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PLASMOR: A LASER-PLASMA SIMULATION CODE, II

D. Salzmann, A.D. Krumbein and H. Szichman

Israel Atomic Energy Commission
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CONTENTS

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ABSTRACT

This report supplements a previous one[1] which describes the PLASMOR hydrodynamics code. The present report documents, the recent changes and additions made in the code. In particular described are two new subroutines, for radiative preheat, a system of preprocessors which prepares the code before run, a list of postprocessors which simulate experimental setups, and the basic data sets required to run PLASMOR. In the Appendix a new computer-based manual which lists the main features of PLASMOR is reproduced.

---

1. INTRODUCTION

Two years have passed from the time that the first report describing the PLASMOR laser-plasma simulation code[1] was published. During this period the PLASMOR has grown from a relatively straightforward hydrodynamics code into a system of programs. It was felt, therefore, that it is the time to supplement the first report by a new one and to document the recent changes and additions made in the code.

The new features of PLASMOR can be divided into three groups: First, some new physics was introduced into the code. This includes the computation of the radiative preheat (which is partially reported also in I) and black-body radiation diffusion. Second, postprocessors were written to carry out additional calculations based on the main PLASMOR output. These postprocessors control the graphics output and simulate some of the experimental diagnostics measurements. These processors run mainly, but not only, on the IBM-PC computer. Finally, major changes of a more technical character were introduced into the code to simplify the handling, debugging and running of the PLASMOR code. The most important of these is the build-up of a manual of PLASMOR on the computer disc, which is supposed to be updated periodically (see below).

The recent changes in PLASMOR helped in reducing the program size and run time, by deleting, or moving to postprocessors, portions of the

program which are seldom used and are not essential for the solution of the hydrodynamic equations. In fact, the source program is reduced to 55% of its original size and the running time on a selected problem was reduced by 12%. The program work area was changed to be dimensionally variable according to the problem requirements (compared to the constant number of cells used heretofore).

2. GENERAL

The present version of the PLASMOR system can be divided into three main parts, see Fig. 1. These are, (a) Preprocessors, (b) the main hydrodynamics code, PLASMOR, and (c) Postprocessors. Each of these groups operates through its own data-bases, which are prepared by a series of auxiliary programs.

The separation of the preprocessors and the postprocessors from the main program greatly facilitates the running of the code. In fact, the use of the preprocessor provides an easy way to change the array dimensions in the common blocks and to reduce the source program, to about 55% of its original size. An immediate consequence is the reduction of the program working area, and a subsequent reduction of CPU-time.

The use of postprocessors, which simulate the experimental diagnostics, also helps in reducing the run time. The transfer of these routines from the main program to the postprocessors has two main effects on the program. First, they are used only when necessary, and secondly, "bugs" in these programs do not stop the execution of the main program.

In section 3 the new additions to PLASMOR are described as well as the structure of the PLASMOR data sets. Section 4 is devoted to the description of the preprocessors and in particular, the new PLASMOR manual. In section 5 the postprocessors are listed and described.

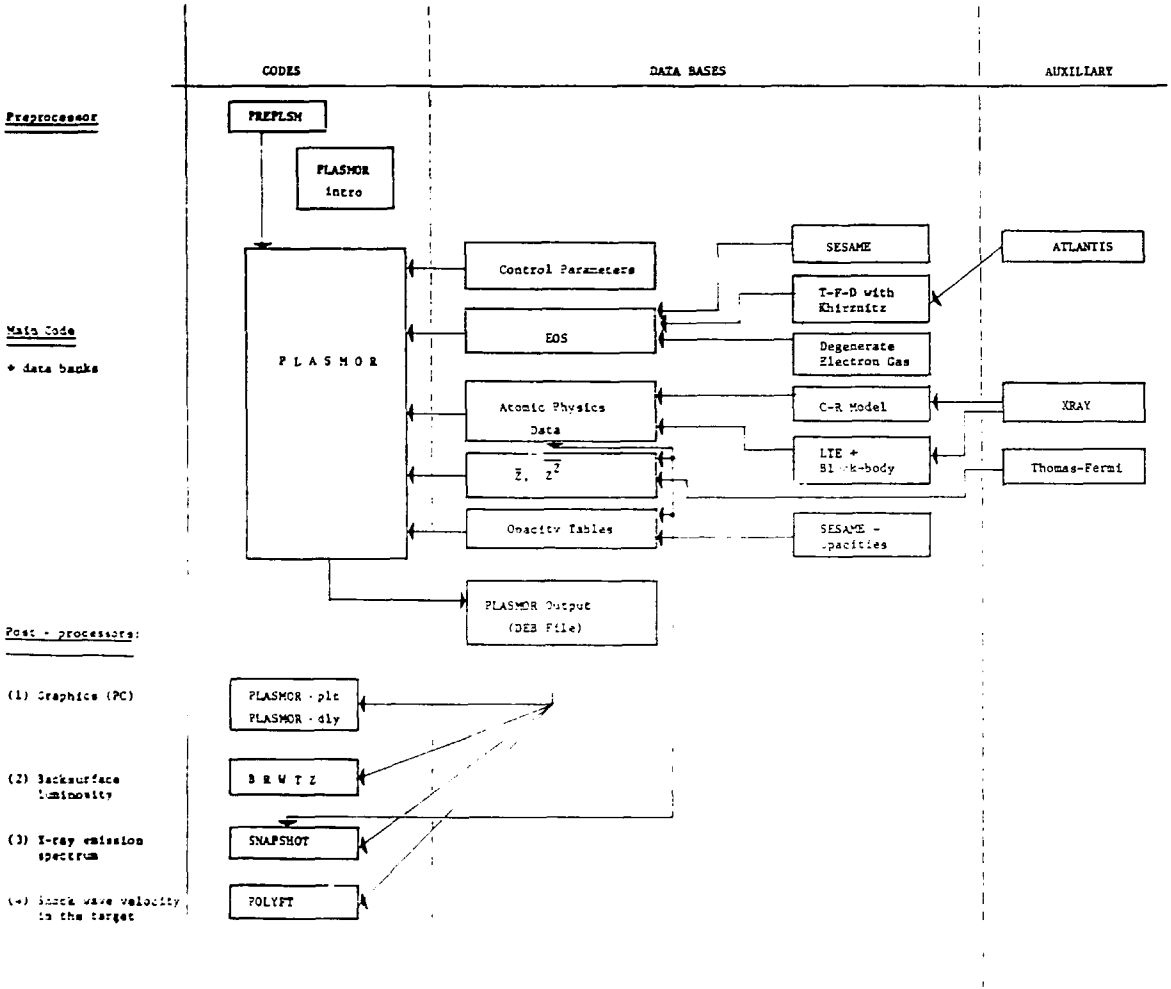
3. NEW FEATURES OF PLASMOR

This discussion concerning the new features of PLASMOR is divided into two parts viz. new routines in PLASMOR and a description of the data bases, which is not included in I.

3.1 New Routines in PLASMOR

3.1.1 Radiation Preheat

This routine has already been partially described in I. Here


CODES
DATA BASES
AUXILIARY
Preprocessor
PREPLSM
PLASMOR
intro
Main Code
* data banks
PLASMOR
Control Parameters
EOS
Atomic Physics
Data
$\bar{Z}$, $\overline{Z^2}$
Opacity Tables
PLASMOR Output
(DEB File)
SESAME
T-F-D with
Khirznitz
Degenerate
Electron Gas
C-R Model
LTE +
Black-body
SESAME -
opacities
ATLANTIS
XRAY
Thomas-Fermi
Post - processors:
(1) Graphics (PC)
PLASMOR · plt
PLASMOR · dly
(2) Backsurface
luminosity
BRWTZ
(3) X-ray emission
spectrum
SNAPSHOT
(4) Shock wave velocity
in the target
POLYFT

however, we give more detailed explanation.

