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**EOSMOD:**

***Subroutine Package for Calculating  
Equations of State and Opacities***



**Los Alamos**

Los Alamos National Laboratory  
Los Alamos, New Mexico 87545

Edited by Helen M. Sinoradzki

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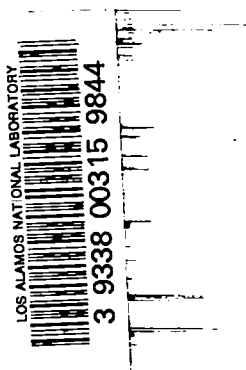
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# **EOSMOD: A Subroutine Package for Calculating Equations of State and Opacities**

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EOSMOD: A SUBROUTINE PACKAGE FOR  
CALCULATING EQUATIONS OF STATE AND OPACITIES

by

James M. Hyman and Morris M. Klein

ABSTRACT

The EOSMOD package includes a set of FORTRAN subroutines written to make the SESAME equation-of-state and opacity tables readily available. We have tried to make these routines as accessible as possible for casual users with routine problems and at the same time, allow sufficient flexibility for sophisticated users with complicated situations. This has caused only a slight loss in efficiency (~5%) compared to using the SESAME routines directly.

---

I. INTRODUCTION

The SESAME library is a collection of data files containing equations of state (EOS), Rosseland mean opacities, and other material properties over a wide range of temperatures, pressures, and densities. Group T-4 at Los Alamos National Laboratory developed a FORTRAN subroutine library<sup>1-3</sup> to access and analyze these data files. The EOSMOD subroutine package was developed to complement the T-4 routines and simplify the interface between these codes and the user's program. The EOSMOD routines do the bookkeeping, unit's conversion, and large core memory (LCM) initialization; reduce the number of parameters the casual user needs to be aware of; and are written in a structured modular design to allow a sophisticated user to modify and optimize the package easily for a particular problem.

To use the package, just access the SESAME data files as described in Sec. VIII and call the driver subroutine. The package then locates the requested data file, converts it to the units specified by the user, and stores it in LCM. On all subsequent calls, the package remembers the contents and location of the file and interpolates the data at the user's requested values.

If the EOS or opacity of a mixture is needed, then the directory of mixtures currently available (MIXDIR) should be checked. If the specific mixture is not in the library, then a SESAME data file may be generated using the procedure described in Refs. 4, 5, and 6.

## II. EQUATION-OF-STATE AND OPACITY ROUTINES

The first time a routine is called for each new material (LMAT), the table is converted to the kind of units (KUNIT) requested by the user and copies into LCM. The location or material table number (IMATE) is returned to indicate the location of the EOS table or to indicate whether an error was encountered in the initialization; for example, if the material was not found in the library.

The EOS tables can be loaded in two different formats. The standard SESAME format is for calculating the pressure  $P$  and internal energy  $E$  of a material as a function of the density  $R$  and temperature  $T$ . Subroutine EOSDRT loads and reads the tables in this format.

The inverted SESAME format is for calculating  $P$  and  $T$  as a function of  $R$  and  $E$  with subroutine EOSDRE. These inverted tables also can be accessed in other ways using the iterative subroutines EOSIRT and EOSIPT. Subroutine EOSIPT calculates  $E$  and  $R$  as function of  $P$  and  $T$ , and subroutine EOSIRT calculates  $P$  and  $E$  as a function of  $R$  and  $T$ . These iterative subroutines use an iterative scheme that is slow compared to the direct methods used in subroutines EOSDRT and EOSDRE. Their main use is for initial state computations and occasional diagnostics.

To speed up the execution time when using subroutine EOSDRE or EOSDRT, the user can request that the package return only  $T$ ,  $P$ , or  $E$  using the computational mode flag KBR. Computer time can also be saved by using the KFN flag to indicate a bilinear interpolation of the data rather than the more accurate (but slower) rational interpolation. These interpolation procedures are described in more detail in Refs. 1 and 7.

A. Subroutine EOSDRE (input R and E, output P and T)

The calling sequence when  $\rho$  and E are independent variables (input) and  $P(\rho, E)$  and  $T(\rho, E)$  are dependent variables (output) is

CALL EOSDRE (LMAT,R,E,P,T,KEOS,IMATE).

The arguments are defined as follows.

INPUT VARIABLES

LMAT	Material name in an A10 field; for example, LMAT = "HELIUM." The materials available are listed in Sec. VII and the file MIXDIR. (The material SESAME number can also be used to specify the material by setting LMAT to the SESAME number; for example, LMAT = "5760" for helium.)
R	Density ( $\rho$ ).
E	Internal energy.
KEOS	Multiple parameter flag to describe how to write and retrieve the data file. KEOS has four decimal digits: KBR, KUNIT, KREPE, and KFN ( $KEOS = 1000*KBR + 100*KUNIT + 10*KREPE + KFN$ ).
KBR	Computational flag to indicate which quantities and their partial derivatives are to be calculated and returned by the package.  0      Compute P and T and their partial derivatives $\partial P/\partial \rho$ , $\partial P/\partial E$ , $\partial T/\partial \rho$ , and $\partial T/\partial E$ . 1      Compute P and its partial derivatives $\partial P/\partial \rho$ and $\partial P/\partial E$ . 2      Compute T and its partial derivatives $\partial T/\partial \rho$ and $\partial T/\partial E$ .
KUNIT	Kind of units for writing the data file. The units are explained fully in Sec. IX.  0      SESAME EOS units. 1      CGS units. 2      Standard International Units (SIU). 3      Hydrox EOS units. 4      Hydrox opacity units. 5      SESAME opacity units. 6      LASNEX units.
KREPE	Computational flag to indicate whether E is to be represented as energy per unit mass or energy per unit volume.  0      Energy in units of energy per unit mass (for example, ergs/g). This is the usual E.



	1	Energy in units of energy per unit volume (for example, ergs/cm <sup>3</sup> ). This is the energy density $\rho E$ commonly computed in hydrodynamic computer codes.
KFN		Indicates the form of the function used to interpolate the data tables.
	0	Accurate rational function interpolation.
	1	Fast bilinear function interpolation.
IMATE		Indicates whether to load the data file if it does not exist for LMAT or go directly to a previously loaded file.
	0	Check if the data file for LMAT has been loaded. If not, search for the file, convert it to the proper units, and copy it into LCM using the inverted SESAME format.
	N>0	Equal to the LMAT table number. This number was returned by the package on a previous call to subroutine EOSDRE, EOSIPT, or EOSIRT and is distinct for each LMAT. This option is faster than IMATE = 0 because it skips searching the directory of previously loaded data files.

#### OUTPUT VARIABLES

P		Array of dimension 3 containing the pressure and its partial derivatives.
	P(1)	Pressure.
	P(2)	Density derivative of the pressure ( $\partial P / \partial \rho$ ).
	P(3)	Energy derivative of the pressure ( $\partial P / \partial E$ ).
T		Array of dimension 3 containing the temperature and its partial derivatives. This array must be dimensional even if the partial derivatives are not computed.
	T(1)	Temperature.
	T(2)	Density derivative of the temperature ( $\partial T / \partial \rho$ ).
	T(3)	Energy derivative of the temperature ( $\partial T / \partial E$ ).
IMATE		Indicates the success or failure of locating and loading the data file for LMAT.
	0	LMAT not found.
	N>0	LMAT table number (success).
	N<0	Insufficient LCM storage. The LCM memory allocation must be increased by at least $ N $ storage locations by the procedure described in Sec. V.

B. Subroutine EOSIPT (input P and T, output R and E)

The calling sequence when P and T are independent variables (input) and  $\rho(P,T)$  and  $E(P,T)$  are dependent variables (output) is

CALL EOSIPT (LMAT,P,T,R,E,KEOS,IMATE).

This routine reads the EOS data in the inverted SESAME format and uses an iterative method to interpolate the data. The arguments are defined as follows.

INPUT VARIABLES

LMAT      Material name in an A10 field; for example, LMAT = "HELIUM."  
The materials available are listed in Sec. VII and the file MIXDIR. (The material SESAME number can also be used to specify the material by setting LMAT to the SESAME number; for example, LMAT = "5760" for helium.)

P          Pressure.

T          Temperature.

KEOS      Multiple parameter flag to describe how to write and retrieve the data file. KEOS has three decimal digits: KUNIT, KREPE, and KFN (KEOS = 100\*KUNIT + 10\*KREPE + KFN).

KUNIT      Kind of units for writing the data file. The units are explained fully in Sec. IX.

- 0          SESAME EOS units.
- 1          CGS units.
- 2          Standard International Units (SIU).
- 3          Hydrox EOS units.
- 4          Hydrox opacity units.
- 5          SESAME opacity units.
- 6          LASNEX units.

KREPE      Computational flag to indicate whether E is to be represented as energy per unit mass or energy per unit volume.

- 0          Energy in units of energy per unit mass (for example, ergs/g). This is the usual E.
- 1          Energy in units of energy per unit volume (for example, ergs/cm<sup>3</sup>). This is the energy density  $\rho E$  commonly computed in hydrodynamic computer codes.

KFN        Indicates the form of the function used to interpolate the data tables.

- 0          Accurate rational function interpolation.
- 1          Fast bilinear function interpolation.

IMATE       Indicates whether to load the data file if it does not exist for LMAT or go directly to a previously loaded file.

0           Check if the data file for LMAT has been loaded. If not, search for the file, convert it to the proper units, and copy it into LCM using the inverted SESAME format.

N>0        Equal to the LMAT table number. This number was returned by the package on a previous call to subroutine EOSDRE, EOSIPT, or EOSIRT and is distinct for each LMAT. This option is faster than IMATE = 0 because it skips searching the directory of previously loaded data files.

#### OUTPUT VARIABLES

R           Density.

E           Internal energy.

IMATE       Indicates the success or failure of locating and loading the data file for LMAT.

0           LMAT not found or the iteration failed to converge.

N>0        LMAT table number (success).

N<0        Insufficient LCM storage. The LCM memory allocation must be increased by at least |N| storage locations by the procedure described in Sec. V.

C. Subroutine EOSIRT (input R and T, output P and E)

The calling sequence when  $\rho$  and T are independent variables (input) and  $P(\rho, T)$  and  $E(\rho, T)$  are dependent variables (output) is

CALL EOSIRT (LMAT,R,T,P,E,KEOS,IMATE).

This routine reads the EOS data in the inverted SESAME format and uses an iterative method to interpolate the data. The arguments are defined as follows.

INPUT VARIABLES

LMAT      Material name in an A10 field; for example, LMAT = "HELIUM."  
The materials available are listed in Sec. VII and the file MIXDIR. (The material SESAME number can also be used to specify the material by setting LMAT to the SESAME number; for example, LMAT = "5760" for helium.)

R          Density.

T          Temperature.

KEOS      Multiple parameter flag to describe how to write and retain the data file. KEOS has three decimal digits: KUNIT, KREPE, and KFN ( $KEOS = 100 \times KUNIT + 10 \times KREPE + KFN$ ).

KUNIT      Kind of units for writing the data file. The units are explained fully in Sec. IX.

- 0          SESAME EOS units.
- 1          CGS units.
- 2          Standard International Units (SIU).
- 3          Hydrox EOS units.
- 4          Hydrox opacity units.
- 5          SESAME opacity units.
- 6          LASNEX units.

KREPE      Computational flag to indicate whether E is to be represented as energy per unit mass or energy per unit volume.

- 0          Energy in units of energy per unit mass (for example, ergs/g). This is the usual E.
- 1          Energy in units of energy per unit volume (for example, ergs/cm<sup>3</sup>). This is the energy density  $\rho E$  commonly computed in hydrodynamic computer codes.

KFN          Indicates the form of the function used to interpolate the data tables.

- 0          Accurate rational function interpolation.
- 1          Fast bilinear function interpolation.

IMATE       Indicates whether to load the data file if it does not exist for LMAT or go directly to a previously loaded file.

0           Check if the data file for LMAT has been loaded. If not, search for the file, convert it to the proper units, and copy it into LCM using the inverted SESAME format.

N>0        Equal to the LMAT table number. This number was returned by the package on a previous call to subroutine EOSDRE, EOSIPT, EOSDRT, or EOSIRT and is distinct for each LMAT. This option is faster than IMATE = 0 because it skips searching the directory of previously loaded data files.

#### OUTPUT VARIABLES

P           Pressure.

E           Internal energy.

IMATE       Indicates the success or failure of locating and loading the data file for LMAT.

0           Material not found or iteration failed to converge.

N>0        LMAT table number (success).

N<0        Insufficient LCM storage. The LCM memory allocation must be increased by at least |N| storage locations by the procedure described in Sec. V.

D. Subroutine EOSDRT (input R and T, output P and E)

The calling sequence when  $\rho$  and T are independent variables (input) and  $P(\rho,T)$  and  $E(\rho,T)$  are dependent variables (output) is

CALL EOSDRT (LMAT,R,T,P,E,KEOS,IMATE).

The arguments are defined as follows.

INPUT VARIABLES

LMAT      Material name in an A10 field; for example, LMAT = "HELIUM."  
The materials available are listed in Sec. VII and in the file MIXDIR. (The material SESAME number can also be used to specify the material by setting LMAT to the SESAME number; for example, LMAT = "5760" for helium.)

R          Density ( $\rho$ ).

T          Temperature.

KEOS      Multiple parameter flag to describe how to write and retrieve the data file. KEOS has four decimal digits: KBR, KUNIT, KREPE, and KFN ( $KEOS = 1000*KBR + 100*KUNIT + 10*KREPE + KFN$ ).

KBR          Computational flag to indicate which quantities and their partial derivatives are to be calculated and returned by the package.

0          Compute P and E and their partial derivatives  $\partial P/\partial \rho$ ,  $\partial P/\partial T$ ,  $\partial E/\partial \rho$ , and  $\partial E/\partial T$ .

1          Compute P and its partial derivatives  $\partial P/\partial \rho$  and  $\partial P/\partial T$ .

2          Compute T and its partial derivatives  $\partial E/\partial \rho$  and  $\partial E/\partial T$ .

KUNIT      Kind of units for writing the data file. The units are explained fully in Sec. IX.

0          SESAME EOS units.

CGS units.

2          Standard International Units (SIU).

3          Hydrox EOS units.

4          Hydrox opacity units.

5          SESAME opacity units.

6          LASNEX units.

KREPE      Computational flag to indicate whether E is to be represented as energy per unit mass or energy per unit volume.

0          Energy in units of energy per unit mass (for example, ergs/g). This is the usual E.

	1	Energy in units of energy per unit volume (for example, ergs/cm <sup>3</sup> ). This is the energy density $\rho E$ commonly computed in hydrodynamic computer codes.
KFN		Indicates the form of the function used to interpolate the data tables.
	0	Accurate rational function interpolation.
	1	Fast bilinear function interpolation.
IMATE		Indicates whether to load the data file if it does not exist for LMAT or go directly to a previously loaded file.
	0	Check if the data file for LMAT has been loaded. If not, search for the file, convert it to the proper units, and copy it into LCM using the standard SESAME format.
	N>0	Equal to the LMAT table number. This number was returned by the package on a previous call to subroutine EOSDRE, EOSIPT, EOSDRT, or EOSIRT and is distinct for each LMAT. This option is faster than IMATE = 0 because it skips searching the directory of previously loaded data files.

#### OUTPUT VARIABLES

P		Array of dimension 3 containing the pressure and its partial derivatives.
	P(1)	Pressure.
	P(2)	Density derivative of the pressure ( $\partial P / \partial \rho$ ).
	P(3)	Temperature derivative of the pressure ( $\partial P / \partial T$ ).
E		Array of dimension 3 containing the internal energy and its partial derivatives. This array must be dimensional even if the partial derivatives are not computed.
	E(1)	Internal energy.
	E(2)	Density derivative of the internal energy ( $\partial E / \partial \rho$ ).
	E(3)	Energy derivative of the internal energy ( $\partial E / \partial T$ ).
IMATE		Indicates the success or failure of locating and loading the data file for LMAT.
	0	LMAT not found.
	N>0	LMAT table number (success).
	N<0	Insufficient LCM storage. The LCM memory allocation must be increased by at least $ N $ storage locations by the procedure described in Sec. V.

E. Subroutine EOSORT (input R and T, output O)

The Rosseland mean opacity<sup>8</sup> of the material (LMAT) can be calculated by calling subroutine OPCRT. The density R and temperature T are the independent input variables, and the opacity O is the dependent output variable. When the internal energy, but not the temperature, is known, the user must first call subroutine EOSDRE to get the temperature. The (KUNIT) that the table is to be written in and the type of interpolation function (KFN) to be used must be provided by the user. The material opacity table number (IMATO) is returned by the package to indicate the location of the opacity table in LCM or if an error was encountered by the routine.

The calling sequence when  $\rho$  and T are independent variables (input) and O is the dependent variable (output) is

CALL EOSORT (LMAT,R,T,O,KOPC,IMATO)

The arguments are defined as follows.

INPUT VARIABLES

LMAT	Material name in an A10 field; for example, LMAT = "HELIUM." The materials available are listed in Sec. VII and in the file MIXDIR. (The material SESAME number can also be used to specify the material by setting LMAT to the SESAME number; LMAT = "15760".
R	Density ( $\rho$ ).
T	Temperature.
KOPC	Multiple parameter flag to describe how to write and retrieve the data file. KEOS has three decimal digits: KUNIT, KREPO, and KFN (KEOS = 100*KUNIT + 10*KREPO + KFN).
KUNIT	Computational flag to indicate the kind of units for writing the data file. The units are explained fully in Sec. IX.  0        SESAME EOS units. 1        CGS units. 2        Standard International Units (SIU). 3        Hydrox EOS units. 4        Hydrox opacity units. 5        SESAME opacity units. 6        LASNEX units.
KREPO	Computational flag to indicate which representation to use for the opacity.  0        Opacity represented as $\kappa$ in dimensional units of $\text{length}^2/\text{mass}$ . 1        Opacity represented as a mean-free path, $\Lambda = 1/(\kappa\rho)$ , in dimensional units of length.



KFN                Indicates the form of the function used to interpolate the data tables.

                  0            Accurate rational function interpolation.

                  1            Fast bilinear function interpolation.

IMATO            Indicates whether to load the data file if it does not exist for LMAT or go directly to a previously loaded file.

                  0            Check if the data file for LMAT has been loaded. If not, search for the file, convert it to the proper units, and copy it into LCM.

                  N>0          Equal to the LMAT table number. This number was returned by the package on a previous call to subroutine OPCRT and is distinct for each LMAT. This option is faster than IMATE = 0 because it skips searching the directory of previously loaded data files.

#### OUTPUT VARIABLES

0                Opacity.

IMATEO          Indicates the success or failure of locating and loading the data file for LMAT.

0                LMAT not found.

N>0             LMAT table number (success).

N<0             Insufficient LCM storage. The LCM memory allocation must be increased by at least |N| storage locations by the procedure described in Sec. V.

### III. SCALING THE TABLES

#### A. Density Scaling

When the atomic mass of the desired material is different from the mass of the SESAME material and the material properties are expected to be similar, then a simple density scale factor can be incorporated into the EOS and opacity tables. This is usually sufficient for isotope mixtures of a specific material.

The density scale factor (DSFAC) for the material LMAT can be incorporated into the tables through the user supplied subroutine EOSSCL(LMAT, DSFAC). This routine will be called by EOSMOD, and the routine should return DSFAC equal to the ratio of the atomic mass of the SESAME material and the desired material; that is,

$$\text{DSFAC} = \frac{\text{atomic mass of SESAME material LMAT}}{\text{atomic mass of desired material}}$$

In example B, Sec. VI, the EOS of a 60% deuterium/40% tritium mixture is approximated from the EOS of deuterium by defining

$$\text{DSFAC} = \frac{2}{0.60 \times 2 + 0.40 \times 3} = 0.833$$

#### B. Adding New Units

When the EOS and opacity tables are copied from the SESAME data file into LCM, they are converted to the user's specified units by multiplying the data by a conversion factor. The EOS conversion factors for temperature, density, pressure, and internal energy are TFACE, RFACE, PFACE, and EFACE, respectively. The opacity conversion factors for density, temperature, and opacity are RFACO, TFACO, and OFACO, respectively.

