,'*',F8.5,'+(1.0-',F8.5,')*',F8.5,'EXP(-(T-',E  DTAU1550
                  212.5,')/',E12.5,')',5X,'FOR TIME GREATER THAN ',E12.5,2X,'HOUR')    DTAU1560
ISN 0135      5500 FORMAT (1H0,2X,'FB = ',F8.5)                                        DTAU1570
ISN 0136      6000 FORMAT (1H0,2X,'FRACTION OF IODINE RELEASED',5X,F12.5//3X,'MEAN WI  DTAU1580
                  1ND VELOCITY',14X,F12.5,3X,'M/HR '//3X,'SOURCE HEIGHT ABOVE THE GRO  DTAU1590
                  2UND',2X,F12.5,3X,'M'//3X,'SHADOW EFFECT FACTOR',12X,F12.5//3X,'BUI  DTAU1600
                  3LDING X-SECT. AREA',11X,F12.5,3X,'M**2'//3X,'BREATHING RATE',18X,   DTAU1610
                  4F12.5,3X,'M**3/HR')                                                 DTAU1620
ISN 0137      7000 FORMAT (1H0,2X,'* COMPUTED PROPORTIONALITY FACTORS FOR DOSES AT SP  DTAU1630
                  *ECIFIED DISTANCES'//4X,'N',4X,'DOWNWIND DISTANCE',5X,'DOSE(N)/DOSE  DTAU1640
                  *(1)'/16X,'(M)'//(3X,I2,F16.4,F21.5))                                DTAU1650
ISN 0138      8000 FORMAT (1H0,11X,' TIME (HR)',8X,' FP(T)'//(E20.5,F20.5))            DTAU1660
ISN 0139      9000 FORMAT (1H1,2X,'*** TIME OUT OF TABLE RANGE ***')                   DTAU1670
             C                                                                         DTAU1680
ISN 0140           END                                                                 DTAU1690
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LEVEL 13  (23 MAY 67)                        OS/360  FORTRAN H                                        DATE  68.024/15.54.25
          COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=50,SOURCE,BCD,NOLIST,DECK,LOAD,MAP,NOEDIT,NOID
   ISN 0002                SUBROUTINE BLWDWN(WMAS,WENR)                                    BLWD   0
                 C                                                                         BLWD  10
                 C         DETERMINES FOR EACH TIME STEP THE MASS AND ENERGY INCREMENTS,   BLWD  20
                 C         INSIDE THE FREE VOLUME OF THE CONTAINMENT BUILDING, DUE TO THE  BLWD  30
                 C         BLOWDOWN OF HIGH ENTHALPY COOLANT.                              BLWD  40
                 C                                                                         BLWD  50
   ISN 0003                COMMON/     /THETA,THETAP,THETAR,DTHETA,NTHETA                  BLWD  60
   ISN 0004                COMMON/CONTRL/LEX2,IENRY                                        BLWD  70
   ISN 0005                DIMENSION KBD(4),CBD(4)                                         BLWD  80
   ISN 0006                REAL KBD                                                        BLWD  90
   ISN 0007                GO TO (10,60),IENRY                                             BLWD 100
   ISN 0008             10 CONTINUE                                                        BLWD 110
   ISN 0009                READ (5,1000) TAUB1,(KBD(I),I=1,4)                              BLWD 120
   ISN 0010                READ (5,1000) TAUB2,(CBD(I),I=1,4)                              BLWD 130
   ISN 0011                WRITE (6,2000)                                                  BLWD 140
   ISN 0012                WRITE (6,2100) TAUB1,(I,KBD(I),I=1,4)                           BLWD 150
   ISN 0013                WRITE (6,2200) TAUB2,(I,CBD(I),I=1,4)                           BLWD 160
   ISN 0014                RETURN                                                          BLWD 170
   ISN 0015             60 GO TO (20,30),LEX2                                              BLWD 180
   ISN 0016             20 GBD=KBD(1)+(KBD(2)+KBD(3)*TAUB1)*TAUB1                          BLWD 190
   ISN 0017                HBD=CBD(1)+CBD(2)*TAUB2-CBD(3)                                  BLWD 200
   ISN 0018             30 CONTINUE                                                        BLWD 210
   ISN 0019                IF (THETAR.GT.TAUB1) GO TO 12                                   BLWD 220
   ISN 0021                WMAS=KBD(1)+(KBD(2)+KBD(3)*THETAR)*THETAR                       BLWD 230
   ISN 0022                GO TO 11                                                        BLWD 240
   ISN 0023             12 WMAS=GBD*EXP((TAUB1-THETAR)/KBD(4))                             BLWD 250
   ISN 0024             11 WMAS=WMAS*DTHETA                                                BLWD 260
   ISN 0025                IF (THETAR.GT.TAUB2) GO TO 14                                   BLWD 270
   ISN 0027                WENR=CBD(1)+CBD(2)*THETAR                                       BLWD 280
   ISN 0028                GO TO 13                                                        BLWD 290
   ISN 0029             14 WENR=CBD(3)+HBD*EXP((TAUB2-THETAR)/CBD(4))                      BLWD 300
   ISN 0030             13 WENR=WENR*WMAS                                                  BLWD 310
   ISN 0031                RETURN                                                          BLWD 320
   ISN 0032           1000 FORMAT (7E10.0)                                                 BLWD 330
   ISN 0033           2000 FORMAT (1H0,2X,'* BLOWDOWN DATA'//3X,'COEFFICIENTS OF EQS (57) AND BLWD 340
                          * (58)'//)                                                       BLWD 350
   ISN 0034           2100 FORMAT (3X,7HTAUB1 =E15.5,4(4X,3HKBD,I1,2H =,E15.5))            BLWD 360
   ISN 0035           2200 FORMAT (3X,7HTAUB2 =E15.5,4(4X,3HCBD,I1,2H =,E15.5))            BLWD 370
   ISN 0036                END                                                             BLWD 380
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LEVEL 13  (23 MAY 67)                      OS/360  FORTRAN H                                    DATE  68.024/15.54.59
          COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=50,SOURCE,BCD,NOLIST,DECK,LOAD,MAP,NOEDIT,NOID
   ISN 0002              SUBROUTINE DECAY (HP,POWER,*)                                      DECY   0
                 C                                                                          DECY  10
                 C       DETERMINES, AS A FUNCTION OF TIME, THE TOTAL ENERGY RELEASED BY    DECY  20
                 C       FISSION PRODUCT DECAY, FOLLOWING INFINITE REACTOR OPERATION.       DECY  30
                 C                                                                          DECY  40
   ISN 0003              COMMON/    /DUM(2),THETAR,DTHETA                                   DECY  50
   ISN 0004              COMMON/CONTRL/LEX2,IENRY                                           DECY  60
   ISN 0005              DIMENSION TDC(60),EDC(60)                                          DECY  70
   ISN 0006              GO TO (10,220),IENRY                                               DECY  80
   ISN 0007           10 CONTINUE                                                           DECY  90
   ISN 0008              READ (5,1003) NDC                                                  DECY 100
   ISN 0009              READ  (5,1001)(TDC(K),K=1,NDC)                                     DECY 110
   ISN 0010              READ  (5,1001)(EDC(K),K=1,NDC)                                     DECY 120
   ISN 0011              WRITE (6,2000)                                                     DECY 130
   ISN 0012              WRITE (6,2001)  (TDC(K),EDC(K),K=1,NDC)                            DECY 140
   ISN 0013              HPCON = POWER*8.600096E+5                                          DECY 150
   ISN 0014              RETURN                                                             DECY 160
   ISN 0015          220 GO TO (20,30),LEX2                                                 DECY 170
   ISN 0016           20 CONTINUE                                                           DECY 180
   ISN 0017              DO 3232 K=1,NDC                                                    DECY 190
   ISN 0018         3232 TDC(K)=ALOG10(TDC(K))                                              DECY 200
   ISN 0019           30 CONTINUE                                                           DECY 210
   ISN 0020              THETLG=ALOG10(THETAR)                                              DECY 220
   ISN 0021              IF(THETLG-TDC(1))21,22,22                                          DECY 230
   ISN 0022           22 DO 24 I=1,NDC                                                      DECY 240
   ISN 0023              IF(THETLG-TDC(I))25,26,24                                          DECY 250
   ISN 0024           24 CONTINUE                                                           DECY 260
   ISN 0025              WRITE (6,988)                                                      DECY 270
   ISN 0026              RETURN 1                                                           DECY 280
   ISN 0027           26 HP=HPCON*EDC(I)*DTHETA                                             DECY 290
   ISN 0028              GO TO 21                                                           DECY 300
   ISN 0029           25 HP=HPCON*(EDC(I-1)+(EDC(I)-EDC(I-1))*(THETLG-TDC(I-1))/(TDC(I)-TDC DECY 310
                        1(I-1)))*DTHETA                                                     DECY 320
   ISN 0030           21 CONTINUE                                                           DECY 330
   ISN 0031              RETURN                                                             DECY 340
   ISN 0032          988 FORMAT (1H0,40H** TIME OUT OF RANGE OF DECAY TABLES **    )        DECY 350
   ISN 0033         1001 FORMAT (7E10.0)                                                    DECY 360
   ISN 0034         1003 FORMAT (7I10.0)                                                    DECY 370
   ISN 0035         2000 FORMAT (1H1,3X,27HDECAY HEAT CALCULATION DATA///6X,19HTIME AFTER S DECY 380
                        1HUTDOWN,5X,17HPER CENT OF POWER/13X,6H(HOUR),15X,8HRELEASED//)     DECY 390
   ISN 0036         2001 FORMAT (0PE20.5,2PF22.4)                                           DECY 400
   ISN 0037              END                                                                DECY 410
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LEVEL 13  (23 MAY 67)                         OS/360  FORTRAN H                                          DATE  68.024/15.55.08
          COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=50,SOURCE,BCD,NOLIST,DECK,LOAD,MAP,NOEDIT,NOID
   ISN 0002                 SUBROUTINE ISLB1                                                    ISL1   0
                  C                                                                             ISL1  10
                  C         CARRIES OUT THE COMPUTATION OF THE HEAT FLOWS EXCHANGED WITH THE    ISL1  20
                  C         FREE VOLUME BY THE INTERNAL SLABS.                                  ISL1  30
                  C         THE TEMPERATURE DISTRIBUTION IS CALCULATED BY SOLVING NUMERICALLY   ISL1  40
                  C         THE FOURIER EQUATION FOR HEAT CONDUCTION.                           ISL1  50
                  C                                                                             ISL1  60
   ISN 0003                 DIMENSION TP1(100),TP2(100),E(100),F(100)                           ISL1  70
   ISN 0004                 COMMON /     /DUM(3),DTHETA,NTHETA                                  ISL1  80
   ISN 0005                 COMMON /SLAB/TF,RHO,HEATF,HEATA                                     ISL1  90
   ISN 0006                 COMMON/CONTRL/LEX2,IENRY,IPRCY,KTR2,ISW1,ISW2,ISW3,ISW4,ISW5,ISW6   ISL1 100
   ISN 0007                 REAL*8 ALFA,ALAD,BET1,BET2,A,B,C,AA,HH,CC,A1,B1,AA1,HH1,ALFAN,ALAD  ISL1 110
                           1N,AN,BN,AAN,HHN,D,E,F                                               ISL1 120
                  C                                                                             ISL1 130
   ISN 0008                 GO TO(10,600),IENRY                                                 ISL1 140
                  C                                                                             ISL1 150
   ISN 0009              10 CONTINUE                                                            ISL1 160
   ISN 0010                 IS=1                                                                ISL1 170
   ISN 0011                 CALL IRWIN (IS,AREA,XLI,XKI,CI,DENI,NI,NF,COST,RV,TP1.              ISL1 180
   ISN 0012                 RETURN                                                              ISL1 190
                  C                                                                             ISL1 200
   ISN 0013             600 GO TO(20,30),LEX2                                                   ISL1 210
                  C                                                                             ISL1 220
   ISN 0014              20 DNI=NI                                                              ISL1 230
   ISN 0015                 DELTAI=XLI/DNI                                                      ISL1 240
   ISN 0016                 R1=DELTAI/(2.0*XKI)                                                 ISL1 250
   ISN 0017                 NE=NI-1                                                             ISL1 260
   ISN 0018                 ALFA=XKI/(DENI*CI)                                                  ISL1 270
   ISN 0019                 ALAD=ALFA/(DELTAI**2)                                               ISL1 280
   ISN 0020                 BET1=DTHETA*0.6                                                     ISL1 290
   ISN 0021                 BET2=DTHETA*0.4                                                     ISL1 300
   ISN 0022                 A=ALAD*BET1                                                         ISL1 310
   ISN 0023                 B=1.0+2.0*A                                                         ISL1 320
   ISN 0024                 C=A                                                                 ISL1 330
   ISN 0025                 AA=ALAD*BET2                                                        ISL1 340
   ISN 0026                 HH=1.0-2.0*AA                                                       ISL1 350
   ISN 0027                 CC=AA                                                               ISL1 360
   ISN 0028                 A1=A                                                                ISL1 370
   ISN 0029                 B1=1.0+A1                                                           ISL1 380
   ISN 0030                 AA1=AA                                                              ISL1 390
   ISN 0031                 HH1=1.0-AA1                                                         ISL1 400
                  C                                                                             ISL1 410
   ISN 0032              30 CONTINUE                                                            ISL1 420
   ISN 0033                 IF(NF)32,31,32                                                      ISL1 430
   ISN 0034              31 H=COST                                                              ISL1 440
   ISN 0035                 R=R1+RV+1.0/H                                                       ISL1 450
   ISN 0036                 GO TO 33                                                            ISL1 460
   ISN 0037              32 DELTAT=ABS(TF-TP1(NI))                                              ISL1 470
   ISN 0038                 H=19.3066*RHO*(DELTAT**0.25)                                        ISL1 480
```

```
ISN 0039              R=R1+RV+1.0/H                                                ISL1 490
ISN 0040         33   ALFAN=1.0/(R*DENI*CI)                                        ISL1 500
ISN 0041              ALADN=ALFAN/DELTAI                                           ISL1 510
ISN 0042              AN=BET1*ALADN                                                ISL1 520
ISN 0043              BN=1.0+AN+A                                                  ISL1 530
ISN 0044              AAN=BET2*ALADN                                               ISL1 540
ISN 0045              HHN=1.0-(AAN+AA)                                             ISL1 550
ISN 0046              D=AA1*TP1(2)+HH1*TP1(1)                                      ISL1 560
ISN 0047              E(1)=A1/B1                                                   ISL1 570
ISN 0048              F(1)=D/B1                                                    ISL1 580
ISN 0049              DO 35 I=2,NE                                                 ISL1 590
ISN 0050              D=AA*TP1(I+1)+HH*TP1(I)+CC*TP1(I-1)                          ISL1 600
ISN 0051              E(I)=A/(B-C*E(I-1))                                          ISL1 610
ISN 0052         35   F(I)=(D+C*F(I-1))/(B-C*E(I-1))                               ISL1 620
ISN 0053              E(NI)=AN/(BN-C*E(NE))                                        ISL1 630
ISN 0054              D=AAN*TF+HHN*TP1(NI)+CC*TP1(NE)                              ISL1 640
ISN 0055              F(NI)=(D+C*F(NE))/(BN-C*E(NE))                               ISL1 650
ISN 0056              TP2(NI)=E(NI)*TF+F(NI)                                       ISL1 660
ISN 0057              DO 36 I=1,NE                                                 ISL1 670
ISN 0058              J=NI-I                                                       ISL1 680
ISN 0059              TP2(J)=E(J)*TP2(J+1)+F(J)                                    ISL1 690
ISN 0060         36   CONTINUE                                                     ISL1 700
ISN 0061              TPA=0.4*(TP1(NI)-TF)+0.6*(TP2(NI)-TF)                        ISL1 710
ISN 0062              HEATF=2.0*AREA*TPA*DTHETA/R                                  ISL1 720
            C                                                                      ISL1 730
ISN 0063              IF(IPRCY)2304,2100,2304                                      ISL1 740
ISN 0064       2304   IF(NTHETA-1)2303,2100,2303                                   ISL1 750
ISN 0065       2303   IF(NTHETA-KTR2)2301,2100,2301                                ISL1 760
ISN 0066       2100   CONTINUE                                                     ISL1 770
ISN 0067              IF(ISW1.EQ.0) GO TO 2301                                     ISL1 780
ISN 0069              CALL IPRINT (8HISLAB 1 ,NI,TP1,TP2)                          ISL1 790
ISN 0070       2301   DO 2302 I=1,NI                                               ISL1 800
ISN 0071       2302   TP1(I)=TP2(I)                                                ISL1 810
            C                                                                      ISL1 820
ISN 0072              RETURN                                                       ISL1 830
ISN 0073              END                                                          ISL1 840
```

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        COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=50,SOURCE,BCD,NOLIST,DECK,LOAD,MAP,NOEDIT,NOID
  ISN 0002               SUBROUTINE ISLB2                                                    ISL2   0
                   C                                                                         ISL2  10
                   C     CARRIES OUT THE COMPUTATION OF THE HEAT FLOWS EXCHANGED WITH THE    ISL2  20
                   C     FREE VOLUME BY THE INTERNAL SLABS.                                  ISL2  30
                   C     THE TEMPERATURE DISTRIBUTION IS CALCULATED BY SOLVING NUMERICALLY   ISL2  40
                   C     THE FOURIER EQUATION FOR HEAT CONDUCTION.                           ISL2  50
                   C                                                                         ISL2  60
  ISN 0003               DIMENSION TP1(100),TP2(100),E(100),F(100)                           ISL2  70
  ISN 0004               COMMON /    /DUM(3),DTHETA,NTHETA                                   ISL2  80
  ISN 0005               COMMON /SLAB/TF,RHO,HEATF,HEATA                                     ISL2  90
  ISN 0006               COMMON/CONTRL/LEX2,IENRY,IPRCY,KTR2,ISW1,ISW2,ISW3,ISW4,ISW5,ISW6   ISL2 100
  ISN 0007               REAL*8 ALFA,ALAD,BET1,BET2,A,B,C,AA,HH,CC,A1,B1,AA1,HH1,ALFAN,ALAD  ISL2 110
                        1N,AN,BN,AAN,HHN,D,E,F                                               ISL2 120
                   C                                                                         ISL2 130
  ISN 0008               GO TO(10,600),IENRY                                                 ISL2 140
                   C                                                                         ISL2 150
  ISN 0009            10 CONTINUE                                                            ISL2 160
  ISN 0010               IS=2                                                                ISL2 170
  ISN 0011               CALL IRWIN (IS,AREA,XLI,XKI,CI,DENI,NI,NF,COST,RV,TP1)              ISL2 180
  ISN 0012               RETURN                                                              ISL2 190
                   C                                                                         ISL2 200
  ISN 0013           600 GO TO(20,30),LEX2                                                   ISL2 210
                   C                                                                         ISL2 220
  ISN 0014            20 DNI=NI                                                              ISL2 230
  ISN 0015               DELTAI=XLI/DNI                                                      ISL2 240
  ISN 0016               R1=DELTAI/(2.0*XKI)                                                 ISL2 250
  ISN 0017               NE=NI-1                                                             ISL2 260
  ISN 0018               ALFA=XKI/(DENI*CI)                                                  ISL2 270
  ISN 0019               ALAD=ALFA/(DELTAI**2)                                               ISL2 280
  ISN 0020               BET1=DTHETA*0.6                                                     ISL2 290
  ISN 0021               BET2=DTHETA*0.4                                                     ISL2 300
  ISN 0022               A=ALAD*BET1                                                         ISL2 310
  ISN 0023               B=1.0+2.0*A                                                         ISL2 320
  ISN 0024               C=A                                                                 ISL2 330
  ISN 0025               AA=ALAD*BET2                                                        ISL2 340
  ISN 0026               HH=1.0-2.0*AA                                                       ISL2 350
  ISN 0027               CC=AA                                                               ISL2 360
  ISN 0028               A1=A                                                                ISL2 370
  ISN 0029               B1=1.0+A1                                                           ISL2 380
  ISN 0030               AA1=AA                                                              ISL2 390
  ISN 0031               HH1=1.0-AA1                                                         ISL2 400
                   C                                                                         ISL2 410
  ISN 0032            30 CONTINUE                                                            ISL2 420
  ISN 0033               IF(NF)32,31,32                                                      ISL2 430
  ISN 0034            31 H=COST                                                              ISL2 440
  ISN 0035               R=R1+RV+1.0/H                                                       ISL2 450
  ISN 0036               GO TO 33                                                            ISL2 460
  ISN 0037            32 DELTAT=ABS(TF-TP1(NI))                                              ISL2 470
  ISN 0038               H=19.3066*RHO*(DELTAT**0.25)                                        ISL2 480
```

```
      R=R1+RV+1.0/H
   33 ALFAN=1.0/(R*DENI*CI)
      ALADN=ALFAN/DELTAI
      AN=BET1*ALADN
      BN=1.0+AN+A
      AAN=BET2*ALADN
      HHN=1.0-(AAN+AA)
      D=AA1*TP1(2)+HH1*TP1(1)
      E(1)=A1/B1
      F(1)=D/B1
      DO 35 I=2,NE
      D=AA*TP1(I+1)+HH*TP1(I)+CC*TP1(I-1)
      E(I)=A/(B-C*E(I-1))
   35 F(I)=(D+C*F(I-1))/(B-C*E(I-1))
      E(NI)=AN/(BN-C*E(NE))
      D=AAN*TF+HHN*TP1(NI)+CC*TP1(NE)
      F(NI)=(D+C*F(NE))/(BN-C*E(NE))
      TP2(NI)=E(NI)*TF+F(NI)
      DO 36 I=1,NE
      J=NI-I
      TP2(J)=E(J)*TP2(J+1)+F(J)
   36 CONTINUE
      TPA=0.4*(TP1(NI)-TF)+0.6*(TP2(NI)-TF)
      HEATF=2.0*AREA*TPA*DTHETA/R
C
      IF(IPRCY)2304,2100,2304
 2304 IF(NTHETA-1)2303,2100,2303
 2303 IF(NTHETA-KTR2)2301,2100,2301
 2100 CONTINUE
      IF(ISW1.EQ.0) GO TO 2301
      CALL IPRINT (8HISLAB 2 ,NI,TP1,TP2)
 2301 DO 2302 I=1,NI
 2302 TP1(I)=TP2(I)
C
      RETURN
      END
```