Radiant energy arising in the corona can be absorbed in the target core resulting in the preheat of the colder portion of the target. This preheat may be especially important at low laser intensities where fast electron phenomena have not as yet come into play.

It is assumed that the plasma can be divided into two portions (see figure 2); a hot region which emits intense X-ray radiation, but is practically transparent to its own radiation, and a cold compressed region which strongly absorbs the incident radiation but has only faint black body radiation. A rather sharp boundary separates these regions.

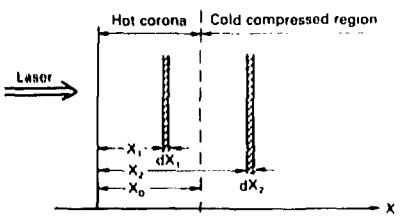


FIGURE 2. Schematic division of the plasma into hot and cold portions and visual aid for the parameter in formulas 1 to 3

Assuming planar symmetry, it can be shown that the total radiative energy absorbed in cell number k per unit time is given by

$$\bar{r}_k = 2\pi \int_0^{\infty} d\omega \bar{I}(\omega) [E_2(\tau_k) - E_2(\tau_{k+1}) \qquad (1)$$

where

$$\tau_k \equiv \tau(x_0; x_k; \omega) = \int_{X_0}^{X_k} n(x) \sigma(x; \omega) dx \qquad (2)$$

is the optical depth of cell k from the interface,

$$\bar{I}(\omega) = \int_0^{X_0} I(x; \omega) n(x) dx \qquad (3)$$

is the total radiation flux from the hot region in the photon energy bin $[\omega, \omega + d\omega]$ and $E_2(y)$ is an exponential integral function of order 2. In (1) to (3), $n(x)$ is the ion density, $\sigma(x;\omega)$ is the photoabsorption cross section of photons having energy ω at depth x in the target, x_0 is the location of the interface between the hot and cold regions and $I(x;\omega)dx$ is the emission rate from the infinite slab between x and $x + dx$. Equation (1) is the basic expression for the calculation of the radiation reabsorption.

It should be noted that (1) incorporates an integration over the isotropic photon emission, i.e., it does not assume a unidirectional photon propagation as other similar computer codes do. This integration is, in fact, the origin on the exponential integral in (1). See I for further explanations about the radiation preheat routines.

3.1.2 Black-body Radiation Diffusion

Incorporated in the program is the black body radiation diffusion in the cold substrate using the well-known expression for this process,

$$S = -\kappa(T)\nabla T \tag{4}$$

where the radiative conductivity is given by,

$$\kappa(T) = \frac{16}{3}\, \ell_R\, \sigma_{SB}\, T^3 \tag{5}$$

Here l_R is the Rosseland mean free path and σ_{SB} is the Stefan-Boltzmann factor. Equation 4 is incorporated into the energy equation in subroutine TEMPS in a manner similar to the electron heat conduction. The Rossland m.f.p. is read from the opacity tables (see below).

3.2 Data Bases

PLASMOR uses five sets of data bases, see Fig. 1. These are the control cards to run a problem, Equation-of-State (EOS) tables, Atomic Physics tables (DXR tables), average-Z and average Z^2 tables and finally, when available, opacity tables (Rosseland m.f.p.).

3.2.1 Control Cards

The control cards are the main input cards to run the program. For a full description see Appendix A below.

3.2.2 EOS Tables

Three sources are available for the EOS used in PLASMOR.

(i) The earliest is a degenerate-electron-gas (Fermi-Dirac statistics) type EOS. This EOS turned out to be inadequate, except, perhaps, for a pure hydrogen high-temperature plasma. For other types of plasmas this EOS overestimates the plasma pressure and predicts compressions which are too high.

(ii) The SESAME-type EOS tables[4] developed in Los-Alamos, are available for a set of 32 materials, from Hydrogen to Uranium, including compounds and mixtures such as polyethylene, air, water and others. These tables list the pressure P and internal energy E as functions of the temperature and density of the plasma for $0 \leq T \leq 10^8$ K and densities up to 10^4 times solid state density.

In spite of some inaccuracies that were found in some parameter regions, the SESAME tables are assumed to be very reliable and are frequently used world-wide. These tables are periodically updated by the Los-Alamos group and the new verions (which include new materials) are available on a commercial basis.

(iii) A set of high accuracy tables are available for aluminum[5]. This set was prepared by us using an auxiliary program ATLANTIS, and is explained in full in I. We hope to develop this method for other materials as well.

3.2.3 Atomic Physics Tables (DXR tables)

The content and the formulas for the preparations of these tables are explained in full in I. Todate, tables are available for berrylium, carbon, oxygen, neon and aluminum.

In contrast to the EOS tables, PLASMOR can run without the DXR tables. In that case, the main inaccuracy in the result arises from neglecting the radiative cooling of the plasma. For high-Z plasmas this

omission may be important, but then a black-body emission mechanism can yield sufficient accuracy. Such an option however, is still not included in PLASMOR.

The DXR tables include, apart from the radiative cooling, also the emission rates of the various continuous-spectrum energy groups, the line emission rates, $\bar{Z}$, $\overline{Z^2}$, total ionization energy and total photoabsorption cross-sections.

3.2.4 $\bar{Z}$ and $\overline{Z^2}$

The values of $\bar{Z}$ and $\overline{Z^2}$ are extensively used in PLASMOR for the calculation of the electron density and the local electron pressure in the plasma. Values of $\bar{Z}$ and $\overline{Z^2}$ are available from two sources:

(i) The DXR tables tabulate explicitly $\bar{Z}$ and Z^2 on a mesh of temperatures and densities. The advantage of using these tables is the fact that the values of $\bar{Z}$ and $\overline{Z^2}$ are obtained from a Collisional-Radiative (CR) model, and are, therefore, more accurate for laser-plasmas than those obtained from other models.

(ii) For high-Z plasmas, where the Thomas-Fermi model is valid, a simple algorithm, developed by More[6], can be used to yield reasonably accurate results.

3.2.5 Opacity Tables

Opacity tables are used only if radiation transport is calculated. These tables list the values of the Rosseland mean free path, which are required by Eq. (5).

Opacity tables are likewise available from the Los Alamos group on a commercial basis though not always for the same materials for which there are SESAME EOS tables. We have available for use in PLASMOR at present, opacities for Aluminum, titanium, iron, copper, CH_2 and SiO_2.

4. PREPROCESSORS

4.1 The set PREPLSM

The common blocks of PLASMOR took up a significant portion of the source program. This resulted in an unnecessarily long program which was very difficult to handle. To illustrate this difficulty, it is enough to mention that to change a parameter in one of the common blocks which is

used throughout the program, becomes a "dangerous" task, nearly always accompanied by unavoidable bugs. It was therefore felt that a decoupling between the common blocks and the subroutines was necessary in order to make the program more flexible.

In the present version, the common blocks are located at the beginning of the MAIN program. The beginning of each block is tagged by *CD NAME by where NAME is the name of the common block. The end of all the blocks is tagged by *END. Each subroutine which uses a block includes a line *CALL NAME. The program PREPLSM FORTRAN is used to substitute the relevant blocks into the calling subroutines. PREPLSM is applied to the source program, before compilation. The run time of PREPLSM is about 7 seconds.