These factors are defined in the EOSMOD subroutine EOSCON according to the user's specifications (KUNIT) and communicated to the various EOSMOD routines through the common blocks

```
COMMON /EOSCCE/ TFACE,RFACE,PFACE,EFACE
COMMON /EOSCCO/ TFACO,RFACO,OFACO
```

If the desired units are not automatically available in the package, the user can reset the conversion factors at execution time (not in a data statement) in the user-provided routine EOSSCL (See Sec. V.A). This is done in example 5B.

The scale factor is the constant that the data in the original SESAME EOS table units (KUNIT = 0) or SESAME opacity table units (KUNIT = 5) must be multiplied by to convert the data to the desired units. The conversion factors for KUNIT = 0-6 are easily found in subroutine EOSCON listed in the Appendix A.

#### IV. USER NOTES

##### A. Information File

The file EOSINFO contains the latest user notes and information on the EOSMOD package. Users are encouraged to add notes to this file that will be helpful to others using the package.

##### B. Graphic Output

Several plotting routines exist for displaying EOS and opacity data stored in the SESAME format. The routines are maintained by Los Alamos Group T-4 and are described in the data file S2DHELP. See Ref. 9.

##### C. Increasing LCM Allocation

On the CDC 7600's at the Laboratory, the EOSMOD default LCM allocation is 12 000 words. This is enough storage to load approximately four EOS tables. The allocation can be increased to LCMX, say 20 000 words, by declaring

```
LEVEL 2, TBLS
COMMON /S2DIR/ LCMX
COMMON /SESDAT/ TBLS (20000)
LCMX=20000
```

in the main program. LCMX must be set to the dimension of TBLS at execution time not in a data statement. Example 2B in Sec. VI does this.

##### D. Reducing the EOS Data Range

Subroutine WINDOW in the Hydses package can be used to reduce the size of a standard temperature-based SESAME data table when the full density and temperature range are not needed. Because the use of this routine requires knowledge of where and how the tables are stored in LCM, we refer the interested user to the HYDSES report<sup>2,10</sup> for further information.

##### E. Error Flags and Messages

All error messages are written into a file called "OUTPUT." The name of this file is defined at compile time in the Hollerith variable LOUT in the common block

```
COMMON/EOSCZ/LOUT.
```

LOUT can be changed to another file name or unit number of the user at execution time before the first call to EOSMOD.

##### F. Creating an EOS/Opacity Table for Mixtures

The EOS/opacity tables suitable for gas mixtures can be created with the aid of the BCON controller MIXB.<sup>5</sup> These EOS mixture tables currently are prepared under the assumption that the ideal mixing of individual com-

ponent parts occurs. The pressure of the mixture is taken, as in Dalton's law, to be the weighted mole fraction of the partial pressures of the component parts. Opacity mixture tables are created by weighing the opacities of each component in frequency space according to the component's fraction of the total mass and then by integrating the resultant frequency spectrum to obtain the Rossland mean opacity for the mixture. These tables are generated in SESAME format with a simple input deck.

#### G. Listing the Available Materials

The EOS and opacity materials, and SESAME numbers are listed in the common blocks

```
COMMON/EOSC5/NMAT,LABMAT(40),IDMAT(40)
COMMON/EOSC7/NMATO,LABMO(40),IDMATO(40).
```

There are NMAT (NMATO) EOS (opacity) materials in the common blocks. The labels in LABMAT (LABMO) are in an A10 format and correspond to the SESAME material ID in IDMAT (IDMATO).

To list the EOS tables, execute the code

```
DO 10 I = 1,NMAT
10 PRINT 20, LABMAT(I),IDMAT(I)
20 FORMAT (1X,A10,I10).
```

A complete description of each material can be found using the T-4 SESAME utility LSTX. (See Sec. VIII and Ref. 11.)

### V. EXAMPLES

#### A. Simplest Example

The following program will compute the pressure of helium in microbars at a temperature of 300 K and a density of 0.01 g/cm<sup>3</sup>.

```
PROGRAM TST(OUTPUT)
DIMENSION P(3),E(3)
LMAT = "HELIUM"
R = 0.01
T = 300.0
KEOS = 110
IMATE = 0
CALL EOSDRT(LMAT,R,T,P,E,KEOS,IMATE)
PRINT 10, P(1)
10 FORMAT("PRESSURE = ", 1PE12.4," MICROBARS")
CALL EXIT
END
```

The execute line is

```
FTN (I=TEST, GLIB=EOSLIB, GO)
```

The output from this program is:

```
PRESSURE = 6.3498E+07 MICROBARS
```

#### B. Advanced EOS Example

In this example we scale the density for a 60% deuterium/40% tritium mixture, add a new set of MKS units, and increase LCM so we can load four EOS tables.

```
PROGRAM TST(OUTPUT)
C
C  DECLARE THE COMMON BLOCKS USED BY EOSMOD(HYDSES) TO STORE THE TABLES
  LEVEL 2,TBLS
  COMMON /S2DIR/ LCMX
  COMMON /SESDAT/ TBLS(20000)
C
C  DECLARE THE COMMON BLOCK WITH THE FILE LABELS
  COMMON /EOSC2/ LF41,LF42,LF43,LF44,LF45
C
  DIMENSION P(3),E(3)
C
C  INCREASE THE LCM STORAGE AVAILABLE TO EOSMOD
C  THE MAXIMUM LCM STORAGE IN /SESDAT/ IS LCMX WORDS
  LCMX = 20000
C
C  SET THE DENSITY IN KILOGRAMS
C  AND THE TEMPERATURE IN DEGREES KELVIN
  R = 1.E-5
  T = 300.0
  KEOS = 110
C
C  THE TABLE FOR DEUTERIUM IS CONVERTED BY EOSMOD TO A MIXTURE BY
C  SCALING THE DENSITY IN SUBROUTINE EOSSL.
  LMAT = "DEUTERIUM"
  IMATE = 0
  CALL EOSDRT(LMAT,R,T,P,E,KEOS,IMATE)
  PRINT 10,P(1)
10 FORMAT ("40% D + 60% T, PRESSURE =", 1PE12.4, "BARS")
C
  LMAT = "HELIUM"
  IMATE = 0
  CALL EOSDRT(LMAT,R,T,P,E,KEOS,IMATE)
  PRINT 20,LMAT,P(1)
C
```

```

C   DECLARE THE NAME OF THE PRIVATE EOS DATA TABLES AND DIRECTORY
      LF44 = "MIXLIB"
      LF45 = "MIXDIR"

C
C   FIND EOS PRESSURE OF A 90% DEUTERIUM 10% NEON MIXTURE.
C   THE EOS IS CONTAINED IN THE PRIVATE TABLES MIXLIB AND MIXDIR
      LMAT = "D90NE10"
      IMATE = 0
      CALL EOSDRT(LMAT,R,T,P,E,KEOS,IMATE)
      PRINT 20,LMAT,P(1)

C
20  FORMAT(1X,A10," PRESSURE = ",1PE12.4," "BARS")

C
      CALL EXIT
      END

      SUBROUTINE EOSSCL (LMAT,DSFAC)
      COMMON /EOSCCE/ TFACE,RFACE,PFACE,EFACE,KPE

C
C   SET UP A NEW SET OF UNITS TO BE USED BY THE CODE
C   PFACE AND EFACE ARE THE CONVERSION FACTORS FOR THE MKS SYSTEM
C   YOU ONLY NEED TO DEFINE THE CONVERSION FACTORS THAT DIFFER
C   FROM THE KEOS DECLARED UNITS (CGS SYSTEM)
C   CONVERT THE PRESSURE TO BARS
      PFACE = 1.E+6
      EFACE = 1.E+6

C
C   WE NOW RESCALE THE DENSITY FOR DEUTERIUM TO WHAT IT
C   SHOULD BE FOR A 60% DEUTERIUM AND 40% TRIDIUM MIXTURE

      IF(LMAT.EQ."DEUTERIUM") DSFAC=0.833

C
      RETURN
      END

```

The output from this program is

40% D + 60% T	PRESSURE = 6.1923E+04 BARS
HELIUM	PRESSURE = 5.6817E+04 BARS
D90NE10	PRESSURE = 7.3926E+05 BARS

# VI. MATERIALS AVAILABLE

The following materials are currently available using EOSMOD.<sup>11</sup>

Material Name (LMAT)	EOS File Name	Opacity File Name	Temperature Maximum (K)	Density Minimum (g/cm <sup>3</sup> )	Density Minimum (g/cm <sup>3</sup> )	SESAME Material Number
ALLUVIUM (Nevada)	SESAME		4×10 <sup>8</sup>	0.018	4.7×10 <sup>4</sup>	7111
ALUMINUM	SESAME	SESAME	4×10 <sup>8</sup>	0.021	2.7×10 <sup>3</sup>	3710
AL2O3 (= Al <sub>2</sub> O <sub>3</sub> )	SESAME		4×10 <sup>8</sup>	0.031	4.0×10 <sup>8</sup>	7410
ARGON		SESAME				5170
BERYLLIUM	SESAME	SESAME	4×10 <sup>8</sup>	0.014	4.0×10 <sup>4</sup>	2020
BORON		SESAME				2330
BORON CARB(ide)	SESAME		6×10 <sup>4</sup>	0.0002	3.2	7081
BRASS	SESAME		4×10 <sup>8</sup>	0.066	1.7×10 <sup>5</sup>	4100
CALCIUM		SESAME				2030
CARBON		SESAME				2180
CH (= polystyrene)	SESAME		4×10 <sup>8</sup>	0.0082	2.1×10 <sup>4</sup>	7590
CH2 (= polyethylene)	SESAME		4×10 <sup>8</sup>	0.082	1.8×10 <sup>4</sup>	7170
CHLORINE		SESAME				5020
CHROMIUM		SESAME				3070
COPPER	SESAME		4×10 <sup>8</sup>	0.070	1.8×10 <sup>5</sup>	3330
DEUTERIUM	SESAME	SESAME	4×10 <sup>8</sup>	0.0	3.5×10 <sup>3</sup>	5263
GOLD	SESAME		4×10 <sup>8</sup>	0.15	3.9×10 <sup>5</sup>	2700
GRANITE	SESAME		4×10 <sup>8</sup>	0.021	5.3×10 <sup>4</sup>	7390
HELIUM	SESAME	SESAME	1×10 <sup>8</sup>	0.0018	4.7×10 <sup>3</sup>	5760
HE (= High Explosive)	SESAME		4×10 <sup>8</sup>	0.014	3.7×10 <sup>4</sup>	8180
IRON	SESAME	SESAME	4×10 <sup>8</sup>	0.061	1.6×10 <sup>5</sup>	2140
IRON2	SESAME		1.2×10 <sup>4</sup>	0.0	12.5	2145
LEAD	SESAME		4×10 <sup>8</sup>	0.088	2.3×10 <sup>5</sup>	3200
LITHIUM		SESAME				2290
6LID (= <sup>6</sup> LiD)	SESAME		4×10 <sup>8</sup>	0.0062	1.6×10 <sup>4</sup>	7240
6LIH (= <sup>6</sup> LiH)	SESAME		4×10 <sup>8</sup>	0.0053	1.4×10 <sup>4</sup>	7370
MAGNESIUM		SESAME				3080
MOLYBDENUM	SESAME		4×10 <sup>8</sup>	0.08	0.2×10 <sup>5</sup>	2980
NEON	SESAME		4×10 <sup>8</sup>	0.011	2.9×10 <sup>4</sup>	5410
NICKEL	SESAME		4×10 <sup>8</sup>	0.069	1.8×10 <sup>5</sup>	3100
NITROGEN		SESAME				5000
OXYGEN		SESAME				5010
PBX-9502		SESAME				8200
PHOSPHORUS		SESAME				3910
PLATINUM	SESAME		4×10 <sup>8</sup>	0.17	2.1×10 <sup>4</sup>	3730
POLYE (= polyethylene)	SESAME		4×10 <sup>8</sup>	0.0072	1.8×10 <sup>4</sup>	7170

Material Name (LMAT)	EOS File Name	Opacity File Name	Temperature Maximum (K)	Density Minimum (g/cm <sup>3</sup> )	Density Minimum (g/cm <sup>3</sup> )	SESAME Material Number
POLYS (= polystyrene)	SESAME		4×10 <sup>8</sup>	0.0082	2.1×10 <sup>4</sup>	7590
POTASSIUM		SESAME				2460
SiO2 (= SiO <sub>2</sub> )	SESAME	SESAME	4×10 <sup>8</sup>	0.017	4.4×10 <sup>4</sup>	7380
SILICON		SESAME				3810
SODIUM	SESAME	SESAME	1×10 <sup>4</sup>	0.0	1.3	2448
SS (Steel)	SESAME	SESAME	4×10 <sup>8</sup>	0.062	1.6×10 <sup>5</sup>	4270
STAINLESS (Steel)	SESAME		4×10 <sup>8</sup>	0.062	1.6×10 <sup>5</sup>	4270
STEAM	SESAME		1300	0.0	0.9	7151
SULPHUR		SESAME				4010
TITANIUM		SESAME				2960
TITANIUM N (Nitride)		SESAME				6000
UO2 (= UO <sub>2</sub> )	SESAME		3×10 <sup>4</sup>	0.0	14.3	7432
URANIUM	SESAME		4×10 <sup>8</sup>	0.15	4.0×10 <sup>5</sup>	1540
URETHANE	SESAME		4×10 <sup>9</sup>	0.0099	2.5×10 <sup>4</sup>	7560
VERMICULIT	SESAME		4×10 <sup>8</sup>	0.021	5.4×10 <sup>4</sup>	7520
WATER	SESAME	SESAME	1.8×10 <sup>8</sup>	2.0×10 <sup>-6</sup>	4.0×10 <sup>2</sup>	7150

On the CRAY-1 use only the first eight characters in the above material names.

## VII. LOCATION OF COMPUTER FILES AT LOS ALAMOS

The files needed to execute any of the EOSMOD subroutines are available on the CDC 7600 computers at Los Alamos. For most users, it will be sufficient to attach the EOSMOD library,

MASS GET/EOSMOD/EOSLIB

and load the binary source with their program, that is,

FTN (I = program, GLIB = EOSLIB, ...)

For more advanced users, we list the location of most of the SESAME files which may be useful in complicated situations

File Name	Description	CFS File Location
EOSFTN	FORTTRAN source of EOSMOD	/EOSMOD/EOSFTN
EOSINFO	User information	/EOSMOD/EOSINFO
EOSLIB	Compiled FTN Library file of EOSMOD	/EOSMOD/EOSLIB



<u>File Name</u>	<u>Description</u>	<u>CFS File Location</u>
MIXDATA	T-7 mixture EOS and opacity data file	/EOSMOD/MIXLIB
MIXDIR	directory of MIXLIB	/EOSMOD/MIXDIR
EOSTST	Test program	/EOSMOD/EOSTST
MIXB	T-4 procedure to generate mixture	
HYDSES	Subroutine package for using SESAME in hydrodynamic codes	
SAC		/088077/SES/SAC
SAX	change files in a library	/088077/SES/SAX
SESAME	unclassified EOS data file	public
SESAMEA	classified EOS data file	secret
SESAME	unclassified opacity data file	public
S2MV2	create, modify, and print EOS data	/SESAME/SEMV2
S2DV3	plots SESAME data	/SESAME/S2DV3
S2DHELP	help package for SES2D	/SESAME/S2DHELP
DSPLX	computes Hugoniot, isentropes and isobars <sup>12</sup>	/SESAME/DSPLX
S3D	3-D graphics for EOS data	/SESAME/S3D
LSTX	list of current SESAME materials	/SESAME/LSTX

#### VIII. RELATIONSHIPS BETWEEN UNITS

The KUNIT parameter indicates the kind of units the table is to be written in for R, T, P, E, and O. This parameter can have the following integer values and corresponding meanings

KUNIT	0	SESAME EOS Units
		R - grams/cm <sup>3</sup>
		E - megajoules/kilogram (= 10 <sup>10</sup> ergs/gram)
		P - gigapascals (= 10 <sup>10</sup> dyne/cm <sup>2</sup> )
		T - degrees Kelvin
		O - cm <sup>2</sup> /gram <sup>1</sup>
	1	CGS Units
		R - grams/cm <sup>3</sup>
		E - ergs/gram
		P - microbars (= 1 dyne/cm <sup>2</sup> )
		T - degrees Kelvin
		O - cm <sup>2</sup> /gram
	2	Standard International Units (SIU)
		R - kilograms/meter <sup>3</sup>
		E - joules/kilogram (= 10 ergs/gram)
		P - pascals (= 10 dyne/cm <sup>2</sup> )

T - degrees Kelvin  
O - meter<sup>2</sup>/kilogram<sup>2</sup>

3 Hydrox EOS Units

R - grams/cm<sup>3</sup>  
E - megabar cm<sup>3</sup>/gram (= 10<sup>12</sup> ergs/gram)  
P - megabar (= 10<sup>12</sup> dyn/cm<sup>2</sup>)  
T - degrees Kelvin  
O - gram/cm<sup>2</sup>

4 Hydrox Opacity Units

R - grams/cm<sup>3</sup>  
E - megabar cm<sup>2</sup>/gram (= 10<sup>12</sup> ergs/gram)  
P - megabars (= 10<sup>12</sup> dyne/cm<sup>2</sup>)  
T - electron volts  
O - gram/cm<sup>2</sup>

5 SESAME Opacity Units

R - grams/cm<sup>3</sup>  
E - megajoules/kilogram (= 10<sup>10</sup> ergs/gram)  
P - gigapascals (= 10<sup>10</sup> dyne/cm<sup>2</sup>)  
T - electron volts  
O - cm<sup>2</sup>/gram<sup>1</sup>

6 LASNEX Units

R - grams/cm<sup>3</sup>  
E - jerks (= 1 erg/gram)  
P - jerks/cm<sup>3</sup> (= 1 dyne/cm<sup>2</sup>)  
T - keV  
O - cm<sup>2</sup>/gram

The EOS and opacity tables are scaled according to the numerical value of KUNIT when the tables are copied into LCM. The scaling factors used to convert the tables are defined in subroutine EOSCON listed in the Appendixes. This subroutine can be changed easily by the user to write the tables in units other than those provided automatically by the package.