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LEVEL 13  (23 MAY 67)                    OS/360  FORTRAN H                                          DATE  68.024/15.55.29
           COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=50,SOURCE,BCD,NOLIST,DECK,LOAD,MAP,NOEDIT,NOID
  ISN 0002                SUBROUTINE ISLB3                                                      ISL3    0
                C                                                                               ISL3   10
                C         CARRIES OUT THE COMPUTATION OF THE HEAT FLOWS EXCHANGED WITH THE      ISL3   20
                C         FREE VOLUME BY THE INTERNAL SLABS.                                    ISL3   30
                C         THE TEMPERATURE DISTRIBUTION IS CALCULATED BY SOLVING NUMERICALLY     ISL3   40
                C         THE FOURIER EQUATION FOR HEAT CONDUCTION.                             ISL3   50
                C                                                                               ISL3   60
  ISN 0003                DIMENSION TP1(100),TP2(100),E(100),F(100)                             ISL3   70
  ISN 0004                COMMON /    /DUM(3),DTHETA,NTHETA                                     ISL3   80
  ISN 0005                COMMON /SLAB/TF,RHO,HEATF,HEATA                                       ISL3   90
  ISN 0006                COMMON/CONTRL/LEX2,IENRY,IPRCY,KTR2,ISW1,ISW2,ISW3,ISW4,ISW5,ISW6     ISL3  100
  ISN 0007                REAL*8 ALFA,ALAD,BET1,BET2,A,B,C,AA,HH,CC,A1,B1,AA1,HH1,ALFAN,ALAD    ISL3  110
                         1N,AN,BN,AAN,HHN,D,E,F                                                 ISL3  120
                C                                                                               ISL3  130
  ISN 0008                GO TO(10,600),IENRY                                                   ISL3  140
                C                                                                               ISL3  150
  ISN 0009             10 CONTINUE                                                              ISL3  160
  ISN 0010                IS=3                                                                  ISL3  170
  ISN 0011                CALL IRWIN (IS,AREA,XLI,XKI,CI,DENI,NI,NF,COST,RV,TP1)                ISL3  180
  ISN 0012                RETURN                                                                ISL3  190
                C                                                                               ISL3  200
  ISN 0013            600 GO TO(20,30),LEX2                                                     ISL3  210
                C                                                                               ISL3  220
  ISN 0014             20 DNI=NI                                                                ISL3  230
  ISN 0015                DELTAI=XLI/DNI                                                        ISL3  240
  ISN 0016                R1=DELTAI/(2.0*XKI)                                                   ISL3  250
  ISN 0017                NE=NI-1                                                               ISL3  260
  ISN 0018                ALFA=XKI/(DENI*CI)                                                    ISL3  270
  ISN 0019                ALAD=ALFA/(DELTAI**2)                                                 ISL3  280
  ISN 0020                BET1=DTHETA*0.6                                                       ISL3  290
  ISN 0021                BET2=DTHETA*0.4                                                       ISL3  300
  ISN 0022                A=ALAD*BET1                                                           ISL3  310
  ISN 0023                B=1.0+2.0*A                                                           ISL3  320
  ISN 0024                C=A                                                                   ISL3  330
  ISN 0025                AA=ALAD*BET2                                                          ISL3  340
  ISN 0026                HH=1.0-2.0*AA                                                         ISL3  350
  ISN 0027                CC=AA                                                                 ISL3  360
  ISN 0028                A1=A                                                                  ISL3  370
  ISN 0029                B1=1.0+A1                                                             ISL3  380
  ISN 0030                AA1=AA                                                                ISL3  390
  ISN 0031                HH1=1.0-AA1                                                           ISL3  400
                C                                                                               ISL3  410
  ISN 0032             30 CONTINUE                                                              ISL3  420
  ISN 0033                IF(NF)32,31,32                                                        ISL3  430
  ISN 0034             31 H=COST                                                                ISL3  440
  ISN 0035                R=R1+RV+1.0/H                                                         ISL3  450
  ISN 0036                GO TO 33                                                              ISL3  460
  ISN 0037             32 DELTAT=ABS(TF-TP1(NI))                                                ISL3  470
  ISN 0038                H=19.3066*RHO*(DELTAT**0.25)                                          ISL3  480
```

```
ISN 0039               R=R1+RV+1.0/H                                          ISL3 490
ISN 0040            33 ALFAN=1.0/(R*DENI*CI)                                  ISL3 500
ISN 0041               ALADN=ALFAN/DELTAI                                     ISL3 510
ISN 0042               AN=BET1*ALADN                                          ISL3 520
ISN 0043               BN=1.0+AN+A                                            ISL3 530
ISN 0044               AAN=BET2*ALADN                                         ISL3 540
ISN 0045               HHN=1.0-(AAN+AA)                                       ISL3 550
ISN 0046               D=AA1*TP1(2)+HH1*TP1(1)                                ISL3 560
ISN 0047               E(1)=A1/B1                                             ISL3 570
ISN 0048               F(1)=D/B1                                              ISL3 580
ISN 0049               DO 35 I=2,NE                                           ISL3 590
ISN 0050               D=AA*TP1(I+1)+HH*TP1(I)+CC*TP1(I-1)                    ISL3 600
ISN 0051               E(I)=A/(B-C*E(I-1))                                    ISL3 610
ISN 0052            35 F(I)=(D+C*F(I-1))/(B-C*E(I-1))                         ISL3 620
ISN 0053               E(NI)=AN/(BN-C*E(NE))                                  ISL3 630
ISN 0054               D=AAN*TF+HHN*TP1(NI)+CC*TP1(NE)                        ISL3 640
ISN 0055               F(NI)=(D+C*F(NE))/(BN-C*E(NE))                         ISL3 650
ISN 0056               TP2(NI)=E(NI)*TF+F(NI)                                 ISL3 660
ISN 0057               DO 36 I=1,NE                                           ISL3 670
ISN 0058               J=NI-I                                                 ISL3 680
ISN 0059               TP2(J)=E(J)*TP2(J+1)+F(J)                              ISL3 690
ISN 0060            36 CONTINUE                                               ISL3 700
ISN 0061               TPA=0.4*(TP1(NI)-TF)+0.6*(TP2(NI)-TF)                  ISL3 710
ISN 0062               HEATF=2.0*AREA*TPA*DTHETA/R                            ISL3 720
              C                                                               ISL3 730
ISN 0063               IF(IPRCY)2304,2100,2304                                ISL3 740
ISN 0064          2304 IF(NTHETA-1)2303,2100,2303                             ISL3 750
ISN 0065          2303 IF(NTHETA-KTR2)2301,2100,2301                          ISL3 760
ISN 0066          2100 CONTINUE                                               ISL3 770
ISN 0067               IF(ISW1.EQ.0) GO TO 2301                               ISL3 780
ISN 0069               CALL IPRINT (8HISLAB 3 ,NI,TP1,TP2)                    ISL3 790
ISN 0070          2301 DO 2302 I=1,NI                                         ISL3 800
ISN 0071          2302 TP1(I)=TP2(I)                                          ISL3 810
              C                                                               ISL3 820
ISN 0072               RETURN                                                 ISL3 830
ISN 0073               END                                                    ISL3 840
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LEVEL 13  (23 MAY 67)                      OS/360  FORTRAN H                                      DATE  68.024/15.55.40
          COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=50,SOURCE,BCD,NOLIST,DECK,LOAD,MAP,NOEDIT,NOID
    ISN 0002                 SUBROUTINE ISLB4                                                      ISL4    0
                     C                                                                             ISL4   10
                     C       CARRIES OUT THE COMPUTATION OF THE HEAT FLOWS EXCHANGED WITH THE      ISL4   20
                     C       FREE VOLUME BY THE INTERNAL SLABS.                                    ISL4   30
                     C       THE TEMPERATURE DISTRIBUTION IS CALCULATED BY SOLVING NUMERICALLY     ISL4   40
                     C       THE FOURIER EQUATION FOR HEAT CONDUCTION.                             ISL4   50
                     C                                                                             ISL4   60
    ISN 0003                 DIMENSION TP1(100),TP2(100),E(100),F(100)                             ISL4   70
    ISN 0004                 COMMON /     /DUM(3),DTHETA,NTHETA                                    ISL4   80
    ISN 0005                 COMMON /SLAB/TF,RHO,HEATF,HEATA                                       ISL4   90
    ISN 0006                 COMMON/CONTRL/LEX2,IENRY,IPRCY,KTR2,ISW1,ISW2,ISW3,ISW4,ISW5,ISW6     ISL4  100
    ISN 0007                 REAL*8 ALFA,ALAD,BET1,BET2,A,B,C,AA,HH,CC,A1,B1,AA1,HH1,ALFAN,ALAD    ISL4  110
                            1N,AN,BN,AAN,HHN,D,E,F                                                 ISL4  120
                     C                                                                             ISL4  130
    ISN 0008                 GO TO(10,600),IENRY                                                   ISL4  140
                     C                                                                             ISL4  150
    ISN 0009              10 CONTINUE                                                              ISL4  160
    ISN 0010                 IS=4                                                                  ISL4  170
    ISN 0011                 CALL IRWIN (IS,AREA,XLI,XKI,CI,DENI,NI,NF,COST,RV,TP1)                ISL4  180
    ISN 0012                 RETURN                                                                ISL4  190
                     C                                                                             ISL4  200
    ISN 0013             600 GO TO(20,30),LEX2                                                     ISL4  210
                     C                                                                             ISL4  220
    ISN 0014              20 DNI=NI                                                                ISL4  230
    ISN 0015                 DELTAI=XLI/DNI                                                        ISL4  240
    ISN 0016                 R1=DELTAI/(2.0*XKI)                                                   ISL4  250
    ISN 0017                 NE=NI-1                                                               ISL4  260
    ISN 0018                 ALFA=XKI/(DENI*CI)                                                    ISL4  270
    ISN 0019                 ALAD=ALFA/(DELTAI**2)                                                 ISL4  280
    ISN 0020                 BET1=DTHETA*0.6                                                       ISL4  290
    ISN 0021                 BET2=DTHETA*0.4                                                       ISL4  300
    ISN 0022                 A=ALAD*BET1                                                           ISL4  310
    ISN 0023                 B=1.0+2.0*A                                                           ISL4  320
    ISN 0024                 C=A                                                                   ISL4  330
    ISN 0025                 AA=ALAD*BET2                                                          ISL4  340
    ISN 0026                 HH=1.0-2.0*AA                                                         ISL4  350
    ISN 0027                 CC=AA                                                                 ISL4  360
    ISN 0028                 A1=A                                                                  ISL4  370
    ISN 0029                 B1=1.0+A1                                                             ISL4  380
    ISN 0030                 AA1=AA                                                                ISL4  390
    ISN 0031                 HH1=1.0-AA1                                                           ISL4  400
                     C                                                                             ISL4  410
    ISN 0032              30 CONTINUE                                                              ISL4  420
    ISN 0033                 IF(NF)32,31,32                                                        ISL4  430
    ISN 0034              31 H=COST                                                                ISL4  440
    ISN 0035                 R=R1+RV+1.0/H                                                         ISL4  450
    ISN 0036                 GO TO 33                                                              ISL4  460
    ISN 0037              32 DELTAT=ABS(TF-TP1(NI))                                                ISL4  470
    ISN 0038                 H=19.3066*RHO*(DELTAT**0.25)                                          ISL4  480
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                                                                                                       PAGE 002
ISN 0039          R=R1+RV+1.0/H                                                   ISL4 490
ISN 0040       33 ALFAN=1.0/(R*DENI*CI)                                           ISL4 500
ISN 0041          ALADN=ALFAN/DELTAI                                              ISL4 510
ISN 0042          AN=BET1*ALADN                                                   ISL4 520
ISN 0043          BN=1.0+AN+A                                                     ISL4 530
ISN 0044          AAN=BET2*ALADN                                                  ISL4 540
ISN 0045          HHN=1.0-(AAN+AA)                                                ISL4 550
ISN 0046          D=AA1*TP1(2)+HH1*TP1(1)                                         ISL4 560
ISN 0047          E(1)=A1/B1                                                      ISL4 570
ISN 0048          F(1)=D/B1                                                       ISL4 580
ISN 0049          DO 35 I=2,NE                                                    ISL4 590
ISN 0050          D=AA*TP1(I+1)+HH*TP1(I)+CC*TP1(I-1)                             ISL4 600
ISN 0051          E(I)=A/(B-C*E(I-1))                                             ISL4 610
ISN 0052       35 F(I)=(D+C*F(I-1))/(B-C*E(I-1))                                  ISL4 620
ISN 0053          E(NI)=AN/(BN-C*E(NE))                                           ISL4 630
ISN 0054          D=AAN*TF+HHN*TP1(NI)+CC*TP1(NE)                                 ISL4 640
ISN 0055          F(NI)=(D+C*F(NE))/(BN-C*E(NE))                                  ISL4 650
ISN 0056          TP2(NI)=E(NI)*TF+F(NI)                                          ISL4 660
ISN 0057          DO 36 I=1,NE                                                    ISL4 670
ISN 0058          J=NI-I                                                          ISL4 680
ISN 0059          TP2(J)=E(J)*TP2(J+1)+F(J)                                       ISL4 690
ISN 0060       36 CONTINUE                                                        ISL4 700
ISN 0061          TPA=0.4*(TP1(NI)-TF)+0.6*(TP2(NI)-TF)                           ISL4 710
ISN 0062          HEATF=2.0*AREA*TPA*DTHETA/R                                     ISL4 720
           C                                                                      ISL4 730
ISN 0063          IF(IPRCY)2304,2100,2304                                         ISL4 740
ISN 0064     2304 IF(NTHETA-1)2303,2100,2303                                      ISL4 750
ISN 0065     2303 IF(NTHETA-KTR2)2301,2100,2301                                   ISL4 760
ISN 0066     2100 CONTINUE                                                        ISL4 770
ISN 0067          IF(ISW1.EQ.0) GO TO 2301                                        ISL4 780
ISN 0069          CALL IPRINT (8HISLAB 4 ,NI,TP1,TP2)                             ISL4 790
ISN 0070     2301 DO 2302 I=1,NI                                                  ISL4 800
ISN 0071     2302 TP1(I)=TP2(I)                                                   ISL4 810
           C                                                                      ISL4 820
ISN 0072          RETURN                                                          ISL4 830
ISN 0073          END                                                             ISL4 840
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LEVEL 13  (23 MAY 67)                     OS/360  FORTRAN H                                   DATE  68.031/11.53.29
          COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=50,SOURCE,BCD,NOLIST,DECK,LOAD,MAP,NOEDIT,NOID
  ISN 0002                SUBROUTINE ESLB1                                                   ESL1   0
                C                                                                            ESL1  10
                C         CARRIES OUT THE COMPUTATION OF THE HEAT FLOWS EXCHANGED WITH THE   ESL1  20
                C         FREE VOLUME BY THE EXTERNAL SLABS.                                 ESL1  30
                C         THE TEMPERATURE DISTRIBUTION IS CALCULATED BY SOLVING NUMERICALLY  ESL1  40
                C         THE FOURIER EQUATION FOR HEAT CONDUCTION.                          ESL1  50
                C                                                                            ESL1  60
  ISN 0003                DIMENSION TP1(100),TP2(100),E(100),F(100)                          ESL1  70
  ISN 0004                COMMON/     /THETA,DUM(2),DTHETA,NTHETA                            ESL1  80
  ISN 0005                COMMON /SLAB/TF,RHO,HEATF,HEATA                                    ESL1  90
  ISN 0006                COMMON/CONTRL/LEX2,IENRY,IPRCY,KTR2,ISW1,ISW2,ISW3,ISW4,ISW5,ISW6  ESL1 100
  ISN 0007                REAL*8 ALFA,ALAD,BET1,BET2,A,B,C,AA,HH,CC,A1,B1,AA1,HH1,ALFA1,ALAD ESL1 110
                         11,C1,CC1,ALFAN,ALADN,AN,BN,AAN,HHN,D,E,F                           ESL1 120
                C                                                                            ESL1 130
  ISN 0008                GO TO(10,600),IENRY                                                ESL1 140
                C                                                                            ESL1 150
  ISN 0009             10 CONTINUE                                                           ESL1 160
  ISN 0010                IS=1                                                               ESL1 170
  ISN 0011                CALL ERWIN (IS,AREA,XLI,XKI,CI,DENI,NI,NF,NA,COST,TA,GAMMAE,CX3,   ESL1 180
                         1TAQ,RVI,RVE,CX1,CX2,TAUSPE,TP1)                                    ESL1 190
  ISN 0012                RETURN                                                             ESL1 200
                C                                                                            ESL1 210
  ISN 0013            600 GO TO(20,30),LEX2                                                  ESL1 220
                C                                                                            ESL1 230
  ISN 0014             20 DNI=NI                                                             ESL1 240
  ISN 0015                DELTAI=XLI/DNI                                                     ESL1 250
  ISN 0016                R1=DELTAI/(2.0*XKI)                                                ESL1 260
  ISN 0017                NE=NI-1                                                            ESL1 270
  ISN 0018                IF(NA.EQ.0) GO TO 42                                               ESL1 280
  ISN 0020                IF(NA.GT.0.AND.ISW6.EQ.0) GO TO 42                                 ESL1 290
  ISN 0022                GC=GAMMAE*(1.0/CX3+R1)/AREA*2.0                                    ESL1 300
  ISN 0023                AK1=1.0/(1.0+GC)                                                   ESL1 310
  ISN 0024                AK2=1.0/(1.0+1.0/GC)                                               ESL1 320
  ISN 0025                TK=AK2*TAQ                                                         ESL1 330
  ISN 0026                H2=CX3                                                             ESL1 340
  ISN 0027             42 CONTINUE                                                           ESL1 350
  ISN 0028                ALFA=XKI/(DENI*CI)                                                 ESL1 360
  ISN 0029                ALAD=ALFA/(DELTAI**2)                                              ESL1 370
  ISN 0030                BET1=DTHETA*0.6                                                    ESL1 380
  ISN 0031                BET2=DTHETA*0.4                                                    ESL1 390
  ISN 0032                A=ALAD*BET1                                                        ESL1 400
  ISN 0033                B=1.0+2.0*A                                                        ESL1 410
  ISN 0034                C=A                                                                ESL1 420
  ISN 0035                AA=ALAD*BET2                                                       ESL1 430
  ISN 0036                HH=1.0-2.0*AA                                                      ESL1 440
  ISN 0037                CC=AA                                                              ESL1 450
  ISN 0038                A1=A                                                               ESL1 460
  ISN 0039                AA1=AA                                                             ESL1 470
                C                                                                            ESL1 480
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ISN 0040       30 CONTINUE                                               ESL1 490
ISN 0041          IF(THETA.LT.TAUSPE) GO TO 51                           ESL1 500
ISN 0043          IF(NA.LT.0) GO TO 51                                   ESL1 510
ISN 0045          NA=-NA                                                 ESL1 520
ISN 0046          H2=CX3                                                 ESL1 530
ISN 0047       51 IF(NA)48,45,46                                         ESL1 540
ISN 0048       45 ALFA1=0.0                                              ESL1 550
ISN 0049          GO TO 44                                               ESL1 560
ISN 0050       48 TA=AK1*TP1(1)+TK                                       ESL1 570
ISN 0051          GO TO 49                                               ESL1 580
ISN 0052       46 H2=CX1+CX2*ABS(TA-TP1(1))                              ESL1 590
ISN 0053       49 R2= R1+RVE+1.0/H2                                      ESL1 600
ISN 0054          ALFA1=1.0/(R2*DENI*CI)                                 ESL1 610
ISN 0055       44 ALAD1=ALFA1/DELTAI                                     ESL1 620
ISN 0056          C1=BET1*ALAD1                                          ESL1 630
ISN 0057          B1=1.0+A1+C1                                           ESL1 640
ISN 0058          CC1=BET2*ALAD1                                         ESL1 650
ISN 0059          HH1=1.0-(AA1+CC1)                                      ESL1 660
ISN 0060          IF(NF)32,31,32                                         ESL1 670
ISN 0061       31 H=COST                                                 ESL1 680
ISN 0062          GO TO 33                                               ESL1 690
ISN 0063       32 DELTAT=ABS(TF-TP1(NI))                                 ESL1 700
ISN 0064          H=19.3066*RHO*(DELTAT**0.25)                           ESL1 710
ISN 0065       33 R = R1+RVI+1.0/H                                       ESL1 720
ISN 0066          ALFAN=1.0/(R*DENI*CI)                                  ESL1 730
ISN 0067          ALADN=ALFAN/DELTAI                                     ESL1 740
ISN 0068          AN=BET1*ALADN                                          ESL1 750
ISN 0069          BN=1.0+AN+A                                            ESL1 760
ISN 0070          AAN=BET2*ALADN                                         ESL1 770
ISN 0071          HHN=1.0-(AAN+AA)                                       ESL1 780
ISN 0072          D=AA1*TP1(2)+HH1*TP1(1)+CC1*TA                         ESL1 790
ISN 0073          E(1)=A1/B1                                             ESL1 800
ISN 0074          F(1)=(C1*TA+D)/B1                                      ESL1 810
ISN 0075          DO 35 I=2,NE                                           ESL1 820
ISN 0076          D=AA* TP1(I+1)+HH*TP1(I)+CC*TP1(I-1)                   ESL1 830
ISN 0077          E(I)=A/(B-C*E(I-1))                                    ESL1 840
ISN 0078       35 F(I)=(D+C*F(I-1))/(B-C*E(I-1))                         ESL1 850
ISN 0079          E(NI)=AN/(BN-C*E(NE))                                  ESL1 860
ISN 0080          D=AAN*TF+HHN*TP1(NI)+CC*TP1(NE)                        ESL1 870
ISN 0081          F(NI)=(D+C*F(NE))/(BN-C*E(NE))                         ESL1 880
ISN 0082          TP2(NI)=E(NI)*TF+F(NI)                                 ESL1 890
ISN 0083          DO 36 I=1,NE                                           ESL1 900
ISN 0084          J=NI-I                                                 ESL1 910
ISN 0085          TP2(J)=E(J)*TP2(J+1)+F(J)                              ESL1 920
ISN 0086       36 CONTINUE                                               ESL1 930
ISN 0087          TPA=0.4*(TP1(NI)-TF)+0.6*(TP2(NI)-TF)                  ESL1 940
ISN 0088          TPB=0.4*(TA-TP1(1))+0.6*(TA-TP2(1))                    ESL1 950
ISN 0089          HEATF=AREA*TPA*DTHETA/R                                ESL1 960
ISN 0090          IF(NA)16,15,16                                         ESL1 970
ISN 0091       16 HEATA=AREA*TPB*DTHETA/R2                               ESL1 980
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ISN 0092            GO TO 17                                                                   ESL1 990
ISN 0093         15 HEATA=0.0                                                                  ESL11000
              C                                                                                ESL11010
ISN 0094         17 IF(IPRCY)2304,2100,2304                                                    ESL11020
ISN 0095       2304 IF(NTHETA-1)2303,2100,2303                                                 ESL11030
ISN 0096       2303 IF(NTHETA-KTR2)2301,2100,2301                                              ESL11040
ISN 0097       2100 CONTINUE                                                                   ESL11050
ISN 0098            IF(ISW1.EQ.0) GO TO 2301                                                   ESL11060
              C                                                                                ESL11070
ISN 0100            CALL IPRINT (8HESLAB 1 ,NI,TP1,TP2)                                        ESL11080
ISN 0101       2301 DO 2302 I=1,NI                                                             ESL11090
ISN 0102       2302 TP1(I)=TP2(I)                                                              ESL11100
ISN 0103            RETURN                                                                     ESL11110
ISN 0104            END                                                                        ESL11120
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ISN 0002             SUBROUTINE ESLB2
               C
               C     CARRIES OUT THE COMPUTATION OF THE HEAT FLOWS EXCHANGED WITH THE
               C     FREE VOLUME BY THE EXTERNAL SLABS.
               C     THE TEMPERATURE DISTRIBUTION IS CALCULATED BY SOLVING NUMERICALLY
               C     THE FOURIER EQUATION FOR HEAT CONDUCTION.
               C
ISN 0003             DIMENSION TP1(100),TP2(100),E(100),F(100)
ISN 0004             COMMON/     /THETA,DUM(2),DTHETA,NTHETA
ISN 0005             COMMON /SLAB/TF,RHO,HEATF,HEATA
ISN 0006             COMMON/CONTRL/LEX2,IENRY,IPRCY,KTR2,ISW1,ISW2,ISW3,ISW4,ISW5,ISW6
ISN 0007             REAL*8 ALFA,ALAD,BET1,BET2,A,B,C,AA,HH,CC,A1,B1,AA1,HH1,ALFA1,ALAD
                    11,C1,CC1,ALFAN,ALADN,AN,BN,AAN,HHN,D,E,F
               C
ISN 0008             GO TO(10,600),IENRY
               C
ISN 0009          10 CONTINUE
ISN 0010             IS=2
ISN 0011             CALL ERWIN (IS,AREA,XLI,XKI,CI,DENI,NI,NF,NA,COST,TA,GAMMAE,CX3,
                    1TAQ,RVI,RVE,CX1,CX2,TAUSPE,TP1)
ISN 0012             RETURN
               C
ISN 0013         600 GO TO(20,30),LEX2
               C
ISN 0014          20 DNI=NI
ISN 0015             DELTAI=XLI/DNI
ISN 0016             R1=DELTAI/(2.0*XKI)
ISN 0017             NE=NI-1
ISN 0018             IF(NA.EQ.0) GO TO 42
ISN 0020             IF(NA.GT.0.AND.ISW6.EQ.0) GO TO 42
ISN 0022             GC=GAMMAE*(1.0/CX3+R1)/AREA*2.0
ISN 0023             AK1=1.0/(1.0+GC)
ISN 0024             AK2=1.0/(1.0+1.0/GC)
ISN 0025             TK=AK2*TAQ
ISN 0026             H2=CX3
ISN 0027          42 CONTINUE
ISN 0028             ALFA=XKI/(DENI*CI)
ISN 0029             ALAD=ALFA/(DELTAI**2)
ISN 0030             BET1=DTHETA*0.6
ISN 0031             BET2=DTHETA*0.4
ISN 0032             A=ALAD*BET1
ISN 0033             B=1.0+2.0*A
ISN 0034             C=A
ISN 0035             AA=ALAD*BET2
ISN 0036             HH=1.0-2.0*AA
ISN 0037             CC=AA
ISN 0038             A1=A
ISN 0039             AA1=AA
               C
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ISN 0040          30 CONTINUE                                                  ESL2 490
ISN 0041             IF(THETA.LT.TAUSPE) GO TO 51                              ESL2 500
ISN 0043             IF(NA.LT.0) GO TO 51                                      ESL2 510
ISN 0045             NA=-NA                                                    ESL2 520
ISN 0046             H2=CX3                                                    ESL2 530
ISN 0047          51 IF(NA)48,45,46                                            ESL2 540
ISN 0048          45 ALFA1=0.0                                                 ESL2 550
ISN 0049             GO TO 44                                                  ESL2 560
ISN 0050          48 TA=AK1*TP1(1)+TK                                          ESL2 570
ISN 0051             GO TO 49                                                  ESL2 580
ISN 0052          46 H2=CX1+CX2*ABS(TA-TP1(1))                                 ESL2 590
ISN 0053          49 R2= R1+RVE+1.0/H2                                         ESL2 600
ISN 0054             ALFA1=1.0/(R2*DENI*CI)                                    ESL2 610
ISN 0055          44 ALAD1=ALFA1/DELTAI                                        ESL2 620
ISN 0056             C1=BET1*ALAD1                                             ESL2 630
ISN 0057             B1=1.0+A1+C1                                              ESL2 640
ISN 0058             CC1=BET2*ALAD1                                            ESL2 650
ISN 0059             HH1=1.0-(AA1+CC1)                                         ESL2 660
ISN 0060             IF(NF)32,31,32                                            ESL2 670
ISN 0061          31 H=COST                                                    ESL2 680
ISN 0062             GO TO 33                                                  ESL2 690
ISN 0063          32 DELTAT=ABS(TF-TP1(NI))                                    ESL2 700
ISN 0064             H=19.3066*RHO*(DELTAT**0.25)                              ESL2 710
ISN 0065          33 R = R1+RVI+1.0/H                                          ESL2 720
ISN 0066             ALFAN=1.0/(R*DENI*CI)                                     ESL2 730
ISN 0067             ALADN=ALFAN/DELTAI                                        ESL2 740
ISN 0068             AN=BET1*ALADN                                             ESL2 750
ISN 0069             BN=1.0+AN+A                                               ESL2 760
ISN 0070             AAN=BET2*ALADN                                            ESL2 770
ISN 0071             HHN=1.0-(AAN+AA)                                          ESL2 780
ISN 0072             D=AA1*TP1(2)+HH1*TP1(1)+CC1*TA                            ESL2 790
ISN 0073             E(1)=A1/B1                                                ESL2 800
ISN 0074             F(1)=(C1*TA+D)/B1                                         ESL2 810
ISN 0075             DO 35 I=2,NE                                              ESL2 820
ISN 0076             D=AA* TP1(I+1)+HH*TP1(I)+CC*TP1(I-1)                      ESL2 830
ISN 0077             E(I)=A/(B-C*E(I-1))                                       ESL2 840
ISN 0078          35 F(I)=(D+C*F(I-1))/(B-C*E(I-1))                            ESL2 850
ISN 0079             E(NI)=AN/(BN-C*E(NE))                                     ESL2 860
ISN 0080             D=AAN*TF+HHN*TP1(NI)+CC*TP1(NE)                           ESL2 870
ISN 0081             F(NI)=(D+C*F(NE))/(BN-C*E(NE))                            ESL2 880
ISN 0082             TP2(NI)=E(NI)*TF+F(NI)                                    ESL2 890
ISN 0083             DO 36 I=1,NE                                              ESL2 900
ISN 0084             J=NI-I                                                    ESL2 910
ISN 0085             TP2(J)=E(J)*TP2(J+1)+F(J)                                 ESL2 920
ISN 0086          36 CONTINUE                                                  ESL2 930
ISN 0087             TPA=0.4*(TP1(NI)-TF)+0.6*(TP2(NI)-TF)                     ESL2 940
ISN 0088             TPB=0.4*(TA-TP1(1))+0.6*(TA-TP2(1))                       ESL2 950
ISN 0089             HEATF=AREA*TPA*DTHETA/R                                   ESL2 960
ISN 0090             IF(NA)16,15,16                                            ESL2 970
ISN 0091          16 HEATA=AREA*TPB*DTHETA/R2                                  ESL2 980
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ISN 0092            GO TO 17                                                             ESL20990
ISN 0093         15 HEATA=0.0                                                            ESL21000
              C                                                                          ESL21010
ISN 0094         17 IF(IPRCY)2304,2100,2304                                              ESL21020
ISN 0095       2304 IF(NTHETA-1)2303,2100,2303                                           ESL21030
ISN 0096       2303 IF(NTHETA-KTR2)2301,2100,2301                                        ESL21040
ISN 0097       2100 CONTINUE                                                             ESL21050
ISN 0098            IF(ISW1.EQ.0) GO TO 2301                                             ESL21060
              C                                                                          ESL21070
ISN 0100            CALL IPRINT (8HESLAB 2 ,NI,TP1,TP2)                                  ESL21080
ISN 0101       2301 DO 2302 I=1,NI                                                       ESL21090
ISN 0102       2302 TP1(I)=TP2(I)                                                        ESL21100
ISN 0103            RETURN                                                               ESL21110
ISN 0104            END                                                                  ESL21120
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LEVEL 13  (23 MAY 67)                        OS/360  FORTRAN H                                  DATE  68.024/15.54.34
          COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=50,SOURCE,BCD,NOLIST,DECK,LOAD,MAP,NOEDIT,NOID
   ISN 0002               SUBROUTINE IPRINT(A,NI,T1,T2)                                    IPRT    0
                C                                                                          IPRT   10
                C         PRINTS THE TEMPERATURE DISTRIBUTION OF THE INTERNAL AND EXTERNAL IPRT   20
                C         SLABS.                                                           IPRT   30
                C                                                                          IPRT   40
   ISN 0003               DIMENSION T1(100),T2(100),A(2)                                   IPRT   50
   ISN 0004               WRITE (6,10) (A(I),I=1,2)                                        IPRT   60
   ISN 0005               WRITE (6,20) (T1(I),I=1,NI)                                      IPRT   70
   ISN 0006               WRITE (6,20) (T2(I),I=1,NI)                                      IPRT   80
   ISN 0007               RETURN                                                           IPRT   90
   ISN 0008            10 FORMAT (1H0,16HTEMPERATURES OF ,2A4/)                            IPRT  100
   ISN 0009            20 FORMAT (2X,10F9.3)                                               IPRT  110
   ISN 0010               END                                                              IPRT  120
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LEVEL 13  (23 MAY 67)                    OS/360  FORTRAN H                                DATE  68.024/15.54.42
          COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=50,SOURCE,BCD,NOLIST,DECK,LOAD,MAP,NOEDIT,NOID
   ISN 0002              SUBROUTINE IRWIN(IS,S,XL,XK,CP,RO,NI,NF,CS,RINS,T)                       IRWN    0
                C                                                                                 IRWN   10
                C        READS AND PRINTS INPUT DATA FOR ISLB SUBROUTINES.                        IRWN   20
                C                                                                                 IRWN   30
   ISN 0003              DIMENSION T(100)                                                         IRWN   40
   ISN 0004              READ (5,1000) S,XL,XK,CP,RO,NI,NF                                        IRWN   50
   ISN 0005              READ (5,1000)CS,RINS                                                     IRWN   60
   ISN 0006              NE=NI                                                                    IRWN   70
   ISN 0007              READ (5,1001) (T(I),I=1,NE)                                              IRWN   80
   ISN 0008              WRITE (6,100) IS,S,XL,XK,CP,RO,CS,RINS,NI,NF                             IRWN   90
   ISN 0009              WRITE (6,200) (T(I),I=1,NE)                                              IRWN  100
   ISN 0010              RETURN                                                                   IRWN  110
   ISN 0011          100 FORMAT (1H1,2X,'* * INTERNAL SLAB',I2,' INPUT DATA'////3X,'SURFACE IRWN  120
                        * AREA',20X,F10.4,2X,'M**2'//3X,'THICKNESS OF A HALF SLAB',8X,F10.4 IRWN  130
                        *,2X,'M'//3X,'THERMAL CONDUCTIVITY',12X,F10.4,2X,'KCAL/M*HR*C'//3X, IRWN  140
                        *'SPECIFIC HEAT',19X,F10.4,2X,'KCAL/KG*C'//3X,'DENSITY',25X,F10.4,2 IRWN  150
                        *X,'KG/M**3'//3X,'HEAT TRANSFER COEFFICIENT',7X,F10.4,2X,'KCAL/M**2 IRWN  160
                        **HR*C'//3X,'INSULATION THERMAL RESISTANCE',3X,F10.4,2X,'M**2*HR*C/ IRWN  170
                        *KCAL'//3X,'NUMBER OF LAYERS',16X,I10//3X,'NF CONTROL PARAMETER',12 IRWN  180
                        *X,I10////)                                                       IRWN  190
   ISN 0012          200 FORMAT (////3X,'* TEMPERATURE DISTRIBUTION'//(5X,10F9.3))            IRWN  200
   ISN 0013         1000 FORMAT (5E10.0,2I5)                                                  IRWN  210
   ISN 0014         1001 FORMAT (7E10.0)                                                      IRWN  220
   ISN 0015              END                                                                  IRWN  230
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          COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=50,SOURCE,BCD,NOLIST,DECK,LOAD,MAP,NOEDIT,NOID
  ISN 0002            SUBROUTINE ERWIN(IS,S,XL,XK,CP,RO,NI,NF,NA,CS,TA,GAM,CX,TAQ,RINSI, ERWN   0
                     1RINSE,CX1,CX2,TAUSPE,T)                                             ERWN  10
                C                                                                         ERWN  20
                C     READS AND PRINTS INPUT DATA FOR ESLB SUBROUTINES.                   ERWN  30
                C                                                                         ERWN  40
  ISN 0003            COMMON/CONTRL/ISW(9),ISW6                                           ERWN  50
  ISN 0004            DIMENSION T(100)                                                    ERWN  60
  ISN 0005            READ (5,1000) S,XL,XK,CP,RO,NI,NF,NA                                ERWN  70
  ISN 0006            READ (5,1001) CS,CX1,CX2,TA,RINSI,RINSE                             ERWN  80
  ISN 0007            WRITE (6,100) IS,S,XL,XK,CP,RO,CS,RINSI,NI,NF,NA                    ERWN  90
  ISN 0008            IF(NA.EQ.0) GO TO 1                                                 ERWN 100
  ISN 0010            WRITE (6,400) CX1,CX2,TA,RINSE                                      ERWN 110
  ISN 0011            IF(ISW6.EQ.0) GO TO 1                                               ERWN 120
  ISN 0013            READ (5,1001) TAQ,GAM,TAUSPE,CX                                     ERWN 130
  ISN 0014            WRITE (6,500) TAUSPE,TAQ,GAM,CX                                     ERWN 140
  ISN 0015          1 CONTINUE                                                            ERWN 150
  ISN 0016            NE=NI                                                               ERWN 160
  ISN 0017            READ (5,1001) (T(I),I=1,NE)                                         ERWN 170
  ISN 0018            WRITE (6,200) (T(I),I=1,NE)                                         ERWN 180
  ISN 0019            RETURN                                                              ERWN 190
  ISN 0020        100 FORMAT (1H1,2X,'* * EXTERNAL SLAB',I2,' INPUT DATA'////3X,'SURFACE ERWN 200
                     * AREA',30X,F10.4,2X,'M**2'//3X,'THICKNESS OF THE SLAB',21X,F10.4,2 ERWN 210
                     *X,'M'//3X,'THERMAL CONDUCTIVITY',22X,F10.4,2X,'KCAL/M*HR*C'//3X,'S ERWN 220
                     *PECIFIC HEAT',29X,F10.4,2X,'KCAL/KG*C'//3X,'DENSITY',35X,F10.4,2X, ERWN 230
                     *'KG/M**3'//3X,'HEAT TRANSFER COEFFICIENT (INT.FACE)',6X,F10.4,2X,' ERWN 240
                     *KCAL/M**2*HR*C'//3X,'INSULATION THERMAL RESISTANCE (INT.FACE)'2X,F ERWN 250
                     *10.4,2X,'M**2*HR*C/KCAL'//3X,'NUMBER OF LAYERS',26X,I10//3X,'NF CO ERWN 260
                     *NTROL PARAMETER',22X,I10//3X,'NA CONTROL PARAMETER',22X,I10)       ERWN 270
  ISN 0021        200 FORMAT (////3X,'* TEMPERATURE DISTRIBUTION'//(5X,10F9.3))           ERWN 280
  ISN 0022        400 FORMAT (1H0,2X,26HC'EXT (CONSTANT OF EQ. 73),16X,F10.4,2X,'KCAL/M* ERWN 290
                     **2*HR*C'//3X,27HC''EXT (CONSTANT OF EQ. 73),15X,F10.4,2X,'KCAL/M** ERWN 300
                     *2*HR*C**2'//3X,'EXTERNAL AIR TEMPERATURE',18X,F10.4,2X,'C'//3X,'IN ERWN 310
                     *SULATION THERMAL RESISTANCE (EXT.FACE)',2X,F10.4,2X,'M**2*HR*C/KCA ERWN 320
                     *L')                                                                 ERWN 330
  ISN 0023        500 FORMAT (1H0,2X,'* EXTERNAL SPRAY DATA'//3X,'STARTING TIME',42X,F10 ERWN 340
                     *.4,2X,'HR'//3X,'WATER TEMPERATURE AT OUTLET OF THE NOZZLES',13X,F1 ERWN 350
                     *0.4,2X,'C'//3X,'MASS FLOW RATE',41X,F10.4,2X,'KG/HR'//3X,'HEAT TRA ERWN 360
                     *NSFER COEFFICIENT WITH EXTERNAL COOLING MEDIUM',1X,F10.4,2X,'KCAL/ ERWN 370
                     *M**2*HR*C')                                                         ERWN 380
  ISN 0024       1000 FORMAT (5E10.0,3I5)                                                 ERWN 390
  ISN 0025       1001 FORMAT (7E10.0)                                                     ERWN 400
  ISN 0026            END                                                                 ERWN 410
```