The first block is *CD PAR, which includes the PARAMETER statement through which one can assign variable values to the array dimensions. The two parameters: NCL (number of cells) and MIX-(number of DXR tables) define all the common block lengths. These variables should be set before the PLASMOR run.

The routine PREPLSM EXEC is a control file which carries out the following tasks:

(i) runs PREPLSM
(ii) compiles PLASMOR
(iii) links PLASMOR
(iv) erases extra unused files
(v) runs PLASMOR

To run PLASMOR one has only type "PREPLSM" and the program carries out all the above commands in sequence. Care should be taken to update PREPLSM FILEDEF when necessary.

4.2 PLASMOR MANUAL

The PLASMOR MANUAL is intended to provide an updated manual to facilitate running PLASMOR.

The PLASMOR MANUAL data set is stored on the computer disc and includes a list of the central properties of PLASMOR.

The following data are included in PLASMOR MANUAL:

(i) Subroutines - a list of the subroutines, divided into categories of their function and numbered according to their use and calling sequence. The subroutines in the code are arranged according to the same order.

(ii) I/O units - list of the I/O units and the data sets linked to them

(iii) Common block- list and short definition of the variables in the various common blocks. This portion of the mannual should be of the greatest help to the user.

(iv) Input cards - list, definition and format of the input cards required to run PLASMOR. Significant changes were entered into the input cards since the publication of I.

We intend to update PLASMOR MANUAL whenever new features are introduced into the code. In this way we end up with a manual which can be easily changed and is always updated.

An updated printout of the PLASMOR MANUAL is given in Appendix A.

4.3 The set ZIHUI

The programs ZIHUI are short auxiliary programs which help in handling PLASMOR:

(i) ZIHUI1 FORTRAN - identifies and lists the variables and arrays in the various common blocks, and writes them on the disc as ZIHUI1 OUT.

(ii) ZIHUI2 FORTRAN - lists the names of the variables and arrays that are used in the various subroutines and writes them on the disc as ZIHUI2 OUT. The program cannot distinguish the FORTRAN statements from the variable names so it lists the statements together with the variables. Run time of ZIHUI2 is about 40 sec.

(iii) ZIHUI3 FORTRAN - compares the outputs of ZIHUI1 and ZIHUI2 and lists (on ZIHUI3 OUT) the variables which are never used in PLASMOR as well as the blocks used in each subroutine. This program helps greatly in

cleaning up PLASMOR and in deleting unused variables. Run time is about 20 sec.

(iv) ZIHUI4 FORTRAN - given a variable name, this auxiliary program returns the names of the subroutines that use this variable. This program uses ZIHUI2 OUT. It works interactively i.e. type in the variable - the computer prints out the subroutines and waits for the next variable. Typing in a blank stops execution.

5. POST PROCESSORS

5.1 AUTOEXEC

This internal routine of the IBM-PC links the PC to the mainframe and, using a user-friendly system, enables the transfer of the PLASMOR DEB main output file from the mainframe to the PC hard disc.

The linkage is carried out by answering properly the computer's questions. When the linkage is finished one can use the regular CMS operating system commands (copy file) to copy data files from the mainframe to the PC hard disc.

The transfer of the files may take several hours, depending on the file length, and is preferably carried out at night.

5.2 Graphics

Two systems of packages for graphics are available on the IBM-PC, one for display on the monitor screen for a visual check of the PLASMOR results, and the second for plotting the results. Both programs are written in BASIC.

5.2.1 PLASMOR.DLY

This program displays the output of PLASMOR on the monitor. The spatial behavior of three variables, namely, the temperature, the pressure and the compression, are shown for a predetermined list of timesteps.

This program enables the user to choose the proper ranges of the axes which will be used later, in the final plots.

PLASMOR.DLG performs the same task as PLASMOR.DLY but on a logarithmic scale. For the control parameters see 5.2.2 below.

5.2.2 PLASMOR.PLG

After choosing the proper axes, one can use PLASMOR.PLG to plot the above parameters temperature, pressure and compression from PLASMOR.DEB. PLASMOR.PLG provides logarithmic axes, whereas PLASMOR.PLY provides linear scales (which are usually less useful).

The possibility of plotting the PLASMOR results was a very great advance in the use of PLASMOR. It enabled us to detect small phenomena inside the plasma[2,3], which were otherwise very difficult to read off of a numerical printout and practically impossible to plot by hand. It also provided an easy way of choosing a set of representative graphs for publication.

The input parameters are entered into the program in lines 1110 - 1140 and they include the following:

1110: width of plot, scale of ρ/ρ_0, scale of P, scale of T, lower limit of T

1120: width of plotter in pixels

1130: first timestep to be plotted, frequency of plot, speed of plot, dummy, dummy

1140: name of file to be plotted

5.3 BRWTZ.FOR

The program BRWTZ.FOR simulates the streak camera recording after the arrival of the shock front on the backsurface of the target. The program can simulate only a one-dimensional emission. The light emission, reabsorption by the outer layers of the plasma and the streak camera response functions are included. The recorded light intensity is given by,

$$I = C \int_0^\infty dx\ F(x)\ S(x)\ \frac{x^3}{\exp(x/kT - 1)} \qquad (6)$$

where C is a numerical constant proportional to the Stefan-Boltzmann factor, $x = h\nu$ is the photon energy, S(x) is the streak camera spectral response function, and

$$F(x) = \exp\left[-\int \sigma(x,y)\sigma(y)dy\right] \qquad (7)$$

Here $\sigma(x,y)$ is the photoabsorption cross-section of photons with energy x at a depth y from the backsurface. In Eq. (6) black-body radiation from the shocked region is assumed. The density $\rho(y)$ of the material ejected from the back surface is allowed to expand laterally at a constant opening angle (SLOPE) which is fixed arbitrarily, so that the computational results will fit the experimental ones.

Comparisons between the computational and experimental results showed good agreement, but the results have not as yet been published.

5.4 SNAPSHOT FORTRAN

This program uses the results of PLASMOR FORTRAN to calculate the instantaneous and time-integrated continuous and line X-ray spectra emitted by a plasma. The X-ray emission rates are taken from the appropriate DXR table. Reabsorption is neglected, but it is intended to add it in the near future.

The program reads from the PLASMOR DEB output the local temperature and density in each cell at every time step. Spatial integration is carried out to find the instantaneous spectral emission rate, and finally, the spectra are added up to obtain the time-integrated emission spectrum.

An option is available which simulates the spectrum recorded by a spectrograph whose entrance window is covered by a thin berrylium or aluminum foil. The absorption factor of these foils is taken into account in the recorded spectrum.

This program was used to simulate experimental values of the temperature of KrF - laser produced aluminum plasma[7], and agreement to high accuracy was obtained between the simulations and the experiments[7]. A graph of Ref. (3) was also computed by this program.

5.5 POLYFT FORTRAN

This program reads the PLASMOR DEB output, finds the location of the shock front at each timestep and fits a linear or quadratic polynomial to these locations as a function of time. From the fitted values the instantaneous shock velocity and/or acceleration can be derived.