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## APPENDIX A

### SUBROUTINE LISTING

#### User Callable Routines

EOSDRE (input R and E, output P and T) . . . . .	24
EOSDRT (input R and T, output P and E) . . . . .	28
EOSIPT (input P and T, output R and E) . . . . .	32
EOSIRT (input R and T, output P and E) . . . . .	35
EOSORT (input R and T, output O) . . . . .	38

```

1      SUBROUTINE EOSORE (LMAT,R,E,P,T,KEOS,IMATE)
2 C
3 C      *****
4 C      *
5 C      * PURPOSE-
6 C      *   GIVEN THE DENSITY (R) AND ENERGY (E) OF A MATERIAL (LMAT)
7 C      *   THIS SUBROUTINE RETURNS THE PRESSURE (P) AND INTERNAL
8 C      *   TEMPERATURE (T) USING THE LASL T-4 SESAME EOS ROUTINES
9 C      *
10 C     * INPUT VARIABLES-
11 C     *
12 C     *   LMAT = MATERIAL IN AN A10 FIELD, FOR EXAMPLE- LMAT = "HELIUM"
13 C     *           THE MATERIAL SESAME NUMBER CAN ALSO BE USED TO SPECIFY
14 C     *           THE MATERIAL BY SETTING LMAT TO THE SESAME
15 C     *           NUMBER, FOR EXAMPLE- LMAT = "5760" FOR HELIUM
16 C     *
17 C     *   R = DENSITY (RHO)
18 C     *
19 C     *   E = INTERNAL ENERGY
20 C     *
21 C     *   KEOS = MULTIPLE PARAMETER FLAG TO DESCRIBE HOW TO WRITE
22 C     *           AND RETRIEVE THE DATA FILE. KEOS HAS FOUR DECIMAL DIGITS,
23 C     *
24 C     *   KEOS = 1000*KBR + 100*KUNIT + 10*KREPE + KFN WHERE
25 C     *
26 C     *   KBR = COMPUTATIONAL MODE FLAG TO INDICATE WHICH
27 C     *           QUANTITIES AND THEIR PARTIAL DERIVATIVES ARE TO
28 C     *           BE CALCULATED AND RETURNED BY THE PACKAGE.
29 C     *           = 0  COMPUTE PRESSURE AND TEMPERATURE
30 C     *           = 1  COMPUTE PRESSURE ONLY
31 C     *           = 2  COMPUTE TEMPERATURE ONLY
32 C     *
33 C     *   KUNIT= KIND OF UNITS
34 C     *           0 (SESAMEE) R-G/CC,T-DEG.K,D-CM**2/G,P-GPA,E-MJ/KG
35 C     *           1 (CGS) R-G/CC,T-DEG.K,D-CM**2/GM,P-MUBR,E-ERGS/GM
36 C     *           2 (SIU) R-KG/M**3,T-DEG.K,P-PA,E-J/KG,D-M**2/KG
37 C     *           3 (HYOROXE) R-G/CC,T-DEG.K,P-MBR,E-MBR*CC/GM,D-CM**2/G
38 C     *           4 (HYOROXD) R-G/CC,T-KEV,P-MBR,E-MBR*CC/G,D-CM**2/G
39 C     *           5 (SESAMEO) R-G/CC,T-EV,D-CM**2/G,P-GPA,E-MJ/KG
40 C     *           6 (LASNEX) R-G/CC,T-KEV,D-CM**2/GM,P-JRKS/CC,ED-JRKS/CC
41 C     *
42 C     *   LEGEND-
43 C     *           R = DENSITY
44 C     *           T = TEMPERATURE
45 C     *           O = OPACITY
46 C     *           P = PRESSURE
47 C     *           E = INTERNAL ENERGY
48 C     *
49 C     *           CC = CUBIC CENTIMETER
50 C     *           CM = CENTIMETER
51 C     *           DEG. K = DEGREES KELVIN
52 C     *           EV = ELECTRON VOLT
53 C     *           G = GRAM
54 C     *           GPA = GIGA PASCALS
55 C     *           J = JOULES
56 C     *           JRKS = JERKS
57 C     *           KEV = KILO ELECTRON VOLTS
58 C     *           KG = KILOGRAM
59 C     *           M = METER
60 C     *           MBR = MEGABAR
61 C     *           MUBR = MICROBAR
62 C     *           PA = PASCAL

```

```

63 C      *
64 C      *   KREPE = COMPUTATION FLAG TO INDICATE WHETHER E IS
65 C      *           IS TO BE REPRESENTED AS ENERGY PER UNIT MASS OR ENERGY
66 C      *           PER UNIT VOLUME
67 C      *           0 ENERGY IN UNITS OF ENERGY PER UNIT MASS. FOR EXAMPLE-
68 C      *           UNITS OF ERGS/GRAM WHEN KUNIT = 1. THIS IS THE USUAL E.
69 C      *           1 ENERGY IN UNITS OF ENERGY PER UNIT VOLUME. FOR EXAPMLE-
70 C      *           UNITS OF ERGS/CM**3 WHEN KUNIT = 1. THIS IS THE ENERGY
71 C      *           DENSITY RHO*E COMMONLY COMPUTED IN HYDRODYNAMIC
72 C      *           COMPUTER CODES.
73 C      *
74 C      *   KFN = KIND OF FUNTION INTERPOLATION IN THE TABLES
75 C      *           = 0 RATIONAL APPROXIMATIONS (ACCURATE)
76 C      *           = 1 BILINEAR APPROXIMATIONS (FAST)
77 C      *
78 C      *   IMATE = INDICATES WHETHER TO LOAD THE DATA FILE IF
79 C      *           IT DOES NOT EXIST FOR LMAT OR GO DIRECTLY TO A
80 C      *           PREVIOUSLY LOADED FILE.
81 C      *           =0 CHECK IF THE DATA FILE FOR LMAT HAS BEEN LOADED.
82 C      *           IF NOT, SEARCH FOR THE FILE, COMVERT IT TO THE PROPER UNITS
83 C      *           AND COPY IT INTO LCM USING THE INVERTED SESAME FORMAT.
84 C      *           >0 EQUAL TO THE LMAT TABLE NUMBER. THIS NUMBER WAS RETURNED
85 C      *           BY THE PACKAGE ON A PREVIOUS CALL TO SUBROUTINE EOSORE,
86 C      *           EOSIPT OR EOSIRT. THIS OPTION IS FASTER THAN IMATE = 0
87 C      *           BECAUSE IT SKIPS SEARCH IN THE DIRECTOR OF THE
88 C      *
89 C      * OUTPUT VARIABLES-
90 C      *
91 C      *   P = ARRAY OF DIMENSION 3 CONTAINING THE PRESSURE AND
92 C      *           ITS PARTIAL DERIVATIVES. THIS ARRAY MUST BE DIMENSIONED
93 C      *           EVEN IF THE PARTIAL DERIVATIVES ARE NOT COMPUTED.
94 C      *
95 C      *   P(1) = PRESSURE
96 C      *   P(2) = DENSITY DERIVATIVE OF THE PRESSURE (OP/OR)
97 C      *   P(3) = TEMPERATURE DERIVATIVE OF THE PRESSURE (OP/OE)
98 C      *
99 C      *   T = ARRAY OF DIMENSION 3 CONTAINING THE TEMPERATURE AND
100 C      *           ITS PARTIAL DERIVATIVES. THIS ARRAY MUST BE DIMENSIONED
101 C      *           EVEN IF THE PARTIAL DERIVATIVES ARE NOT COMPUTED
102 C      *
103 C      *   T(1) = INTERNAL TEMPERATURE
104 C      *   T(2) = DENSITY DERIVATIVE OF THE TEMPERATURE (OT/OR)
105 C      *   T(3) = ENERGY DERIVATIVE OF THE TEMPERATURE (OT/OE)
106 C      *
107 C      *   IMATE = INDICATES THE SUCCESS OR FAILURE OF
108 C      *           LOCATING AND LOADING THE DATA FILE FOR LMAT.
109 C      *
110 C      *           = N>0 MATERIAL TABLE NUMBER (SUCCESS)
111 C      *           0 MATERIAL (LMAT) NOT IN LIBRARY
112 C      *           -N (N>1) INSUFFICIENT STORAGE
113 C      *           THE LCM STORAGE MUST BE INCREASED BY AT LEAST
114 C      *           N STORAGE LOCATIONS. SEE THE EOSMOD MANUAL
115 C      *
116 C      * REMARKS- THIS SUBROUTINE IS PART OF THE EOSMOD PACKAGE
117 C      *
118 C      * SAMPLE DRIVER PROGRAM-
119 C      *
120 C      *   PROGRAM TST(OUTPUT)
121 C      *   DIMENSION P(3),E(3)
122 C      *   LMAT = "HELIUM"
123 C      *   R = 0.001
124 C      *   E = 1.0

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125 C      *      KEOS = 110
126 C      *      IMATE = 0
127 C      *      CALL EOSORE(LMAT,R,E,P,T,KEOS,IMATE)
128 C      *      PRINT 10,P(1)
129 C      *      10 FORMAT(" PRESSURE = ",E10.2," MICROBARS")
130 C      *      CALL EXIT
131 C      *      END
132 C      *
133 C      * PROGRAMMER- J. M. HYMAN AND M. KLEIN, GROUP T-7, LASL
134 C      *
135 C      * REFERENCE- J. M. HYMAN, M. M. KLEIN
136 C      *      EOSMOO- A SUBROUTINE PACKAGE FOR CALCULATING
137 C      *      EQUATIONS-OF-STATE AND OPACITIES
138 C      *      LOS ALAMOS SCIENTIFIC LABORATORY RPT.,LA-8502-M,1980
139 C      *
140 C      * DATE- MARCH 6, 1980
141 C      *
142 C      *****
143 C
144 C      COMMON BLOCKS FOR THE SESAME EOS ROUTINES
145 C      LEVEL 2, TBLS
146 C      COMMON /S2OIRX/ LCMX, NRS, LCFW(10,3)
147 C      COMMON /SESQATX/ TBLS(11000)
148 C      COMMON /INTOROX/ KFN
149 C      COMMON /SESINX/ IRC, IOT, RHO, ENERGY, KBR, IFL
150 C      COMMON /SESOUTX/ PRES(3), TEMP(3)
151 C
152 C      COMMON BLOCKS FOR THE EOSMOO ROUTINES
153 C      COMMON /EOSCZ/ LOUT
154 C      COMMON /EOSC3/ INIT, IRDIM, IR(60,3), KUP(60,3)
155 C      COMMON /EOSC4/ NTABLE, NTABLO, IFLP, LCNT
156 C
157 C      DIMENSION T(3), P(3)
158 C      DATA KEOS /-99/,KBR5/O/,KFNS/O/,LMATS/1H /
159 C
160 C      *****
161 C
162 C      IDT=1 LOCATOR OF DATA TYPE FOR IR,GETINVX(., IOT,...)
163 C      FOR THE INVERTED SESAME FORMAT
164 C      IDT=1
165 C
166 C      CHECK IF THE UNITS HAVE CHANGED SINCE THE LAST CALL
167 C      IF(KEOS.NE.KEOS.OR.LMAT.NE.LMATS) GO TO 5
168 C      LMATS=LMAT
169 C      KBR=KBR5
170 C      KFN=KFNS
171 C      GO TO 10
172 C      5 CONTINUE
173 C
174 C      CHECK THE VALIDITY OF THE INPUT PARAMETERS
175 C      CALL EOSKUT(KEOS,KBR,KUNIT,KREPE,KFN,KEOS,KBR5,KFNS,IMATE,IDT
176 C      1 ,IERR)
177 C      IF(IERR.LT.0) GO TO 80
178 C      10 CONTINUE
179 C
180 C      FIND THE MATERIAL
181 C      IF (IMATE.GT.0) GO TO 60
182 C      CALL EOSGET(LMAT,KUNIT,KREPE,IMATE,IOT,IERR)
183 C      IF(IMATE.LE.0.OR.IERR.LT.0) GO TO 80
184 C      60 CONTINUE
185 C
186 C      TRANSFER INPUT CALL PARAMETERS TO COMMON BLOCK

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187      ENERGY=E
188      RHO=R
189      IRC=IR(IMATE,1)
190 C
191 C      CALCULATE THE EQUATION OF STATE
192      CALL T4DATIX
193 C      * T4DATIX DOES NOT RETURN AN ERROR FLAG FOR DATA OUT OF RANGE
194 C
195 C      RESTORE OUTPUT VARIABLES FOR RETURN
196      75 CONTINUE
197      P(1)=PRES(1)
198      P(2)=PRES(2)
199      P(3)=PRES(3)
200      T(1)=TEMP(1)
201      T(2)=TEMP(2)
202      T(3)=TEMP(3)
203 C
204      80 CONTINUE
205      IFLP=IERR
206      RETURN
207      END

```



```

1      SUBROUTINE EOSORT (LMAT,R,T,P,E,KEOS,IMATE)
2 C
3 C      *****
4 C      *
5 C      * PURPOSE-
6 C      *   GIVEN THE DENSITY (R) AND TEMPERATURE (T) OF A MATERIAL (LMAT)
7 C      *   THIS SUBROUTINE RETURNS THE PRESSURE (P) AND INTERNAL
8 C      *   ENERGY (E) USING THE LASL T-4 SESAME EOS ROUTINES
9 C      *
10 C      *
11 C      * INPUT VARIABLES-
12 C      *
13 C      *   LMAT = MATERIAL IN AN A10 FIELD, FOR EXAMPLE- LMAT = "HELIUM"
14 C      *           THE MATERIAL SESAME NUMBER CAN ALSO BE USED TO SPECIFY
15 C      *           THE MATERIAL BY SETTING LMAT TO THE SESAME
16 C      *           NUMBER, FOR EXAMPLE- LMAT = "5760" FOR HELIUM
17 C      *
18 C      *   R = DENSITY (RHO)
19 C      *
20 C      *   T = TEMPERATURE
21 C      *
22 C      *   KEOS = MULTIPLE PARAMETER FLAG TO DESCRIBE HOW TO WRITE
23 C      *           AND RETRIEVE THE DATA FILE. KEOS HAS FOUR DECIMAL DIGITS,
24 C      *
25 C      *   KEOS = 1000*KBR + 100*KUNIT + 10*KREPE + KFN WHERE
26 C      *
27 C      *   KBR = COMPUTATIONAL MODE FLAG TO INDICATE WHICH
28 C      *           QUANTITIES AND THEIR PARTIAL DERIVATIVES ARE TO
29 C      *           BE CALCULATED AND RETURNED BY THE PACKAGE.
30 C      *           = 0   COMPUTE PRESSURE AND TEMPERATURE
31 C      *           = 1   COMPUTE PRESSURE ONLY
32 C      *           = 2   COMPUTE TEMPERATURE ONLY
33 C      *
34 C      *   KUNIT= KIND OF UNITS
35 C      *           0 (SESAMEE) R-G/CC,T-DEG.K,O-CM**2/G,P-GPA,E-MJ/KG
36 C      *           1 (CGS) R-G/CC,T-DEG.K,O-CM**2/GM,P-MUBR,E-ERGS/GM
37 C      *           2 (SIU) R-KG/M**3,T-DEG.K,P-PA,E-J/KG,O-M**2/KG
38 C      *           3 (HYORDXE) R-G/CC,T-DEG.K,P-MBR,E-MBR*CC/GM,O-CM**2/G
39 C      *           4 (HYOROXD) R-G/CC,T-KEV,P-MBR,E-MBR*CC/G,O-CM**2/G
40 C      *           5 (SESAMED) R-G/CC,T-EV,O-CM**2/G,P-GPA,E-MJ/KG
41 C      *           6 (LASNEX) R-G/CC,T-KEV,O-CM**2/GM,P-JRKS/CC,EO-JRKS/CC
42 C      *
43 C      *   LEGEND-
44 C      *           R = DENSITY
45 C      *           T = TEMPERATURE
46 C      *           O = OPACITY
47 C      *           P = PRESSURE
48 C      *           E = INTERNAL ENERGY
49 C      *
50 C      *           CC = CUBIC CENTIMETER
51 C      *           CM = CENTIMETER
52 C      *           DEG. K = DEGREES KELVIN
53 C      *           EV = ELECTRON VOLT
54 C      *           G = GRAM
55 C      *           GPA = GIGA PASCALS
56 C      *           J = JOULES
57 C      *           JRKS = JERKS
58 C      *           KEV = KILO ELECTRON VOLTS
59 C      *           KG = KILOGRAM
60 C      *           M = METER
61 C      *           MBR = MEGABAR
62 C      *           MUBR = MICROBAR

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63 C      *          PA = PASCAL
64 C      *
65 C      *  KREPE = COMPUTATION FLAG TO INDICATE WHETHER E IS
66 C      *          IS TO BE REPRESENTED AS ENERGY PER UNIT MASS OR ENERGY
67 C      *          PER UNIT VOLUME
68 C      *          0 ENERGY IN UNITS OF ENERGY PER UNIT MASS. FOR EXAMPLE-
69 C      *          UNITS OF ERGS/GRAM WHEN KUNIT = 1. THIS IS THE USUAL E.
70 C      *          1 ENERGY IN UNITS OF ENERGY PER UNIT VOLUME. FOR EXAPMLE-
71 C      *          UNITS OF ERGS/CM**3 WHEN KUNIT = 1. THIS IS THE ENERGY
72 C      *          DENSITY RHO+E COMMONLY COMPUTED IN HYORODYNAMIC
73 C      *          COMPUTER CODES.
74 C      *
75 C      *  KFN = KIND OF FUNTION INTERPOLATION IN THE TABLES
76 C      *          = 0 RATIONAL APPROXIMATIONS (ACCURATE)
77 C      *          = 1 BILINEAR APPROXIMATIONS (FAST)
78 C      *
79 C      *  IMATE = INDICATES WHETHER TO LOAD THE DATA FILE IF
80 C      *          IT DOES NOT EXIST FOR LMAT OR GO DIRECTLY TO A
81 C      *          PREVIOUSLY LOADED FILE.
82 C      *          =0 CHECK IF THE DATA FILE FOR LMAT HAS BEEN LOADED.
83 C      *          IF NOT, SEARCH FOR THE FILE, CONVERT IT TO THE PROPER UNITS
84 C      *          AND COPY IT INTO LCM USING THE STANDARD SESAME FORMAT.
85 C      *          >0 EQUAL TO THE LMAT TABLE NUMBER. THIS NUMBER WAS RETURNED
86 C      *          BY THE PACKAGE ON A PREVIOUS CALL TO SUBROUTINE EOSORE,
87 C      *          EOSIPT OR EOSIRT. THIS OPTION IS FASTER THAN IMATE = 0
88 C      *          BECAUSE IT SKIPS SEARCH IN THE DIRECTOR OF THE
89 C      *
90 C      *  OUTPUT VARIABLES-
91 C      *
92 C      *  P = ARRAY OF DIMENSION 3 CONTAINING THE PRESSURE AND
93 C      *          ITS PARTIAL DERIVATIVES. THIS ARRAY MUST BE DIMENSIONED
94 C      *          EVEN IF THE PARTIAL DERIVATIVES ARE NOT COMPUTED.
95 C      *
96 C      *  P(1) = PRESSURE
97 C      *  P(2) = DENSITY DERIVATIVE OF THE PRESSURE (OP/OR)
98 C      *  P(3) = TEMPERATURE DERIVATIVE OF THE PRESSURE (OP/OT)
99 C      *
100 C      *  E = ARRAY OF DIMENSION 3 CONTAINING THE ENERGY AND
101 C      *          ITS PARTIAL DERIVATIVES. THIS ARRAY MUST BE DIMENSIONED
102 C      *          EVEN IF THE PARTIAL DERIVATIVES ARE NOT COMPUTED
103 C      *
104 C      *  E(1) = INTERNAL ENERGY
105 C      *  E(2) = DENSITY DERIVATIVE OF THE ENERGY (OE/OR)
106 C      *  E(3) = TEMPERATURE DERIVATIVE OF THE ENERGY (OE/OT)
107 C      *
108 C      *  IMATE = INDICATES THE SUCCESS OR FAILURE OF
109 C      *          LOCATING AND LOADING THE DATA FILE FOR LMAT.
110 C      *
111 C      *          = N>0 MATERIAL TABLE NUMBER (SUCCESS)
112 C      *          0 MATERIAL (LMAT) NOT IN LIBRARY
113 C      *          -N (N>1) INSUFFICIENT STORAGE
114 C      *          THE LCM STORAGE MUST BE INCREASED BY AT LEAST
115 C      *          N STORAGE LOCATIONS. SEE THE EOSMOD MANUAL
116 C      *
117 C      *  REMARKS- THIS SUBROUTINE IS PART OF THE EOSMOD PACKAGE
118 C      *
119 C      *  SAMPLE DRIVER PROGRAM-
120 C      *
121 C      *  PROGRAM TST(OUTPUT)
122 C      *  DIMENSION P(3),E(3)
123 C      *  LMAT = "HELIUM"
124 C      *  R = 0.001

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125 C      *      T = 300.0
126 C      *      KEOS = 110
127 C      *      IMATE = 0
128 C      *      CALL EOSORT(LMAT,R,T,P,E,KEOS,IMATE)
129 C      *      PRINT 10,P(1)
130 C      *      10 FORMAT(" PRESSURE = ",E10.2," MICROBARS")
131 C      *      CALL EXIT
132 C      *      END
133 C      *
134 C      * REMARKS- THIS SUBROUTINE IS PART OF THE EOSMOD PACKAGE
135 C      *
136 C      * PROGRAMMER- J. M. HYMAN AND M. KLEIN, GROUP T-7, LASL
137 C      *
138 C      * REFERENCE- J. M. HYMAN, M. M. KLEIN
139 C      *      EOSMOD- A SUBROUTINE PACKAGE FOR CALCULATING
140 C      *      EQUATIONS-OF-STATE AND OPACITIES
141 C      *      LOS ALAMOS SCIENTIFIC LABORATORY RPT.,LA-8502-M,1980
142 C      *
143 C      * DATE- MARCH 6, 1980
144 C      *
145 C      *****
146 C
147 C      COMMON BLOCKS FOR THE SESAME EOS ROUTINES
148 C      LEVEL 2, TBLS
149 C      COMMON /S2DIRX/ LCMX, NRS, LCFW(10,3)
150 C      COMMON /SESQATX/ TBLS(11000)
151 C      COMMON /INTOROX/ KFN
152 C      COMMON /SESINX/ IRC, IOT, RHO, TEMP, KBR, IFL
153 C      COMMON /SESOUTX/ PRES(3), ENERGY(3)
154 C
155 C      COMMON BLOCKS FOR THE EOSMOD ROUTINES
156 C      COMMON /EDSCZ/ LOUT
157 C      COMMON /EDSCCE/ TFACE, RFACE, PFACE, EFACE, KREPE
158 C      COMMON /EDSC1/ LU41, LU42, LU43, LU44, LU45
159 C      COMMON /EDSC3/ INIT, IROIM, IR(60,3), KUP(60,3)
160 C      COMMON /EDSC4/ NTABLE, NTABLO, IFLP, LCNT
161 C
162 C      DIMENSION E(3), P(3)
163 C      DATA KEOSS /-99/,KBR5/O/,KFNS/O/,LMATS/1H /
164 C
165 C      *****
166 C
167 C      IOT=3 LOCATOR OF DATA TYPE FOR IR,GETEOSX(.. IOT,...)
168 C      FOR THE STANDARD SESAME FORMAT
169 C      IOT=3
170 C
171 C      CHECK IF THE UNITS HAVE CHANGED SINCE THE LAST CALL
172 C      IF(KEOSS.NE.KEOS.OR.LMAT.NE.LMATS) GO TO 5
173 C      LMATS=LMAT
174 C      KBR=KBR5
175 C      KFN=KFNS
176 C      GO TO 10
177 C      5 CONTINUE
178 C
179 C      CHECK THE VALIDITY OF THE INPUT PARAMETERS
180 C      CALL EOSKUT(KEOS,KBR,KUNIT,KREPE,KFN,KEOSS,KBR5,KFNS,IMATE,IDT
181 C      1 ,IERR)
182 C      IF(IERR.LT.0) GO TO 80
183 C      10 CONTINUE
184 C
185 C      FIND THE MATERIAL
186 C      IF (IMATE.GT.0) GO TO 60

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187      CALL EDSGET(LMAT,KUNIT,KREPE,IMATE,1DT,IERR)
188      IF(IMATE.LE.O.OR.IERR.LT.O) GO TO 80
189      60 CONTINUE
190 C
191 C      TRANSFER INPUT CALL PARAMETERS TO COMMON BLOCK
192      TEMP=T
193      RHO=R
194      IRC=IR(IMATE,3)
195 C
196 C      CALCULATE THE EQUATION OF STATE
197      * CALL T4DATX
198 C      * T4DATX DOES NOT RETURN AN EROR FLAG FOR DATA OUT OF RANGE
199 C
200      75 CONTINUE
201 C      RESTORE OUTPUT VARIABLES FOR RETURN TO CALL
202      P(1)=PRES(1)
203      P(2)=PRES(2)
204      P(3)=PRES(3)
205      E(1)=ENERGY(1)
206      E(2)=ENERGY(2)
207      E(3)=ENERGY(3)
208 C
209      80 CONTINUE
210      IFLP=IERR
211      RETURN
212      END