```
LEVEL 13  (23 MAY 67)                      OS/360  FORTRAN H                                    DATE  68.024/15.56.15
         COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=50,SOURCE,BCD,NOLIST,DECK,LOAD,MAP,NOEDIT,NOID
   ISN 0002                SUBROUTINE ISLB5                                                     ISL5    0
               C           DUMMY SUBROUTINE                                                     ISL5   10
   ISN 0003                IS=5                                                                 ISL5   20
   ISN 0004                RETURN                                                               ISL5   30
   ISN 0005                END                                                                  ISL5   40
```

```
LEVEL 13  (23 MAY 67)                                OS/360  FORTRAN H                                        DATE  68.024/15.56.21
          COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=50,SOURCE,BCD,NOLIST,DECK,LOAD,MAP,NOEDIT,NOID
  ISN 0002              SUBROUTINE ISLB6                                                         ISL6    0
                C       DUMMY SUBROUTINE                                                         ISL6   10
  ISN 0003              IS=6                                                                     ISL6   20
  ISN 0004              RETURN                                                                   ISL6   30
  ISN 0005              END                                                                      ISL6   40
```

```
LEVEL 13  (23 MAY 67)                          OS/360  FORTRAN H                                       DATE  68.024/15.56.28
         COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=50,SOURCE,BCD,NOLIST,DECK,LOAD,MAP,NOEDIT,NOID
  ISN 0002                SUBROUTINE ESLB3                                                      ESL3    0
               C          DUMMY SUBROUTINE                                                      ESL3   10
  ISN 0003                IS=3                                                                  ESL3   20
  ISN 0004                RETURN                                                                ESL3   30
  ISN 0005                END                                                                   ESL3   40
```

```
LEVEL 13  (23 MAY 67)                          OS/360  FORTRAN H                                       DATE  68.024/15.56.35
         COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=50,SOURCE,BCD,NOLIST,DECK,LOAD,MAP,NOEDIT,NOID
  ISN 0002                SUBROUTINE ESLB4                                                      ESL4    0
               C          DUMMY SUBROUTINE                                                      ESL4   10
  ISN 0003                IS=4                                                                  ESL4   20
  ISN 0004                RETURN                                                                ESL4   30
  ISN 0005                END                                                                   ESL4   40
```

4.7 Sample problem

The sample problem presented in the following has been solved in two runs, i.e., the first run covering the blowdown phase of the primary high enthalpy coolant, the second run covering the subsequent phase up to 5 hours after the initiation of the accident.

Output data of the first run are, of course, used as input data for the second run.

In the following a table is presented giving input and output for the two runs. The outputs are presented in the short form.

```
** SAMPLE PROBLEM FOR PREST (BLOWDOWN PHASE)    1,10,68 **                   T00
    0    1    1    1    0    0    0    0    1   60                           M00
         4         2      3000 .555556-5       0.0       0.0                 M01
   16420.0       0.0       0.0     0.721      30.0     110.0                 M02
     16610      0.02   13.0475      0.13    7500.0   10    0               1-I01
    111.96       0.0                                                       1-I02
     265.0     265.0     265.0     265.0     265.0     265.0     265.0     1-I03
     265.0     265.0     265.0                                             1-I03
      80.0      0.05   13.0475      0.13    7500.0   10    0               2-I01
    55.656       0.0                                                       2-I02
     265.0     265.0     265.0     265.0     265.0     265.0     265.0     2-I03
     265.0     265.0     265.0                                             2-I03
     417.0     0.008   13.0475      0.13    7500.0    8    0               3-I01
    55.620       0.0                                                       3-I02
     265.0     265.0     265.0     265.0     265.0     265.0     265.0     3-I03
     265.0                                                                 3-I03
     257.0      0.07   13.0475      0.13    7500.0   20    0               4-I01
    111.96       0.0                                                       4-I02
      74.0      74.0      74.0      74.0      74.0      74.0      74.0     4-I03
      74.0      74.0      74.0      74.0      74.0      74.0      74.0     4-I03
      74.0      74.0      74.0      74.0      74.0      74.0               4-I03
    6740.0       0.5   2.28645      0.23    2500.0   10    0    0          1-E01
   75.5777                                                                 1-E02
      50.0      50.0      50.0      50.0      50.0      50.0      50.0     1-E04
      50.0      50.0      50.0                                             1-E04
    1060.0    0.0157   13.0475      0.13    7500.0   16    0    1          2-E01
    111.96     9.756       0.0      30.0       0.0       0.0               2-E02
      30.0      30.0      30.0      30.0      30.0      30.0      30.0     2-E04
      30.0      30.0      30.0      30.0      30.0      30.0      30.0     2-E04
      30.0      30.0                                                       2-E04
   14  120  120                                                              C01
        10.0      .01252      .00940       591.6                             C02
        12.0      .01429      .01066       590.5                             C02
        15.0      .01738      .01283       588.8                             C02
        18.0      .02104      .01537       587.1                             C02
        20.0      .02383      .01729       586.0                             C02
        21.0      .02535      .01833       585.5                             C02
        22.0      .02695      .01942       584.9                             C02
        23.0      .02863      .02056       584.3                             C02
        24.0      .03041      .02177       583.8                             C02
        25.0      .03229      .02304       583.2                             C02
        26.0      .03426      .02436       582.6                             C02
        27.0      .03634      .02576       582.1                             C02
        28.0      .03853      .02722       581.5                             C02
        29.0      .04083      .02875       580.9                             C02
        30.0      .04325      .03036       580.4                             C02
        31.0      .04579      .03204       579.8                             C02
        32.0      .04847      .03381       579.2                             C02
        33.0      .05128      .03565       578.7                             C02
        34.0      .05422      .03757       578.1                             C02
        35.0      .05732      .03960       577.5                             C02
        36.0      .06056      .04170       577.0                             C02
        37.0      .06397      .04391       576.4                             C02
        38.0      .06754      .04622       575.8                             C02
        39.0      .07128      .04863       575.2                             C02
        40.0      .07519      .05113       574.7                             C02
        41.0      .07930      .05376       574.1                             C02
        42.0      .08359      .05650       573.5                             C02
        43.0      .08808      .05935       573.0                             C02
        44.0      .09278      .06233       572.4                             C02
```

```
  45.0       .09770      .06544      571.8                     CO2
  46.0       .10283      .06866      571.2                     CO2
  47.0       .10820      .07203      570.7                     CO2
  48.0       .11381      .07554      570.1                     CO2
  49.0       .11966      .07918      569.5                     CO2
  50.0       .12577      .08298      569.0                     CO2
  51.0       .13215      .08693      568.4                     CO2
  52.0       .13880      .09104      567.9                     CO2
  53.0       .14573      .09530      567.3                     CO2
  54.0       .15296      .09974      566.7                     CO2
  55.0       .16050      .10440      566.1                     CO2
  56.0       .16835      .10910      565.5                     CO2
  57.0       .17652      .11410      565.0                     CO2
  58.0       .18504      .11930      564.4                     CO2
  59.0       .19390      .12460      563.8                     CO2
  60.0       .20310      .13020      563.2                     CO2
  61.0       .21270      .13590      562.6                     CO2
  62.0       .22270      .14190      562.0                     CO2
  63.0       .23300      .14810      561.4                     CO2
  64.0       .24380      .15450      560.8                     CO2
  65.0       .25500      .16120      560.2                     CO2
  66.0       .26660      .16800      559.7                     CO2
  67.0       .27870      .17520      559.1                     CO2
  68.0       .29130      .18260      558.5                     CO2
  69.0       .30430      .19020      557.9                     CO2
  70.0       .31780      .19810      557.3                     CO2
  71.0       .33180      .20630      556.7                     CO2
  72.0       .34630      .21470      556.1                     CO2
  73.0       .36130      .22350      555.5                     CO2
  74.0       .37690      .23250      554.9                     CO2
  75.0       .39310      .24180      554.3                     CO2
  76.0       .40980      .25150      553.7                     CO2
  77.0       .42720      .26140      553.1                     CO2
  78.0       .44510      .27170      552.5                     CO2
  79.0       .46370      .28230      551.9                     CO2
  80.0       .48290      .29330      551.2                     CO2
  81.0       .50280      .30460      550.5                     CO2
  82.0       .52340      .31620      549.9                     CO2
  83.0       .54470      .32830      549.3                     CO2
  84.0       .56670      .34070      548.7                     CO2
  85.0       .58940      .35350      548.1                     CO2
  86.0       .61290      .36660      547.5                     CO2
  87.0       .63720      .38020      546.9                     CO2
  88.0       .66230      .39420      546.3                     CO2
  89.0       .68820      .40860      545.6                     CO2
  90.0       .71490      .42350      545.0                     CO2
  91.0       .74250      .43880      544.4                     CO2
  92.0       .77100      .45450      543.8                     CO2
  93.0       .80040      .47070      543.2                     CO2
  94.0       .83070      .48740      542.5                     CO2
  95.0       .86190      .50450      541.9                     CO2
  96.0       .89420      .52220      541.3                     CO2
  97.0       .92740      .54030      540.7                     CO2
  98.0       .96160      .55890      540.0                     CO2
  99.0       .99690      .57810      539.4                     CO2
 100.0      1.03320      .59770      538.8                     CO2
 101.0      1.07070      .61810      538.0                     CO2
 102.0      1.10920      .63880      537.4                     CO2
 103.0      1.14890      .66020      536.8                     CO2
 104.0      1.18980      .68220      536.1                     CO2
 105.0      1.23180      .70470      535.5                     CO2
```