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2. H. Szichman, A.D. Krumbein and D. Salzmann, "Radiative Transport and Preheat Calculations in Laser Irradiated Aluminum Targets", Laser and Particle Beams, 4, 403 (1986).
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6. R.M. More, "Atomic Physics in Inertial Confinement Fusion", Lawrence Livermore National Laboratory Report, [illegible], [illegible].
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APPENDIX: Printout of PLASMOR MANUAL

FILE: PLASMOR MANUAL A VM/SP CONVERSATIONAL MONITOR SYSTEM

CONTENT
****

UPDATES
****

17.3.1987 PREPARATION OF THIS DOCUMENT [illegible]

INTRODUCTION
****

(1) THE ORIGINAL [illegible] OF THE [illegible] ARE STORED ON DISK [illegible] PLASMOR [illegible]

(2) EQUATIONS ARE [illegible] ACCORDING TO THE [illegible]-REPORT IN WHICH THEY APPEAR. [illegible] EQUATION 22 IN REPORT [illegible] PLASMOR.

SUBROUTINES
****

1. DATA INPUT AND INITIALIZATION

1.1	CONST	MATHEMATICAL AND PHYSICAL CONSTANTS
1.2	RDDIX	READ ATOMIC DATA TABLES
1.3	[illegible]	READ CONTROL DATA FROM INPUT CARDS
1.4	PROFIL	INITIALIZE DENSITY PROFILE
1.5	[illegible]	PRINTOUT INPUT DATA