```

```

1      SUBROUTINE EOSIPT (LMAT,P,T,R,E,KEOS,IMATE)
2 C
3 C      *****
4 C      *
5 C      * PURPOSE-
6 C      *   GIVEN THE PRESSURE (P) AND TEMPERATURE (T) OF A MATERIAL (LMAT)
7 C      *   THIS SUBROUTINE RETURNS THE PRESSURE (P) AND INTERNAL
8 C      *   ENERGY (E) USING THE LASL T-4 SESAME EQUATION OF STATE ROUTINES
9 C      *
10 C     * AN ITERATIVE METHOD IS USED TO INTERPOLATE THE TABLES
11 C     *
12 C     * INPUT VARIABLES-
13 C     *
14 C     *   LMAT = MATERIAL IN AN A10 FIELD, FOR EXAMPLE- LMAT = "HELIUM"
15 C     *           THE MATERIAL SESAME NUMBER CAN ALSO BE USED TO SPECIFY
16 C     *           THE MATERIAL BY SETTING LMAT TO THE SESAME
17 C     *           NUMBER, FOR EXAMPLE- LMAT = "5760" FOR HELIUM
18 C     *
19 C     *   P = PRESSURE
20 C     *
21 C     *   T = TEMPERATURE
22 C     *
23 C     *   KEOS = MULTIPLE PARAMETER FLAG TO DESCRIBE HOW TO WRITE
24 C     *           AND RETRIEVE THE DATA FILE. KEOS HAS FOUR DECIMAL DIGITS.
25 C     *
26 C     *   KEOS = 100*KUNIT + 10*KREPE WHERE
27 C     *
28 C     *   KUNIT= KIND OF UNITS
29 C     *       0 (SESAMEE) R-G/CC,T-DEG.K,O-CM**2/G,P-GPA,E-MJ/KG
30 C     *       1 (CGS) R-G/CC,T-DEG.K,O-CM**2/GM,P-MUBR,E-ERGS/GM
31 C     *       2 (SIU) R-KG/M**3,T-DEG.K,P-PA,E-J/KG,O-M**2/KG
32 C     *       3 (HYDROXE) R-G/CC,T-DEG.K,P-MBR,E-MBR*CC/GM,O-CM**2/G
33 C     *       4 (HYDROXD) R-G/CC,T-KEV,P-MBR,E-MBR*CC/G,O-CM**2/G
34 C     *       5 (SESAMEO) R-G/CC,T-EV,O-CM**2/G,P-GPA,E-MJ/KG
35 C     *       6 (LASNEX) R-G/CC,T-KEV,O-CM**2/GM,P-JRKS/CC,EJ-JRKS/CC
36 C     *
37 C     *   LEGEND-
38 C     *       R = DENSITY
39 C     *       T = TEMPERATURE
40 C     *       O = OPACITY
41 C     *       P = PRESSURE
42 C     *       E = INTERNAL ENERGY
43 C     *
44 C     *       CC = CUBIC CENTIMETER
45 C     *       CM = CENTIMETER
46 C     *       DEG. K = DEGREES KELVIN
47 C     *       EV = ELECTRON VOLT
48 C     *       G = GRAM
49 C     *       GPA = GIGA PASCALS
50 C     *       J = JOULES
51 C     *       JRKS = JERKS
52 C     *       KEV = KILO ELECTRON VOLTS
53 C     *       KG = KILOGRAM
54 C     *       M = METER
55 C     *       MBR = MEGABAR
56 C     *       MUBR = MICROBAR
57 C     *       PA = PASCAL
58 C     *
59 C     *   KREPE = COMPUTATION FLAG TO INDICATE WHETHER E IS
60 C     *           IS TO BE REPRESENTED AS ENERGY PER UNIT MASS OR ENERGY
61 C     *           PER UNIT VOLUME
62 C     *           0 ENERGY IN UNITS OF ENERGY PER UNIT MASS. FOR EXAMPLE-

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63 C      *      UNITS OF ERGS/GRAM WHEN KUNIT = 1. THIS IS THE USUAL E.
64 C      *      1 ENERGY IN UNITS OF ENERGY PER UNIT VOLUME. FOR EXAPMLE-
65 C      *      UNITS OF ERGS/CM**3 WHEN KUNIT = 1. THIS IS THE ENERGY
66 C      *      DENSITY RHO*E COMMONLY COMPUTED IN HYDRODYNAMIC
67 C      *      COMPUTER CODES.
68 C      *
69 C      * IMATE = INDICATES WHETHER TO LOAD THE DATA FILE IF
70 C      *      IT DOES NOT EXIST FOR LMAT OR GO DIRECTLY TO A
71 C      *      PREVIOUSLY LOADED FILE.
72 C      *      =O CHECK IF THE DATA FILE FOR LMAT HAS BEEN LOADED.
73 C      *      IF NOT, SEARCH FOR THE FILE, CONVERT IT TO THE PROPER UNITS
74 C      *      AND COPY IT INTO LCM USING THE INVERTED SESAME FORMAT.
75 C      *      >O EQUAL TO THE LMAT TABLE NUMBER. THIS NUMBER WAS RETURNED
76 C      *      BY THE PACKAGE ON A PREVIOUS CALL TO SUBROUTINE EOSORE,
77 C      *      EOSIPT OR EOSIRT. THIS OPTION IS FASTER THAN IMATE = O
78 C      *      BECAUSE IT SKIPS SEARCH IN THE DIRECTOR OF THE
79 C      *
80 C      * OUTPUT VARIABLES-
81 C      *
82 C      * R = DENSITY
83 C      *
84 C      * E = INTERNAL ENERGY
85 C      *
86 C      * IMATE = INDICATES THE SUCCESS OR FAILURE OF
87 C      *      LOCATING AND LOADING THE DATA FILE FOR LMAT.
88 C      *
89 C      *      = N>O MATERIAL TABLE NUMBER (SUCCESS)
90 C      *      O      MATERIAL (LMAT) NOT IN LIBRARY
91 C      *      -N (N>1) INSUFFICIENT STORAGE
92 C      *      THE LCM STORAGE MUST BE INCREASED BY AT LEAST
93 C      *      N STORAGE LOCATIONS. SEE THE EOSMOD MANUAL
94 C      *
95 C      * REMARKS- THIS SUBROUTINE IS PART OF THE EOSMOD PACKAGE
96 C      *
97 C      * SAMPLE DRIVER PROGRAM-
98 C      *
99 C      *      PROGRAM TST(OUTPUT)
100 C      *      DIMENSION P(3),E(3)
101 C      *      LMAT = "HELIUM"
102 C      *      R = 0.001
103 C      *      T = 300.0
104 C      *      KEOS = 110
105 C      *      IMATE = 0
106 C      *      CALL EOSIPT(LMAT,P,T,R,E,KEOS,IMATE)
107 C      *      PRINT 10,P(1)
108 C      *      10 FORMAT(" DENSITY = ",E10.2," MICROBARS")
109 C      *      CALL EXIT
110 C      *      END
111 C      *
112 C      * REMARKS- THIS SUBROUTINE IS PART OF THE EOSMOD PACKAGE
113 C      *
114 C      * PROGRAMMER- J. M. HYMAN AND M. KLEIN, GROUP T-7, LASL
115 C      *
116 C      * REFERENCE- J. M. HYMAN, M. M. KLEIN
117 C      *      EOSMOD- A SUBROUTINE PACKAGE FOR CALCULATING
118 C      *      EQUATIONS-OF-STATE AND OPACITIES
119 C      *      LOS ALAMOS SCIENTIFIC LABORATORY RPT.,LA-8502-M,1980
120 C      *
121 C      * DATE- MARCH 6, 1980
122 C      *
123 C      *****
124 C

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125 C      COMMON BLOCKS FOR THE SESAME EOS ROUTINES
126          LEVEL 2, TBLS
127          COMMON /S2DIRX/ LCMX, NRS, LCFW(10,3)
128          COMMON /SESATX/ TBLS(11000)
129          COMMON /SESINX/ DUM(4), KBR, DUM1
130          COMMON /INTORDX/ KFN
131 C
132 C      COMMON BLOCKS FOR THE EOSMOD ROUTINES
133          COMMON /EDSCZ/ LOUT
134          COMMON /EDSC3/ INIT, IROIM, IR(60,3), KUP(60,3)
135          COMMON /EDSC4/ NTABLE, NTABLO, IFLP, LCNT
136 C
137          DIMENSION R(3), E(3)
138          DATA KEOSS /-99/,KBR5/O/,KFNS/O/,LMATS/1H /
139 C
140 C      *****
141 C
142 C      IOT=1 LOCATOR OF DATA TYPE FOR IR,GETINVX(., IOT,...)
143 C      FOR THE INVERTED SESAME FORMAT
144          IDT=1
145 C
146 C      CHECK IF THE UNITS HAVE CHANGED SINCE THE LAST CALL
147          IF(KEOSS.NE.KEOS.OR.LMAT.NE.LMATS) GO TO 5
148          LMATS=LMAT
149          KBR=KBR5
150          KFN=KFNS
151          GO TO 10
152      5 CONTINUE
153 C
154 C      CHECK THE VALIDITY OF THE INPUT PARAMETERS
155          CALL EOSKUT(KEOS,KBR,KUNIT,KREPE,KFN,KEOSS,KBR5,KFNS,IMATE,IOT
156      1 ,IERR)
157          IF(IERR.LT.0) GO TO 75
158      10 CONTINUE
159 C
160 C      FIND THE MATERIAL
161          IF (IMATE.GT.0) GO TO 60
162          CALL EOSGET(LMAT,KUNIT,KREPE,IMATE,IOT,IERR)
163          IF(IMATE.LE.0.OR.IERR.LT.0) GO TO 75
164      60 CONTINUE
165 C
166 C      CALCULATE THE EQUATION OF STATE
167          CALL T4PTREX (IR(IMATE,1),1,TBLS,P,T,R,E,IERR)
168 C
169 C      PRINT AN ERROR MESSAGE IF T4PTREX FAILS TO CONVERGE
170          IF (IERR.EQ.0) WRITE(LOUT,80) LMAT,P,T
171          IF (IERR.EQ.0) IMATE=0
172 C
173      75 CONTINUE
174          IFLP=IERR
175          RETURN
176 C
177      80 FORMAT(" FAILED TO CONVERGE WHEN ITERATING ON THE INVERTED",
178      1 /, " EOS TABLES IN SUBROUTINE T4PTREX CALLED BY EOSIPT",/,
179      2 " THE REQUESTED VALUES FOR RHO, PRESSURE, TEMPERATURE AND ENERGY",
180      2 /, " MAY BE OUT OF RANGE OR NEAR THE EDGE OF THE TABLE",/,
181      3 " CHECK THE EOSMOD WRITEUP FOR THE DATA RANGE",/,
182      1 " LMAT =",A10,
183      4 " PRESSURE =",1PE12-4, " TEMPERATURE =",1PE12-4)
184          END

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1      SUBROUTINE EOSIRT (LMAT,R,T,P,E,KEOS,IMATE)
2 C
3 C      *****
4 C      *
5 C      * PURPDSE-
6 C      * GIVEN THE DENSITY (R) AND TEMPERATURE (T) OF A MATERIAL )
7 C      * (LMAT), THIS SUBROUTINE RETURNS THE PRESSURE (P) AND INTERNAL
8 C      * ENERGY (T) USING THE LASL E-4 SESAME EQUATION OF STATE ROUTINES
9 C      *
10 C     * AN ITERATIVE METHOD IS USED TO INTERPOLATE THE TABLES
11 C     * SUBROUTINE EOSORT USES A FASTER DIRECT METHOD
12 C     *
13 C     * INPUT VARIABLES-
14 C     *
15 C     * LMAT = MATERIAL IN AN A10 FIELD, FOR EXAMPLE- LMAT = "HELIUM"
16 C     * THE MATERIAL SESAME NUMBER CAN ALSO BE USED TO SPECIFY
17 C     * THE MATERIAL BY SETTING LMAT TO THE SESAME
18 C     * NUMBER, FOR EXAMPLE- LMAT = "5760" FOR HELIUM
19 C     *
20 C     * R = DENSITY (RHD)
21 C     *
22 C     * T = TEMPERATURE
23 C     *
24 C     * KEOS = MULTIPLE PARAMETER FLAG TO DESCRIBE HOW TO WRITE
25 C     * AND RETRIEVE THE DATA FILE. KEOS HAS FOUR DECIMAL DIGITS,
26 C     *
27 C     * KEOS = 100*KUNIT + 10*KREPE WHERE
28 C     *
29 C     * KUNIT= KIND OF UNITS
30 C     * 0 (SESAMEE) R-G/CC,T-DEG.K,O-CM**2/G,P-GPA,E-MJ/KG
31 C     * 1 (CGS) R-G/CC,T-DEG.K,O-CM**2/GM,P-MUBR,E-ERGS/GM
32 C     * 2 (SIU) R-KG/M**3,T-DEG.K,P-PA,E-J/KG,O-M**2/KG
33 C     * 3 (HYDROXE) R-G/CC,T-DEG.K,P-MBR,E-MBR*CC/GM,O-CM**2/G
34 C     * 4 (HYDROXD) R-G/CC,T-KEV,P-MBR,E-MBR*CC/G.O-CM**2/G
35 C     * 5 (SESAMEO) R-G/CC,T-EV,O-CM**2/G,P-GPA,E-MJ/KG
36 C     * 6 (LASNEX) R-G/CC,T-KEV,O-CM**2/GM,P-JRKS/CC,ED-JRKS/CC
37 C     *
38 C     * LEGEND-
39 C     * R = DENSITY
40 C     * T = TEMPERATURE
41 C     * O = OPACITY
42 C     * P = PRESSURE
43 C     * E = INTERNAL ENERGY
44 C     *
45 C     * CC = CUBIC CENTIMETER
46 C     * CM = CENTIMETER
47 C     * DEG. K = DEGREES KELVIN
48 C     * EV = ELECTRON VOLT
49 C     * G = GRAM
50 C     * GPA = GIGA PASCALS
51 C     * J = JOULES
52 C     * JRKS = JERKS
53 C     * KEV = KILO ELECTRON VOLTS
54 C     * KG = KILOGRAM
55 C     * M = METER
56 C     * MBR = MEGABAR
57 C     * MUBR = MICROBAR
58 C     * PA = PASCAL
59 C     *
60 C     * KREPE = COMPUTATION FLAG TO INDICATE WHETHER T IS
61 C     * IS TO BE REPRESENTED AS ENERGY PER UNIT MASS OR ENERGY
62 C     * PER UNIT VOLUME

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63 C      *      O ENERGY IN UNITS OF ENERGY PER UNIT MASS. FOR EXAMPLE-
64 C      *      UNITS OF ERGS/GRAM WHEN KUNIT = 1. THIS IS THE USUAL T.
65 C      *      1 ENERGY IN UNITS OF ENERGY PER UNIT VOLUME. FOR EXAPMLE-
66 C      *      UNITS OF ERGS/CM**3 WHEN KUNIT = 1. THIS IS THE ENERGY
67 C      *      DENSITY RHO*T COMMONLY COMPUTED IN HYDROOYNAMIC
68 C      *      COMPUTER CODES.
69 C      *
70 C      * IMATE = INDICATES WHETHER TO LOAD THE DATA FILE IF
71 C      *      IT DOES NOT EXIST FOR LMAT OR GO OIRECTLY TO A
72 C      *      PREVIOUSLY LOADED FILE.
73 C      *      =O CHECK IF THE DATA FILE FOR LMAT HAS BEEN LOADED.
74 C      *      IF NOT, SEARCH FOR THE FILE, CONVERT IT TO THE PROPER UNITS
75 C      *      AND COPY IT INTO LCM USING THE INVERTED SESAME FORMAT.
76 C      *      >O EQUAL TO THE LMAT TABLE NUMBER. THIS NUMBER WAS RETURNED
77 C      *      BY THE PACKAGE ON A PREVIOUS CALL TO SUBROUTINE EOSORE,
78 C      *      EOSIPT OR EOSIRT. THIS OPTION IS FASTER THAN IMATE = O
79 C      *      BECAUSE IT SKIPS SEARCH IN THE OIRECTOR OF THE
80 C      *
81 C      * OUTPUT VARIABLES-
82 C      *
83 C      * P = PRESSURE
84 C      *
85 C      * E = INTERNAL ENERGY
86 C      *
87 C      * IMATE = INDICATES THE SUCCESS OR FAILURE OF
88 C      *      LOCATING AND LOADING THE DATA FILE FOR LMAT.
89 C      *
90 C      *      = N>O MATERIAL TABLE NUMBER (SUCCESS)
91 C      *      O MATERIAL (LMAT) NOT IN LIBRARY
92 C      *      -N (N>1) INSUFFICIENT STORAGE
93 C      *      THE LCM STORAGE MUST BE INCREASED BY AT LEAST
94 C      *      N STORAGE LOCATIONS. SEE THE EOSMOD MANUAL
95 C      *
96 C      * REMARKS- THIS SUBROUTINE IS PART OF THE EOSMOD PACKAGE
97 C      *
98 C      * SAMPLE DRIVER PROGRAM-
99 C      *
100 C      *      PROGRAM TST(OUTPUT)
101 C      *      DIMENSION P(3),T(3)
102 C      *      LMAT = "HELIUM"
103 C      *      R = 0.001
104 C      *      T = 300.0
105 C      *      KEOS = 110
106 C      *      IMATE = 0
107 C      *      CALL EOSIRT(LMAT,R,T,P,E,KEOS,IMATE)
108 C      *      PRINT 10,P(1)
109 C      *      10 FORMAT(" PRESSURE = ",E10.2," MICROBARS")
110 C      *      CALL EXIT
111 C      *      END
112 C      *
113 C      * REMARKS- THIS SUBROUTINE IS PART OF THE EOSMOD PACKAGE
114 C      *
115 C      * PROGRAMMER- J. M. HYMAN AND M. KLEIN, GROUP T-7, LASL
116 C      *
117 C      * REFERENCE- J. M. HYMAN, M. M. KLEIN
118 C      *      EOSMOD- A SUBROUTINE PACKAGE FOR CALCULATING
119 C      *      EQUATIONS-OF-STATE AND OPACITIES
120 C      *      LOS ALAMOS SCIENTIFIC LABORATORY RPT.,LA-8502-M,1980
121 C      *
122 C      * DATE- MARCH 6, 1980
123 C      *
124 C      *****

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125 C
126 C      COMMON BLOCKS FOR THE SESAME EOS ROUTINES
127      LEVEL 2, TBLS
128      COMMON /S2DIRX/ LCMX, NRS, LCFW(10,3)
129      COMMON /SES0ATX/ TBLS(11000)
130      COMMON /SESINX/ DUM(4), KBR, DUM1
131      COMMON /INTORDX/ KFN
132 C
133 C      COMMON BLOCKS FOR THE EOSMOD ROUTINES
134      COMMON /E0SCZ/ LOUT
135      COMMON /E0SC3/ INIT, IRDIM, IR(60,3), KUP(60,3)
136      COMMON /E0SC4/ NTABLE, NTABLO, *IFLP, LCNT
137 C
138      DIMENSION P(3), E(3)
139      DATA KE0SS /-99/,KBR5/0/,KFNS/0/,LMATS/1H /
140 C
141 C      *****
142 C
143 C      IOT=1 LOCATOR OF DATA TYPE FOR IR.GETINVX(.. IOT,...)
144 C      FOR THE INVERTED SESAME FORMAT
145      IOT=1
146 C
147 C      CHECK IF THE UNITS HAVE CHANGED SINCE THE LAST CALL
148      IF(KE0SS.NE.KE0S.OR.LMAT.NE.LMATS) GO TO 5
149      LMATS=LMAT
150      KBR=KBR5
151      KFN=KFNS
152      GO TO 10
153      5 CONTINUE
154 C
155 C      CHECK THE VALIDITY OF THE INPUT PARAMETERS
156      CALL E0SKUT(KE0S,KBR,KUNIT,KREPE,KFN,KE0SS,KBR5,KFNS,IMATE,IOT
157      1 ,IERR)
158      IF(IERR.LT.0) GO TO 75
159      10 CONTINUE
160 C
161 C      FIND THE MATERIAL
162      IF (IMATE.GT.0) GO TO 60
163      CALL E0SGET(LMAT,KUNIT,KREPE,IMATE,IOT,IERR)
164      IF(IMATE.LE.0.OR.IERR.LT.0) GO TO 75
165      60 CONTINUE
166 C
167 C      CALCULATE THE EQUATION OF STATE
168      CALL T4RTPEX (IR(IMATE,1),1,TBLS,R,T,P,E,IERR)
169 C
170 C      PRINT AN ERROR MESSAGE IF T4RTPEX FAILED TO CONVERGE
171      IF (IERR.EQ.0) WRITE(LOUT,80) LMAT,R,T
172      IF (IERR.EQ.0) IMATE=0
173 C
174      75 CONTINUE
175      . IFLP=IERR
176      RETURN
177 C
178      80 FORMAT(" FAILED TO CONVERGE WHEN ITERATING ON THE INVERTED",
179      1 /," EDS TABLES IN SUBROUTINE T4PTREX CALLED BY E0SIRT",/,
180      2 " THE REQUESTED VALUES FOR RHO, PRESSURE, TEMPERATURE AND ENERGY"
181      2 ,/," MAY BE OUT OF RANGE OR NEAR THE EDGE OF THE TABLE",/,
182      3 " CHECK THE EOSMOD WRITEUP FOR THE DATA RANGE",/,
183      1 " LMAT =",A10,
184      4 " DENSITY =",1PE12.4," TEMPERATURE =",1PE12.4)
185      END

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1      SUBROUTINE EOSDRT (LMAT,R,T,O,KOPC,IMATO)
2 C
3 C      *****
4 C      *
5 C      * PURPOSE-
6 C      * GIVEN THE DENSITY (R) AND TEMPERATURE(T) OF A MATERIAL (LMAT)
7 C      * THIS ROUTINE RETURNS THE OPACITY (O) USING THE LASL
8 C      * HYDSES (T-4) ROUTINES
9 C      *
10 C     * INPUT VARIABLES-
11 C     *
12 C     * LMAT = MATERIAL IN AN A10 FIELD, FOR EXAMPLE- LMAT = "HELIUM"
13 C     * THE MATERIAL SESAME NUMBER CAN ALSO BE USED TO SPECIFY
14 C     * THE MATERIAL BY SETTING LMAT TO THE SESAME
15 C     * NUMBER, FOR EXAMPLE- LMAT = "5760" FOR HELIUM
16 C     *
17 C     * R = DENSITY (RHO)
18 C     *
19 C     * T = TEMPERATURE
20 C     *
21 C     * KOPC = MULTIPLE PARAMETER FLAG TO DESCRIBE HOW TO WRITE
22 C     * AND RETRIEVE THE DATA FILE. KOPC HAS FOUR DECIMAL DIGITS.
23 C     *
24 C     * KOPC = 100*KUNIT + 10*KREPE + KFN WHERE
25 C     *
26 C     * KUNIT= KIND OF UNITS
27 C     * 0 (SESAMEE) R-G/CC,T-DEG.K,O-CM**2/G,P-GPA,E-MJ/KG
28 C     * 1 (CGS) R-G/CC,T-DEG.K,O-CM**2/GM,P-MUBR,E-ERGS/GM
29 C     * 2 (SIU) R-KG/M**3,T-DEG.K,P-PA,E-J/KG,O-M**2/KG
30 C     * 3 (HYDROXE) R-G/CC,T-DEG.K,P-MBR,E-MBR*CC/GM,O-CM**2/G
31 C     * 4 (HYDROXD) R-G/CC,T-KEV,P-MBR,E-MBR*CC/G,O-CM**2/G
32 C     * 5 (SESAMEO) R-G/CC,T-EV,O-CM**2/G,P-GPA,E-MJ/KG
33 C     * 6 (LASNEX) R-G/CC,T-KEV,D-CM**2/GM,P-JRKS/CC,EO-JRKS/CC
34 C     *
35 C     * LEGEND-
36 C     * R = DENSITY
37 C     * T = TEMPERATURE
38 C     * O = OPACITY
39 C     * P = PRESSURE
40 C     * E = INTERNAL ENERGY
41 C     *
42 C     * CC = CUBIC CENTIMETER
43 C     * CM = CENTIMETER
44 C     * DEG. K = DEGREES KELVIN
45 C     * EV = ELECTRON VOLT
46 C     * G = GRAM
47 C     * GPA = GIGA PASCALS
48 C     * J = JOULES
49 C     * JRKS = JERKS
50 C     * KEV = KILO ELECTRON VOLTS
51 C     * KG = KILOGRAM
52 C     * M = METER
53 C     * MBR = MEGABAR
54 C     * MUBR = MICROBAR
55 C     * PA = PASCAL
56 C     *
57 C     * KREPD = COMPUTATIONAL FLAG TO INDICATE WHICH REPRESENTATION
58 C     * TO USE FOR THE OPACITY VARIABLE.
59 C     * 0 OPACITY REPRESENTED AS KAPPA IN DIMENSIONAL
60 C     * UNITS OF LENGTH**2/MASS
61 C     * 1 OPACITY REPRESENTED AS A MEAN-FREE PATH,
62 C     * LAMBOA = 1/(KAPPA*RHO), IN DIMENSIONAL

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63 C      *          UNITS OF LENGTH.
64 C      *
65 C      *   KFN = KIND OF FUNTION INTERPOLATION IN THE TABLES
66 C      *       = 0 RATIONAL APPROXIMATIONS (ACCURATE)
67 C      *       = 1 BILINEAR APPROXIMATIONS (FAST)
68 C      *
69 C      *   IMATO = INDICATES WHETHER TO LOAD THE DATA FILE IF
70 C      *       IT DOES NOT EXIST FOR LMAT OR GO DIRECTLY TO A
71 C      *       PREVIOUSLY LOADED FILE.
72 C      *   =0 CHECK IF THE DATA FILE FOR LMAT HAS BEEN LOADED.
73 C      *       IF NOT, SEARCH FOR THE FILE, CONVERT IT TO THE PROPER UNITS
74 C      *       AND COPY IT INTO LCM USING THE INVERTED SESAME FORMAT.
75 C      *   >0 EQUAL TO THE LMAT TABLE NUMBER. THIS NUMBER WAS RETURNED
76 C      *       BY THE PACKAGE ON A PREVIOUS CALL TO SUBROUTINE EOSORT,
77 C      *       THIS OPTION IS FASTER THAN IMATO = 0
78 C      *       BECAUSE IT SKIPS SEARCH IN THE DIRECTOR OF THE
79 C      *
80 C      * OUTPUT VARIABLES-
81 C      *
82 C      *   0 = OPACITY
83 C      *
84 C      *   IMATO = INDICATES THE SUCCESS OR FAILURE OF
85 C      *       LOCATING AND LOADING THE DATA FILE FOR LMAT.
86 C      *
87 C      *       = N>0 MATERIAL TABLE NUMBER (SUCCESS)
88 C      *       0   MATERIAL (LMAT) NOT IN LIBRARY
89 C      *       -N  (N>1) INSUFFICIENT STORAGE
90 C      *           THE LCM STORAGE MUST BE INCREASED BY AT LEAST
91 C      *           N STORAGE LOCATIONS.  SEE THE EOSMOD MANUAL
92 C      *
93 C      * REMARKS- THIS SUBROUTINE IS PART OF THE EOSMOD PACKAGE
94 C      *
95 C      * SAMPLE DRIVER PROGRAM-
96 C      *
97 C      *   PROGRAM TST(OUTPUT)
98 C      *   DIMENSION P(3),E(3)
99 C      *   LMAT = "HELIUM"
100 C      *   R = 0.001
101 C      *   T = 300.0
102 C      *   KOPC = 500
103 C      *   IMATO = 0
104 C      *   CALL EOSORT(LMAT,R,T,D,KOPC,IMATO)
105 C      *   PRINT 10,P(1)
106 C      *   10 FDRMAT(" OPACITY = ",E10.2)
107 C      *   CALL EXIT
108 C      *   END
109 C      *
110 C      * EXTERNALS AND COMMON BLOCKS-
111 C      *   QLOG10 = QUICK VERSION OF ALOG10
112 C      *
113 C      * REMARKS- THIS SUBROUTINE IS PART OF THE EOSMOD PACKAGE
114 C      *
115 C      * PROGRAMMER- J. M. HYMAN AND M. KLEIN, GROUP T-7 LASL
116 C      *
117 C      * REFERENCE- J. M. HYMAN, M. M. KLEIN
118 C      *           EOSMOD- A SUBROUTINE PACKAGE FOR CALCULATING
119 C      *           EQUATIONS-OF-STATE AND OPACITIES
120 C      *           LOS ALAMOS SCIENTIFIC LABORATORY RPT.,LA-8502-M,1980
121 C      *
122 C      * DATE- MARCH 6, 1979
123 C      *
124 C      * *****

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125 C
126 C      COMMON BLOCKS FOR THE SESAME EOS ROUTINES
127 C      DIMS TBLS,LCMX,NLBUF,LCFW(,),ZZ()
128 C      LEVEL 2, TBLS
129 C      COMMON /S2DIRX/ LCMX, NRS, LCFW(10,3)
130 C      COMMON /SESQATX/ TBLS(11000)
131 C      COMMON /INTORDX/ KFN
132 C      COMMON /SESINX/ IRC, IOT, RHO, TEMP, KBR, IFL
133 C      COMMON /SESOUTX/ OPACITY(3), PLANKO(3)
134 C
135 C      COMMON BLOCKS FOR THE EOSMOD ROUTINES
136 C      COMMON /EDSCZ/ LOUT
137 C      COMMON /EDSCD/ TFACO, RFACO, OFACO, KREPO
138 C      COMMON /EDSC1/ LU41, LU42, LU43, LU44, LU45
139 C      COMMON /EDSC3/ INIT, IROIM, IR(60,3), KUP(60,3)
140 C      COMMON /EDSC4/ NTABLE, NTABLO, IFLP, LCNT
141 C
142 C      DATA KOPCS /-99/, KFNS/O/,LMATS/1H /
143 C
144 C      *****
145 C
146 C      CHECK POSITIVITY OF INPUT PARAMETERS
147 C      IF((T.GT.O.O).AND.(R.GT.O.O)) GO TO 4
148 C      IMATO=-1
149 C
150 C      WRITE(LOUT,20)R,T
151 C 20 FORMAT(" THE DENSITY =",1E12.4," OR THE TEMPERATURE ="
152 C      1 ,E12.4," IS NONPOSITIVE")
153 C
154 C      GO TO 75
155 C 4 CONTINUE
156 C
157 C      SET INITIAL VARIABLES FOR OPACITY TABLES
158 C      IOT=2 LOCATOR OF DATA TYPE FOR IR AND SUB. GETPRX(,IOT,....)
159 C      IDT=2
160 C
161 C      CHECK IF THE UNITS HAVE CHANGED SINCE THE LAST CALL
162 C      IF(KOPCS.NE.KOPC.OR.LMAT.NE.LMATS) GO TO 5
163 C      KFN=KFNS
164 C      LMATS=LMAT
165 C      KOPCS=KOPC
166 C      GO TO 10
167 C 5 CONTINUE
168 C
169 C      UNSCRAMBLE MULTIPLE FLAG KOPC
170 C      CALL EOSKUT(KOPC,KDUMMY,KUNIT,KREPO,KFN,KOPCS,KBRS,KFNS,IMATO,IDT
171 C      1 ,IERR)
172 C      IF(IERR.LT.O) GO TO 75
173 C 10 CONTINUE
174 C
175 C      FIND THE MATERIAL
176 C      IF (IMATO.GT.O) GO TO 60
177 C      CALL EOSGET(LMAT,KUNIT,KREPO,IMATO,IOT,IERR)
178 C      IF(IMATO.LE.O.OR.IERR.LT.O) GO TO 75
179 C
180 C 60 CONTINUE
181 C
182 C      TRANSFER INPUT CALL PARAMETERS TO COMMON BLOCK
183 C      TEMP=QLOG10(T)
184 C      RHO=QLOG10(R)
185 C      KBR=1
186 C      IRC=IR(IMATO,2)

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187 C
188 C      CALCULATE THE EQUATION OF STATE
189      CALL T4OATX
190 C      T4OATX DOES NOT RETURN AN ERROR FLAG
191 C      FOR DATA OUT OF BOUNDS
192 C
193 C      RESTORE OUTPUT VARIABLES FOR RETURN TO CALL
194      IFLP=IERR
195      O=10.**OPACITY(1)
196 75 CONTINUE
197      RETURN
198      END
```