```
       106.0     1.27510      .72780       534.9                             C02
       107.0     1.31960      .75160       534.2                             C02
       108.0     1.36540      .77600       533.6                             C02
       109.0     1.41250      .80100       532.9                             C02
       110.0     1.46090      .82640       532.3                             C02
       111.0     1.51060      .85300       531.6                             C02
       112.0     1.56180      .88000       530.9                             C02
       113.0     1.61440      .90770       530.3                             C02
       114.0     1.66840      .93610       529.6                             C02
       115.0     1.72390      .96520       529.0                             C02
       116.0     1.78090      .99510       528.3                             C02
       117.0     1.83940     1.02600       527.7                             C02
       118.0     1.89950     1.05700       527.0                             C02
       119.0     1.96120     1.08900       526.3                             C02
       120.0     2.02450     1.12200       525.6                             C02
       121.0     2.08950     1.15600       524.9                             C02
       122.0     2.15610     1.19000       524.3                             C02
       123.0     2.22450     1.22500       523.6                             C02
       124.0     2.29470     1.26200       523.0                             C02
       125.0     2.36660     1.29900       522.3                             C02
       126.0     2.44040     1.33700       521.5                             C02
       127.0     2.51600     1.37500       520.9                             C02
       128.0     2.59350     1.41500       520.2                             C02
       129.0     2.67300     1.45600       519.5                             C02
       130.0     2.75440     1.49700       518.9                             C02
       131.0     2.83780     1.54000       518.1                             C02
       132.0     2.92330     1.58300       517.4                             C02
       133.0     3.01100     1.62800       516.7                             C02
       134.0     3.10000     1.67300       516.1                             C02
       135.0     3.19200     1.71900       515.4                             C02
  13346.00     0.171                                                         C03
       0.5       0.1       0.2       0.5    7200.0                           D01
                1.25                                                         D02
    6    3   22                                                              D03
     500.0     800.0    1500.0                                               D04
      0.00      0.05      0.10      0.20      0.30      0.40      0.50       D05
      0.60      0.70      0.80      0.90      1.00      1.20      1.40       D05
      1.60      1.80      2.00      2.20      2.40      2.60      2.80       D05
      3.00                                                                   D05
       0.0  1.0800-5  1.5840-5  2.3400-5  2.9520-5  3.4560-5  3.8880-5       D06
  4.2840-5  4.6080-5  4.7880-5  4.9320-5  4.9680-5  5.0760-5  5.1660-5       D06
  5.2632-5  5.3640-5  5.4720-5  5.5620-5  5.6628-5  5.7600-5  5.8680-5       D06
  5.9580-5                                                                   D06
        50                                                                   Y01
 2.77778-4 5.55556-4 8.33333-4 1.11111-3 1.38889-3 1.66667-3 1.94444-3       Y02
 2.22222-3 2.50000-3 2.77778-3 3.88889-3 5.55556-3 8.33333-3 1.11111-2       Y02
 1.38889-2 1.66667-2 1.94444-2 2.22222-2 2.50000-2 2.77778-2 3.88889-2       Y02
 5.55556-2 8.33333-2 1.11111-1 1.38889-1 1.66667-1 1.94444-1 2.22222-1       Y02
 2.50000-1 2.77778-1 5.55556-1 8.33333-1 1.11111+0 1.38888+0 1.66666+0       Y02
 1.94444+0 2.22222+0 2.50000+0 2.77777+0 5.55555+0 8.33333+0 1.11111+1       Y02
 1.38888+1 1.66666+1 1.94444+1 2.22222+1 2.50000+1 2.77777+1 3.88888+1       Y02
 5.55555+1 7.22222+1 8.33333+1 1.11111+2 1.38888+2 1.66666+2 1.94444+2       Y02
   6.230-2   5.900-2   5.680-2   5.550-2   5.410-2   5.325-2   5.225-2       Y03
   5.150-2   5.075-2   5.000-2   4.750-2   4.500-2   4.200-2   3.975-2       Y03
   3.810-2   3.660-2   3.555-2   3.450-2   3.380-2   3.310-2   3.040-2       Y03
   2.785-2   2.525-2   2.350-2   2.210-2   2.115-2   2.040-2   1.975-2       Y03
   1.915-2   1.855-2   1.575-2   1.400-2   1.280-2   1.200-2   1.130-2       Y03
   1.095-2   1.040-2   1.000-2   0.960-2   0.780-2   0.690-2   0.630-2       Y03
   0.590-2   0.555-2   0.530-2   0.505-2   0.495-2   0.475-2   0.438-2       Y03
   0.400-2   0.375-2   0.362-2   0.340-2   0.325-2   0.310-2   0.296-2       Y03
       0.0 0.24809+8       0.0       0.0   0.695-3                           B01
     100.0     424.5       0.0       0.0       0.0                           B02
```

```
** SAMPLE PROBLEM FOR PREST (PHASE SUBSEQUENT TO BLOWDOWN) **              T00
  0    0    1    1    1    1    0    0    1   90                           M00
       4         2      9000 0.55556-3 .166639-1     0.522                 M01
16412.91 17600.184 7518119.0     2.012   103.501     110.0                 M02
0.1666-1         1       4.5                                              SP01
 90000.0                                                                  SP02
    25.0                                                                  SP03
   166.0      0.02   13.0475      0.13    7500.0   10    0               1-I01
  111.96       0.0                                                       1-I02
 254.543   254.302   253.821   253.100   252.138   250.935   249.492      1I03
 247.810   245.891   243.736                                              1I03
    80.0      0.05   13.0475      0.13    7500.0   10    0               2-I01
  55.656       0.0                                                       2-I02
 264.247   264.165   263.994   263.659   263.153   262.400   261.320      2I03
 259.821   257.802   255.209                                              2I03
   417.0     0.008   13.0475      0.13    7500.0    8    0               3-I01
  55.620       0.0                                                       3-I02
 247.608   247.532   247.380   247.153   246.850   246.471   246.017      3I03
 245.488                                                                  3I03
   257.0      0.07   13.0475      0.13    7500.0   20    0               4-I01
  111.96       0.0                                                       4-I02
  73.996    73.996    73.996    73.998    74.003    74.012    74.026      4I03
  74.048    74.082    74.133    74.207    74.310    74.452    74.642      4I03
  74.890    75.209    75.607    76.093    76.673    77.350                4I03
  6740.0       0.5   2.28645      0.23    2500.0   10    0    0          1-E01
 75.5777                                                                 1-E02
  50.000    50.000    50.000    50.000    50.000    50.000    50.000      1E04
  50.000    50.000    51.194                                              1E04
  1060.0    0.0157   13.0475      0.13    7500.0   16    0    1          2-E01
  111.96     9.756       0.0      30.0       0.0       0.0               2-E02
    25.0   90000.0  0.1666-1     489.6                                    2E03
  36.473    36.511    36.582    36.687    36.825    36.996    37.201      2E04
  37.439    37.709    38.013    38.349    38.717    39.118    39.552      2E04
  40.017    40.513                                                        2E04
 14  120  120                                                              C01
      10.0      .01252      .00940       591.6                             C02
      12.0      .01429      .01066       590.5                             C02
      15.0      .01738      .01283       588.8                             C02
      18.0      .02104      .01537       587.1                             C02
      20.0      .02383      .01729       586.0                             C02
      21.0      .02535      .01833       585.5                             C02
      22.0      .02695      .01942       584.9                             C02
      23.0      .02863      .02056       584.3                             C02
      24.0      .03041      .02177       583.8                             C02
      25.0      .03229      .02304       583.2                             C02
      26.0      .03426      .02436       582.6                             C02
      27.0      .03634      .02576       582.1                             C02
      28.0      .03853      .02722       581.5                             C02
      29.0      .04083      .02875       580.9                             C02
      30.0      .04325      .03036       580.4                             C02
      31.0      .04579      .03204       579.8                             C02
      32.0      .04847      .03381       579.2                             C02
      33.0      .05128      .03565       578.7                             C02
      34.0      .05422      .03757       578.1                             C02
      35.0      .05732      .03960       577.5                             C02
      36.0      .06056      .04170       577.0                             C02
      37.0      .06397      .04391       576.4                             C02
      38.0      .06754      .04622       575.8                             C02
      39.0      .07128      .04863       575.2                             C02
      40.0      .07519      .05113       574.7                             C02
```

```
  41.0       .07930      .05376      574.1                            CO2
  42.0       .08359      .05650      573.5                            CO2
  43.0       .08808      .05935      573.0                            CO2
  44.0       .09278      .06233      572.4                            CO2
  45.0       .09770      .06544      571.8                            CO2
  46.0       .10283      .06866      571.2                            CO2
  47.0       .10820      .07203      570.7                            CO2
  48.0       .11381      .07554      570.1                            CO2
  49.0       .11966      .07918      569.5                            CO2
  50.0       .12577      .08298      569.0                            CO2
  51.0       .13215      .08693      568.4                            CO2
  52.0       .13880      .09104      567.9                            CO2
  53.0       .14573      .09530      567.3                            CO2
  54.0       .15296      .09974      566.7                            CO2
  55.0       .16050      .10440      566.1                            CO2
  56.0       .16835      .10910      565.5                            CO2
  57.0       .17652      .11410      565.0                            CO2
  58.0       .18504      .11930      564.4                            CO2
  59.0       .19390      .12460      563.8                            CO2
  60.0       .20310      .13020      563.2                            CO2
  61.0       .21270      .13590      562.6                            CO2
  62.0       .22270      .14190      562.0                            CO2
  63.0       .23300      .14810      561.4                            CO2
  64.0       .24380      .15450      560.8                            CO2
  65.0       .25500      .16120      560.2                            CO2
  66.0       .26660      .16800      559.7                            CO2
  67.0       .27870      .17520      559.1                            CO2
  68.0       .29130      .18260      558.5                            CO2
  69.0       .30430      .19020      557.9                            CO2
  70.0       .31780      .19810      557.3                            CO2
  71.0       .33180      .20630      556.7                            CO2
  72.0       .34630      .21470      556.1                            CO2
  73.0       .36130      .22350      555.5                            CO2
  74.0       .37690      .23250      554.9                            CO2
  75.0       .39310      .24180      554.3                            CO2
  76.0       .40980      .25150      553.7                            CO2
  77.0       .42720      .26140      553.1                            CO2
  78.0       .44510      .27170      552.5                            CO2
  79.0       .46370      .28230      551.9                            CO2
  80.0       .48290      .29330      551.2                            CO2
  81.0       .50280      .30460      550.5                            CO2
  82.0       .52340      .31620      549.9                            CO2
  83.0       .54470      .32830      549.3                            CO2
  84.0       .56670      .34070      548.7                            CO2
  85.0       .58940      .35350      548.1                            CO2
  86.0       .61290      .36660      547.5                            CO2
  87.0       .63720      .38020      546.9                            CO2
  88.0       .66230      .39420      546.3                            CO2
  89.0       .68820      .40860      545.6                            CO2
  90.0       .71490      .42350      545.0                            CO2
  91.0       .74250      .43880      544.4                            CO2
  92.0       .77100      .45450      543.8                            CO2
  93.0       .80040      .47070      543.2                            CO2
  94.0       .83070      .48740      542.5                            CO2
  95.0       .86190      .50450      541.9                            CO2
  96.0       .89420      .52220      541.3                            CO2
  97.0       .92740      .54030      540.7                            CO2
  98.0       .96160      .55890      540.0                            CO2
  99.0       .99690      .57810      539.4                            CO2
 100.0      1.03320      .59770      538.8                            CO2
 101.0      1.07070      .61810      538.0                            CO2
```

```
       102.0     1.10920      .63880       537.4                             C02
       103.0     1.14890      .66020       536.8                             C02
       104.0     1.18980      .68220       536.1                             C02
       105.0     1.23180      .70470       535.5                             C02
       106.0     1.27510      .72780       534.9                             C02
       107.0     1.31960      .75160       534.2                             C02
       108.0     1.36540      .77600       533.6                             C02
       109.0     1.41250      .80100       532.9                             C02
       110.0     1.46090      .82640       532.3                             C02
       111.0     1.51060      .85300       531.6                             C02
       112.0     1.56180      .88000       530.9                             C02
       113.0     1.61440      .90770       530.3                             C02
       114.0     1.66840      .93610       529.6                             C02
       115.0     1.72390      .96520       529.0                             C02
       116.0     1.78090      .99510       528.3                             C02
       117.0     1.83940     1.02600       527.7                             C02
       118.0     1.89950     1.05700       527.0                             C02
       119.0     1.96120     1.08900       526.3                             C02
       120.0     2.02450     1.12200       525.6                             C02
       121.0     2.08950     1.15600       524.9                             C02
       122.0     2.15610     1.19000       524.3                             C02
       123.0     2.22450     1.22500       523.6                             C02
       124.0     2.29470     1.26200       523.0                             C02
       125.0     2.36660     1.29900       522.3                             C02
       126.0     2.44040     1.33700       521.5                             C02
       127.0     2.51600     1.37500       520.9                             C02
       128.0     2.59350     1.41500       520.2                             C02
       129.0     2.67300     1.45600       519.5                             C02
       130.0     2.75440     1.49700       518.9                             C02
       131.0     2.83780     1.54000       518.1                             C02
       132.0     2.92330     1.58300       517.4                             C02
       133.0     3.01100     1.62800       516.7                             C02
       134.0     3.10000     1.67300       516.1                             C02
       135.0     3.19200     1.71900       515.4                             C02
  13346.00     0.171                                                         C03
       0.5       0.1       0.2       0.5    7200.0                           D01
                1.25                                                         D02
    6    3   22                                                              D03
     500.0     800.0    1500.0                                               D04
      0.00      0.05      0.10      0.20      0.30      0.40      0.50       D05
      0.60      0.70      0.80      0.90      1.00      1.20      1.40       D05
      1.60      1.80      2.00      2.20      2.40      2.60      2.80       D05
      3.00                                                                   D05
       0.0  1.0800-5  1.5840-5  2.3400-5  2.9520-5  3.4560-5  3.8880-5       D06
  4.2840-5  4.6080-5  4.7880-5  4.9320-5  4.9680-5  5.0760-5  5.1660-5       D06
  5.2632-5  5.3640-5  5.4720-5  5.5620-5  5.6628-5  5.7600-5  5.8680-5       D06
  5.9580-5                                                                   D06
        50                                                                   Y01
 2.77778-4 5.55556-4 8.33333-4 1.11111-3 1.38889-3 1.66667-3 1.94444-3       Y02
 2.22222-3 2.50000-3 2.77778-3 3.88889-3 5.55556-3 8.33333-3 1.11111-2       Y02
 1.38889-2 1.66667-2 1.94444-2 2.22222-2 2.50000-2 2.77778-2 3.88889-2       Y02
 5.55556-2 8.33333-2 1.11111-1 1.38889-1 1.66667-1 1.94444-1 2.22222-1       Y02
 2.50000-1 2.77778-1 5.55556-1 8.33333-1 1.11111+0 1.38888+0 1.66666+0       Y02
 1.94444+0 2.22222+0 2.50000+0 2.77777+0 5.55555+0 8.33333+0 1.11111+1       Y02
 1.38888+1 1.66666+1 1.94444+1 2.22222+1 2.50000+1 2.77777+1 3.88888+1       Y02
 5.55555+1 7.22222+1 8.33333+1 1.11111+2 1.38888+2 1.66666+2 1.94444+2       Y02
   6.230-2   5.900-2   5.680-2   5.550-2   5.410-2   5.325-2   5.225-2       Y03
   5.150-2   5.075-2   5.000-2   4.750-2   4.500-2   4.200-2   3.975-2       Y03
   3.810-2   3.660-2   3.555-2   3.450-2   3.380-2   3.310-2   3.040-2       Y03
   2.785-2   2.525-2   2.350-2   2.210-2   2.115-2   2.040-2   1.975-2       Y03
   1.915-2   1.855-2   1.575-2   1.400-2   1.280-2   1.200-2   1.130-2       Y03
   1.095-2   1.040-2   1.000-2   0.960-2   0.780-2   0.690-2   0.630-2       Y03
   0.590-2   0.555-2   0.530-2   0.505-2   0.495-2   0.475-2   0.438-2       Y03
   0.400-2   0.375-2   0.362-2   0.340-2   0.325-2   0.310-2   0.296-2       Y03
```

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                                                 * * * P R E S T * * *
PROBLEM TITLE
                           ** SAMPLE PROBLEM FOR PREST (BLOWDOWN PHASE)  1,10,68 **
INPUT DATA

PRINTING PARAMETER                     0
BLOWDOWN PARAMETER                     1
DECAY HEAT PARAMETER                   1
DOSE CALCULATION PARAMETER             1
INTERNAL SPRAY PARAMETER               0
EXTERNAL SPRAY PARAMETER               0
CHEMICAL HEAT PARAMETER                0
NUCLEAR HEAT PARAMETER                 0
PLOTTING PARAMETER                   501

ISLABS NUMBER                          4
ESLABS NUMBER                          2
MAXIMUM NUMBER OF TIME STEPS        3000
INITIAL VALUE OF TIME         0.0            HR
TIME STEP VALUE               0.5555559E-05  HR
INITIAL VALUE OF DOSE         0.0            REM
```

```
* * INTERNAL SLAB 1 INPUT DATA

SURFACE AREA                          166.0000  M**2
THICKNESS OF A HALF SLAB                0.0200  M
THERMAL CONDUCTIVITY                   13.0475  KCAL/M*HR*C
SPECIFIC HEAT                           0.1300  KCAL/KG*C
DENSITY                              7500.0000  KG/M**3
HEAT TRANSFER COEFFICIENT             111.9600  KCAL/M**2*HR*C
INSULATION THERMAL RESISTANCE           0.0     M**2*HR*C/KCAL
NUMBER OF LAYERS                            10
NF CONTROL PARAMETER                         0



* TEMPERATURE DISTRIBUTION
    265.000  265.000  265.000  265.000  265.000  265.000  265.000  265.000  265.000  265.000
```

```
* * INTERNAL SLAB 2 INPUT DATA

SURFACE AREA                          80.0000  M**2
THICKNESS OF A HALF SLAB               0.0500  M
THERMAL CONDUCTIVITY                  13.0475  KCAL/M*HR*C
SPECIFIC HEAT                          0.1300  KCAL/KG*C
DENSITY                             7500.0000  KG/M**3
HEAT TRANSFER COEFFICIENT             55.6560  KCAL/M**2*HR*C
INSULATION THERMAL RESISTANCE          0.0     M**2*HR*C/KCAL
NUMBER OF LAYERS                           10
NF CONTROL PARAMETER                        0




* TEMPERATURE DISTRIBUTION
    265.000   265.000   265.000   265.000   265.000   265.000   265.000   265.000   265.000   265.000
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* * INTERNAL SLAB 3 INPUT DATA

SURFACE AREA                         417.0000  M**2
THICKNESS OF A HALF SLAB               0.0080  M
THERMAL CONDUCTIVITY                  13.0475  KCAL/M*HR*C
SPECIFIC HEAT                          0.1300  KCAL/KG*C
DENSITY                             7500.0000  KG/M**3
HEAT TRANSFER COEFFICIENT             55.6200  KCAL/M**2*HR*C
INSULATION THERMAL RESISTANCE          0.0     M**2*HR*C/KCAL
NUMBER OF LAYERS                            8
NF CONTROL PARAMETER                        0



* TEMPERATURE DISTRIBUTION
    265.000  265.000  265.000  265.000  265.000  265.000  265.000  265.000
```

```
* * INTERNAL SLAB 4 INPUT DATA

SURFACE AREA                          257.0000  M**2
THICKNESS OF A HALF SLAB                0.0700  M
THERMAL CONDUCTIVITY                   13.0475  KCAL/M*HR*C
SPECIFIC HEAT                           0.1300  KCAL/KG*C
DENSITY                              7500.0000  KG/M**3
HEAT TRANSFER COEFFICIENT             111.9600  KCAL/M**2*HR*C
INSULATION THERMAL RESISTANCE           0.0     M**2*HR*C/KCAL
NUMBER OF LAYERS                            20
NF CONTROL PARAMETER                         0


* TEMPERATURE DISTRIBUTION
     74.000    74.000    74.000    74.000    74.000    74.000    74.000    74.000    74.000    74.000
     74.000    74.000    74.000    74.000    74.000    74.000    74.000    74.000    74.000    74.000
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* * EXTERNAL SLAB 1 INPUT DATA

SURFACE AREA                                6740.0000  M**2
THICKNESS OF THE SLAB                          0.5000  M
THERMAL CONDUCTIVITY                           2.2864  KCAL/M*HR*C
SPECIFIC HEAT                                  0.2300  KCAL/KG*C
DENSITY                                     2500.0000  KG/M**3
HEAT TRANSFER COEFFICIENT (INT.FACE)          75.5777  KCAL/M**2*HR*C
INSULATION THERMAL RESISTANCE (INT.FACE)       0.0     M**2*HR*C/KCAL
NUMBER OF LAYERS                                   10
NF CONTROL PARAMETER                                0
NA CONTROL PARAMETER                                0


* TEMPERATURE DISTRIBUTION
     50.000   50.000   50.000   50.000   50.000   50.000   50.000   50.000   50.000   50.000
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* * EXTERNAL SLAB 2 INPUT DATA

SURFACE AREA                                  1060.0000  M**2
THICKNESS OF THE SLAB                            0.0157  M
THERMAL CONDUCTIVITY                            13.0475  KCAL/M*HR*C
SPECIFIC HEAT                                    0.1300  KCAL/KG*C
DENSITY                                       7500.0000  KG/M**3
HEAT TRANSFER COEFFICIENT (INT.FACE)           111.9600  KCAL/M**2*HR*C
INSULATION THERMAL RESISTANCE (INT.FACE)         0.0     M**2*HR*C/KCAL
NUMBER OF LAYERS                                     16
NF CONTROL PARAMETER                                  0
NA CONTROL PARAMETER                                  1
C'EXT (CONSTANT OF EQ. 73)                       9.7560  KCAL/M**2*HR*C
C''EXT (CONSTANT OF EQ. 73)                      0.0     KCAL/M**2*HR*C**2
EXTERNAL AIR TEMPERATURE                        30.0000  C
INSULATION THERMAL RESISTANCE (EXT.FACE)         0.0     M**2*HR*C/KCAL


* TEMPERATURE DISTRIBUTION

     30.000    30.000    30.000    30.000    30.000    30.000    30.000    30.000    30.000    30.000
     30.000    30.000    30.000    30.000    30.000    30.000
```

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   PHYSICAL PROPERTIES OF AIR, WATER, AND STEAM

SPECIFIC HEAT OF AIR AT CONSTANT VOLUME    0.17100   KCAL/KG*C


  TEMPERATURE       SATURATION       SPECIFIC HEAT      DENSITY OF
                     PRESSURE       OF EVAPORATION        VAPOUR
      (C)          (KG/CM**2)         (KCAL/KG)         (KG/M**3)