2. GRAND LOOP OF COMPUTATION

2.0	[illegible]	[illegible] LOOP CONTROL ROUTINE
2.1	[illegible]	PRINTOUT EVERY [illegible]
2.2	[illegible]	TIME STEP CONSTRAINTS, DELTA-[illegible]
2.3	ABSORB	LASER ENERGY ABSORPTION
2.3.1	LASAHI	LASER PULSE SHAPE
2.3.2	[illegible]	[illegible]THERMAL ELECTRONS ENERGY DEPOSITION
2.4	[illegible]	SOLUTION OF THE ENERGY EQUATION, NEW TEMPERATURE
2.4.1	[illegible]	[illegible] MEAN FREE PATH
2.4.2	[illegible]	SOLUTION OF THE TRIDIAGONAL SET OF EQUATIONS
2.5	[illegible]	ARTIFICIAL VISCOSITY
2.6	[illegible]	TEMPERATURE RELAXATION AND COULOMB LOGARITHM
2.7	[illegible]	DUMP COMMON BLOCKS
2.9.1	[illegible]	[illegible] VALUES FOR [illegible]
2.10	[illegible]	EQUATION OF STATE
2.10.1	SESAME	
2.10.2	SESINP	READIN SESAME EOS VALUES
2.10.3	NUCLEO	CALCULATION OF NUCLEAR PART OF THE EOS
2.10.31	[illegible]	

```
2.11      LAST       ENERGY BALANCE AND VARIABLE RECYCLING
2.12      IONSET     IONIZATION DATA
2.13      ENERA      RADIATION ENERGY DEPOSITION
2.13.1    XEIX       XEIX=E1-EXPONENTIAL INTEGRAL FUNCTION

3.   AUXILIARY ROUTINES

3.1       FINL       NUMERICAL INTERPOLATION
3.2       LINT       LINEAR INTERPOLATION
3.3       INFL       INITIALIZES A FLOATING POINT VECTOR
3.4       INT        INITIALIZES A FIXED POINT VECTOR


                    INPUT/OUTPUT UNITS
                    ******************

FILE 1          IR31 DATA      STORAGE OF COMMON BLOCKS FOR RESTART
                                 PURPOSES
FILE 2          IR32 DATA      STORAGE OF COMMON BLOCKS FOR RESTART
                                 PURPOSES
FILE 3          RESTR DATA     CONTROL CARDS FOR RESTART
FILE 5 (INS)    PLASM INPUT    CONTROL CARDS FOR RUNNING PLASMOR
FILE 6 (OUTS)   PLASMOR OUT    OUTPUT FILE FOR MISCELLANEOUS PRINTOUT.
FILE 7          RSSAL DATA     LIST OF RUSSEL AND ... F. RATES
FILE 10         OXRAL5 DATA    ATOMIC DATA ( OXRAL ) TABLES
FILE 21         AL THEOS       HENRIK'S EQUATION-OF-STATE TABLES
FILE 31         AL SSNFILL     SESAME EQUATION-OF-STATE TABLES
FILE 40         TERMINAL       PROMPT OUTPUT FOR DEBUGGING PURPOSES
FILE 70         NUCLEA OUT     COLD PRESSURE DATA FOR EOS TABLES
FILE 80         PLASMOR DEBS   MAIN OUTPUT OF PLASMOR


                    COMMON BLOCKS
                    *************


1.   COMMON/CONSTA/

   MOST OF THE MATHEMATICAL AND PHYSICAL CONSTANTS IN /CONSTA/ ARE SELF-
     EXPLANATORY. FULL DESCRIPTION OF THE VARIABLES IS GIVEN IN SUB-
     ROUTINE CONST. THE FOLLOWING ARE NOTEWORTHY:

   TENI(I)          = 10**I,   I=-10,....,0,....,10
   FCT(I)           = I!       I=0,.....,12

2.   COMMON/VAR1/                     COMPUTED CELL VARIABLES

   RA      LOCATION OF THE INTERFACE BETWEEN CELLS J AND J+1, TIMESTEP I
   RB      LOCATION OF THE INTERFACE BETWEEN CELLS J AND J+1, TIMESTEP I+1
   R2A     RA**2
   R2B     RB**2
   UA      VELOCITY OF INTERFACE BETWEEN THE CELLS, TIMESTEP I+1
   TNA     ELECTRON TEMPERATURE IN CELL J, TIMESTEP I
   VOLI    INITIAL VOLUME OF CELL J
   VOLA    VOLUME OF CELL J AT TIMESTEP I
   VOLB    VOLUME OF CELL J AT TIMESTEP I+1
   TNB     ELECTRON TEMPERATURE IN CELL J, TIMESTEP I+1
   TPA     ION TEMPERATURE IN CELL J, TIMESTEP I
   TPB     ION TEMPERATURE IN CELL J, TIMESTEP I+1
   USQ     VELOCITY OF INTERFACE BETWEEN CELLS J AND J+1, TIMESTEP I+1
   PRESS   PRESSURE
   LOGLAM  LOG LAMBDA , FOR ELECTRONS
   C       VECTOR TO STORE DATA FOR TRIDIAGONAL EQUATIONS
   D       VECTOR TO STORE DATA FOR TRIDIAGONAL EQUATIONS
   TPAM    SEE PROFILE ( DOESN'T SEEM TO BE USED )
   FRCL    FRACTIONAL INCREASE OF CELL SIZE
   UP      ARTIFICIAL VISCOSITY FACTOR
   DN      RATIO OF NET ENERGY TRANSFERED BY ELECTRONS THERMAL CONDUCTIVITY INTO
             CELL J, CALC'D IN TEMPS, USED IN TCALC. SEE EQ. 1.33
   ZZ      AVERAGE Z
   ZZSQ    AVERAGE Z**2
   NE      NUMBER OF ELECTRONS IN CELL J
   NDENA   ELECTRON NUMBER DENSITY IN CELL J, TIMESTEP I
   NEDENB  ELECTRON NUMBER DENSITY IN CELL J, TIMESTEP I+1
   W       ENERGY ABSORBED BY THE SYSTEM ( SEE ABSCAL )
```

```
A        VECTOR TO STORE DATA FOR TRIDIAGONAL EQUATIONS
SUMI     TOTAL NUMBER OF IONS IN CELL J ( = NI(J) IN IONSET )
AVEMAS   AVERAGE MASS OF IONS IN CELL J
XLEION   LOG LAMBDA I FOR IONS
NMASS    AVERAGE MASS OF NEUTRAL PARTICLES
NF       TOTAL NUMBER OF NEUTRAL PARTICLES IN CELL J ( SET TO 0 IN IONSET )
NH       TOTAL NUMBER OF HEAVY PARTICLES ( IONS + NEUTRALS )
CVB      SPECIFIC HEAT AT CONSTANT DENSITY
CPOEE    SPECIFIC HEAT AT CONSTANT PRESSURE
ESAVE    IONIZATION ENERGY IN CELL J

ZSAVE    SEE IONCAL ( IN IONSET )
ERR      TOTAL RADIATED ENERGY FROM CELL J ( CALC'D IN BRENCA
ERR I    TOTAL RADIATED ENERGY IN CONTINUOUS SPECTRUM, INTEGRATED OVER ALL
           CELLS ( CALC'D IN SPECAL
KAPPA    NEGATIVE ENERGY ( SEE IONCAL )
ERRL     TOTAL RADIATED ENERGY IN LINE SPECTRUM, INTEGRATED OVER ALL
           CELLS ( CALC'D IN SPECAL
TEX      LOWER LEVEL OF TEMPERATURE IN THE DAR TABLES
TEY      UPPER LEVEL OF TEMPERATURE IN THE DAR TABLES
DEX      LOWER LIMIT OF DENSITY IN THE DAR TABLES
DEY      UPPER LIMIT OF DENSITY IN THE DAR TABLES
EEE      [illegible] OVER ALL CELLS
ZL I     [illegible] FOR MATERIAL M
FT       FRACTION OF HEAVY PARTICLES IN REGION I
ZZY      [illegible] FOR MATERIAL M
UIE      IONIZATION ENERGY
CIO      AUXILIARY VECTOR , DEFINED IN ROUTP
AI       [illegible] FOR [illegible] ELECTRON TEMPERATURE
                    [illegible]   INPUT  PARAMETERS
                    [illegible]   [illegible]  IONIZED
                    [illegible]   [illegible]  INTERPOLATED