## INTERNAL SUBROUTINES

EOSBEG (initializes all the common block variables) . . . .	43
EOSCON (defines the table conversion factors) . . . . .	46
EOSDSL (allows the user to scale the density) . . . . .	49
EOSEFD (finds the EOS table) . . . . .	51
EOSFAS (assigns the input files) . . . . .	54
EOSGET (loads the Sesame EOS data files) . . . . .	56
EOSKUT (checks the validity of KPARM) . . . . .	59
EOSOFD (finds the opacity table) . . . . .	61

```

1      SUBROUTINE EOSBEG
2 C
3 C      *****
4 C      *
5 C      * PURPOSE-
6 C      *       TO INITIALIZE ALL COMMON BLDCKS IN ONE PLACE OF CODE
7 C      *
8 C      * INPUT VARIABLES-
9 C      * NONE
10 C      *
11 C      * OUTPUT VARIABLES-
12 C      * ALL OUTPUT IS AT COMPILE TIME IN THE COMMON BLOCKS.
13 C      * THIS ALLOWS THE USER AN EASY WAY TO CHANGE THE VARIABLES
14 C      * BY SETTING THEM TO ANY OTHER VALUE AT EXECUTION
15 C      * TIME IN THEIR MAIN PROGRAM
16 C      *
17 C      * -----
18 C      *
19 C      * LOCALLY DEFINED SESAME VARIABLES-
20 C      * TBL5 = ARRAY FOR STORAGE OF THE EOS TABLES
21 C      * LCMX = LENGTH OF THE TBL5 ARRAY
22 C      * NRS = UPPER BOUND ON THE NUMBER OF MAT REGIONS LCFW(NRS,)
23 C      * LCFW = ARRAY USED AS A DIRECTORY BY THE SESAME ROUTINES
24 C      * IR = MATERIAL REGION NUMBER
25 C      * IRC = IR (DEFINED TO PERMIT SUBROUTINE CALL
26 C      * IOS2 = SESAME MATERIAL NUMBER
27 C      * TBL5 = NAME OF AN ARRAY DESIGNATED FOR THE STORAGE OF TABLES
28 C      * LCNT = CRRRENT WORD IN THE ARRAY TBL5
29 C      * LU41 = UNIT NUMBER ASSIGNED TO THE SESAME INPUT FILE SES2CL
30 C      * LU42 = UNIT NUMBER ASSIGNED TO THE SESAME INPUT FILE SESAME
31 C      * LU43 = UNIT NUMBER ASSIGNED TO SESAME/8 FILES
32 C      * LU44 = UNIT NUMBER ASSIGNED TO MIXLIB (MIXTURES)
33 C      * LU45 = UNIT NUMBER ASSIGNED TO MIXLIB DIRECTORY.
34 C      * KFN = 0 RATIONAL APPRDXIMATIONS (ACCURATE)
35 C      * KFN = 1 BILINEAR APPROXIMATIONS (FAST)
36 C      * ZB (OUTPUT FROM GETINPX) AT. CHARGE,AT. CHG**2,MASS
37 C      * IOT = DATA TYPE INDICATOR
38 C      * MID (IO) MATERIAL IO =1 INVERSE TABLES =2 OPACITY
39 C      *
40 C      * EXTERNAL FILES TO HANDLE EOS, OPACITIES AND MIXTURES
41 C      * SES2CL - CLASSIFIED SESAME LIBRARY
42 C      * SESAME - CUCLASSIFIED SESAME LIBRARY
43 C      * SESAME - OPACITY TABLE FROM T4
44 C      * MIXLIB - PRIVATE (EOS,OPC) TABLES CREATED BY MIXB(OR MIXER)
45 C      * MIXOIR - DIRECTORY OF MIXTURES ON MIXLIB ( NAME,NO (A10.I3))
46 C      *
47 C      * EXTERNALS AND COMMON BLOCKS-
48 C      * SESAME ROUTINES- S2GET,S2EDS
49 C      * SESAME ROUTINES MATCHKX,TABRANX,INBUFRX,OPACKX,ISRCHKX.
50 C      * T4INTPX,GETINPX,RATFN1X,T4OATIX,INV3O1X,T4RTPEX
51 C      * SESAME COMMON BLOCKS-S2DIRX,RTBLK2X,SES0ATX,SESINX,SESOUTX,INTORDX
52 C      * EOSMOD COMMON BLOCKS- EOSC1,-7
53 C      * EOSMOD COMMON (ALSO INSERTED INTO GETINPX) EOSCCE, EOSCCO
54 C      *
55 C      * REMARKS- THIS SUBROUTINE IS PART OF THE EOSMOD PACKAGE
56 C      *
57 C      * PROGRAMMER- J. M. HYMAN AND M. KLEIN, GROUP T-7, LASL
58 C      *
59 C      * REFERENCE- J. M. HYMAN, M. M. KLEIN
60 C      *              EOSMOD- A SUBROUTINE PACKAGE FOR CALCULATING
61 C      *              EQUATIONS-OF-STATE AND OPACITIES
62 C      *              LOS ALAMOS SCIENTIFIC LABORATORY RPT..LA-8502-M.1980

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63 C      *
64 C      * DATE- MARCH 6, 1980
65 C      *
66 C      *****
67 C
68 C      COMMON BLOCKS FOR THE SESAME EOS ROUTINES
69 C      DIMS TBLS,LCMX,NLBUF,LCFW(,),ZZ()
70 C      MUST BE WATCHED IF CHANGING DIMENSIONS
71 C      APPEAR IN RTBLK2X,SESDATX,S2DIRX,DATA LCMX...
72 C      LEVEL 2, TBLS
73 C      COMMON /S2DIRX/ LCMX, NRS, LCFW(10,3)
74 C      COMMON /SESDATX/ TBLS(11000)
75 C      COMMON /SESINX/ OUM(4), KBR, OUM1
76 C      COMMON /INTOROX/ KFN
77 C
78 C      COMMON BLOCKS FOR THE EOSMOD ROUTINES
79 C      COMMON /EOSCZ/ LOUT
80 C      COMMON /EOSC1/ LU41, LU42, LU43, LU44, LU45
81 C      COMMON /EOSC2/ LF41, LF42, LF43, LF44, LF45
82 C      COMMON /EOSC3/ INIT, IRDIM, IR(60,3), KUP(60,3)
83 C      COMMON /EOSC4/ NTABLE, NTABLO, IFLP, LCNT
84 C      COMMON /EOSC5/ NMAT, LABMAT(60), IOMAT(60), IMATEL
85 C      COMMON /EOSC6/ NMCL, LABMCL(60), IOMCL(60)
86 C      COMMON /EOSC7/ NMATO, LABMO(60), IOMATO(60), IMATOL
87 C
88 C      EOSMOD COMMON BLOCKS USED BY THE MODIFIED SESAME ROUTINES
89 C      COMMON /EOSCCE/ TFACE, RFACE, PFACE, EFACE, KREPE
90 C      COMMON /EDSCCO/ TFACO, RFACO, OFACO, KREPO
91 C
92 C      DESIGNATE THE OUTPUT FILE FOR THE ERROR MESSAGES
93 C      DATA LOUT/"OUTPUT"/
94 C
95 C      DATA LCMX /11000/, NRS /10/, LCNT /1/, LCFW /30*0/,
96 C      1 IR/180*0/,NTABLE/1/,NTABLO/0/,INIT/0/,IRDIM/60/,KUP/180*(-1)/
97 C
98 C      DATA LU41 /41/, LU42 /42/, LU43 /42/, LU44 /44/, LU45 /45/
99 C      DATA LF41/6HSES2CL/,LF42/6HSESAME/,LF43/6HSESAME/,LF44/6HMXLIB/
100 C      1 ,LF45/6HMXIDIR/
101 C
102 C      INITIALIZE THE CONTENTS OF THE EOS TABLE SESAME
103 C      DATA NMAT /32/
104 C      DATA LABMAT/
105 C      1 "ALLUVIUM","ALUMINUM","AL2O3","BERYLLIUM","BORON C",
106 C      1 "BRASS","COPPER","DEUTERIUM","GOLD","GRANITE",
107 C      2 "HELIUM","HE","IRON","IRON2","LEAD","GLIO","GLIH",
108 C      3 "MOLY","NEON","NICKEL","PLATINUM","POLYE","POLYS","SIO2",
109 C      4 "SODIUM","SS","STEAM","UD2","URANIUM","URETHANE","VERMICULIT",
110 C      6 "WATER"/
111 C      DATA IOMAT/7111,3710,7410,2020,7081,
112 C      1 4100,3330,5263,2700,7390,
113 C      2 5760,8180,2140,2145,3200,7240,7370,
114 C      3 2980,5410,3100,3730,7170,7590,
115 C      4 7380,2448,4270,7151,7432,1540,7560,7520,
116 C      5 7150/
117 C
118 C      INITIALIZE THE CONTENTS OF THE CLASSIFIED EOS TABLE SES2CL
119 C      DATA NMCL/O/
120 C      DATA LABMCL/40*(1H )/
121 C      DATA IOMCL/40*O/
122 C
123 C      INITIALIZE THE CONTENTS OF THE OPACITY TABLE SESAME
124 C      DATA NMATO /27/

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125      DATA LABMO/"ALUMINUM","ARGON","BERYLLIUM","BORON","CALCIUM"
126      1 ,"CARBON","CHLORINE","CHROMIUM","DEUTERIUM","HELIUM"
127      2 ,"IRON","LITHIUM","MAGNESIUM","NITROGEN"
128      3 ,"OXYGEN","PBX-9502","PHOSPHORUS","POTASSIUM","SiO2"
129      4 ,"SILICON","SODIUM","SS","STAINLESS","SULPHUR"
130      5 ,"TITANIUM","TITANIUM N","WATER"/
131 C
132      DATA IOMATO/13710,15170,12020,12330,12030
133      1 ,12180,15020,13070,15263,15760
134      2 ,12140,12290,13080,15000
135      3 ,15010,18200,13910,12460,17380
136      4 ,13810,12448,14270,14270,14010
137      5 ,12960,16000,17150/
138 C
139      IMATEL=NMAT
140      IMATOL=NMATO
141 C
142      INIT=1
143      RETURN
144      END