    10.0000          0.0125           591.59985          0.00940
    12.0000          0.0143           590.50000          0.01066
    15.0000          0.0174           588.79980          0.01283
    18.0000          0.0210           587.09985          0.01537
    20.0000          0.0238           586.00000          0.01729
    21.0000          0.0253           585.50000          0.01833
    22.0000          0.0269           584.89990          0.01942
    23.0000          0.0286           584.29980          0.02056
    24.0000          0.0304           583.79980          0.02177
    25.0000          0.0323           583.19995          0.02304
    26.0000          0.0343           582.59985          0.02436
    27.0000          0.0363           582.09985          0.02576
    28.0000          0.0385           581.50000          0.02722
    29.0000          0.0408           580.89990          0.02875
    30.0000          0.0432           580.39990          0.03036
    31.0000          0.0458           579.79980          0.03204
    32.0000          0.0485           579.19995          0.03381
    33.0000          0.0513           578.69995          0.03565
    34.0000          0.0542           578.09985          0.03757
    35.0000          0.0573           577.50000          0.03960
    36.0000          0.0606           577.00000          0.04170
    37.0000          0.0640           576.39990          0.04391
    38.0000          0.0675           575.79980          0.04622
    39.0000          0.0713           575.19995          0.04863
    40.0000          0.0752           574.69995          0.05113
    41.0000          0.0793           574.09985          0.05376
    42.0000          0.0836           573.50000          0.05650
    43.0000          0.0881           573.00000          0.05935
    44.0000          0.0928           572.39990          0.06233
    45.0000          0.0977           571.79980          0.06544
    46.0000          0.1028           571.19995          0.06866
    47.0000          0.1082           570.69995          0.07203
    48.0000          0.1138           570.09985          0.07554
    49.0000          0.1197           569.50000          0.07918
    50.0000          0.1258           569.00000          0.08298
    51.0000          0.1321           568.39990          0.08693
    52.0000          0.1388           567.89990          0.09104
    53.0000          0.1457           567.29980          0.09530
    54.0000          0.1530           566.69995          0.09974
    55.0000          0.1605           566.09985          0.10440
    56.0000          0.1683           565.50000          0.10910
    57.0000          0.1765           565.00000          0.11410
    58.0000          0.1850           564.39990          0.11930
    59.0000          0.1939           563.79980          0.12460
    60.0000          0.2031           563.19995          0.13020
    61.0000          0.2127           562.59985          0.13590
    62.0000          0.2227           562.00000          0.14190
    63.0000          0.2330           561.39990          0.14810
    64.0000          0.2438           560.79980          0.15450
    65.0000          0.2550           560.19995          0.16120
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  66.0000          0.2666        559.69995        0.16800
  67.0000          0.2787        559.09985        0.17520
  68.0000          0.2913        558.50000        0.18260
  69.0000          0.3043        557.89990        0.19020
  70.0000          0.3178        557.29980        0.19810
  71.0000          0.3318        556.69995        0.20630
  72.0000          0.3463        556.09985        0.21470
  73.0000          0.3613        555.50000        0.22350
  74.0000          0.3769        554.89990        0.23250
  75.0000          0.3931        554.29980        0.24180
  76.0000          0.4098        553.69995        0.25150
  77.0000          0.4272        553.09985        0.26140
  78.0000          0.4451        552.50000        0.27170
  79.0000          0.4637        551.89990        0.28230
  80.0000          0.4829        551.19995        0.29330
  81.0000          0.5028        550.50000        0.30460
  82.0000          0.5234        549.89990        0.31620
  83.0000          0.5447        549.29980        0.32830
  84.0000          0.5667        548.69995        0.34070
  85.0000          0.5894        548.09985        0.35350
  86.0000          0.6129        547.50000        0.36660
  87.0000          0.6372        546.89990        0.38020
  88.0000          0.6623        546.29980        0.39420
  89.0000          0.6882        545.59985        0.40860
  90.0000          0.7149        545.00000        0.42350
  91.0000          0.7425        544.39990        0.43880
  92.0000          0.7710        543.79980        0.45450
  93.0000          0.8004        543.19995        0.47070
  94.0000          0.8307        542.50000        0.48740
  95.0000          0.8619        541.89990        0.50450
  96.0000          0.8942        541.29980        0.52220
  97.0000          0.9274        540.69995        0.54030
  98.0000          0.9616        540.00000        0.55890
  99.0000          0.9969        539.39990        0.57810
 100.0000          1.0332        538.79980        0.59770
 101.0000          1.0707        538.00000        0.61810
 102.0000          1.1092        537.39990        0.63880
 103.0000          1.1489        536.79980        0.66020
 104.0000          1.1898        536.09985        0.68220
 105.0000          1.2318        535.50000        0.70470
 106.0000          1.2751        534.89990        0.72780
 107.0000          1.3196        534.19995        0.75160
 108.0000          1.3654        533.59985        0.77600
 109.0000          1.4125        532.89990        0.80100
 110.0000          1.4609        532.29980        0.82640
 111.0000          1.5106        531.59985        0.85300
 112.0000          1.5618        530.89990        0.88000
 113.0000          1.6144        530.29980        0.90770
 114.0000          1.6684        529.59985        0.93610
 115.0000          1.7239        529.00000        0.96520
 116.0000          1.7809        528.29980        0.99510
 117.0000          1.8394        527.69995        1.02600
 118.0000          1.8995        527.00000        1.05700
 119.0000          1.9612        526.29980        1.08900
 120.0000          2.0245        525.59985        1.12200
 121.0000          2.0895        524.89990        1.15600
 122.0000          2.1561        524.29980        1.19000
 123.0000          2.2245        523.59985        1.22500
 124.0000          2.2947        523.00000        1.26200
 125.0000          2.3666        522.29980        1.29900
 126.0000          2.4404        521.50000        1.33700
```

```
127.0000            2.5160          520.89990          1.37500
128.0000            2.5935          520.19995          1.41500
129.0000            2.6730          519.50000          1.45600
130.0000            2.7544          518.89990          1.49700
131.0000            2.8378          518.09985          1.54000
132.0000            2.9233          517.39990          1.58300
133.0000            3.0110          516.69995          1.62800
134.0000            3.1000          516.09985          1.67300
135.0000            3.1920          515.39990          1.71900
```

```
DOSE CALCULATION DATA


FB =  0.50000

FRACTION OF IODINE RELEASED               0.50000

MEAN WIND VELOCITY                     7200.00000    M/HR

SOURCE HEIGHT ABOVE THE GROUND            0.0        M

SHADOW EFFECT FACTOR                      0.50000

BUILDING X-SECT. AREA                     0.0        M**2

BREATHING RATE                            1.25000    M**3/HR

     RELATIVE PRESSURE      LEAKAGE
        (KG/CM**2)          (1/HR)

           0.0             0.0
           0.0500          0.10800E-04
           0.1000          0.15840E-04
           0.2000          0.23400E-04
           0.3000          0.29520E-04
           0.4000          0.34560E-04
           0.5000          0.38880E-04
           0.6000          0.42840E-04
           0.7000          0.46080E-04
           0.8000          0.47880E-04
           0.9000          0.49320E-04
           1.0000          0.49680E-04
           1.2000          0.50760E-04
           1.4000          0.51660E-04
           1.6000          0.52632E-04
           1.8000          0.53640E-04
           2.0000          0.54720E-04
           2.2000          0.55620E-04
           2.4000          0.56628E-04
           2.6000          0.57600E-04
           2.8000          0.58680E-04
           3.0000          0.59580E-04

METEOROLOGICAL CATEGORIES CONSIDERED   A   B   C   D   E   F

* COMPUTED PROPORTIONALITY FACTORS FOR DOSES AT SPECIFIED DISTANCES

 N    DOWNWIND DISTANCE      DOSE(N)/DOSE(1)
            (M)

 1        500.0000               1.00000
 2        800.0000               0.46408
 3       1500.0000               0.17593
```

```
DECAY HEAT CALCULATION DATA

  TIME AFTER SHUTDOWN      PER CENT OF POWER
        (HOUR)                  RELEASED


     0.27778E-03                 6.2300
     0.55556E-03                 5.9000
     0.83333E-03                 5.6800
     0.11111E-02                 5.5500
     0.13889E-02                 5.4100
     0.16667E-02                 5.3250
     0.19444E-02                 5.2250
     0.22222E-02                 5.1500
     0.25000E-02                 5.0750
     0.27778E-02                 5.0000
     0.38889E-02                 4.7500
     0.55556E-02                 4.5000
     0.83333E-02                 4.2000
     0.11111E-01                 3.9750
     0.13889E-01                 3.8100
     0.16667E-01                 3.6600
     0.19444E-01                 3.5550
     0.22222E-01                 3.4500
     0.25000E-01                 3.3800
     0.27778E-01                 3.3100
     0.38889E-01                 3.0400
     0.55556E-01                 2.7850
     0.83333E-01                 2.5250
     0.11111E 00                 2.3500
     0.13889E 00                 2.2100
     0.16667E 00                 2.1150
     0.19444E 00                 2.0400
     0.22222E 00                 1.9750
     0.25000E 00                 1.9150
     0.27778E 00                 1.8550
     0.55556E 00                 1.5750
     0.83333E 00                 1.4000
     0.11111E 01                 1.2800
     0.13889E 01                 1.2000
     0.16667E 01                 1.1300
     0.19444E 01                 1.0950
     0.22222E 01                 1.0400
     0.25000E 01                 1.0000
     0.27778E 01                 0.9600
     0.55555E 01                 0.7800
     0.83333E 01                 0.6900
     0.11111E 02                 0.6300
     0.13889E 02                 0.5900
     0.16667E 02                 0.5550
     0.19444E 02                 0.5300
     0.22222E 02                 0.5050
     0.25000E 02                 0.4950
     0.27778E 02                 0.4750
     0.38889E 02                 0.4380
     0.55555E 02                 0.4000
```

```
 CONTAINMENT BUILDING DATA


INITIAL FREE VOLUME                      16420.0000  M**3
INITIAL MASS OF WATER                        0.0     KG
INITIAL ENERGY OF WATER                      0.0     KCAL
INITIAL ABS. TOTAL PRESSURE                  0.7210  KG/CM**2
INITIAL TEMPERATURE                         30.0000  C
NOMINAL REACTOR POWER                      110.0000  MW
MASS OF AIR                              13346.0000  KG

* BLOWDOWN DATA
COEFFICIENTS OF EQS (57) AND (58)

TAUB1 =     0.0          KBD1 =     0.24809E 08    KBD2 =     0.0              KBD3 =     0.0              KBD4 =     0.69500E-03
TAUB2 =     0.10000E 03  CBD1 =     0.42450E 03    CBD2 =     0.0              CBD3 =     0.0              CBD4 =     0.0
```

```
******************************************************************************************************************
      TIME              STEAM PRESSURE        TOTAL PRESSURE         TEMPERATURE          TOTAL DOSE        INTERNAL SPRAY
                                                                                                                  MASS
     (HOURS)            (KG/CM2 ABS.)         (KG/CM2 ABS.)              (C)                 (REM)                (KG)
******************************************************************************************************************

   0.5555559E-05            0.043                 0.721                30.000              0.0                -0.0
   0.3333299E-03            0.460                 1.247                78.822              0.002              -0.0
   0.6666502E-03            0.737                 1.551                90.806              0.009              -0.0
   0.9999706E-03            0.910                 1.736                96.467              0.018              -0.0
   0.1333291E-02            1.017                 1.850                99.549              0.029              -0.0
   0.1666611E-02            1.083                 1.921               101.325              0.039              -0.0
   0.1999932E-02            1.124                 1.964               102.374              0.050              -0.0
   0.2333252E-02            1.149                 1.990               103.004              0.061              -0.0
   0.2666572E-02            1.164                 2.007               103.381              0.072              -0.0
   0.2999893E-02            1.174                 2.017               103.610              0.082              -0.0
   0.3333213E-02            1.179                 2.022               103.747              0.093              -0.0
   0.3666533E-02            1.183                 2.026               103.828              0.104              -0.0
   0.3999837E-02            1.185                 2.028               103.873              0.115              -0.0
   0.4333101E-02            1.186                 2.029               103.897              0.126              -0.0
   0.4666366E-02            1.186                 2.029               103.907              0.137              -0.0
   0.4999630E-02            1.186                 2.029               103.909              0.148              -0.0
   0.5332895E-02            1.186                 2.029               103.906              0.158              -0.0
   0.5666159E-02            1.186                 2.029               103.899              0.169              -0.0
   0.5999424E-02            1.185                 2.029               103.890              0.180              -0.0
   0.6332688E-02            1.185                 2.028               103.881              0.191              -0.0
   0.6665953E-02            1.184                 2.028               103.870              0.202              -0.0
   0.6999217E-02            1.184                 2.027               103.859              0.213              -0.0
   0.7332481E-02            1.184                 2.027               103.847              0.224              -0.0
   0.7665746E-02            1.183                 2.026               103.835              0.234              -0.0
   0.7999010E-02            1.183                 2.026               103.823              0.245              -0.0
   0.8332275E-02            1.182                 2.025               103.811              0.256              -0.0
   0.8665539E-02            1.182                 2.025               103.799              0.267              -0.0
   0.8998804E-02            1.181                 2.024               103.787              0.278              -0.0
   0.9332068E-02            1.181                 2.024               103.775              0.289              -0.0
   0.9665333E-02            1.180                 2.023               103.763              0.299              -0.0
   0.9998597E-02            1.180                 2.023               103.751              0.310              -0.0
   0.1033186E-01            1.179                 2.022               103.738              0.321              -0.0
   0.1066513E-01            1.179                 2.022               103.726              0.332              -0.0
   0.1099839E-01            1.178                 2.021               103.714              0.343              -0.0
   0.1133166E-01            1.178                 2.020               103.701              0.354              -0.0
   0.1166492E-01            1.177                 2.020               103.689              0.364              -0.0
   0.1199818E-01            1.177                 2.019               103.676              0.375              -0.0
   0.1233145E-01            1.176                 2.019               103.664              0.386              -0.0
   0.1266471E-01            1.176                 2.018               103.652              0.397              -0.0
   0.1299798E-01            1.175                 2.018               103.639              0.408              -0.0
   0.1333124E-01            1.175                 2.017               103.626              0.419              -0.0
   0.1366451E-01            1.174                 2.017               103.614              0.430              -0.0
   0.1399777E-01            1.174                 2.016               103.602              0.440              -0.0
   0.1433104E-01            1.173                 2.016               103.589              0.451              -0.0
   0.1466430E-01            1.172                 2.015               103.577              0.462              -0.0
   0.1499756E-01            1.172                 2.015               103.564              0.473              -0.0
   0.1533083E-01            1.171                 2.014               103.551              0.484              -0.0
   0.1566409E-01            1.171                 2.013               103.538              0.495              -0.0
   0.1599736E-01            1.170                 2.013               103.526              0.505              -0.0
   0.1633062E-01            1.170                 2.012               103.513              0.516              -0.0
```

```
  * * INTERMEDIATE RESULTS * *


TEMPERATURES OF ISLAB 1

   254.547  254.307  253.826  253.104  252.142  250.939  249.496  247.814  245.895  243.741
   254.543  254.302  253.821  253.100  252.138  250.935  249.492  247.810  245.891  243.736

TEMPERATURES OF ISLAB 2

   264.248  264.166  263.995  263.660  263.154  262.402  261.321  259.823  257.804  255.211
   264.247  264.165  263.994  263.659  263.153  262.400  261.320  259.821  257.802  255.209

TEMPERATURES OF ISLAB 3

   247.614  247.538  247.386  247.159  246.855  246.477  246.023  245.493
   247.608  247.532  247.380  247.153  246.850  246.471  246.017  245.488

TEMPERATURES OF ISLAB 4

    73.996   73.996   73.996   73.998   74.003   74.012   74.026   74.048   74.082   74.133
    74.206   74.310   74.452   74.642   74.890   75.208   75.606   76.093   76.672   77.350
    73.996   73.996   73.996   73.998   74.003   74.012   74.026   74.048   74.082   74.133
    74.207   74.310   74.452   74.642   74.890   75.209   75.607   76.093   76.673   77.350

TEMPERATURES OF ESLAB 1

    50.000   50.000   50.000   50.000   50.000   50.000   50.000   50.000   50.000   51.193
    50.000   50.000   50.000   50.000   50.000   50.000   50.000   50.000   50.000   51.194

TEMPERATURES OF ESLAB 2

    36.470   36.508   36.579   36.684   36.822   36.994   37.198   37.436   37.707   38.010
    38.346   38.715   39.116   39.549   40.014   40.511
    36.473   36.511   36.582   36.687   36.825   36.996   37.201   37.439   37.709   38.013
    38.349   38.717   39.118   39.552   40.017   40.513

  SLAB          HEAT (KCAL)                 HEAT (KCAL)                 HEAT (KCAL,
          FROM ISLAB TO MIXTURE     FROM ESLAB TO MIXTURE       FROM AIR TO ESLAB

    1            91598.562               -239492.312                   0.0
    2            23007.227               -129331.437                -462.159
    3           117294.375
    4           -24616.414
```

```
TOTAL PRESSURE (ABS.VALUE)                                   2.012   KG/CM**2
TEMPERATURE OF AIR-STEAM MIXTURE                           103.501   C
TOTAL RADIATION DOSE TO THE THYROID                          0.527   REM
FREE VOLUME OF THE CONTAINMENT BUILDING                  16412.910   M**3
DENSITY OF AIR-STEAM MIXTURE                                 1.473   KG/M**3
STEAM PRESSURE                                               1.169   KG/CM**2
TOTAL MASS OF WATER (LIQ.+VAP.PHASE)                     17600.184   KG
MASS OF STEAM                                            10824.969   KG
MASS OF WATER (LIQUID PHASE)                              6775.215   KG
MASS OF BLOWDOWN WATER (LIQ.+VAP.PHASE)                  17102.543   KG
MASS OF INTERNAL SPRAY WATER                                -0.0     KG
ENERGY OF WATER-AIR-STEAM MIXTURE                      7518119.000   KCAL
FISSION PROD. DECAY ENERGY                               67399.375   KCAL
ENERGY OF CHEMICAL ORIGIN                                   -0.0     KCAL
ENERGY DUE TO NUCLEAR EXCURSION                             -0.0     KCAL
ENERGY OF BLOWDOWN WATER (LIQ.+VAP.PHASE)              7260460.000   KCAL
ENERGY OF INTERNAL SPRAY WATER                              -0.0     KCAL

** TIME STEP NUMBER      3000
  TIME =     0.1666389E-01  HR
```

```
                                             * * * P R E S T * * *
PROBLEM TITLE
                         ** SAMPLE PROBLEM FOR PREST (PHASE SUBSEQUENT TO BLOWDOWN) **
INPUT DATA

PRINTING PARAMETER                  0
BLOWDOWN PARAMETER                  0
DECAY HEAT PARAMETER                1
DOSE CALCULATION PARAMETER          1
INTERNAL SPRAY PARAMETER            1
EXTERNAL SPRAY PARAMETER            1
CHEMICAL HEAT PARAMETER             0
NUCLEAR HEAT PARAMETER              0
PLOTTING PARAMETER                563

ISLABS NUMBER                       4
ESLABS NUMBER                       2
MAXIMUM NUMBER OF TIME STEPS     9000
INITIAL VALUE OF TIME          0.1666390E-01  HR
TIME STEP VALUE                0.5555600E-03  HR
INITIAL VALUE OF DOSE          0.5220000E 00  REM
```

```
* * INTERNAL SLAB 1 INPUT DATA

SURFACE AREA                          166.0000  M**2
THICKNESS OF A HALF SLAB                0.0200  M
THERMAL CONDUCTIVITY                   13.0475  KCAL/M*HR*C
SPECIFIC HEAT                           0.1300  KCAL/KG*C
DENSITY                              7500.0000  KG/M**3
HEAT TRANSFER COEFFICIENT             111.9600  KCAL/M**2*HR*C
INSULATION THERMAL RESISTANCE           0.0     M**2*HR*C/KCAL
NUMBER OF LAYERS                            10
NF CONTROL PARAMETER                         0




* TEMPERATURE DISTRIBUTION
    254.543  254.302  253.821  253.100  252.138  250.935  249.492  247.810  245.891  243.736
```

```
* * INTERNAL SLAB 2 INPUT DATA

SURFACE AREA                          80.0000  M**2
THICKNESS OF A HALF SLAB               0.0500  M
THERMAL CONDUCTIVITY                  13.0475  KCAL/M*HR*C
SPECIFIC HEAT                          0.1300  KCAL/KG*C
DENSITY                             7500.0000  KG/M**3
HEAT TRANSFER COEFFICIENT             55.6560  KCAL/M**2*HR*C
INSULATION THERMAL RESISTANCE          0.0     M**2*HR*C/KCAL
NUMBER OF LAYERS                           10
NF CONTROL PARAMETER                        0



* TEMPERATURE DISTRIBUTION
    264.247  264.165  263.994  263.659  263.153  262.400  261.320  259.821  257.802  255.209
```

```
* * INTERNAL SLAB 3 INPUT DATA

SURFACE AREA                          417.0000  M**2
THICKNESS OF A HALF SLAB                0.0080  M
THERMAL CONDUCTIVITY                   13.0475  KCAL/M*HR*C
SPECIFIC HEAT                           0.1300  KCAL/KG*C
DENSITY                              7500.0000  KG/M**3
HEAT TRANSFER COEFFICIENT              55.6200  KCAL/M**2*HR*C
INSULATION THERMAL RESISTANCE           0.0     M**2*HR*C/KCAL
NUMBER OF LAYERS                             8
NF CONTROL PARAMETER                         0



* TEMPERATURE DISTRIBUTION
    247.608  247.532  247.380  247.153  246.850  246.471  246.017  245.488
```

```
* * INTERNAL SLAB 4 INPUT DATA

SURFACE AREA                        257.0000  M**2
THICKNESS OF A HALF SLAB              0.0700  M
THERMAL CONDUCTIVITY                 13.0475  KCAL/M*HR*C
SPECIFIC HEAT                         0.1300  KCAL/KG*C
DENSITY                            7500.0000  KG/M**3
HEAT TRANSFER COEFFICIENT           111.9600  KCAL/M**2*HR*C
INSULATION THERMAL RESISTANCE         0.0     M**2*HR*C/KCAL
NUMBER OF LAYERS                          20
NF CONTROL PARAMETER                       0



* TEMPERATURE DISTRIBUTION
    73.996   73.996   73.996   73.998   74.003   74.012   74.026   74.048   74.082   74.133
    74.207   74.310   74.452   74.642   74.890   75.209   75.607   76.093   76.673   77.350
```

```
* * EXTERNAL SLAB 1 INPUT DATA

SURFACE AREA                                   6740.0000  M**2
THICKNESS OF THE SLAB                             0.5000  M
THERMAL CONDUCTIVITY                              2.2864  KCAL/M*HR*C
SPECIFIC HEAT                                     0.2300  KCAL/KG*C
DENSITY                                        2500.0000  KG/M**3
HEAT TRANSFER COEFFICIENT (INT.FACE)             75.5777  KCAL/M**2*HR*C
INSULATION THERMAL RESISTANCE (INT.FACE)          0.0     M**2*HR*C/KCAL
NUMBER OF LAYERS                                      10
NF CONTROL PARAMETER                                   0
NA CONTROL PARAMETER                                   0


* TEMPERATURE DISTRIBUTION
     50.000    50.000    50.000    50.000    50.000    50.000    50.000    50.000    50.000    51.194
```

```
* * EXTERNAL SLAB 2 INPUT DATA

SURFACE AREA                                     1060.0000  M**2
THICKNESS OF THE SLAB                               0.0157  M
THERMAL CONDUCTIVITY                               13.0475  KCAL/M*HR*C
SPECIFIC HEAT                                       0.1300  KCAL/KG*C
DENSITY                                          7500.0000  KG/M**3
HEAT TRANSFER COEFFICIENT (INT.FACE)              111.9600  KCAL/M**2*HR*C
INSULATION THERMAL RESISTANCE (INT.FACE)            0.0     M**2*HR*C/KCAL
NUMBER OF LAYERS                                        16
NF CONTROL PARAMETER                                     0
NA CONTROL PARAMETER                                     1
C'EXT (CONSTANT OF EQ. 73)                          9.7560  KCAL/M**2*HR*C
C''EXT (CONSTANT OF EQ. 73)                         0.0     KCAL/M**2*HR*C**2
EXTERNAL AIR TEMPERATURE                           30.0000  C
INSULATION THERMAL RESISTANCE (EXT.FACE)            0.0     M**2*HR*C/KCAL
* EXTERNAL SPRAY DATA
STARTING TIME                                                   0.0167  HR
WATER TEMPERATURE AT OUTLET OF THE NOZZLES                     25.0000  C
MASS FLOW RATE                                              90000.0000  KG/HR
HEAT TRANSFER COEFFICIENT WITH EXTERNAL COOLING MEDIUM        489.5999  KCAL/M**2*HR*C


* TEMPERATURE DISTRIBUTION

     36.473   36.511   36.582   36.687   36.825   36.996   37.201   37.439   37.709   38.013
     38.349   38.717   39.118   39.552   40.017   40.513
```

```
   PHYSICAL PROPERTIES OF AIR, WATER, AND STEAM

SPECIFIC HEAT OF AIR AT CONSTANT VOLUME   0.17100   KCAL/KG*C


  TEMPERATURE       SATURATION        SPECIFIC HEAT      DENSITY OF
                     PRESSURE       OF EVAPORATION        VAPOUR
      (C)           (KG/CM**2)         (KCAL/KG)         (KG/M**3)