         INPUT                                   CALCULATE IONSET
          [illegible] LOW                        [illegible] ZZ(J)-INITIAL + Z-[illegible]
          [illegible] HIGH                       [illegible] ZZ(J)-MAX = [illegible]
          [illegible] INITIAL                    [illegible] = Z   MAX = [illegible]
          [illegible] FULL IONIZ.                [illegible] INITIAL = C.

                 [illegible] INITIAL IONIZATION INPUT [illegible]
         [illegible]  TEMPERATURE BELOW WHICH INITIAL IONIZATION FOR [illegible]
         [illegible]  INITIAL  ZZ
         [illegible]  INITIAL  ZZS
         [illegible]  INITIAL  [illegible] ENERGY ERGS/ION

CAPA     [illegible]
TEI      INITIAL ELECTRON TEMPERATURE ( IN KELVINS )
TIP      INITIAL ION TEMPERATURE ( IN KELVINS )
CMASS    ATOMIC WEIGHT OF MATERIAL M
FF       FRACTIONAL [illegible] OF MATERIAL M IN REGION I
WAT      ATOMIC WEIGHT OF MATERIAL M
[illegible] [illegible]
EP       USED IN CALCULATION OF [illegible] WHEN [illegible] IS NOT USED ( [illegible] )


1.   COMMON [illegible]                          GENERAL VARIABLES

[illegible] [illegible]
[illegible] [illegible] PEAK POWER DENSITY, [illegible]
RQUA     THICKNESS OF REGION I
CUT      DURATION OF LASER PULSE, IN UNITS OF [illegible]
TOUT     TERMINATION TIME FOR SIMULATION
[illegible] INITIAL [illegible]
[illegible] INITIAL ION DENSITY
COEF     COEFFICIENT FOR SPITZER CORRECTION TERM TO THE ELECTRON THERMAL
           CONDUCTIVITY
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RADI	RADIUS OF ... CELL (ONLY FOR SPHERICAL GEOMETRY)
FLAS	FRACTION OF TOTAL LASER ENERGY WHICH CAN BE ... IN ONE TIMESTEP (USUALLY SET TO 0.05)
FCLF	COURANT-LEWY-FRIEDRICH FACTOR (USUALLY = .6)
FMCN	LARGEST FRACTIONAL DECREASE IN ELECTRON ENERGY ALLOWED IN ANY CELL IN A GIVEN TIMESTEP (USUALLY = 0.25)
FMCP	LARGEST FRACTIONAL INCREASE IN ELECTRON ENERGY ALLOWED IN ANY CELL IN A GIVEN TIMESTEP (USUALLY = 0.20)
FVOL	LARGEST FRACTIONAL CHANGE IN CELL THICKNESS ALLOWED IN ANY CELL IN A GIVEN TIMESTEP (USUALLY = 0.10)
FMAX	MAXIMUM ALLOWABLE COMPRESSION OF CENTER CELL (USUALLY = 20.0)
FABS	FRACTION OF REMAINING LASER BEAM ENERGY ABSORBED AT CRITICAL SURFACE
FRAD	MAXIMUM ALLOWABLE RADIATION LOSS DURING TIMESTEP (USUALLY = 0.2)
EPABS	CRITERION USED IN ABSORB FOR ELECTRON DENSITY GRADIENT (USUALLY = 0.001)
RELAX	NUMERICAL COEFFICIENT FOR ELECTRON-ION RELAXATION TIME CONSTANT, EQ. 1.22
COBAR	SEE CONST
FREQL	LASER FREQUENCY IN SEC**(-1)
PI4	4.*PI
SQRTPI	SQRT(PI)
BOLTZ	BOLTZMANN CONSTANT
CHARG	ELECTRON CHARGE (ESU)
BOLTZH	1.5 * BOLTZ
...	1./BOLTZH
NCUT	CRITICAL DENSITY
NCUTI	1./NCUT
CEF	SEE CONST
CABS	SEE MAIN
CLAM	SEE CONST
CAREN	SEE CONST
FNAPA	DIVISOR OF ... IN MAIN
FFLUX	DIVISOR OF QQ IN TEMPS
DT	THE TIMESTEP
DECVI	ELECTRON THERMAL ENERGY, TIME AND SPACE INTEGRATED
ERROR	RELATIVE ERROR IN TOTAL ENERGY
TIME	TIME
ETBR	TOTAL RADIATED ENERGY
ESENS	TERMINATION COUNTER (SEE LASE)
TOTW	LASER ENERGY ABSORBED UP TO PRESENT TIMESTEP
TERR	TOTAL ERROR
EINTB	THERMAL ENERGY, SPACE INTEGRATED
EKINB	KINETIC ENERGY, SPACE INTEGRATED
ETOTA	TOTAL (THERMAL+KINETIC) ENERGY, SPACE INTEGRATED, TIMESTEP ...
ESUP	TOTAL ENERGY SUPPLIED BY THE LASER UP TO PRESENT TIMESTEP
ETOTB	TOTAL (THERMAL+KINETIC) ENERGY, SPACE INTEGRATED, TIMESTEP ...
TOTMOM	SUM OVER ... MOMENTUM , FOR ERROR CHECK
POSMOM	POS.MOMENTUM OUTWARD CALCULATED IN MOMENTUM LOOP
EKMOM	KINETIC E. OF THE ... PART WHICH IS MOVING OUT
OUTMOM	AS POSMOM BUT CALCULATED IN SEPARATE LOOP ...
TCEL	SEE CONST
CFIED	SEE MAIN
CCTE	CONV. FACTOR FROM DEGREES TO EV
CCTEI	CONV. FACTOR FROM EV TO DEGREES
TRAS	TERMINATION PARAMETER (SEE LASE)
DTSU	SEE ARIVES

DTA	TIMESTEP, (SEE ICRO)
DTB	TIMESTEP, (SEE ICRO)
ESTAR	LATENT + THERMAL ENERGY ORIGINALLY PRESENT IN THE SYSTEM
ERAD	TOTAL RADIATED ENERGY
PULA	LASER PULSE SHAPE
EIOT	TOTAL ENERGY GOING INTO HOT ELECTRONS
TIMEN	TIME / RISETIME
DECV	ELECTRON THERMAL ENERGY, SPACE INTEGRATED
FLAT	DELTA-LATENT ENERGY, SPACE INTEGRATED
TOTEL	TOTAL LATENT ENERGY, SPACE INTEGRATED
ECONTI	RADIATED ENERGY IN CONTINUOUS SPECTRUM, SPACE INTEGRATED
TONTI	TOTAL CONTINUOUS EMISSION, SPACE + TIME INTEGRATED
ELINE	RADIATED ENERGY IN LINE SPECTRUM, SPACE INTEGRATED
TELINE	TOTAL LINE EMISSION, SPACE + TIME INTEGRATED
TPRL	INITIAL ELECT.-TEMP. FOR ADJUSTING PRESSURE AT INTERFACES OF REGIONS FOR COLD SYSTEM (=300)
TPRH	EL.TEMP AT WHICH NO MORE ADJUSTMENT (=1.E4)
	TPRL , TPRH FOR ICALL1 = 2

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3.     COMMON/VAR3/                         FIXED POINT VARIABLES

MMAX     NUMBER OF ISOTOPES
NZ       ATOMIC NUMBER OF MATERIAL
NO       =1 EXCEPT FOR HYDROGEN WHERE =0
MAXNUM   NUMBER OF DIFFERENT REGIONS IN CORE
NUM(K)   NUMBER OF CELLS IN REGION K
NPRTE    SAME AS NPRT FOR THE ELECTRON EQUATION ( SEE BELOW )
ITEM     MAX. NUMBER OF TIME STEPS
IPFREQ   NUMBER OF TIMESTEPS BETWEEN MAJOR OUTPUT PRINTINGS
NPRT     NUMBER OF ITERATIONS OF IMPLICIT NEW. EQUATION FOR
         THE IONS ( SEE TEMPS )
IGAS     EOS FORMULATION. USE =3. SEE INPUT LIST
IION     PLASMA IONIZATION. ( SEE INPUT LIST )
LFREQ    LASER FREQUENCY IN MULTIPLES OF NEODYMIUM FREQUENCY
IREAD    =1 FOR NEW CALCULATION; =2 FOR CONTINUATION
IPUNCH   TERMINATION OPTIONS . SEE INPUT LIST
IGEOM    GEOMETRY OPTION      . SEE INPUT LIST
IPROF    DENSITY PROFILE PARAMETER
JLEFT    INDEX OF INNERMOST CELL WHICH IS ACTIVE IN THE SIMULATION
JMPI     INNERMOST CELL WHERE THE SHOCK HAS ARRIVED. [illegible]
JLMT     JLEFT-1
JLPT     JLEFT+1
ITEMP1   NUMBER OF TEMPERATURE MESH-POINTS IN THE DXR TABLES