```

```

1      SUBROUTINE EOSCON(KUNIT,KREP,LMAT)
2 C
3 C      *****
4 C      *
5 C      * PURPOSE-
6 C      *   .TO PROVIDE THE APPROPRIATE EOS SCALE FACTORS FOR THE
7 C      *   SYSTEM OF UNITS CHOSEN BY KUNIT (SEE BELOW)
8 C      *
9 C      * INPUT VARIABLES-
10 C      *   KUNIT = KIND OF UNITS
11 C      *   0 (SESAMEE) R-G/CC,T-DEG.K,O-CM**2/G,P-GPA,E-MJ/KG
12 C      *   1 (CGS) R-G/CC,T-DEG.K,O-CM**2/GM,P-MUBR,E-ERGS/GM
13 C      *   2 (SIU) R-KG/M**3,T-DEG.K,P-PA,E-J/KG,O-M**2/KG
14 C      *   3 (HYDROXE) R-G/CC,T-DEG.K,P-MBR,E-MBR*CC/GM,O-CM**2/G
15 C      *   4 (HYDROXD) R-G/CC,T-KEV,P-MBR,E-MBR*CC/G,O-CM**2/G
16 C      *   5 (SESAMEO) R-G/CC,T-EV,O-CM**2/G,P-GPA,E-MJ/KG
17 C      *   6 (LASNEX) R-G/CC,T-KEV,O-CM**2/GM,P-JRKS/CC,EO-JRKS/CC
18 C      *
19 C      *   LEGEND-
20 C      *       R = DENSITY
21 C      *       T = TEMPERATURE
22 C      *       O = OPACITY
23 C      *       P = PRESSURE
24 C      *       E = INTERNAL ENERGY
25 C      *
26 C      *       CC = CUBIC CENTIMETER
27 C      *       CM = CENTIMETER
28 C      *       DEG. K = DEGREES KELVIN
29 C      *       EV = ELECTRON VOLT
30 C      *       G = GRAM
31 C      *       GPA = GIGA PASCALS
32 C      *       J = JOULES
33 C      *       JRKS = JERKS
34 C      *       KEV = KILO ELECTRON VOLTS
35 C      *       KG = KILOGRAM
36 C      *       M = METER
37 C      *       MBR = MEGABAR
38 C      *       MUBR = MICROBAR
39 C      *       PA = PASCAL
40 C      *
41 C      *
42 C      * OUTPUT VARIABLES- IN THE COMMON BLOCKS EOSCCE AND EOSCCO
43 C      *   TFACE = TEMPERATURE EOS SCALING FACTOR
44 C      *   RFACE = DENSITY EOS SCALING FACTOR
45 C      *   PFACE = PRESSURE EOS SCALING FACTOR
46 C      *   EFACE = ENERGY EOS SCALING FACTOR
47 C      *
48 C      *   TFACO = TEMPERATURE OPACITY SCALING FACTOR
49 C      *   RFACO = DENSITY OPACITY SCALING FACTOR
50 C      *   OFACO = OPACITY SCALING FACTOR
51 C      *
52 C      * LOCAL VARIABLES-
53 C      *   NONE
54 C      *
55 C      * EXTERNALS AND COMMON BLOCKS-
56 C      *   EOSMOD COMMON BLOCKS- EOSCCE,EOSCCO
57 C      *
58 C      * REMARKS- THIS SUBROUTINE IS PART OF THE EOSMOD PACKAGE
59 C      *
60 C      * PROGRAMMER- J. M. HYMAN AND M. KLEIN, GROUP T-7, LASL
61 C      *
62 C      * REFERENCE- J. M. HYMAN, M. M. KLEIN

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63 C      *           EOSMOD- A SUBROUTINE PACKAGE FOR CALCULATING
64 C      *           EQUATIONS-OF-STATE AND OPACITIES
65 C      *           LDS ALAMOS SCIENTIFIC LABORATORY RPT.,LA-8502-M,1980
66 C      *
67 C      * DATE- MARCH 6, 1980
68 C      *
69 C      *****
70 C
71          COMMON /EOSCCE/ TFACE, RFACE, PFACE, EFACE, KREPE
72          COMMON /EOSCCO/ TFACO, RFACO, DFACO, KREPO
73 C
74          KREPE=KREP
75          KREPO=KREP
76 C
77 C      DEFINE THE DEFAULE SESAME VALUES
78 C      THESE ARE THE UNITS THAT THE SESAME DATA FILES ARE WRITTEN IN
79          TFACE=1.
80          RFACE=1.
81          PFACE=1.
82          EFACE=1.
83 C
84          TFACO=4.0646423
85          RFACO=0.
86          DFACO=0.
87 C
88 C      RESET THE SCALE FACTORS THAT ARE DIFFERENT FROM THE DEFAULT
89          KP1=KUNIT+1
90          GO TO (45,40,30,20,15,10,25), KP1
91 C
92 C      LASNEX UNITS
93      25 PFACE=1.E-6
94          EFACE=1.E-6
95          TFACE=8.617346719E-8
96          TFACO=-3.
97          GO TO 50
98 C
99 C      SESAME OPACITY UNITS
100      10 TFACE=8.61703E-5
101          TFACO=0.0
102          GO TO 50
103 C
104 C      HYDROX OPACITY UNITS
105      15 PFACE=.01
106          EFACE=.01
107          TFACE=8.61703E-8
108          TFACO=-3.
109          GO TO 50
110 C
111 C      HYDROX EOS UNITS
112      20 PFACE=.01
113          EFACE=.01
114          GO TO 50
115 C
116 C      STANDOARD INTERNATIONAL UNITS (SIU)
117      30 RFACE=1.E+3
118          PFACE=1.E+9
119          EFACE=1.E+6
120          RFACO=3.0
121          DFACO=-1.0
122          GO TD 50
123 C
124 C      CGS UNITS

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125      40 PFACE=1.E+10
126      EFACE=1.E+10
127      GO TO 50
128 C
129 C      SESAME EOS UNITS
130      45 OFACD=2.0
131      50 CONTINUE
132 C
133 C      RESCALE THE TABLES IN THE USER PRESCRIBED SCALE FACTORS
134      DSFAC=1.0
135      CALL EOSOSL(LMAT,DSFAC)
136      EFACE=EFACE*DSFAC
137      RFACE=RFACE/DSFAC
138      RFACD=RFACD/DSFAC
139 C
140      RETURN
141      END

```

```

1      SUBROUTINE EOSOSL(LMAT,OSFAC)
2 C
3 C
4 C      *****
5 C      *
6 C      * PURPOSE-
7 C      * TO ALLOW A USER TO RESCALE THE MASS DENSITY IN
8 C      * THE EOS TABLES. THIS IS A USEFUL ROUTINE TO APPROXIMATE THE
9 C      * EOS AND OPACITIES OF DIFFERENT ISOTOPES AND ISOTOPIC MIXTURES
10 C      * OF THE MATERIALS IN THE SESAME LIBRARY
11 C      *
12 C      * AN ALTERNATE PURPOSE IS TO ALLOW A USER TO DEFINE NEW
13 C      * SCALE FACTORS FOR THE UNITS THE TABLE IS TO BE WRITTEN IN
14 C      *
15 C      * INPUT VARIABLE-
16 C      *   LMAT = MATERIAL IN AN A10 FIELD, FOR EXAMPLE- LMAT = "HELIUM"
17 C      *           THE MATERIAL SESAME NUMBER CAN ALSO BE USED TO SPECIFY
18 C      *           THE MATERIAL BY SETTING LMAT TO THE SESAME
19 C      *           NUMBER, FOR EXAMPLE- LMAT = "5760" FOR HELIUM
20 C      *
21 C      * OUTPUT VARIABLE-
22 C      *   OSFAC = DENSITY SCALE FACTOR EQUAL TO THE RATIO OF THE
23 C      *           ATOMIC MASSES OF THE MATERIALS. THAT IS,
24 C      *           OSFAC=ATOMIC MASS DENSITY OF THE SESAME MATERIAL)/
25 C      *           (ATOMIC MASS DENSITY OF THE DESIRED MATERIAL)
26 C      *
27 C      * FOR EXAMPLE- THE EOS OF A 60-40 MIXTURE OF DEUTERIUM-TRITIUM
28 C      * CAN BE APPROXIMATED BY DEFINING OSFAC=2/(0.6*2+0.4*3)=0.833
29 C      * AND CALLING EOSMOD WITH LMAT="DEUTERIUM"
30 C      *
31 C      * INPUT-OUTPUT VARIABLES IN THE COMMON BLOCKS EOSCC2 AND EOSCCO
32 C      *   TFACE = TEMPERATURE EOS SCALING FACTOR
33 C      *   RFACE = DENSITY EOS SCALING FACTOR
34 C      *   PFACE = PRESSURE EOS SCALING FACTOR
35 C      *   EFACE = ENERGY EOS SCALING FACTOR
36 C      *
37 C      *   TFACO = TEMPERATURE OPACITY SCALING FACTOR
38 C      *   RFACO = DENSITY OPACITY SCALING FACTOR
39 C      *   OFACO = OPACITY SCALING FACTOR
40 C      *
41 C      * FOR FURTHER INFORMATION ON THESE FACTORS SEE SUBROUTINE EOSCON
42 C      *
43 C      * EXTERNALS AND COMMON BLOCKS-
44 C      *   EOSMOD COMMON BLOCKS- EOSCCE, EOSCCO
45 C      *
46 C      * REMARKS- THIS SUBROUTINE IS PART OF THE EOSMOD PACKAGE
47 C      *
48 C      * PROGRAMMER- J. M. HYMAN AND M. KLEIN, GROUP T-7, LASL
49 C      *
50 C      * REFERENCE- J. M. HYMAN, M. M. KLEIN
51 C      *               EOSMOD- A SUBROUTINE PACKAGE FOR CALCULATING
52 C      *               EQUATIONS-OF-STATE AND OPACITIES
53 C      *               LOS ALAMOS SCIENTIFIC LABORATORY RPT.,LA-8502-M,1980
54 C      *
55 C      * DATE- MARCH 6, 1980
56 C      *
57 C      *****
58 C      COMMON /EOSCCE/ TFACE, RFACE, PFACE, EFACE, KREPE
59 C      COMMON /EOSCCO/ TFACO, RFACO, OFACO, KREPO
60 C
61 C      DUMMY SUBROUTINE FOR THE PACKAGE.
62 C      IF A USER SUPPLIES THIS ROUTINE THEN THE FACTORS CAN BE

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63 C      BE RESET AS DESCRIBED IN THE MANUAL WHEN THE TABLES ARE
64 C      WRITTEN, OR A DENSITY SCALE FACTOR CAN BE INCLUDED
65 C      TO CHANGE THE DENSITY TABLES BY A CONSTANT FACTOR.
66 C
67 C      FOR EXAMPLE, FOR A 60-40 MIXTURE OF DEUTERIUM-TRITIUM
68 C      THE CODE COULD BE WRITTEN AS-
69 C      IF(LMAT.EQ."DEUTERIUM") OSFAC=0.833
70 C
71 C      RETURN
72 C      END
```

```

1      SUBROUTINE EOSEFO (LMAT,IO,IMATE)
2 C
3 C      *****
4 C      *
5 C      * PURPOSE-
6 C      *   TO LOCATE EOS MATERIAL DEFINED BY HOLLERITH NAME
7 C      *   IN APPROPRIATE FILE AND ASSIGN IT A SESAME (OR
8 C      *   PRIVATE IO) EOS NUMBERNUMBER
9 C      *
10 C     * INPUT VARIABLES-
11 C     *   LMAT = MATERIAL IN AN A10 FIELD, FOR EXAMPLE- LMAT = "HELIUM"
12 C     *   THE MATERIAL SESAME NUMBER CAN ALSO BE USED TO SPECIFY
13 C     *   THE MATERIAL BY SETTING LMAT TO THE SESAME
14 C     *   NUMBER, FOR EXAMPLE- LMAT = "5760" FOR HELIUM
15 C     *
16 C     * OUTPUT VARIABLES-
17 C     *   IO = SESAME OR PRIVATE IO NUMBER AS STORED IN LIBRARY
18 C     *   SESAME ( EOS LIBRARY)
19 C     *   IMATE = LOCATION OF MATERIAL IN ARRAY LABMAT+ MIXOIR
20 C     *   PROVIDED MATERIAL HAS BEEN LOCATED
21 C     *   = 0 IF MATERIAL HAS NOT BEEN LOCATED BY ROUTINE
22 C     *   UPPER BOUND ON IMATE IS 60 (DIM IR(.))
23 C     *
24 C     * LOCAL VARIABLES-
25 C     *   ICFASE = 1 IF THE PUBLIC EOS FILES HAVE BEEN ASSIGNED
26 C     *   ICFASCL = 1 IF THE CLASSIFIED EOS FILES HAVE BEEN ASSIGNED
27 C     *   ICFASP = 1 IF THE PRIVATE EOS FILES HAVE BEEN ASSIGNED
28 C     *
29 C     * EXTERNALS AND COMMON BLOCKS-
30 C     *   EOSMOD COMMON BLOCKS- EOSC1.2,3,5,6
31 C     *   FTN ROUTINES- ENCODE, EOF
32 C     *   LASL T-4 HYOSSES ROUTINE- EOSFAS
33 C     *
34 C     * REMARKS- THIS SUBROUTINE IS PART OF THE EOSMOD PACKAGE
35 C     *
36 C     * PROGRAMMER- J. M. HYMAN AND M. KLEIN, GROUP T-7, LASL
37 C     *
38 C     * REFERENCE- J. M. HYMAN, M. M. KLEIN
39 C     *   EOSMOD- A SUBROUTINE PACKAGE FOR CALCULATING
40 C     *   EQUATIONS-OF-STATE AND OPACITIES
41 C     *   LOS ALAMOS SCIENTIFIC LABORATORY RPT.,LA-8502-M,1980
42 C     *
43 C     * DATE- MARCH 6, 1980
44 C     *
45 C     *****
46 C
47 C     COMMON /EOSCZ/ LOUT
48 C     COMMON /EDSC1/ LU41, LU42, LU43, LU44, LU45
49 C     COMMON /EDSC2/ LF41, LF42, LF43, LF44, LF45
50 C     COMMON /EDSC3/ INIT, IROIM, IR(60,3), KUP(60,3)
51 C     COMMON /EDSC5/ NMAT, LABMAT(60), IOMAT(60), IMATEL
52 C     COMMON /EDSC6/ NMCL, LABMCL(60), IOMCL(60)
53 C
54 C     DATA ICFASE/O/,ICFASCL/O/,ICFASP/O/,IOCNT/1/
55 C
56 C     CHECK IF THE MATERIAL IS IN THE STANDARD SESAME LIST
57 C     DD 10 IMATE=1,IMATEL
58 C     IF (LMAT.EQ.LABMAT(IMATE)) GO TO 40
59 C     10 CONTINUE
60 C
61 C     CHECK IF THE MATERIAL IS IN THE CLASSIFIED EOS SESAME LIST
62 C     DD 12 IMATE=1,NMCL

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63      IF (LMAT.EQ.LABMCL(IMATE)) GO TO 45
64      12 CONTINUE
65 C
66 C      *** ASSIGN EDS PRIVATE FILES TO PROGRAM IF AVAILABLE
67      IF(LU45.EQ.4HNONE) GO TO 31
68      IMATE=NMAT
69      IF(ICFASP .GT. 0 ) GO TO 15
70      ICFASP=1
71      CALL EDSFAS(3)
72      15 CONTINUE
73 C
74 C      THE CURRENT PRIVATE LIST DIRECTORY (MIXDIR) IS ON UNIT LU45
75 C      CHECK IF LF45 EXISTS IN LOCAL FILE SPACE
76      CALL FEXIST(LF45,IFFLAG)
77      IF(IFFLAG .EQ. 0 ) GO TO 30
78 C      IFFLAG = 0 FILE NOT IN LOCAL FILE SPACE
79 C      IFFLAG = 1 FILE LOCAL
80 C
81      REWIND LU45
82      20 READ (LU45,80) LABEL,ID
83      IMATE=IMATE+1
84      IF (LMAT.EQ.LABEL) GO TO 50
85      IF (EOF(LU45)) 30,20
86      30 CONTINUE
87      31 CONTINUE
88 C
89 C      CHECK IF THE LMAT IS A SESAME NUMBER
90      IMAT1=AND(SHIFT(LMAT,6),77B)
91 CRAY CODE IMAT1=AND(SHIFT(LMAT,8),377B)
92 C
93      IF(IMAT1.LT.20B) GO TO 35
94      IF(IMAT1.GT.31B) GO TO 35
95 C
96      DECODE(10,32,LMAT) ID
97      32 FORMAT(I4)
98 C
99      DO 33 IMATE=1,IMATEL
100     IF(ID.EQ.IDMAT(IMATE)) GO TO 40
101     33 CONTINUE
102 C
103     IMATEL=IMATEL+1
104     IMATE=IMATEL
105     LABMAT(IMATE)=LMAT
106     IOMAT(IMATE)=ID
107 C
108 C      ASSUME THE MATERIAL IS IN THE STANDARD SESAME LIST
109 C      IF IT IS NOT, A NONFATAL ERROR WILL OCCUR AT A LATER STEP
110     GO TO 40
111 C
112 C      THE MATERIAL WAS NOT FOUND. PRINT AN ERROR MESSAGE
113     35 IMATE=0
114     WRITE(LOUT,75) LMAT
115     GO TO 999
116 C
117     40 ID=IOMAT(IMATE)
118 C
119 C      *** ASSIGN EDS FILES TO PROGRAM
120     IF(ICFASP .GT. 0 ) GO TO 44
121     ICFASP=1
122     CALL EDSFAS(1)
123     44 CONTINUE
124 C

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```

125          GO TO 999
126 C
127      45 ID=IOMCL(IMATE)
128 C
129 C      *** ASSIGN CLASSIFIED EOS FILES TO PROGRAM
130      IF(ICFASCL .GT. 0 ) GO TO 46
131      ICFASCL=1
132      CALL EOSFAS(4)
133      46 CONTINUE
134 C
135      50 CONTINUE
136      IF (IMATE.LE.IROIM) GO TO 60
137      IMATE=0
138      WRITE(LOUT,90) LMAT
139      60 CONTINUE
140 C
141      999 CONTINUE
142      RETURN
143 C
144      75 FORMAT (" MATERIAL LMAT = ",A10," NOT FOUND")
145      80 FORMAT (A10,I3)
146      90 FORMAT (" IMATE EXCEEDS UPPER BOUND IN SUBROUTINE EOSEFD "
147      1 ,/, " FOR MATERIAL LMAT=",A10)
148      END