    10.0000           0.0125          591.59985          0.00940
    12.0000           0.0143          590.50000          0.01066
    15.0000           0.0174          588.79980          0.01283
    18.0000           0.0210          587.09985          0.01537
    20.0000           0.0238          586.00000          0.01729
    21.0000           0.0253          585.50000          0.01833
    22.0000           0.0269          584.89990          0.01942
    23.0000           0.0286          584.29980          0.02056
    24.0000           0.0304          583.79980          0.02177
    25.0000           0.0323          583.19995          0.02304
    26.0000           0.0343          582.59985          0.02436
    27.0000           0.0363          582.09985          0.02576
    28.0000           0.0385          581.50000          0.02722
    29.0000           0.0408          580.89990          0.02875
    30.0000           0.0432          580.39990          0.03036
    31.0000           0.0458          579.79980          0.03204
    32.0000           0.0485          579.19995          0.03381
    33.0000           0.0513          578.69995          0.03565
    34.0000           0.0542          578.09985          0.03757
    35.0000           0.0573          577.50000          0.03960
    36.0000           0.0606          577.00000          0.04170
    37.0000           0.0640          576.39990          0.04391
    38.0000           0.0675          575.79980          0.04622
    39.0000           0.0713          575.19995          0.04863
    40.0000           0.0752          574.69995          0.05113
    41.0000           0.0793          574.09985          0.05376
    42.0000           0.0836          573.50000          0.05650
    43.0000           0.0881          573.00000          0.05935
    44.0000           0.0928          572.39990          0.06233
    45.0000           0.0977          571.79980          0.06544
    46.0000           0.1028          571.19995          0.06866
    47.0000           0.1082          570.69995          0.07203
    48.0000           0.1138          570.09985          0.07554
    49.0000           0.1197          569.50000          0.07918
    50.0000           0.1258          569.00000          0.08298
    51.0000           0.1321          568.39990          0.08693
    52.0000           0.1388          567.89990          0.09104
    53.0000           0.1457          567.29980          0.09530
    54.0000           0.1530          566.69995          0.09974
    55.0000           0.1605          566.09985          0.10440
    56.0000           0.1683          565.50000          0.10910
    57.0000           0.1765          565.00000          0.11410
    58.0000           0.1850          564.39990          0.11930
    59.0000           0.1939          563.79980          0.12460
    60.0000           0.2031          563.19995          0.13020
    61.0000           0.2127          562.59985          0.13590
    62.0000           0.2227          562.00000          0.14190
    63.0000           0.2330          561.39990          0.14810
    64.0000           0.2438          560.79980          0.15450
    65.0000           0.2550          560.19995          0.16120
```

66.0000	0.2666	559.69995	0.16800
67.0000	0.2787	559.09985	0.17520
68.0000	0.2913	558.50000	0.18260
69.0000	0.3043	557.89990	0.19020
70.0000	0.3178	557.29980	0.19810
71.0000	0.3318	556.69995	0.20630
72.0000	0.3463	556.09985	0.21470
73.0000	0.3613	555.50000	0.22350
74.0000	0.3769	554.89990	0.23250
75.0000	0.3931	554.29980	0.24180
76.0000	0.4098	553.69995	0.25150
77.0000	0.4272	553.09985	0.26140
78.0000	0.4451	552.50000	0.27170
79.0000	0.4637	551.89990	0.28230
80.0000	0.4829	551.19995	0.29330
81.0000	0.5028	550.50000	0.30460
82.0000	0.5234	549.89990	0.31620
83.0000	0.5447	549.29980	0.32830
84.0000	0.5667	548.69995	0.34070
85.0000	0.5894	548.09985	0.35350
86.0000	0.6129	547.50000	0.36660
87.0000	0.6372	546.89990	0.38020
88.0000	0.6623	546.29980	0.39420
89.0000	0.6882	545.59985	0.40860
90.0000	0.7149	545.00000	0.42350
91.0000	0.7425	544.39990	0.43880
92.0000	0.7710	543.79980	0.45450
93.0000	0.8004	543.19995	0.47070
94.0000	0.8307	542.50000	0.48740
95.0000	0.8619	541.89990	0.50450
96.0000	0.8942	541.29980	0.52220
97.0000	0.9274	540.69995	0.54030
98.0000	0.9616	540.00000	0.55890
99.0000	0.9969	539.39990	0.57810
100.0000	1.0332	538.79980	0.59770
101.0000	1.0707	538.00000	0.61810
102.0000	1.1092	537.39990	0.63880
103.0000	1.1489	536.79980	0.66020
104.0000	1.1898	536.09985	0.68220
105.0000	1.2318	535.50000	0.70470
106.0000	1.2751	534.89990	0.72780
107.0000	1.3196	534.19995	0.75160
108.0000	1.3654	533.59985	0.77600
109.0000	1.4125	532.89990	0.80100
110.0000	1.4609	532.29980	0.82640
111.0000	1.5106	531.59985	0.85300
112.0000	1.5618	530.89990	0.88000
113.0000	1.6144	530.29980	0.90770
114.0000	1.6684	529.59985	0.93610
115.0000	1.7239	529.00000	0.96520
116.0000	1.7809	528.29980	0.99510
117.0000	1.8394	527.69995	1.02600
118.0000	1.8995	527.00000	1.05700
119.0000	1.9612	526.29980	1.08900
120.0000	2.0245	525.59985	1.12200
121.0000	2.0895	524.89990	1.15600
122.0000	2.1561	524.29980	1.19000
123.0000	2.2245	523.59985	1.22500
124.0000	2.2947	523.00000	1.26200
125.0000	2.3666	522.29980	1.29900
126.0000	2.4404	521.50000	1.33700

```
127.0000          2.5160       520.89990        1.37500
128.0000          2.5935       520.19995        1.41500
129.0000          2.6730       519.50000        1.45600
130.0000          2.7544       518.89990        1.49700
131.0000          2.8378       518.09985        1.54000
132.0000          2.9233       517.39990        1.58300
133.0000          3.0110       516.69995        1.62800
134.0000          3.1000       516.09985        1.67300
135.0000          3.1920       515.39990        1.71900
```

```
DOSE CALCULATION DATA

FB =  0.50000                                                                                  FOR TIME LESS THAN  0.16660E-01  HOUR
FB =  0.10000* 0.50000+(1.0- 0.10000)* 0.50000EXP(-(T- 0.16660E-01)/ 0.20000E 00)    FOR TIME GREATER THAN  0.16660E-01  HOUR
FRACTION OF IODINE RELEASED           0.50000
MEAN WIND VELOCITY                 7200.00000   M/HR
SOURCE HEIGHT ABOVE THE GROUND        0.0       M
SHADOW EFFECT FACTOR                  0.50000
BUILDING X-SECT. AREA                 0.0       M**2
BREATHING RATE                        1.25000   M**3/HR
     RELATIVE PRESSURE      LEAKAGE
         (KG/CM**2)          (1/HR)

           0.0             0.0
           0.0500          0.10800E-04
           0.1000          0.15840E-04
           0.2000          0.23400E-04
           0.3000          0.29520E-04
           0.4000          0.34560E-04
           0.5000          0.38880E-04
           0.6000          0.42840E-04
           0.7000          0.46080E-04
           0.8000          0.47880E-04
           0.9000          0.49320E-04
           1.0000          0.49680E-04
           1.2000          0.50760E-04
           1.4000          0.51660E-04
           1.6000          0.52632E-04
           1.8000          0.53640E-04
           2.0000          0.54720E-04
           2.2000          0.55620E-04
           2.4000          0.56628E-04
           2.6000          0.57600E-04
           2.8000          0.58680E-04
           3.0000          0.59580E-04
METEOROLOGICAL CATEGORIES CONSIDERED    A    B    C    D    E    F
* COMPUTED PROPORTIONALITY FACTORS FOR DOSES AT SPECIFIED DISTANCES
 N     DOWNWIND DISTANCE      DOSE(N)/DOSE(1)
             (M)

 1         500.0000              1.00000
 2         800.0000              0.46408
 3        1500.0000              0.17593
```

```
DECAY HEAT CALCULATION DATA

  TIME AFTER SHUTDOWN      PER CENT OF POWER
        (HOUR)                 RELEASED

      0.27778E-03               6.2300
      0.55556E-03               5.9000
      0.83333E-03               5.6800
      0.11111E-02               5.5500
      0.13889E-02               5.4100
      0.16667E-02               5.3250
      0.19444E-02               5.2250
      0.22222E-02               5.1500
      0.25000E-02               5.0750
      0.27778E-02               5.0000
      0.38889E-02               4.7500
      0.55556E-02               4.5000
      0.83333E-02               4.2000
      0.11111E-01               3.9750
      0.13889E-01               3.8100
      0.16667E-01               3.6600
      0.19444E-01               3.5550
      0.22222E-01               3.4500
      0.25000E-01               3.3800
      0.27778E-01               3.3100
      0.38889E-01               3.0400
      0.55556E-01               2.7850
      0.83333E-01               2.5250
      0.11111E 00               2.3500
      0.13889E 00               2.2100
      0.16667E 00               2.1150
      0.19444E 00               2.0400
      0.22222E 00               1.9750
      0.25000E 00               1.9150
      0.27778E 00               1.8550
      0.55556E 00               1.5750
      0.83333E 00               1.4000
      0.11111E 01               1.2800
      0.13889E 01               1.2000
      0.16667E 01               1.1300
      0.19444E 01               1.0950
      0.22222E 01               1.0400
      0.25000E 01               1.0000
      0.27778E 01               0.9600
      0.55555E 01               0.7800
      0.83333E 01               0.6900
      0.11111E 02               0.6300
      0.13889E 02               0.5900
      0.16667E 02               0.5550
      0.19444E 02               0.5300
      0.22222E 02               0.5050
      0.25000E 02               0.4950
      0.27778E 02               0.4750
      0.38889E 02               0.4380
      0.55555E 02               0.4000
```

```
 CONTAINMENT BUILDING DATA


INITIAL FREE VOLUME                      16412.9062  M**3
INITIAL MASS OF WATER                    17600.1836  KG
INITIAL ENERGY OF WATER                7518119.0000  KCAL
INITIAL ABS. TOTAL PRESSURE                  2.0120  KG/CM**2
INITIAL TEMPERATURE                        103.5010  C
NOMINAL REACTOR POWER                      110.0000  MW
MASS OF AIR                              13346.0000  KG

INTERNAL SPRAY SYSTEM DATA
      TIN (HR)           TEND (HR)          MASS RATE (KG/HR)      TEMPERATURE (C)
      0.16660E-01         0.45000E 01          0.90000E 05         0.25000E 02
```

```
*******************************************************************************************************************
      TIME           STEAM PRESSURE       TOTAL PRESSURE         TEMPERATURE          TOTAL DOSE        INTERNAL SPRAY
                                                                                                             MASS
     (HOURS)         (KG/CM2 ABS.)        (KG/CM2 ABS.)              (C)                (REM)                (KG)
*******************************************************************************************************************

  0.1721946E-01           1.169                2.012               103.501              0.522                -0.0
  0.1166604E 00           0.897                1.724                96.095              3.058              8950.020
  0.2166531E 00           0.686                1.497                88.919              4.504             17950.020
  0.3166459E 00           0.533                1.330                82.452              5.287             26950.020
  0.4166386E 00           0.427                1.212                76.992              5.715             35950.020
  0.5166314E 00           0.355                1.131                72.560              5.950             44950.020
  0.6166241E 00           0.305                1.073                69.024              6.077             53950.020
  0.7166169E 00           0.269                1.031                66.190              6.112             62950.020
  0.8166096E 00           0.243                1.000                63.887              6.112             71950.000
  0.9166024E 00           0.223                0.976                61.983              6.112             80950.000
  0.1016581E 01           0.207                0.957                60.377              6.112             89950.000
  0.1116488E 01           0.194                0.942                59.005              6.112             98950.000
  0.1216394E 01           0.183                0.929                57.804              6.112            107950.000
  0.1316301E 01           0.174                0.918                56.749              6.112            116950.000
  0.1416208E 01           0.167                0.909                55.805              6.112            125950.000
  0.1516115E 01           0.160                0.901                54.949              6.112            134950.000
  0.1616022E 01           0.154                0.894                54.172              6.112            143950.000
  0.1715929E 01           0.149                0.887                53.458              6.112            152950.000
  0.1815836E 01           0.144                0.881                52.801              6.112            161950.000
  0.1915743E 01           0.140                0.876                52.193              6.112            170950.000
  0.2015650E 01           0.136                0.871                51.627              6.112            179950.000
  0.2115557E 01           0.133                0.867                51.097              6.112            188950.000
  0.2215464E 01           0.130                0.863                50.597              6.112            197950.000
  0.2315371E 01           0.127                0.860                50.126              6.112            206950.000
  0.2415277E 01           0.124                0.856                49.682              6.112            215950.000
  0.2515184E 01           0.121                0.853                49.261              6.112            224950.000
  0.2615091E 01           0.119                0.850                48.862              6.112            233950.000
  0.2714998E 01           0.117                0.848                48.482              6.112            242950.000
  0.2814905E 01           0.115                0.845                48.121              6.112            251950.000
  0.2914812E 01           0.113                0.843                47.777              6.112            260950.000
  0.3014719E 01           0.111                0.841                47.450              6.112            269950.000
  0.3114626E 01           0.109                0.838                47.138              6.112            278950.000
  0.3214533E 01           0.107                0.837                46.839              6.112            287950.000
  0.3314440E 01           0.106                0.835                46.554              6.112            296950.000
  0.3414347E 01           0.104                0.833                46.281              6.112            305950.000
  0.3514254E 01           0.103                0.832                46.019              6.112            314950.000
  0.3614161E 01           0.102                0.830                45.767              6.112            323950.000
  0.3714067E 01           0.100                0.829                45.525              6.112            332950.000
  0.3813974E 01           0.099                0.827                45.285              6.112            341950.000
  0.3913881E 01           0.098                0.826                45.051              6.112            350950.000
  0.4013788E 01           0.097                0.825                44.828              6.112            359950.000
  0.4113695E 01           0.096                0.824                44.613              6.112            368950.000
  0.4213602E 01           0.095                0.823                44.408              6.112            377950.000
  0.4313509E 01           0.094                0.822                44.207              6.112            386950.000
  0.4413416E 01           0.093                0.821                44.011              6.112            395950.000
  0.4513323E 01           0.092                0.820                43.874              6.112            403750.000
  0.4613230E 01           0.093                0.821                44.044              6.112            403750.000
  0.4713137E 01           0.094                0.822                44.185              6.112            403750.000
  0.4813044E 01           0.094                0.823                44.300              6.112            403750.000
  0.4912951E 01           0.095                0.824                44.396              6.112            403750.000
```

```
 * * INTERMEDIATE RESULTS * *


TEMPERATURES OF ISLAB 1

   44.319   44.320   44.320   44.321   44.322   44.323   44.325   44.326   44.328   44.331
   44.320   44.320   44.321   44.321   44.322   44.324   44.325   44.327   44.329   44.331

TEMPERATURES OF ISLAB 2

   46.637   46.633   46.624   46.611   46.594   46.573   46.547   46.517   46.484   46.446
   46.636   46.632   46.623   46.610   46.593   46.571   46.546   46.516   46.482   46.445

TEMPERATURES OF ISLAB 3

   44.349   44.349   44.349   44.349   44.349   44.350   44.350   44.351
   44.349   44.349   44.349   44.350   44.350   44.350   44.351   44.351

TEMPERATURES OF ISLAB 4

   45.059   45.058   45.056   45.054   45.051   45.047   45.042   45.037   45.031   45.024
   45.017   45.009   45.000   44.990   44.980   44.970   44.959   44.947   44.935   44.922
   45.058   45.057   45.056   45.054   45.050   45.047   45.042   45.037   45.031   45.024
   45.016   45.008   44.999   44.990   44.980   44.969   44.958   44.947   44.934   44.922

TEMPERATURES OF ESLAB 1

   50.288   50.380   50.563   50.813   51.072   51.230   51.114   50.499   49.183   47.135
   50.288   50.381   50.563   50.813   51.072   51.230   51.114   50.498   49.182   47.134

TEMPERATURES OF ESLAB 2

   33.564   33.645   33.726   33.806   33.887   33.968   34.049   34.130   34.211   34.293
   34.374   34.455   34.536   34.617   34.699   34.780
   33.564   33.645   33.726   33.807   33.888   33.969   34.050   34.131   34.212   34.293
   34.374   34.455   34.536   34.618   34.699   34.780
  SLAB          HEAT (KCAL)                HEAT (KCAL)                HEAT (KCAL)
         FROM ISLAB TO MIXTURE     FROM ESLAB TO MIXTURE       FROM AIR TO ESLAB

   1            1330669.000              -326929.750                    0.0
   2            1672892.000             -8528461.000              -8586562.000
   3            1312014.000
   4            1038081.188
```

```
TOTAL PRESSURE (ABS.VALUE)                                   0.824   KG/CM**2
TEMPERATURE OF AIR-STEAM MIXTURE                            44.481   C
TOTAL RADIATION DOSE TO THE THYROID                          6.112   REM
FREE VOLUME OF THE CONTAINMENT BUILDING                  15994.934   M**3
DENSITY OF AIR-STEAM MIXTURE                                 0.898   KG/M**3
STEAM PRESSURE                                               0.095   KG/CM**2
TOTAL MASS OF WATER (LIQ.+VAP.PHASE)                    421350.125   KG
MASS OF STEAM                                             1017.823   KG
MASS OF WATER (LIQUID PHASE)                            420332.250   KG
MASS OF BLOWDOWN WATER (LIQ.+VAP.PHASE)                    -0.0      KG
MASS OF INTERNAL SPRAY WATER                            403750.000   KG
ENERGY OF WATER-AIR-STEAM MIXTURE                     19391680.000   KCAL
FISSION PROD. DECAY ENERGY                             5339574.000   KCAL
ENERGY OF CHEMICAL ORIGIN                                  -0.0      KCAL
ENERGY DUE TO NUCLEAR EXCURSION                            -0.0      KCAL
ENERGY OF BLOWDOWN WATER (LIQ.+VAP.PHASE)                  -0.0      KCAL
ENERGY OF INTERNAL SPRAY WATER                        10093750.000   KCAL