ITEMP2   ( DASAL )
IDENSL   NUMBER OF DENSITY MESH-POINTS IN THE DXR TABLES
JM       TOTAL NUMBER OF CELLS
JMP2     JMP1+1
JSTOP    IF JSTOP .GE. 1 THEN STOP EXECUTION
J1       JLEFT
IT       NUMBER OF CURRENT TIMESTEP
ITOL     FIRST TIMESTEP
IPFI     NUMBER OF TIMESTEPS BETWEEN MAJOR OUTPUT PRINTINGS

         [illegible]
IPFL     IPFREQ AFTER COMPUTATION REACHES FIRST REAL CELL [illegible]
IPFS     IPFREQ AFTER SHOCK WAVE IS REFLECTED
JDENS    CELL NUMBER IN WHICH HAVE MAXIMUM COMPRESSION
JTEMAX   CELL NUMBER IN WHICH HAVE MAXIMUM ELECTRON TEMPERATURE
JTIMAX   CELL NUMBER IN WHICH HAVE MAXIMUM ION TEMPERATURE
[illegible]   [illegible] CALCULATION PARAMETER ( SEE INPUT LIST )
[illegible]   [illegible] ( SEE INPUT LIST )
ISA      NUMBER OF TIMESTEPS BETWEEN DUMPS OF DATA ONTO TAPE OR
         DISK FOR PURPOSES OF RESTART
NIMAX    NUMBER OF DXR TABLES

4.     COMMON/VAR4/                         MISCELLANEOUS
ROUR     INTEGRAL OF RHO*DR
TIMAX    MAX. ION TEMPERATURE
TEMAX    MAX. ELECTRON TEMPERATURE
MEL      INDEX OF MATERIAL M
ITEMP    NUMBER OF TEMPERATURE MESH POINTS IN DXR TABLES
ITENP    NUMBER OF DENSITY MESH POINTS IN DXR TABLES
NNM      INDEX OF MATERIAL M
TOLS     LIST OF TEMPERATURES ( LIN SCALE ) IN DXR TABLES
TLOLS    LIST OF TEMPERATURES ( LOG SCALE ) IN DXR TABLES
[illegible]   AVERAGE [illegible] ( LOG SCALE ) IN DXR TABLES
ZBAR     AVERAGE Z**2 ( LOG SCALE ) IN DXR TABLES
RDAS     LIST OF DENSITY MESH POINTS ( LIN SCALE ) IN THE DXR TABLES
DLOAS    LIST OF DENSITY MESH POINTS ( LOG SCALE ) IN THE DXR TABLES
[illegible]   TOTAL RADIATION [illegible] ( SEE [illegible] IN "DIMENSION DTR" BELOW )
[illegible]   IONIZATION ENERGY ( SEE DEFE IN "DIMENSION DTR" BELOW )
SPECE    CONTINUOUS EMISSION SPECTRUM ( SEE DEFE
         IN "DIMENSION DTR" BELOW )
SPTJ     CONTINUOUS EMISSION SPECTRUM - TIME INTEGRATED
SPTTUT   CONTINUOUS EMISSION SPECTRUM - SPACE AND TIME INTEGRATED
[illegible]   LINE EMISSION SPECTRUM ( SEE [illegible] IN "DIMENSION DTR" BELOW )
[illegible]   LINE EMISSION SPECTRUM - TIME INTEGRATED
CLTTOT   LINE EMISSION SPECTRUM - SPACE AND TIME INTEGRATED
[illegible]   LIMITS OF CONTINUOUS SPECTRUM ENERGY GROUPS
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CLN30   LIST EMISSION LINES
DTRR    TIMESTEP INCREASE FROM RADIATION EMISSION CRITERIA
TAU     ELECTRON-ION COLLISIONAL RELAXATION TIME
ESUPT   TOTAL ENERGY SUPPLIED BY THE LASER SAVED AT ...
PHIAL   PHASE OF THE LASER PULSE SHAPE
NSPI    INDEX SHOWING THAT THE SIMULATION EXCEEDED NEGATIVE TEMPERATURE
        ( SEE TEMPS AND LEAH'S EXPLANATIONS )
EATI    LOWER LIMIT OF CONTINUOUS RADIATION
NITION  NUMBER OF INNER ITERATIONS ( SEE TONCAL )
PRES    AVERAGE PRESSURE AROUND THE SHOCK FRONT
COMPI   INITIAL COMPRESSION


5.      COMMON/VARS/                         RADIATION DATA


ECON    CONTINUOUS SPECTRA FOR EACH CELL AND ENERGY RANGE ( ENERA )
XLINT   LINE SPECTRA FOR EACH CELL AND LINE ENERGY( ENERA )
CSIGMA  PHOTOABSORPTION CROSS-SECTION IN CM**2/G, SEE "OSIGMA"
        IN " DIMENSION DTA BELOW "


6.      COMMON/FIX/                          GENERAL FIXED POINT DATA

IC1     INDEX OF THE FIRST CONTINUOUS ENERGY GROUP TO BE USED
IC2     INDEX OF THE LAST CONTINUOUS ENERGY GROUP TO BE USED
IL1     INDEX OF THE FIRST EMISSION LINE TO BE USED
IL2     INDEX OF THE LAST EMISSION LINE TO BE USED
IPROBL
IOS     THE UNIT NUMBER OF THE DAR TABLES
IRE     THE UNIT NUMBER OF THE TEMPORARY DATA STORAGE FOR RESTART
        PURPOSES
INS     UNIT NUMBER OF INPUT DATA SET
IOS     UNIT NUMBER OF PLASMOR OUT


7.      COMMON/TITLE/

DTIME   FIRST TIMESTEP AFTER WHICH FILLD OUTPUT WILL BE PRINTED OUT
XIOL    TOTAL LENGTH OR RADIUS OF THE SYSTEM = RAL(NP2)
PETH    ABSORPTION PATH BETWEEN TWO CELLS ( CALC'D IN EOS )
EABS    FRACTION OF INCIDENT LASER LIGHT GOING TO SUPRATHERMAL ELECTRON
EABSFR  SAVED VALUE OF EABS ( SEE ABSORB )
FABSFR  SAVED VALUE OF FABS
SUPTH   SUPRATHERMAL ELECTRONS TREATED AS MAXWELLIAN
HCDEFS  SPECIFIC HEAT CAPACITY AT CONSTANT PRESSURE
CVRS    SPECIFIC HEAT CAPACITY AT CONSTANT TEMPERATURE
BRFABS  BACKSCATTERING FACTOR, INITIALLY SET=1.0
        ( SEE I P.11. WHERE IT IS CALLED BR. )
ZASER   AVERAGE Z. CALC'D FROM EOS TABLES
PSEC    TIME BASE TO BE PRINTED IN OUTPUT E. G., IF IN NSEC'S
        THEN PSEC = 1.E9 )
THE     CALCULATE THERMAL HOT ELECTRON TAIL ENERGY SEPARATELY
NOEDE   UNIT NUMBER OF PLASMOR OED3. THE MAJOR PRINTOUT DEVICE
BLKRAD  =0. MEANS: DO NOT CALCULATE BLACKBODY RADIATION;
        =1.     : DO CALCULATE IT
LAY     MATERIAL LAYER TO DETERMINE PROPER EOS TO BE USED


8.      COMMON/RSS/                          ROSSELAND MEAN FREE PATH

TASS    LIST OF TEMPERATURE MESH POINTS
DNSRSS  LIST OF DENSITY MESH POINTS
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RSSEND ROSSELAND MEAN FREE PATH
NTRSS NUMBER OF TEMPERATURE MESH POINTS
NDRSS NUMBER OF DENSITY MESH POINTS

9. DIMENSION DTA ATOMIC AND RADIATION DATA

DTEMP	LIST OF LOG OF TEMPERATURES (MAX. 20 VALUES)
DDENS	LIST OF LOG OF DENSITIES (MAX. 15 VALUES)
DDEX	LIST OF ENERGY INTERVALS FROM WHICH FOR CONTINUOUS SPECTRUM
DLMBD	LIST OF WAVELENGTHS OF LINE RADIATION
DZAV	Z-AVERAGE(TEMP,DENS) LINEAR SCALE
DRE	LOG OF ELECTRON DENSITY (TEMP,DENS)
DRZ	LOG OF IONIZATION STATE DENSITY(STATE,TEMP,DENS)/TOTAL DENS
DCETX	LOG OF CONTINUOUS SPECTRUM INTENSITY(ENERGY INTERVAL,TEMP,DENS), UNITS: ERGS/PSEC/10**16 ATOMS/100 EV
DCETT	LOG OF TOTAL INTENSITY(TEMP,DENS) (INCLUDES LINE RADIATION), UNITS: ERGS/PSEC/10**16 ATOMS
DENER	LOG OF INTERNAL ENERGY(TEMP,DENS). UNITS: ERG/ION