```

```

1      SUBROUTINE EOSFAS(KTABLE)
2 C
3 C      *****
4 C      *
5 C      * PURPOSE-
6 C      * TO ASSIGN FILE NAMES TO THE EOS AND OPACITY DATA FILES
7 C      *
8 C      * INPUT VARIABLES-
9 C      * KTABLE = 1 EOS TABLE
10 C      *           2 OPACITY TABLE
11 C      *           3 PRIVATE TABLES
12 C      *           4 SES2CL TABLES
13 C      *
14 C      * OUTPUT VARIABLES-
15 C      * NONE
16 C      *
17 C      * LOCAL VARIABLES-
18 C      * INITE, INITECL, INITO AND INITP ARE SET TO 1 AFTER THE EOS, OPACITY
19 C      * AND PRIVATE FILES HAVE BEEN INITIALIZED
20 C      *
21 C      * EXTERNALS AND COMMON BLOCKS-
22 C      * EOSMOD COMMON BLOCKS- EDSC1, EDSC2
23 C      * FTN SUBROUTINES- QASSIGN, ASSIGN
24 C      *
25 C      * REMARKS- THIS SUBROUTINE IS PART OF THE EOSMOD PACKAGE
26 C      *
27 C      * PROGRAMMER- J. M. HYMAN AND M. KLEIN, GROUP T-7, LASL
28 C      *
29 C      * REFERENCE- J. M. HYMAN, M. M. KLEIN
30 C      *           EOSMOD- A SUBROUTINE PACKAGE FOR CALCULATING
31 C      *           EQUATIONS-OF-STATE AND OPACITIES
32 C      *           LOS ALAMOS SCIENTIFIC LABORATORY RPT., LA-8502-M, 1980
33 C      *
34 C      * DATE- MARCH 6, 1980
35 C      *
36 C      *****
37 C
38      COMMON /EDSCZ/ LOUT
39      COMMON /EDSC1/ LU41, LU42, LU43, LU44, LU45
40      COMMON /EDSC2/ LF41, LF42, LF43, LF44, LF45
41      DATA INITE/O/, INITO/O/, INITP/O/, INITECL/O/
42 C
43      GO TO (10,20,30,40), KTABLE
44 C
45 C      EOS TABLE ASSIGNMENT CODING
46 10 CONTINUE
47      IF(INITE.NE.O) GO TO 999
48      IF((INITO.NE.O).AND.(LF42.EQ.LF43)) GO TO 999
49      INITE=1
50      CALL QASSIGN (LU42,LF42,O,O)
51      GO TO 999
52 C
53 C      OPACITY TABLE ASSIGNMENT CODING
54 20 CONTINUE
55      IF(INITO.NE.O) GO TO 999
56      IF((INITE.NE.O).AND.(LF42.EQ.LF43)) GO TO 999
57      INITO=1
58      CALL QASSIGN (LU43,LF43,O,O)
59      GO TO 999
60 C
61 C      PRIVATE TABLES
62 30 CONTINUE

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```

63      IF(INITP.NE.O) GO TO 999
64      INITP=1
65      CALL QASSIGN (LU44,LF44,O,O)
66      CALL ASSIGN (LU45,LF45,4000B)
67      GO TO 999
68 C
69 C      CLASSIFIED EOS TABLE ASSIGNMENT CODING
70      40 CONTINUE
71      IF(INITECL.NE.O) GO TO 999
72      INITECL=1
73      CALL QASSIGN (LU41,LF41,O,O)
74      GO TO 999
75 C
76      999 RETURN
77      END

```

```

1      SUBROUTINE EOSGET(LMAT,KUNIT,KREP,IMAT,IOT,IERR)
2 C
3 C      *****
4 C      *
5 C      * PURPOSE-
6 C      * LOAD THE SESAME EOS DATA FILES
7 C      *
8 C      * INPUT VARIABLES-
9 C      *   LMAT = MATERIAL IN AN A10 FIELD, FOR EXAMPLE- LMAT = "HELIUM"
10 C      *   THE MATERIAL SESAME NUMBER CAN ALSO BE USED TO SPECIFY
11 C      *   THE MATERIAL BY SETTING LMAT TO THE SESAME
12 C      *   NUMBER, FOR EXAMPLE- LMAT = "5760" FOR HELIUM
13 C      *
14 C      *   KUNIT= KIND OF UNITS
15 C      *       0 (SESAMEE) R-G/CC,T-DEG.K,O-CM**2/G,P-GPA,E-MJ/KG
16 C      *       1 (CGS) R-G/CC,T-DEG.K,O-CM**2/GM,P-MUBR,E-ERGS/GM
17 C      *       2 (SIU) R-KG/M**3,T-DEG.K,P-PA,E-J/KG,O-M**2/KG
18 C      *       3 (HYDROXE) R-G/CC,T-DEG.K,P-MBR,E-MBR*CC/GM,O-CM**2/G
19 C      *       4 (HYDROXD) R-G/CC,T-KEV,P-MBR,E-MBR*CC/G,O-CM**2/G
20 C      *       5 (SESAMEO) R-G/CC,T-EV,D-CM**2/G,P-GPA,E-MJ/KG
21 C      *       6 (LASNEX) R-G/CC,T-KEV,O-CM**2/GM,P-JRKS/CC,ED-JRKS/CC
22 C      *
23 C      *   IMAT = INDICATES WHETHER TO LOAD THE DATA FILE IF
24 C      *   IT DOES NOT EXIST FOR LMAT OR GO DIRECTLY TO A
25 C      *   PREVIOUSLY LOADED FILE.
26 C      *   =0 CHECK IF THE DATA FILE FOR LMAT HAS BEEN LOADED.
27 C      *   IF NOT, SEARCH FOR THE FILE, CONVERT IT TO THE PROPER UNITS
28 C      *   AND COPY IT INTO LCM .
29 C      *   >0 EQUAL TO THE LMAT TABLE NUMBER. THIS NUMBER WAS RETURNED
30 C      *   BY THE PACKAGE ON A PREVIOUS CALL TO SUBROUTINE EOSORE,
31 C      *   EOSIPT OR EOSIRT. THIS OPTION IS FASTER THAN IMAT = 0
32 C      *   BECAUSE IT SKIPS SEARCH IN THE DIRECTOR OF THE
33 C      *
34 C      * OUTPUT VARIABLES-
35 C      *   IERR = 0 SUCCESSFUL
36 C      *   .NE.O UNSUCCESSFUL
37 C      *
38 C      *   TBLS = LCM FILE SPACE WHERE THE EOS TABLES ARE WRITTEN
39 C      *
40 C      * LOCAL VARIABLES-
41 C      *
42 C      * EXTERNALS AND COMMON BLOCKS-
43 C      *   EOSMOD COMMON BLOCKS- EOSC1,EOSC3
44 C      *
45 C      * REMARKS- THIS SUBROUTINE IS PART OF THE EOSMOD PACKAGE
46 C      *
47 C      * PROGRAMMER- J. M. HYMAN AND M. KLEIN, GROUP T-7, LASL
48 C      *
49 C      * REFERENCE- J. M. HYMAN, M. M. KLEIN
50 C      *   EOSMOD- A SUBROUTINE PACKAGE FOR CALCULATING
51 C      *   EQUATIONS-OF-STATE AND OPACITIES
52 C      *   LOS ALAMOS SCIENTIFIC LABORATORY RPT.,LA-8502-M,1980
53 C      *
54 C      * DATE- MARCH 8, 1980
55 C      *
56 C      *****
57 C
58 C      LOAD THE SESAME EOS TABLES IN THE INVERTED FORMAT
59 C
60 C      COMMON BLOCKS FOR THE SESAME EOS ROUTINES
61 C      LEVEL 2, TBLS
62 C      COMMON /S2OIRX/ LCMX, NRS, LCFW(10,3)

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63      COMMON /SESOATX/ TBLS(11000)
64      COMMON /SESINX/ OUM(4), KBR, OUM1
65      COMMON /INTOROX/ KFN
66 C
67 C      COMMON BLOCKS FOR THE EOSMOD ROUTINES
68      COMMON /EDSCZ/ LOUT
69      COMMON /EDSC1/ LU41, LU42, LU43, LU44, LU45
70      COMMON /EDSC3/ INIT, IRDIM, IR(60,3), KUP(60,3)
71      COMMON /EDSC4/ NTABLE, NTABLD, IFLP, LCNT
72 C
73      DIMENSION ZB(3)
74 C
75      IERR=0
76 C
77 C      CALL THE FILE ASSIGNMENT ROUTINE TO ASSIGN READ AND WRITE
78 C      UNIT NUMBERS TO THE INPUT DATA FILES
79      IF(IOT.NE.2) CALL EOSEFD (LMAT,IO,IMAT)
80      IF(IOT.EQ.2) CALL EOSOFD (LMAT,ID,IMAT)
81 C
82      IF (IMAT.LE.0) IERR=-1
83      IF (IMAT.LE.0) GO TO 75
84 C
85 C      CHECK IF THE TABLES HAVE BEEN INITIALIZED
86      IF (IR(IMAT,IOT).GT.0) GO TO 70
87 C
88 C      CONVERT TABLES TO APPROPRIATE UNITS
89      CALL EOSCON(KUNIT,KREP,LMAT)
90 C
91      MIXTST=ID/1000
92 C
93      GO TO (10,20,30),IDT
94 C
95 C      LOAD THE EOS TABLES IN THE INVERTED FORMAT (IOT=1)
96 10 CONTINUE
97      IF(MIXTST.NE.0)CALL GETINVX (NTABLE,IO,IOT,TBLS,LCNT,LU42,IERR,ZB)
98      IF(MIXTST.EQ.0)CALL GETINVX (NTABLE,IO,IOT,TBLS,LCNT,LU44,IERR,ZB)
99      GO TO 40
100 C
101 C      LOAD THE OPACITY TABLES (IOT=2)
102 20 CONTINUE
103 C
104      IF (MIXTST.EQ.0) CALL GETRPOX (NTABLD,IO,IOT,TBLS,LCNT,LU44,IERR)
105      IF (MIXTST.NE.0) CALL GETRPOX (NTABLD,IO,IOT,TBLS,LCNT,LU43,IERR)
106      GO TO 40
107 C
108 C      LOAD THE EOS TABLES IN THE STANDARD FORMAT (IDT=3)
109 30 CONTINUE
110      IF(MIXTST.NE.0)CALL GETEDSX (NTABLE,IO,IOT,TBLS,LCNT,LU42,IERR,ZB)
111      IF(MIXTST.EQ.0)CALL GETEOSX (NTABLE,IO,IOT,TBLS,LCNT,LU44,IERR,ZB)
112 40 CONTINUE
113 C
114 C      IERR RETURNS NEGATIVE IF THERE IS AN INITIALIZATION ERROR
115      IF (IERR.GT.0) GO TO 60
116      IF(IERR.LT.0) WRITE(LOUT,90) IERR
117      IF(IERR.EQ.0) WRITE(LOUT,100)LMAT
118      IF(IERR.EQ.0) IERR=-2
119      GO TO 75
120 C
121 C      THE TABLES HAS BEEN LOADED, SET THE EOSMOD VARIABLES
122 60 IERR=0
123      IF(IOT.NE.2) GO TO 65
124 C

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125 C      OPACITY TABLE UPOATE
126      IR(IMAT,IOT)=NTABLO
127      KUP(IMAT,IDT)=10*KUNIT+KREP
128      NTABLO=NTABLO+1
129      GO TO 70
130 C
131 C      EOS TABLE UPOATE
132 65 CONTINUE
133      IR(IMAT,IOT)=NTABLE
134      KUP(IMAT,IOT)=10*KUNIT+KREP
135      NTABLE=NTABLE+1
136 70 CONTINUE
137 C
138 C      CHECK IF THE UNITS ARE VALID
139      IF(10*KUNIT+KREP.NE.KUP(IMAT,IOT)) IERR=-6
140 C
141      IF(IERR.EQ.-6) WRITE(LOUT,80)KUNIT,KREP,KUP(IMAT,3)
142 80 FORMAT(" THE UNITS HAVE CHANGED SINCE THE LAST USE OF THE TABLE"
143 2./," THE CURRENT VALUES OF KUNIT AND KREP ARE ",2I4
144 3./," THE PREVIOUS VALUES OF KUNIT AND KREP WERE",I5)
145 C
146 75 CONTINUE
147      IF(IERR.LT.0) IMAT=IERR
148 C
149      RETURN
150 C
151 90 FORMAT(" INSUFFICIENT STORAGE IN LCM"
152 1 ./," LACK",I10," WORDS")
153 100 FORMAT(" UNABLE TO LOCATE MATERIAL ",A10./,
154 1 " IN SUBROUTINE EOSGET")
155      END

```

```

1      SUBROUTINE EOSKUT(KPARM,KBR,KUNIT,KREP,KFN,KEOSS,KBR5,KFNS,IMAT,
2      IOT,IERR)
3 C
4 C      *****
5 C      *
6 C      * PURPOSE-
7 C      * TO CHECK THE VALIDITY OF THE INPUT VALUE FOR KPARM
8 C      * AND TO SEPARATE OUT THE INTERNAL PARTS
9 C      *
10 C      * INPUT VARIABLES-
11 C      * KPARM = MULTIPLE PARAMETER FLAG TO DESCRIBE HOW TO WRITE
12 C      * AND RETRIEVE THE DATA FILE. KPARM HAS FOUR DECIMAL DIGITS,
13 C      *
14 C      * KPARM = 1000*KBR + 100*KUNIT + 10*KREP + KFN WHERE
15 C      *
16 C      * OUTPUT VARIABLES-
17 C      * KBR = COMPUTATIONAL MODE FLAG TO INDICATE WHICH
18 C      * QUANTITIES AND THEIR PARTIAL DERIVATIVES ARE TO
19 C      * BE CALCULATED AND RETURNED BY THE PACKAGE.
20 C      *
21 C      * KUNIT= KIND OF UNITS
22 C      * 0 (SESAMEE) R-G/CC,T-DEG.K,O-CM**2/G,P-GPA,E-MJ/KG
23 C      * 1 (CGS) R-G/CC,T-DEG.K,O-CM**2/GM,P-MUBR,E-ERGS/GM
24 C      * 2 (SIU) R-KG/M**3,T-DEG.K,P-PA,E-J/KG,O-M**2/KG
25 C      * 3 (HYDROXE) R-G/CC,T-DEG.K,P-MBR,E-MBR*CC/GM,O-CM**2/G
26 C      * 4 (HYDROXD) R-G/CC,T-KEV,P-MBR,E-MBR*CC/G,O-CM**2/G
27 C      * 5 (SESAMEO) R-G/CC,T-EV,O-CM**2/G,P-GPA,E-MJ/KG
28 C      * 6 (LASNEX) R-G/CC,T-KEV,O-CM**2/GM,P-JRKS/CC,ED-JRKS/CC
29 C      *
30 C      * IF KREP REFERS TO EOS TABLE UNITS
31 C      * KREP = COMPUTATION FLAG TO INDICATE WHETHER E IS
32 C      * IS TO BE REPRESENTED AS ENERGY PER UNIT MASS OR ENERGY
33 C      * PER UNIT VOLUME
34 C      * 0 ENERGY IN UNITS OF ENERGY PER UNIT MASS. FOR EXAMPLE-
35 C      * UNITS OF ERGS/GRAM WHEN KUNIT = 1. THIS IS THE USUAL E.
36 C      * 1 ENERGY IN UNITS OF ENERGY PER UNIT VOLUME. FOR EXAPMLE-
37 C      * UNITS OF ERGS/CM**3 WHEN KUNIT = 1. THIS IS THE ENERGY
38 C      * DENSITY RHO*E COMMONLY COMPUTED IN HYDRODYNAMIC
39 C      * COMPUTER CODES.
40 C      *
41 C      * IF KREP (KREPO) REFERS TO OPACITY TABLE UNITS
42 C      * KREPO = COMPUTATIONAL FLAG TO INDICATE WHICH REPRESENTATION
43 C      * TO USE FOR THE OPACITY VARIABLE.
44 C      * 0 OPACITY REPRESENTED AS KAPPA IN DIMENSIONAL
45 C      * UNITS OF LENGTH**2/MASS
46 C      * 1 OPACITY REPRESENTED AS A MEAN-FREE PATH.
47 C      * LAMBOA = 1/(KAPPA*RHO), IN DIMENSIONAL
48 C      * UNITS OF LENGTH.
49 C      *
50 C      * KFN = KIND OF FUNTION INTERPOLATION IN THE TABLES
51 C      * = 0 RATIONAL APPROXIMATIONS (ACCURATE)
52 C      * = 1 BILINEAR APPROXIMATIONS (FAST)
53 C      *
54 C      * LOCAL VARIABLES-
55 C      *
56 C      * EXTERNALS AND COMMON BLOCKS-
57 C      *
58 C      * REMARKS- THIS SUBROUTINE IS PART OF THE EOSMDD PACKAGE
59 C      *
60 C      * PROGRAMMER- J. M. HYMAN AND M. KLEIN, GROUP T-7, LASL
61 C      *
62 C      * REFERENCE- J. M. HYMAN, M. M. KLEIN

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63 C      *      EOSMOD- A SUBROUTINE PACKAGE FOR CALCULATING
64 C      *      EQUATIONS-OF-STATE AND OPACITIES
65 C      *      LOS ALAMOS SCIENTIFIC LABORATORY RPT.,LA-8502-M,1980
66 C      *
67 C      * DATE- MARCH 6, 1980
68 C      *
69 C      *****
70 C
71      COMMON /EDSCZ/ LOUT
72      COMMON /EDSC3/ INIT, IROIM, IR(60,3), KUP(60,3)
73 C
74      IERR=0
75 C
76      IF(INIT.EQ.0) CALL EOSBEG
77 C
78 C      UNSCRAMBLE MULTIPLE FLAG KPARM
79 C
80      KBR=KPARM/1000
81      ITEMP=KPARM-KBR*1000
82 C
83      KUNIT=ITEMP/100
84      ITEMP=ITEMP-KUNIT*100
85 C
86      KREP=ITEMP/10
87      KFN=ITEMP-10*KREP
88 C
89      KEOSS=KPARM
90      KFNS=KFN
91      KBR5=KBR
92 C
93 C      CHECK IF KPARM IS A VALID INPUT PARAMATER
94      IF(KPARM.LT.0) IERR=-2
95      IF(KBR.GT.2) IERR=-2
96      IF(KUNIT.GT.6) IERR=-2
97      IF(KREP.GT.1) IERR=-2
98      IF(KFN.GT.1) IERR=-2
99 C
100 C      PRINT AN ERROR MESSAGE IF KUNIT IS NOT VALID
101      IF(IERR.LT.0) WRITE(LOUT,10)KPARM,KBR,KUNIT,KREP,KFN
102      10 FORMAT(" ERROR DETECTED IN KPARM VALUE IN SUBROUTINE EOSKUT"
103      1 ,/, " KPARM=",I5, " KBR=",I5, " KUNIT=",I5, " KREP=",I5, " KFN=",I5)
104 C
105 C      CHECK IF THE UNITS HAVE CHANGED
106      IF(IMAT.LE.0) GO TO 90
107      IF(10*KUNIT+KREP.NE.KUP(IMAT,IOT)) IERR=-6
108      IF (IERR.GE.0) GO TO 90
109 C
110      WRITE(LOUT,30)KUNIT,KREP,KUP(IMAT,IOT)
111      30 FORMAT(" THE UNITS HAVE CHANGED SINCE THE LAST USE OF THE TABLE"
112      2,/, " THE CURRENT VALUES OF KUNIT AND KREP ARE ",2I2
113      3,/, " THE PREVIOUS VALUES OF KUNIT AND KREP WERE",I5)
114 C
115      90 CONTINUE
116 C
117      RETURN
118      END