** TIME STEP NUMBER      9000
  TIME =    0.5012857E 01  HR
```

NOMENCLATURE

Roman Symbols:

$A_i\ (t,\bar{u},d,h)$	Intake rate by inhalation of the i^{th} iodine isotope (expressed in Curie per second), at the time t, for a person standing at a distance d from a radioactive point source downwind on the vertical ground projection of the centerline of the cloud, which is emitted by the aforesaid point source at a height h from the ground.
B	Cross sectional area (in cross-wind direction) of the containment building.
c	Dimensionless factor comprised between 0.5 and 1 denoting the fraction of B which is taken into account for the "shadow effect" of the containment building.
$c_{p,w}$	Specific heat of water (liquid phase).
$c_{p,i}; c_{p,j}$	Specific heat of the material of, respectively the i^{th} internal slab and the j^{th} external slab.
$c_{v,a}$	Specific heat of air at constant volume.
$C_{bd1,2,3,4}$	Constants defined by eq. (58).
$C'_{ext}; C''_{ext}$	Constants defined by eq. (73).
$C_{i,n}$	Thermal capacity per unit area of n^{th} layer of the i^{th} internal slab (Layer n=1 is in contact with the internal atmosphere of the containment).
$C_{j,n}$	Thermal capacity per unit area of n^{th} layer of the j^{th} external slab (Layer n=1 is in contact with the internal atmosphere; layer $n=n^{x}$ is in contact with the external atmosphere - air, or the water of the external spray system).

$C_i(t,\bar{u},d,h)$	Concentration in the air (expressed in Curie per unit volume) of the i^{th} iodine isotope, per unit reactor power, at the moment t, at the distance d from a radioactive point source downwind on the vertical ground projection of the centerline of a cloud, emitted by the aforesaid point source at a height h from the ground (valid for all metereological categories considered).
d	Distance d from a radioactive point source downwind on the vertical ground projection of the centerline of a cloud emitted by the aforesaid point source.
$D_i(t,\bar{u},d,h)$	Radiation dose to the thyroid due to inhalation of i^{th} iodine isotope during a time period t.
$D'_i(t,\bar{u},d,h)$	Radiation dose to the thyroid due to inhalation of the i^{th} iodine isotope during a time period t per unit of reactor power.
$D_{tot}(t,\bar{u},d,h)$	Total radiation dose to the thyroid due to inhalation of iodine (all iodine isotopes) during a time period t.
$E_{add}(t)$	$E_{chem}(t) + E_{dec}(t) + E_n(t)$.
$E_{bd}(t)$	Energy introduced into the free volume of the containment building by the blowdown of the high enthalpy coolant of the primary cooling system, at time t.
$E_{chem}(t)$	Energy of chemical origin introduced into the free volume of the containment building (e.g., metal-water reactions), at time t.
$E_{chem,tot}$	Final value of $E_{chem}(t)$.
$E_{dec}(t)$	Energy, due to decay of fission products in the fuel, introduced into free volume of the containment building, at time t.
$E_i(t)$	Energy delivered to the free volume of the containment building by the i^{th} internal slab, at time t.

$E_j(t)$	Energy delivered to the free volume of the containment building by the j^{th} external slab, at time t.
$E_n(t)$	Energy due to nuclear excursion, and/or due to redistribution of fuel temperatures, delivered to the free volume of the containment building, at time t.
$E_{n,tot}$	Final value of $E_n(t)$.
$E_{spi}(t)$	Energy introduced, by the internal spray system, into the free volume of the containment building, at time t.
$E_{tot}(t)$	Total energy contained in the air-steam-water mixture in the free volume of the containment building, at time t.
E^o_{tot}	Total energy contained, in the air-steam-water mixture in the free volume inside the containment building, at time t=0.
$f_E(d,h)$	Function of distance d, at various values of the height h, equal to the envelope of the expression (31) for all meteorological categories considered.
$F_b(t)$	Fraction of radioactive iodine released from the primary cooling system into the containment building, which remains airborne and thus available for release to the outside atmosphere, at time t.
F^o_b	value of $F_b(t)$ at t = 0.
$F_p(t)$	Fraction of the total inventory of the iodine in the fuel which is released form the primary cooling system into the free volume of the containment building, at time t.
h	Height of radioactive source above the ground.

h_i, h_j	Heat transfer coefficients with internal atmosphere of the containment building, respectively, for i^{th} internal or j^{th} external slab, at time t.
$h_{j,ext}$	Heat transfer coefficient with the outside atmosphere (or outside cooling medium) for the j^{th} external slab.
H_g	Specific enthalpy of saturated steam.
H_l	Specific enthalpy of water at saturation conditions.
H_{lg}	Specific heat of evaporation.
k_i, k_j	Heat conductivity of the material, respectively, of the i^{th} internal and of the j^{th} external slab.
K	Constant as defined in eq. (37).
$K_{bd,1,2,3,4}$	Constants defined by eq. (57).
L(t)	Fraction of airborne iodine leaking per unit time from the containment building to the outside atmosphere (dimension: hr^{-1}), at time t.
M_a	Mass of air contained in the containment building.
$M_{spi}(t)$	Mass of water introduced into the free volume of the containment building by the internal spray system, at time t.
$M^o_{w,tot}$	Mass of water (liquid + vapour phase) present in the containment building, at time t=0.
$M_{w,bd}(t)$	Mass of water (liquid + vapour phase) introduced into the free volume of the containment building by the blow-down process, at time t.

$M_{w,g}(t);M_{w,l}(t)$	Mass of water, respectively, in vapour and liquid phase, present in the free volume of the containment building, at time t.
$M_{w,tot}(t)$	Total mass of water (liquid + vapour phase) present in the containment building, at the time t.
$N(t)$	Nuclear power of reactor, at time t.
N^o	Nominal power of reactor.
$P_a(t)$	Partial pressure due to the air in the containment building, at time t.
P_a^o	Partial pressure due to the air in the containment building, at time $t = 0$.
$P_{c,abs}(t)$	Absolute value of the total pressure in the containment building, at time t.
$P_{c,rel}(t)$	Relative value of the total pressure in the containment building, at time t.
P_g^o	Partial pressure due to steam in the containment building at time $t=0$.
$P_g(t)$	Partial pressure due to steam in the containment building at time t.
q_{si}	Equilibrium (saturation) inventory of i^{th} iodine isotope per unit reactor power.
$Q_i(t)$	Strength of the source for the i^{th} iodine isotope expressed in Curie per unit of time, per unit of reactor power, at time t.
R	Breathing rate of a standard adult man (expressed in units of volume per unit of time).

R	Constant of ideal gas law.
$R_{i,n,n-1}$	Overall thermal resistance, per unit area, between the mid-planes of n^{th} and $(n-1)^{th}$ layers of the i^{th} internal slab (see eq. 45).
$R_{i,1,c}$	Overall thermal resistance, per unit area, between the mid-plane of the outer layer of i^{th} internal slab and the atmosphere of the containment building (see eq. 46).
$R_{j,n,n-1}$	Overall thermal resistance per unit area, between the mid-planes of n^{th} and $(n-1)^{th}$ layers of the j^{th} external slab.
$R_{j,1,c}$	Overall thermal resistance, per unit area, between the mid-plane of the outer layer of j^{th} external slab and the atmosphere of the containment building.
$R_{j,ext,n^{x}}$	Overall thermal resistance, per unit area, between the mid-plane the $n^{x\,th}$ layer (n^{x} denotes the outside layer) of the j^{th} external slab and the outside cooling medium (air or water) (see eq. 54).
$S_i;S_j$	Heat exchanging surface area of one face, respectively, of i^{th} internal and j^{th} external slab.
t	Time.
$T_c(t)$	Temperature (°C) of internal atmosphere of the containment building, at time t.
T_c^o	Temperature (°C) of internal atmosphere of the containment building at time t=0.
$T_{c,abs}(t)$	$[T_c(t)+273.16]\,^{o}K$.
T_{ext}	Temperature of the cooling medium on the outside surface of the containment building (air or water).

$T_{a,ext}$	Temperature of air outside the containment building.