DCLNX	LOG OF LINE INTENSITY(LINE,TEMP,DENS)
DZZAV	AVERAGE Z**2 (LINEAR SCALE)
DDTEMP	TEMPERATURES (LINEAR SCALE)
DDDENS	DENSITIES (LINEAR SCALE)
DSIGMA	TABLE OF PHOTOABSORPTION CROSS-SECTIONS (ENERGY GROUP, ZAV) UNITS=CM**2/ION

DTA EQUIVALENCE TABLE:

1	DTEMP (20)	20	TLOAS (	J+1	,NII+	DTEMP (J)
21	DDENS (20)	25	DLDAS (		K,NII+	DDENS (K)
41	DDEX (40)	40	DASI ... -L.		NII+	DDEX(I)
81	DLMBD (20)	20				
101	DZAV (20,15)	300	ZDAS (		J+L,K,NII+ALOG10(	DZAV (J,K)
401	DRE (20,15)	300				
701	DRZ (14,20,15)	4200				
4901	DCETX (25,20,15)	7500	SPECT(I,J ,K,NII+			DCETX (I,J,K)
12401	DCETT (20,15)	300	ADAS (		J+L,K,NII+	DCETT (J,K)
12701	DENER (20,15)	300	ELDAS (		J+L,K,NII+	DENER (J,K)
13001	DCLNX (20,20,15)	6000	CLINE(I,J ,K,NII+			DCLNX (I,J,K)
19001	DZZAV (20,15)	300	ZZDAS (		J+L,K,NII+ALOG10(	DZZAV (J,K)
19301	DDTEMP (20)	20	TDAS (		NII+	DDTEMP (J)
19321	DDDENS (20)	20	DDAS (		NII+	DDDENS (K)

INPUT CARDS
****

TWO PACKAGES OF INPUT CARDS ARE NEEDED TO RUN PLASTIC: ONE TO RUN A NEW PROBLEM AND ONE TO CONTINUE A PREVIOUS RUN. IN THE FIRST OF THESE THE PARAMETERS OF THE PROBLEM ARE ENTERED INTO THE PROGRAM, WHEREAS THE SECOND PACKAGE CONTAINS ONLY SOME CONTROL SWITCHES AND ...

THE MAIN PARAMETERS ARE READ IN FROM THE DISC (THE IRS FILES).

A. INPUT CARDS FOR A NEW PROBLEM

CARD 1. 1 CARD FORMAT(10X, I5)

NTIT NUMBER OF CARDS IN THE HEADER

CARD 2. NTIT CARDS FORMAT(20A4)

CAP4 HEADER, DESCRIPTION OF THE ESSENTIALS OF THE PROBLEM VIZ., NUMBER OF LAYERS, THEIR COMPOSITION AND THICKNESS, THE PULSE RISETIME, LASER POWER AND TIME OF ECS TO BE USED. THE DESCRIPTION DETAILS ARE ENTIRELY UP TO THE USER.

CARD 3. 1 CARD FORMAT(2(10X,I5), 10X,E20.4, 10X,I5)

IREADI =1 FOR NEW CALCULATION; =0 RESTART PREVIOUS PROBLEM
ITEND MAX. NUMBER OF TIMESTEPS (IF TIME < 99999)
CUTE MAXIMUM SIMULATED TIME FOR PROBLEM
NEMAX NUMBER OF DXR-TABLES. A TABLE IS REQUIRED FOR EACH MATERIAL

CARD 4. 1 CARD FORMAT(2(10X,I5))

NDRSS NUMBER OF TEMPERATURE MESH POINTS IN THE ROSSELAND M.F.P. TABLES. IF =0, THEN THE BLACKBODY RADIATION IS NOT CALCULATED
NDRSS NUMBER OF DENSITY MESH POINTS IN THE ROSSELAND M.F.P. TABLES

CARD 5. 1 CARD FORMAT(5E10X.I5))

IMDIF MATERIAL INITIAL DENSITY PARAMETER
=1 SOLID DENSITY THROUGHOUT;
=2 REDUCED DENSITY IN THE LAST 10 CELLS
=3 PARABOLIC INITIAL ELECTRON DE ITY
=4 OTHER
ISA NUMBER OF TIMESTEPS BETWEEN DUMPS OF DATA ONTO TAPE OR DISC FOR PURPOSES OF RESTART
NPEL NUMBER OF TIMESTEPS BETWEEN MAJOR OUTPUT PRINTINGS
LIMC =1 PRINTED AFTER COMPUTATION REACHES FIRST REAL CELL (LEFT +2
IPRES PRINTED AFTER SHOCK WAVE IS REFLECTED (IN CASE OF TARGETS OF MORE THAN ONE LAYER)

CARD 6. 1 CARD FORMAT(5E10X.I5))

KROT SEE COMMON/VAR3/

NPRTE SEE COMMON/VAR3/
IEOS EOS FORMULATION
=1, PERFECT NON-DEGENERATE GAS =2, FERMI-DIRAC EOS
=3, TFC MODEL+ ION+SOLID+GAS INTERPOLATION (USE THIS OPTION ONLY)
IFION PLASMA IONIZATION =1 ACR COMPLEX IONIZATION;
=2 ION DENSITIES FROM DXR TABLES (USE THIS OPTION)
IPRES SEE COMMON/VAR3/

CARD 7. 1 CARD FORMAT(5E10X.I5))

IPSWCH TERMINATION OPTIONS
=1 IF TIME OR NUMBER OF TIMESTEPS EXCEEDED
=4 SAME AS 1 WITH THE ADDITIONAL CONDITION THAT THE COMPRESSION IN CENTER CELL EXCEEDS R*4
ICOM GEOMETRY OPTION =1 SPHERES =2 SLAB =3 SHELL
IRFCT RADIATION CALCULATION PARAMETER:
=1 DO NOT CALCULATE =2 CALCULATE FROM DXR TABLES
NUMREG NUMBER OF DIFFERENT REGIONS IN TARGET
NUMEL NUMBER OF CELLS IN REGION 1

CARD 8. 1 CARD FORMAT(5E10X.I5))

NUMEL ....MAXIMUM NCELL=NUMBER OF CELLS IN REGION K

CARD 9. 2 CARDS FORMAT(5E10X.I5))

ICNTL CONTROL SWITCH FOR THE EOS USED IN THE CALCULATION
=-5 ION PRESSURE CALCULATED FROM SOLID+GAS INTERPOLATION
ICNTL9 =0 NOT USED
ICNTL1 =1000: NOT USED
ICNTL+1 =3000 USED
ICNTL2 =0 PREPARE INPUT FOR SUBSEQUENT CALCULATIONS
=1 PREPARE INPUT, DO NOT CALCULATE
=2 DO NOT PREPARE INPUT, DO NOT CALCULATE
=4 CALCULATE RADIATION PROFILE ABSORPTION ONLY

=4 CALCULATE HOT ELECTRON ABSORPTION ONLY
=5 CALCULATE BOTH HOT ELECTRON AND RADIATION PREHEAT

ICK(6-10) NOT USED

CARD 10. 1 CARD FORMAT(4(5X,E15.4))

IRISE SEE COMMON/VAR2/
POWER SEE COMMON/VAR2/
DTIN SEE COMMON/VAR2/
EUT SEE COMMON/VAR2/

CARD 11. 2*MAXNUM CARDS FORMAT(4(5X,E15.4))

THIS CONTAINS TWO CARDS FOR EACH REGION I, I=1,... MAXNUM I

BOTH IN THE SAME FORMAT

NNUM SEE COMMON/VAR2/
RCOR SEE COMMON/VAR2/
TIN SEE COMMON/VAR1/
TEP SEE COMMON/VAR1/
FACT SEE COMMON/VAR1/
TAPT NOT USED

CARD 12. 1 CARD FORMAT(5X,E15.4)

RADI INNER RADIUS OF SHELL: THIS CARD IS USED ONLY FOR ICOD(4)=1

CARD 13. 1 CARD FORMAT(5X,I5)

NMAX SEE COMMON/VAR1/

CARD 14. NMAX CARD GROUPS

FOR EACH MATERIAL THREE (AT MOST) CARDS ARE READ IN:
IF ICOD(4)=1 THEN ONLY 14A AND 14B
IF ICOD(4)=0 THEN 14A, 14B AND 14D
OTHERWISE: 14A, 14B, 14C

CARD 14A FORMAT(20X, 2I10, E20.4)

NZ ATOMIC NUMBER
IND SEE COMMON/VAR3/
WAT ATOMIC WEIGHT

CARD 14B FORMAT(20X, 3E20.4)

FF FRACTIONAL ABUNDANCE OF MATERIAL N IN REGION I

CARD 14C FORMAT(20X, 4E15.6)

ATIM(1,3,4,5) SEE COMMON/VAR1/

CARD 14D FORMAT(20X, 4E15.6)

ALIMA 1,2,3,15) SEE COMMON/VAR1/

CARD 15. 3 CARDS FORMAT(5(5X,E10.4))

FLAS SEE COMMON/VAR2/
FCLF SEE COMMON/VAR2/
FHCH SEE COMMON/VAR2/
FHCP SEE COMMON/VAR2/
FALL SEE COMMON/VAR2/

FMAX SEE COMMON/VAR2/

[redacted]

FKAPPA SEE COMMON/VAR2/

[redacted]

COMPI SEE COMMON/VAR6/

[redacted]

CTIME SEE COMMON/TITLE/
** 15 SPACES ARE LEFT BLANK

[redacted]

1 OF THE CARDS USED FOR A NEW PROBLEM.

[redacted]

CARD 2. NTIT CARDS FORMAT(20A4)

[redacted]

USED. THE DESCRIPTION DETAILS ARE ENTIRELY UP TO THE USER.

[redacted]

ITIM MAX. NUMBER OF TIMESTEPS. (ITIME < 99999)
CUTI MAXIMUM SIMULATED TIME FOR PROBLEM

[redacted]