$\overline{T}_{spe}$	Mean temperature of external spray cooling water on the outer surface of the containment building, at time t.
$T_{spi}(t)$	Temperature of the cooling medium of the internal system at the outlet of the nozzles, at time t.
$(T_{spe})_{nozzle}$	Temperature of the cooling medium of the external spray system at the outlet of the nozzles.
$T_{i,n}(t)$	Mean temperature of the n^{th} layer of the i^{th} internal slab, at time t.
$T_{j,n}(t)$	Mean temperature of the n^{th} layer of the j^{th} external slab, at time t.
$\overline{u}$	Mean wind velocity.
$U_{bd}(t)$	Specific internal energy of coolant introduced into the free volume of the containment building as a consequence of the blow-down process, at time t.
U_g	Specific internal energy of saturated steam.
U_l	Specific internal energy of water at saturation conditions.
v_l	Specific volume of water at saturation conditions.
V^o	Free volume of the containment building, at time t=0.
$V(t)$	Free volume of the containment building, at time t.
$w_{mol,w}$	Weight of a grammol of water.
x	Spatial coordinate.
x_s	Value of x at the outer surface of a slab which borders on the internal atmosphere.

Greek Symbols:

α	Fraction of F_b^o of the iodine, which is chemically bound in organic compounds (mainly methyl-iodine), and which cannot be removed from the atmosphere in the containment building by the internal spray system.
$\Gamma_{bd}(t)$	Mass flow rate of high enthalpy coolant which is introduced into the free volume of the containment building by the blow-down process, at time t.
$\Gamma_{spe}(t)$	Mass flow rate of external spray system, at time t.
$\Gamma_{spi}(t)$	Mass flow rate of internal spray system, at time t.
$\theta_{dec}(t)$	Total power produced by fission product decay (see eq.(7)), at time t.
η_i	Factor defined by eq. (34) accounting for the effective (biological) half-life and the conversion factor Curie-to-REM for the i^{th} iodine isotope.
ρ	Density.
$\rho_c(t)$	Density of air-steam mixture, at time t.
ρ_g	Density of saturated steam.
ρ_l	Density of water at saturation conditions.
ρ_i, ρ_j	Specific density of the materials, respectively, of i^{th} internal and j^{th} external slab.
$\varphi_i(t)$; $\varphi_j(t)$	Heat flux (per unit surface area) into the free volume of the containment building from, respectively, the i^{th} internal slab and the j^{th} external slab, at time t.

$\varphi_{j;ext}(t)$	Heat flux (per unit surface area) from the outside atmosphere into the j^{th} external slab, at time t.
$\Phi_i; \Phi_j$	Total heat flow into the free volume of the containment building from, respectively, the i^{th} internal slab and the j^{th} external slab.
$\sigma_y; \sigma_z$	Standard deviation of the plume distributions, respectively, in lateral and vertical direction.
τ_{chem}	Time constant for the release of energy of chemical origin into the free volume of the containment building.
τ_b	Time constant relative to the removal of radioactive iodine from the internal atmosphere of the containment building, as defined by eq. (26).
$\tau_{bd1}; \tau_{bd2}$	Time constants defined by eqs. (57) and (58).
τ_n	Time constant for the release of energy of nuclear origin into the free volume of the containment building.
$\tau_{spi}; \tau_{spe}$	Time period comprised between t=0 and the moment in which enters in operation, respectively, the internal and external spray system.
$\xi(t)$	Dimensionless factor which, if multiplied by nominal reactor power N^o, yields the power generated by decay of fission products at time t after shutdown of the reactor.
$\chi_i(t, \bar{u},d,h,MC)$	Concentration in the air (expressed in Curie per unit volume) of the i^{th} iodine isotope,per unit reactor power,at the moment t,at the distance d from the radioactive point source downwind on the vertical ground projection of the centerline of the cloud, emitted by the aforesaid point source at the height h from the ground under metereological category MC.
λ_i	Decay constant of i^{th} iodine isotope.

Subscripts:

a	Referring to air.
bd	referring to blow-down process.
c	Referring to conditions relative to the free volume of the containment building.
chem	Denoting chemical origin.
cond	Referring to air conditioning of the containment building.
dec	Referring to decay of fission products.
ext	Denoting external, i.e., outside of the containment building.
g	Referring to vapour phase of primary coolant.
i	Referring to i^{th} iodine isotope.
i,n	Referring to n^{th} layer of i^{th} internal slab.
i,n^{x}	Referring to adiabatic layer of the i^{th} internal half-slab.
j,n	Referring to n^{th} layer of j^{th} external slab.
j,n^{x}	Referring to the outside layer of the j^{th} external slab.
l	Referring to liquid phase of primary coolant.
lg	Referring to evaporation process.
n	Denoting nuclear origin.
rel	Denoting relative value.
s	Referring to outer surface.
si	Referring to equilibrium (saturation) inventory of i^{th} iodine isotope.
spe	Referring to external spray system.
spi	Referring to internal spray system.
tot	Denoting total value.
w	Denoting water (liquid or vapour phase).

Subscripts

o	Referring to conditions at t=0.
—	Referring to average value.

Abbreviations:

MC	Meteorological category (categories A through F).

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LIST OF FIGURES

ACKNOWLEDGEMENTS

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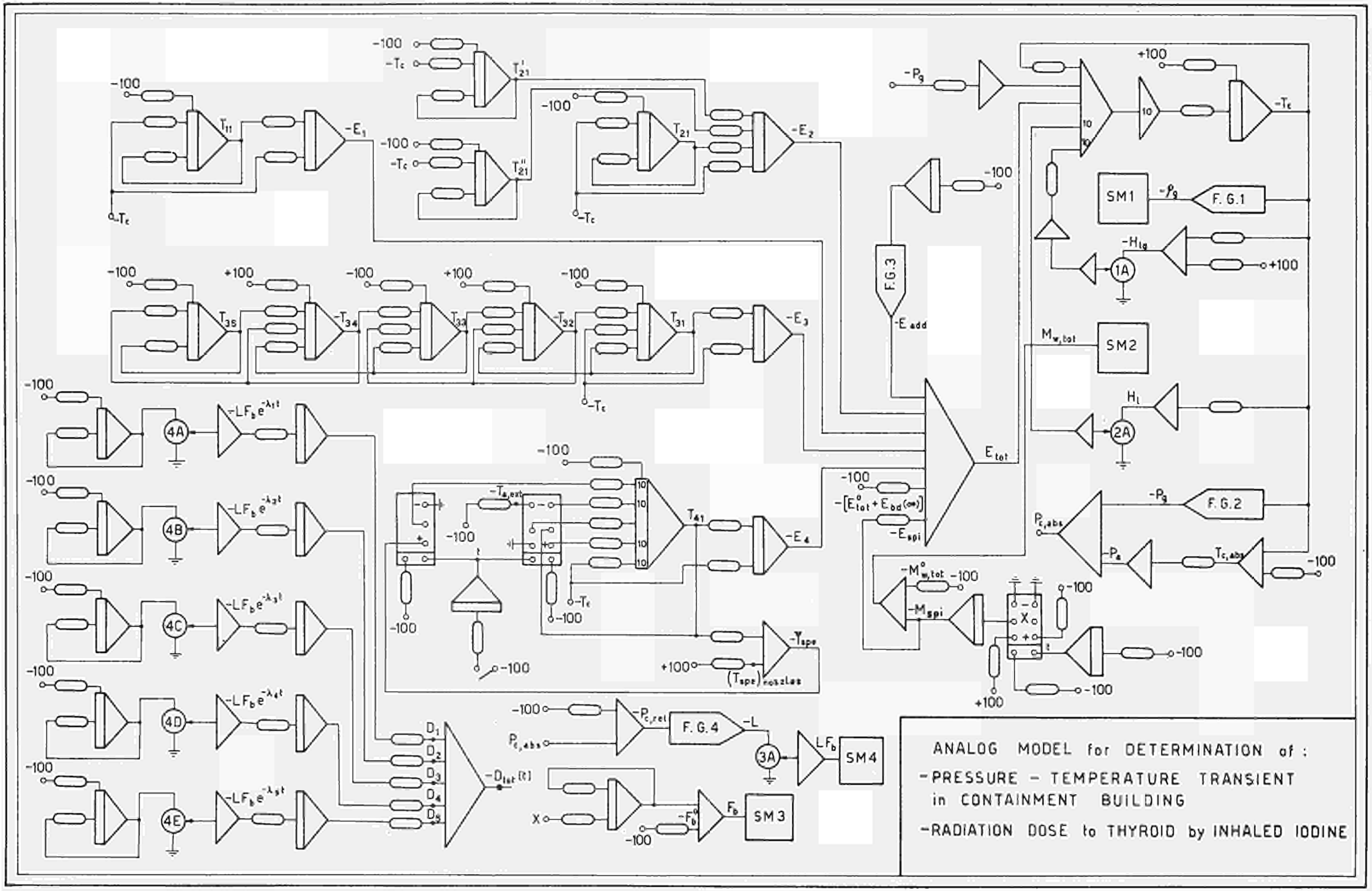

Fig. 1 - Electronic Circuit of Analog Model.

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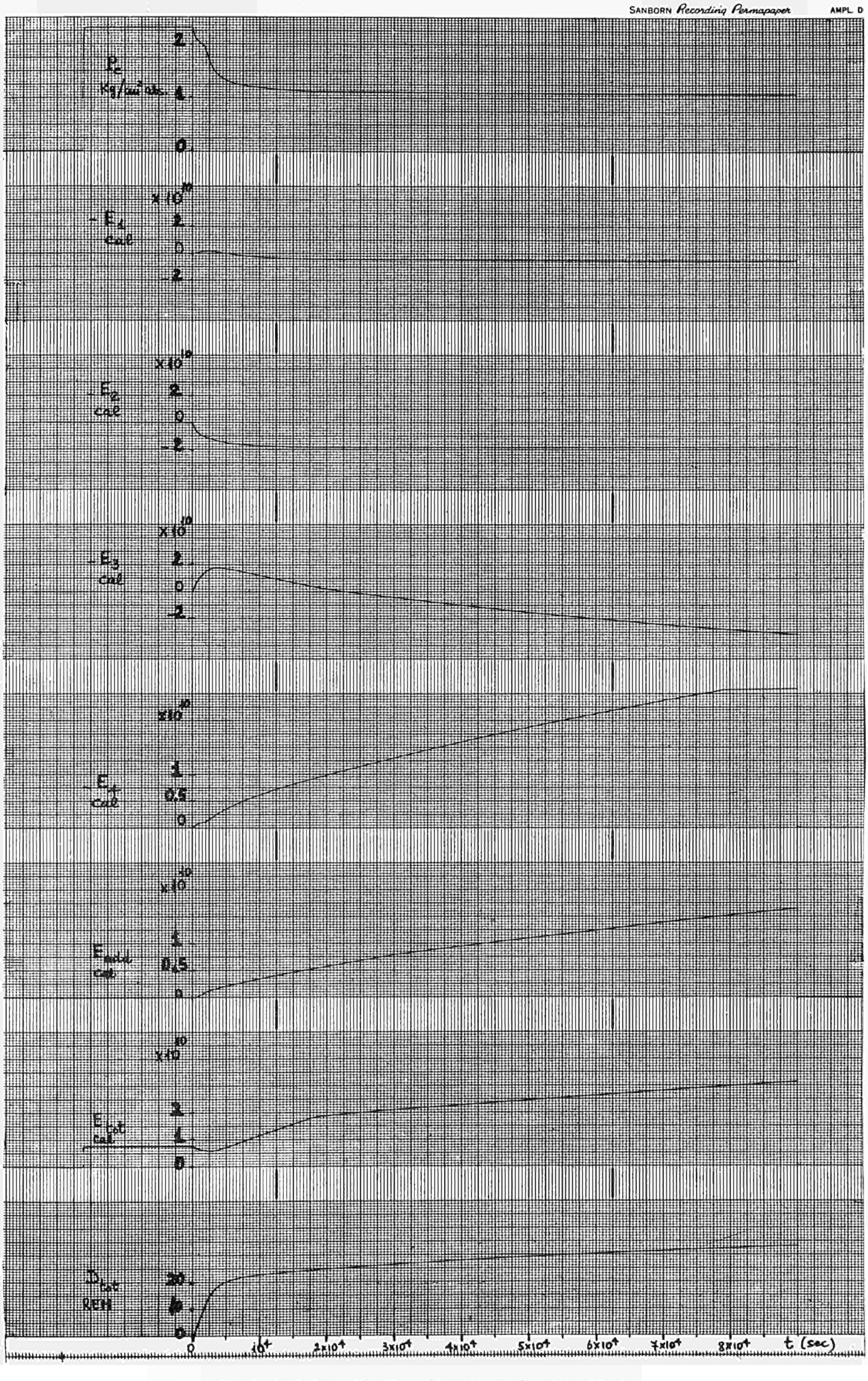

Fig. 2 - Typical Recording Regarding Hypothetical Accident.

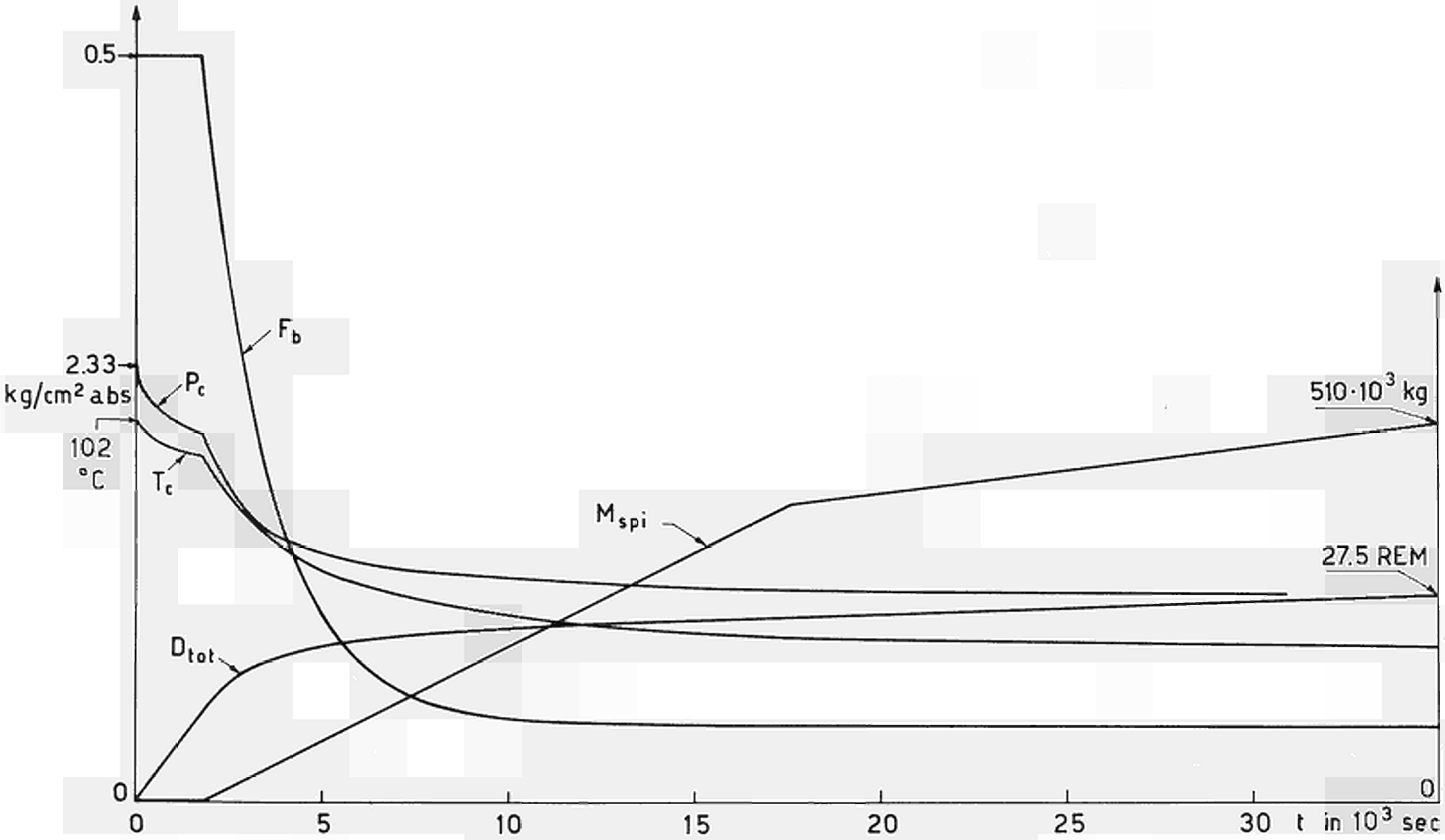

Fig. 3 - Typical Recording Regarding Hypothetical Accident.

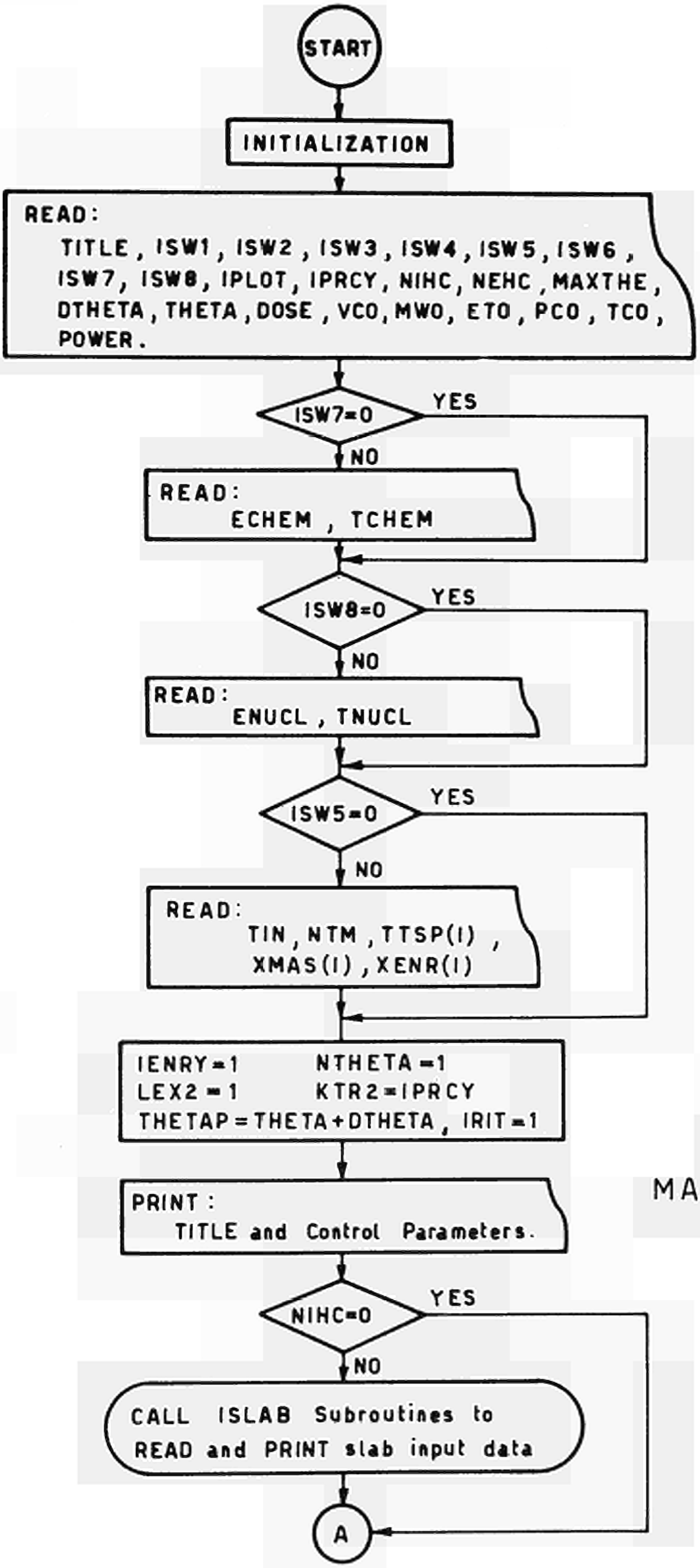

Fig. 4 (1) :

MAIN PROGRAM

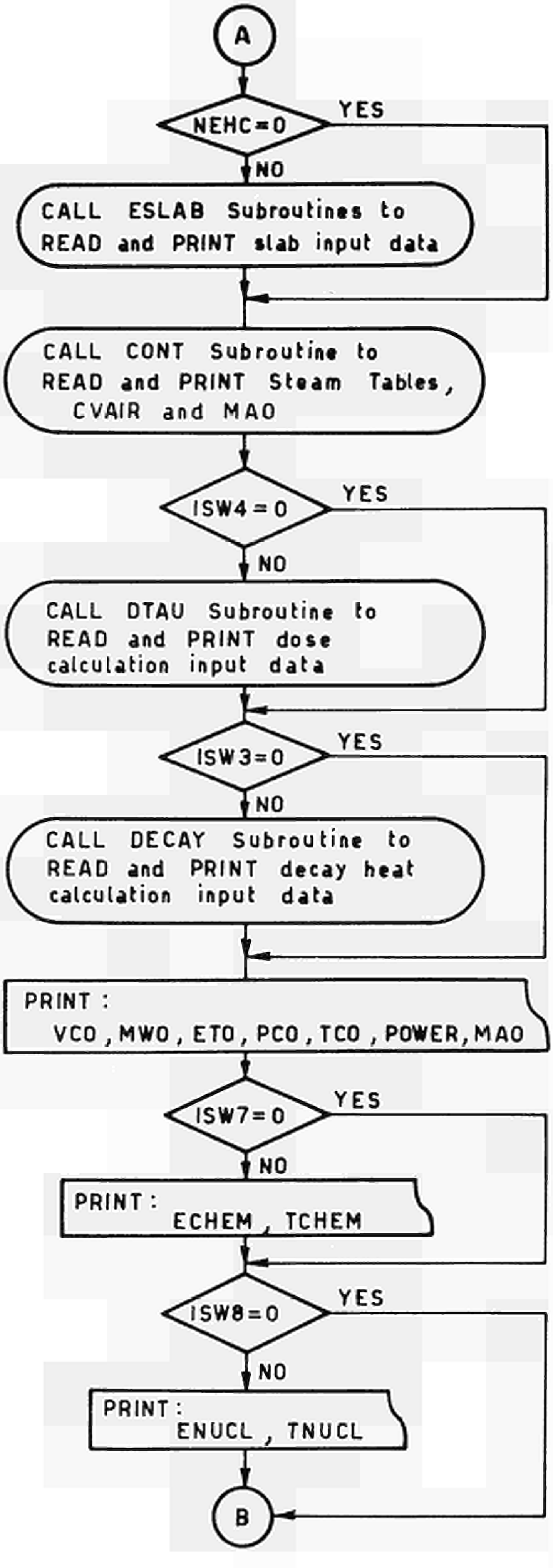
A
NEHC=0
YES
NO
CALL ESLAB Subroutines to READ and PRINT slab input data
CALL CONT Subroutine to READ and PRINT Steam Tables, CVAIR and MAO
ISW4=0
YES
NO
CALL DTAU Subroutine to READ and PRINT dose calculation input data
ISW3=0
YES
NO
CALL DECAY Subroutine to READ and PRINT decay heat calculation input data
PRINT : VCO, MWO, ETO, PCO, TCO, POWER, MAO
ISW7=0
YES
NO
PRINT : ECHEM, TCHEM
ISW8=0
YES
NO
PRINT : ENUCL, TNUCL
B

Fig. 4 (2)

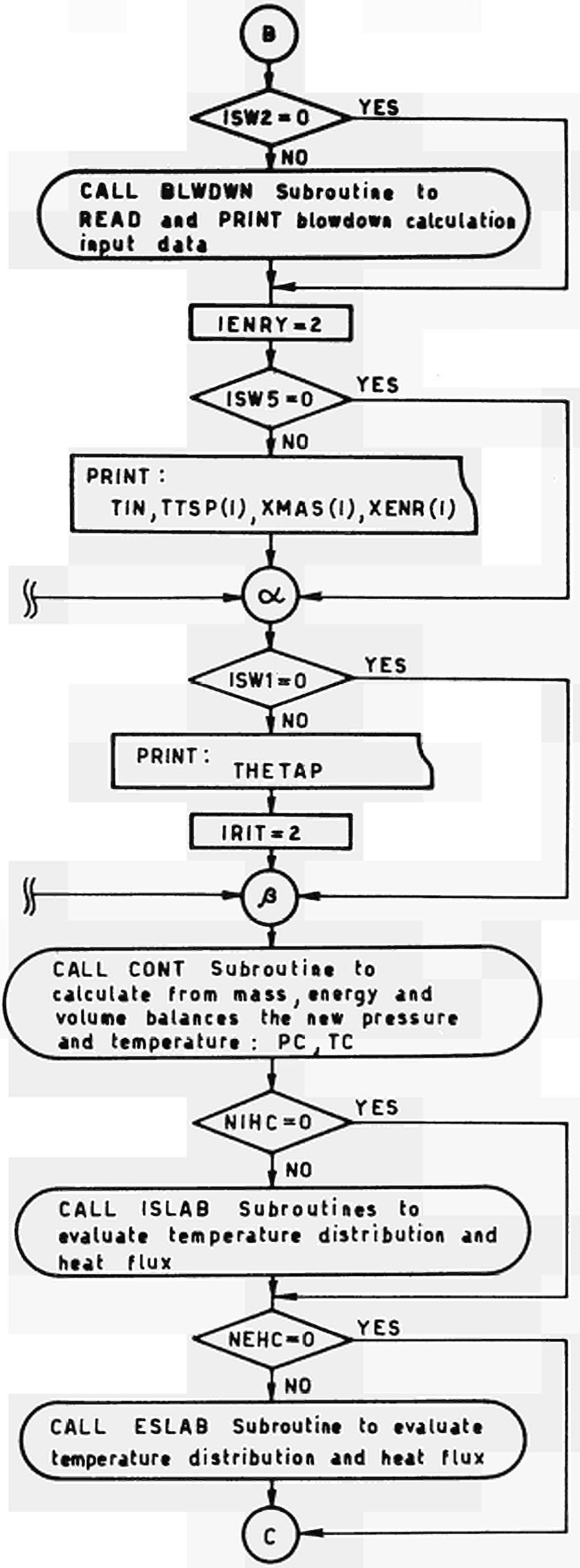
B
ISW2 = 0
YES
NO
CALL BLWDWN Subroutine to READ and PRINT blowdown calculation input data
IENRY = 2
ISW5 = 0
YES
NO
PRINT : TIN, TTSP(I), XMAS(I), XENR(I)
α
ISW1 = 0
YES
NO
PRINT : THETAP
IRIT = 2
β
CALL CONT Subroutine to calculate from mass, energy and volume balances the new pressure and temperature : PC, TC
NIHC = 0
YES
NO
CALL ISLAB Subroutines to evaluate temperature distribution and heat flux
NEHC = 0
YES
NO
CALL ESLAB Subroutine to evaluate temperature distribution and heat flux
C

Fig. 4 (3)

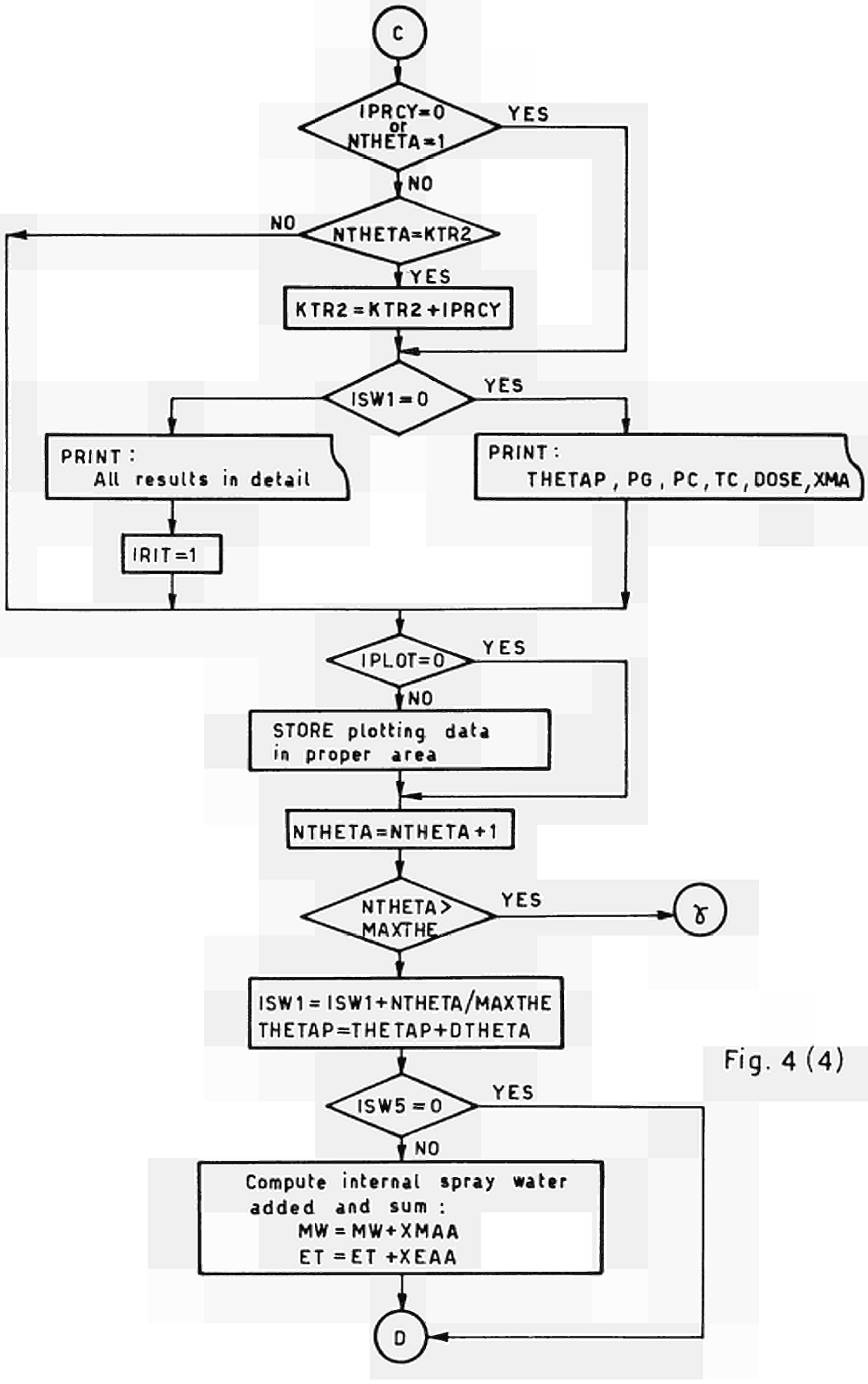
C
IPRCY=0
or
NTHETA=1
YES
NO
NO
NTHETA=KTR2
YES
KTR2=KTR2+IPRCY
ISW1=0
YES
PRINT :
All results in detail
PRINT :
THETAP , PG , PC , TC , DOSE , XMA
IRIT=1
IPLOT=0
YES
NO
STORE plotting data
in proper area
NTHETA=NTHETA+1
NTHETA>
MAXTHE
YES
γ
ISW1=ISW1+NTHETA/MAXTHE
THETAP=THETAP+DTHETA
ISW5=0
YES
NO
Compute internal spray water
added and sum :
MW=MW+XMAA
ET=ET+XEAA
D

Fig. 4 (4)

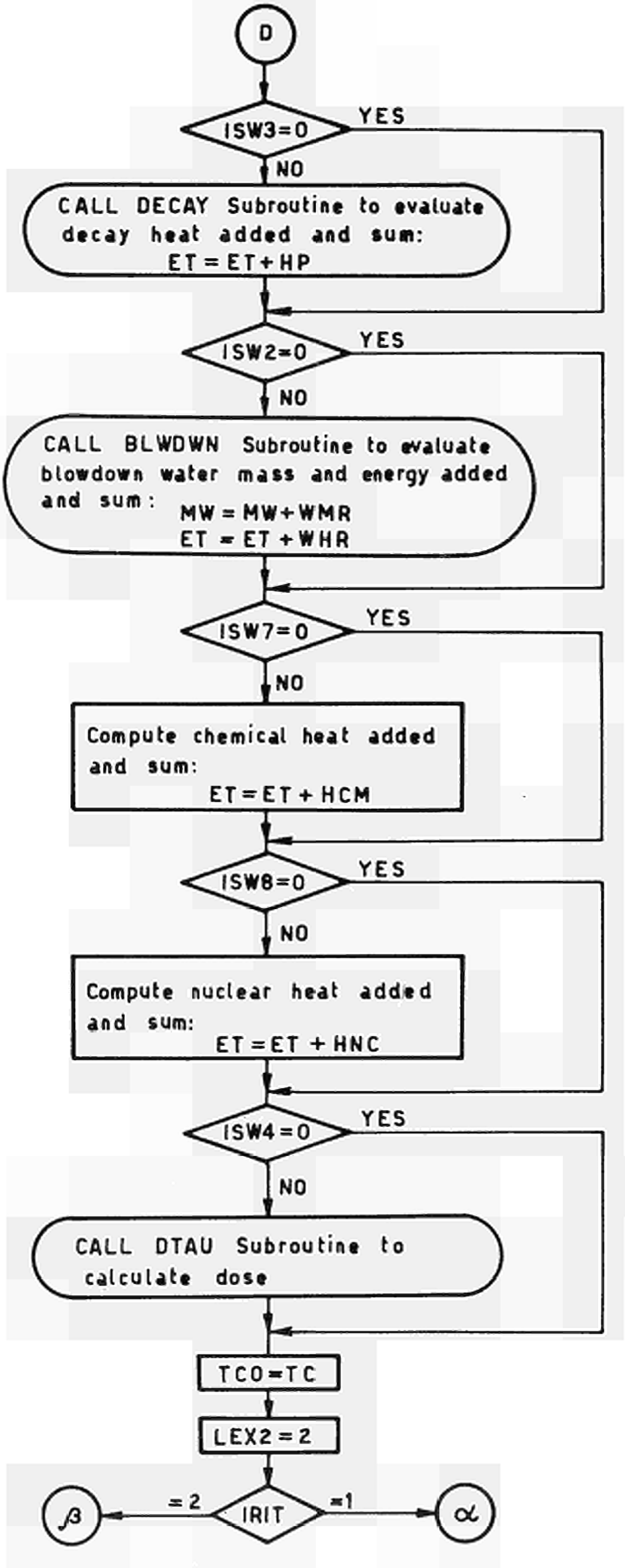
D
ISW3=0
YES
NO
CALL DECAY Subroutine to evaluate decay heat added and sum:
ET=ET+HP
ISW2=0
YES
NO
CALL BLWDWN Subroutine to evaluate blowdown water mass and energy added and sum:
MW=MW+WMR
ET=ET+WHR
ISW7=0
YES
NO
Compute chemical heat added and sum:
ET=ET+HCM
ISW8=0
YES
NO
Compute nuclear heat added and sum:
ET=ET+HNC
ISW4=0
YES
NO
CALL DTAU Subroutine to calculate dose
TCO=TC
LEX2=2
IRIT
=2
=1
β
α

Fig. 4 (5)

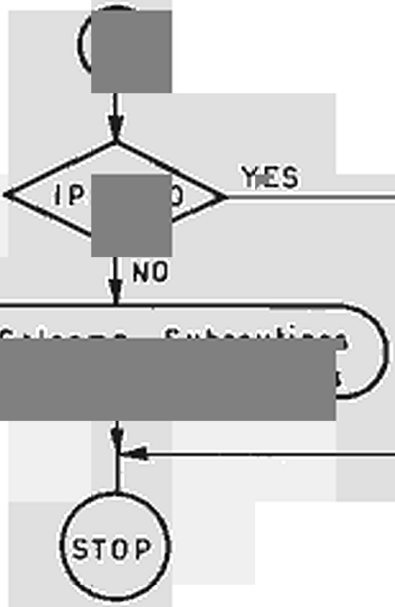

Fig. 4 (6)

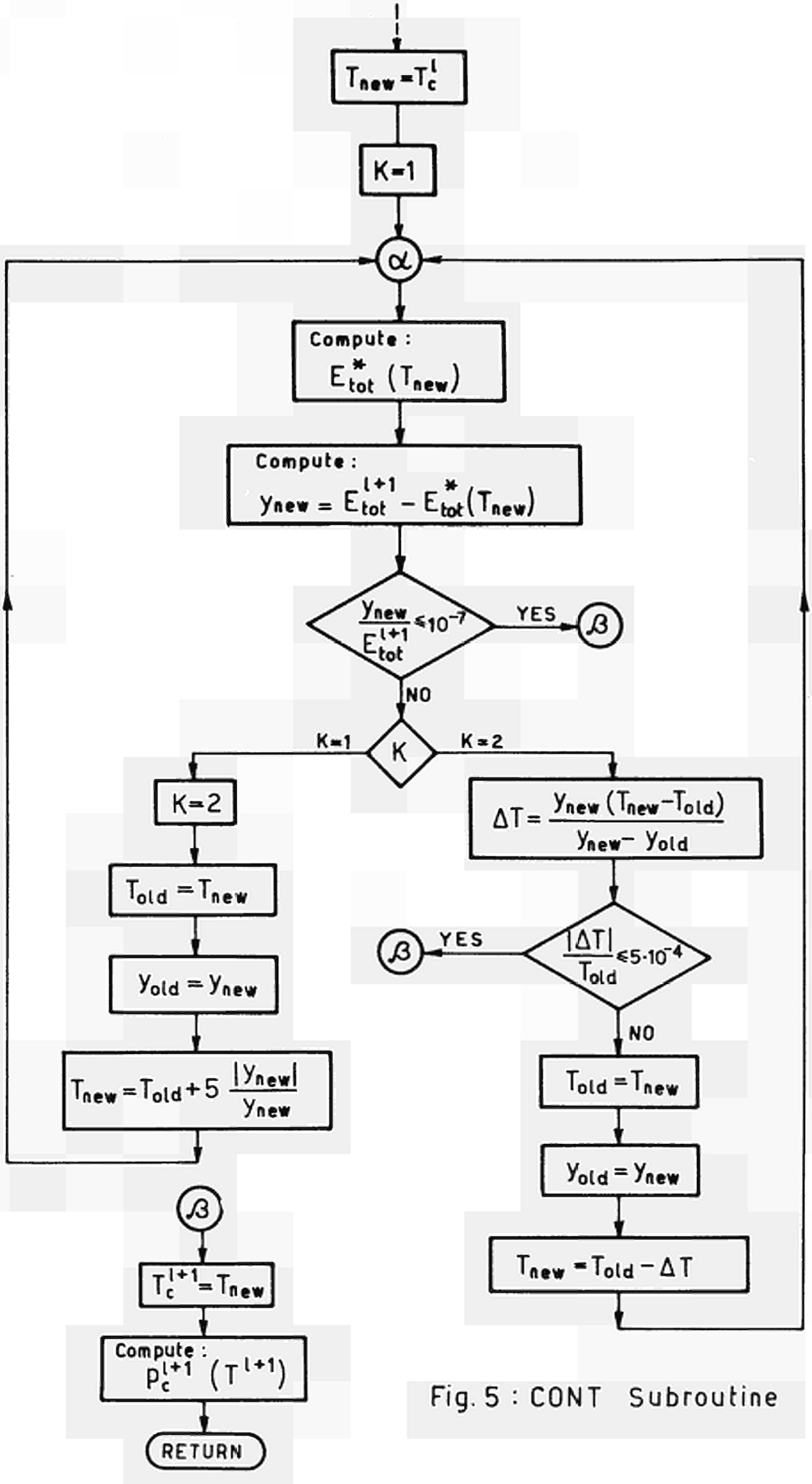

Fig. 5 : CONT Subroutine

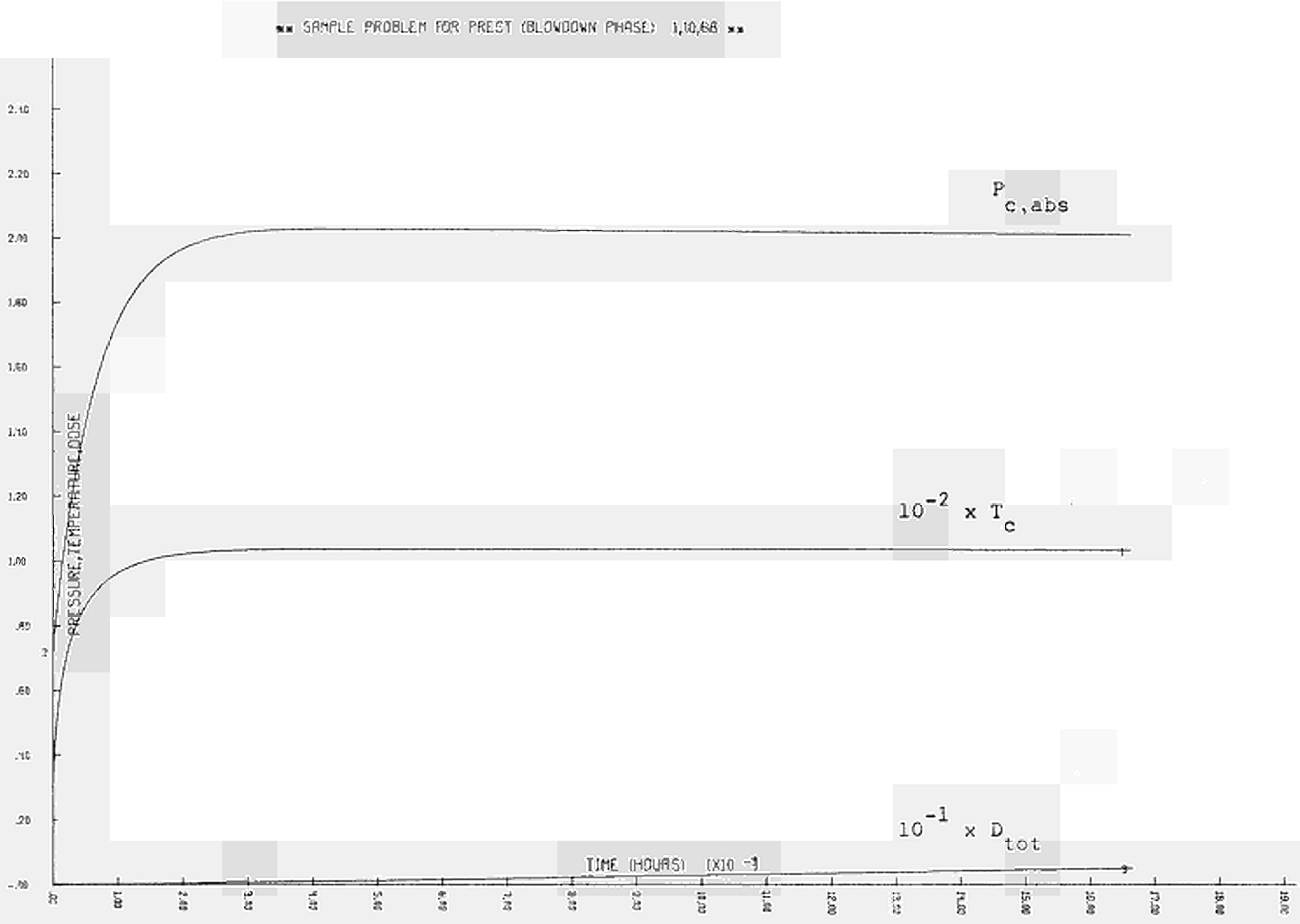

Fig. 6 - Recording Regarding Sample Problem (Blowdown Phase)

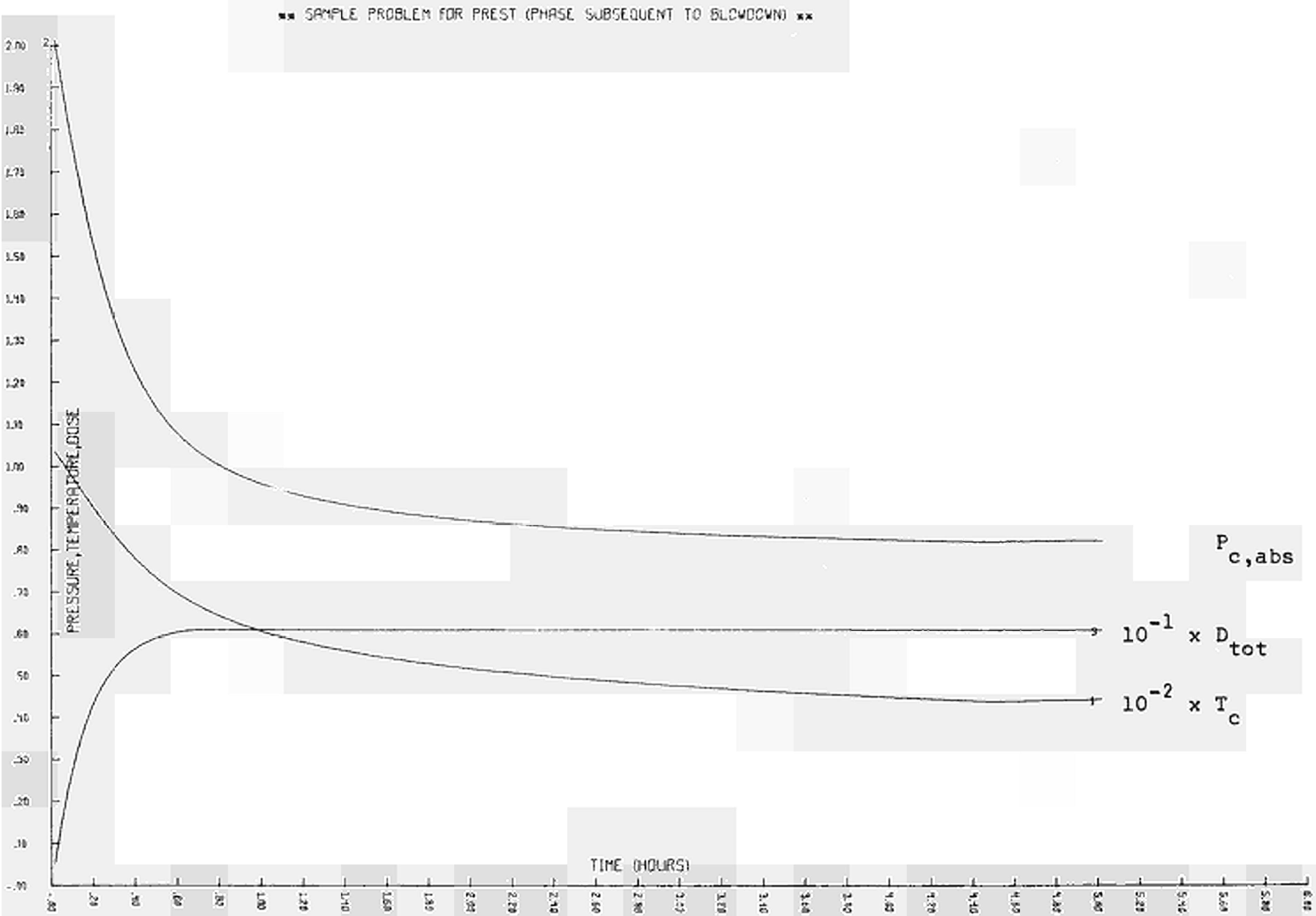

Fig. 7 - Recording Regarding Sample Problem (Phase Subsequent to Blowdown)

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>
> Alfred Nobel

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