```

```

1      SUBROUTINE EOSOFD (LMAT,IO,IMATO)
2 C
3 C      *****
4 C      *
5 C      * PURPOSE-
6 C      * TO OBTAIN MATERIAL NUMBERS FOR OPACITY TABLES
7 C      *
8 C      * INPUT VARIABLES-
9 C      * LMAT = MATERIAL IN AN A10 FIELD, FOR EXAMPLE- LMAT = "HELIUM"
10 C      * THE MATERIAL SESAME NUMBER CAN ALSO BE USED TO SPECIFY
11 C      * THE MATERIAL BY SETTING LMAT TO THE SESAME
12 C      * NUMBER, FOR EXAMPLE- LMAT = "5760" FOR HELIUM
13 C      *
14 C      * OUTPUT VARIABLES-
15 C      * IO= SESAME OR MIXTUREID NUMBER AS STORED
16 C      * IN SESAME OR MIXOIR(MIXLIB)
17 C      * IMATO = LOCATION OF MATERIAL IN ARRAY LABMO + MIXDIR
18 C      * PROVIDED MATERIAL HAS BEEN LOCATED
19 C      * = 0 IF MATERIAL HAS NOT BEEN LOCATED
20 C      *
21 C      * LOCAL VARIABLES-
22 C      * EOSMOO COMMON BLOCKS- EOSC1,EOSC3
23 C      *
24 C      * EXTERNALS AND COMMON BLOCKS-
25 C      *
26 C      * PROGRAMMER- J. M. HYMAN AND M. KLEIN, GROUP T-7, LASL
27 C      *
28 C      * REFERENCE- J. M. HYMAN, M. M. KLEIN
29 C      * EOSMOO- A SUBROUTINE PACKAGE FOR CALCULATING
30 C      * EQUATIONS-OF-STATE AND OPACITIES
31 C      * LOS ALAMOS SCIENTIFIC LABORATORY RPT.,LA-8502-M,1980
32 C      *
33 C      * DATE- MARCH 6, 1980
34 C      *
35 C      *****
36 C
37      COMMON /EOSCZ/ LOUT
38      COMMON /EOSC1/ LU41, LU42, LU43, LU44, LU45
39      COMMON /EOSC2/ LF41, LF42, LF43, LF44, LF45
40      COMMON /EOSC3/ INIT, IROIM, IR(60,3), KUP(60,3)
41      COMMON /EOSC7/ NMATO, LABMO(60), IOMATO(60), IMATOL
42 C
43      DATA ICFASO,ICFASP/2*0/
44 C      **** ASSIGN OPACITY FILES TO PROGRAM
45      IF(ICFASO .GT. 0) GO TO 5
46      ICFASO=1
47      CALL EOSFAS(2)
48      5 CONTINUE
49 C
50 C      CHECK IF THE MATERIAL IS IN THE STANDARD SESAME TABLES
51      DO 10 IMATO=1,IMATOL
52      IF (LMAT.EQ.LABMO(IMATO)) GO TO 40
53      10 CONTINUE
54      IMATO=IMATOL
55 C
56 C      *** ASSIGN PRIVATE OPACITY FILES TO PROGRAM
57      IF(ICFASP .GT. 0) GO TO 15
58      ICFASP=1
59      CALL EOSFAS(3)
60      15 CONTINUE
61 C
62 C      THE CURRENT PRIVATE LIST DIRECTORY (MIXOIR) IS ON UNIT LU45

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```

63 C      CHECK IF LF45 EXISTS IN LOCAL FILE SPACE
64      CALL FEXIST(LF45,IFFLAG)
65      IF(IFFLAG .EQ. 0 ) GO TO 30
66 C      IFFLAG = 0 FILE NOT IN LOCAL FILE SPACE
67 C      IFFLAG = 1 FILE LOCAL
68      REWIND LU45
69      20 READ (LU45,80) LABEL,IO
70      IMATO=IMATO+1
71      IF (LMAT.EQ.LABEL) GO TO 50
72      IF (EOF(LU45)) 30,20
73      30 CONTINUE
74 C
75 C      CHECK IF THE LMAT IS A SESAME NUMBER
76      IMAT1=AND(SHIFT(LMAT,6),77B)
77 CRAY CODE IMAT1=AND(SHIFT(LMAT,8),377B)
78 C
79      IF(IMAT1.LT.20B) GO TO 35
80      IF(IMAT1.GT.31B) GO TO 35
81 C
82      DECODE(10,32,LMAT) IO
83      32 FORMAT(I5)
84 C
85      DO 33 IMATO=1,IMATOL
86      IF(IO.EQ.IOMATO(IMATO)) GO TO 40
87      33 CONTINUE
88 C
89      IMATOL=IMATOL+1
90      IMATD=IMATOL
91      LABMO(IMATO)=LMAT
92      IOMATO(IMATO)=IO
93 C
94 C      ASSUME THE MATERIAL IS IN THE STANDARD SESAME LIST
95 C      IF IT IS NOT. A NONFATAL ERROR WILL OCCUR AT A LATER STEP
96      GO TO 40
97 C
98 C
99 C      THE MATERIAL WAS NOT FOUND. PRINT AN ERROR MESSAGE
100      35 CONTINUE
101      IMATO=0
102      WRITE(LOUT,70) LMAT
103      GO TO 999
104 C
105      40 IO=IOMATO(IMATO)
106      50 CONTINUE
107 C
108      IF (IMATO.LE.IROIM) GO TO 60
109      IMATO=0
110      WRITE(LOUT,90) LMAT
111      60 CONTINUE
112 C
113      999 CONTINUE
114      RETURN
115 C
116 C***** IMPROVE THESE DIAGNOSTICS*****
117      70 FORMAT (" MATERIAL LMAT = ",A10," NOT FOUND")
118      80 FORMAT (A10,I3)
119      90 FORMAT (" IMATD EXCEEDS UPPER BOUND IN SUBROUTINE EOSOFO "
120      1 ,/, " FOR MATERIAL LMAT=",A10)
121      END

```

# T-4 SUBROUTINES USED BY EOSMOD

DPACKX (packs real numbers) . . . . .	64
GETEOSX (loads the total EOS tables) . . . . .	65
GETINVX (gets inverted EOS tables) . . . . .	67
GETRPOX (loads Rosseland/Planck opacity tables) . . . . .	69
INBUFRX (sequential read) . . . . .	71
INV301X (inverts a 301 table) . . . . .	72
ISRCHKX (index search) . . . . .	74
MATCHKX (checks if material table is loaded) . . . . .	75
RATFN1X (one-dimensional interpolator) . . . . .	76
TABRANX (fetches a given table for a given material from a Sesame II library) . . . . .	78
T4DATIX (interpolates the inverted tables) . . . . .	80
T4DATX (search/interpolate for atomic data as functions of region, density, and temperature) . . . . .	83
T4INTPX (interpolates for a function z(x,y) and its derivatives) . . . . .	86
T4PTREX (computes R and E from inverted table) . . . . .	89
T4RTPEX (computes P and E from inverted table) . . . . .	91

```

1      FUNCTION OPACKX(A,B)
2 C-----
3 C
4 C  FUNCTION  OPACKX
5 C
6 C  PURPOSE   TO DOUBBLE PACK ARGUMENTS A AND B INTO A SINGLE WORD
7 C
8 C  REMARKS   SYSTEM DEPENDENT SHIFT FUNCTION
9 C
10 C  PROGRAMMER J.ABOALLAH,JR.
11 C
12 C  DATE      1 MAY 1979
13 C
14 C-----
15      EQUIVALENCE (I1,X1),(I2,X2)
16      DATA MASK/77777777770000000000B/
17      X1=A
18      X2=B
19      I1=I1.AND.MASK
20      I2=I2.AND.MASK
21      I2=SHIFT(I2,30)
22      I1=I1.OR.I2
23      OPACKX=X1
24      RETURN
25      END

```

```

1      SUBROUTINE GETEOSX(IR,MID,IDT,TBLS,LCNT,LU,IFL,ZB)
2 C*****
3 C
4 C      SUBROUTINE GETEOSX(IR,MID,IDT,TBLS,LCNT,LU,IFL,ZB)
5 C
6 C      PURPDSE      TO LOAD THE TOTAL EOS TABLES
7 C
8 C      ARGUMENTS    IR      (INPUT)    REGION NO.
9 C                  MID     (INPUT)    MATERIAL ID.
10 C                 IOT     (INPUT)    DATA TYPE INDICATOR
11 C                 TBLS    (OUTPUT)   ARRAY FOR TABLE STORAGE
12 C                 LCNT    (I/O)     POSITION IN ARRAY FOR STORING TABLES
13 C                 LU      (INPUT)    SESAME LIBRARY UNIT NUMBER
14 C                 IFL     (OUTPUT)   ERROR FLAG
15 C                                     = 2 FOR MATERIAL ALREADY LOADED
16 C                                     = 1 FOR SUCCESSFUL LOADING
17 C                                     = 0 FOR DATA NOT FOUND
18 C                                     = - NO. OF EXTRA WORDS NEEDED FOR
19 C                                     STORAGE
20 C                 ZB      (OUTPUT)   ATOMIC CHARGE,CHARGE**2,AND MASS
21 C                                     ZB(1) = Z
22 C                                     ZB(2) = Z**2
23 C                                     ZB(3) = A
24 C
25 C
26 C      REMARKS      THIS IS THE LASNEX VERSION OF GETEOS
27 C
28 C                  PRESSURES AND ENERGIES ARE DOUBLE PACKED
29 C
30 C                  ENERGY DENSITIES ARE PER UNIT VOLUME (NOT MASS)
31 C
32 C      EXTERNALS    MATCHKX,TABRANX,DPACKX
33 C
34 C      PROGRAMMER   R.C. ALBERS, T-4
35 C
36 C      DATE         25 APRIL 79
37 C
38 C*****
39      LEVEL 2,TBLS
40      DIMENSION TBLS(1),ZB(3)
41 C      REPLACE FOLLOWING LINE BY USER COMMON BLOCKS
42      COMMON/S2OIRX/LCMX,NRS,LCFW(10,3)
43      COMMON /EOSCCE/ TFACE, RFACE, PFACE, EFACE, KREPE
44 C
45 C      CHECK TO SEE IF TABLE HAS BEEN LOADED
46      CALL MATCHKX(MID,NRS,LCFW(1,IOT),TBLS(1),IFLG)
47      IF(IFLG.EQ.0) GO TO 10
48      LCFW(IR,IOT) = IFLG
49      IFL=2
50      RETURN
51      10 NLEFT = LCMX - LCNT - 1
52 C
53 C      FETCH THE 201 TABLE
54      CALL TABRANX(MID,201.,LU,TBLS(LCNT+2),NLEFT,IFL)
55      IF(IFL.LE.0) RETURN
56      ZB(1) = TBLS(LCNT+2)
57      ZB(2) = ZB(1)*ZB(1)
58      ZB(3) = TBLS(LCNT+3)
59      RHOO=TBLS(LCNT+4)
60 C
61 C      FETCH THE 301 TABLE
62      CALL TABRANX(MID,301.,LU,TBLS(LCNT+2),NLEFT,IFL)

```

```

63      IF(IFL.LE.O) RETURN
64 C
65 C      CONVERT TO LASNEX UNITS AND DOUBLE PACK
66      NR = TBLS(LCNT+2)
67      NT = TBLS(LCNT+3)
68      DO 20 I=1,NT
69      LOCT = I + (LCNT + NR + 3)
70 20    TBLS(LOCT)=TFACE*TBLS(LOCT)
71      NWDS = NR*NT
72      DO 30 J=1,NR
73      RHO = TBLS(J + LCNT + 3)*RFACE
74      TBLS(J+LCNT+3)=RHO
75      DO 40 I=1,NT
76      LOCP = (I-1)*NR + J + (NT + NR + LCNT + 3)
77      LOCE = LOCP + NWDS
78      PTEM=TBLS(LOCP)*PFACE
79      ETEM=TBLS(LOCE)*EFACE
80      IF(KREPE.EQ.1)ETEM=ETEM*RHO
81      TBLS(LOCP) = DPACKX(PTEM,ETEM)
82 40    CONTINUE
83 30    CONTINUE
84 C
85 C      RESET INPUT PARAMETERS AND END
86      TBLS(LCNT)=FLOAT(MIO)
87      TBLS(LCNT+1)=RHOO
88      LCFW(IR,IOT)=LCNT
89      LCNT = LCNT + 2 + IFL - NWDS
90      IFL = 1
91      RETURN
92      END

```

```

1      SUBROUTINE GETINVX(IR,MID,IOT,TBLS,LCNT,LU,IFL,ZB)
2 C-----
3 C
4 C      SUBROUTINE GETINVX(IR,MID,IDT,TBLS,LCNT,LU,IFL,ZB)
5 C
6 C      PURPOSE      TO LOAD INVERTED (ENERGY BASED) SESAME II
7 C                   EOS TABLES
8 C
9 C      ARGUMENTS    IR      (INPUT)    REGION NO.
10 C                MID     (INPUT)    SESAME MATERIAL ID
11 C                IOT     (INPUT)    DATA TYPE INDICATOR
12 C                TBLS    (INPUT)    TABLE STORAGE ARRAY
13 C                LCNT    (IN/OUT)    POSITION IN ARRAY FOR STORING TABLES
14 C                LU      (INPUT)    SESAME LIBRARY UNIT NO.
15 C                IFL     (OUTPUT)    ERROR FLAG
16 C                                2=MATERIAL ALREADY LOADED
17 C                                1=SUCCESSFUL LOADING
18 C                                0=DATA NOT FOUND
19 C                                LT.O FOR - THE NO. OF EXTRA WORDS
20 C                                NEEDED FOR LOADING
21 C                ZB      (OUTPUT)    ATOMIC CHARGE,CHARGE**2,AND MASS
22 C                                ZB(1)=Z
23 C                                ZB(2)=Z**2
24 C                                ZB(3)=A
25 C
26 C      REMARKS      UNITS - ENERGY    MBAR*CC/GM
27 C                   TEMP      DEGREES KELVIN
28 C                   DENSITY   GRAMS/CC
29 C                   PRESSURE  MBAR
30 C
31 C                   THIS ROUTINE WAS ORIGINALLY NAMED GETINV BEFORE THE
32 C                   MODIFICATIONS WERE MADE SO IT WOULD INTERFACE WITH EOSMOO
33 C
34 C      EXTERNALS    MATCHKX,TABRANX,INV301X
35 C
36 C      PROGRAMMER    J.ABOALLAH,JR.
37 C
38 C      DATE          13 JUNE 1979
39 C-----
40 C
41 C
42 C      LEVEL 2,TBLS
43 C      COMMON/S2DIRX/LCMX,NRS,LCFW(10,3)
44 C      DIMENSION ZB(3),TBLS(1)
45 C
46 C      OBTAIN THE UNIT CONVERSION FACTORS FROM THE EOSMOO ROUTINES
47 C      COMMON/EOSCCCE/TFACE,RFACE,PFACE,EFACE, KREPE
48 C
49 C      CALL MATCHKX(MID,NRS,LCFW(1,IOT),TBLS(1),IFL)
50 C      IF(IFL.EQ.O) GO TO 10
51 C      LCFW(IR,IOT)=IFL
52 C      IFL=2
53 C      RETURN
54 C 10 NL=LCMX-LCNT-1
55 C . . . . . FETCH EOS TABLES
56 C      CALL TABRANX(MID,201.,LU,TBLS(LCNT+2),NL,IFL)
57 C      IF(IFL.LE.O) RETURN
58 C      ZB(1)=TBLS(LCNT+2)
59 C      ZB(2)=ZB(1)*ZB(1)
60 C      ZB(3)=TBLS(LCNT+3)
61 C      TBLS(LCNT+1)=TBLS(LCNT+4)
62 C      CALL TABRANX(MID,301.,LU,TBLS(LCNT+2),NL,IFL)

```



```

63      IF(IFL.LE.O) RETURN
64      TBLS(LCNT)=FLOAT(MIO)
65 C    CALL PERTCB(IR,TBLS(LCNT),ZB(1),ZB(3))
66      NR=TBLS(LCNT+2)
67      NT=TBLS(LCNT+3)
68      NRT=NR*NT
69      LOCP=LCNT+3+NR+NT
70 C
71 C . . CONVERT TO DESIRED UNITS
72      DO 30 I=1,NT
73 C
74      TBLS(3+I+LCNT+NR)=TFACE*TBLS(3+I+LCNT+NR)
75 C
76      DO 30 J=1,NR
77 C
78      IF(I.GT.1) GO TO 20
79      TBLS(3+J+LCNT)=TBLS(3+J+LCNT)*RFACE
80      RHO=TBLS(3+J+LCNT)
81 20   LOCP=LOCP+1
82 C
83      TBLS(LOCP)=PFACE*TBLS(LOCP)
84      TBLS(LOCP+NRT)=EFACE*TBLS(LOCP+NRT)
85      IF (KREPE.EQ.1) TBLS(LOCP+NRT)=TBLS(LOCP+NRT)*RHO
86 30   CONTINUE
87 C
88 C . . WINDOW TABLES HERE AND RESET VALUES OF NR NT AND
89 C      NRT IF WINDOWING IS NEEDED
90 C . . INVERT TABLES
91 C . . CHECK TO SEE IF THERE IS ENOUGH ROOM TO INVERT THE TABLES
92 C      NINV IS THE LAST LOCATION NEEDED FOR TABLE INVERSION
93      NINV=LCNT+3+2*NRT+2*NR+4*NT
94      IF(NINV.LE.LCMX) GO TO 40
95      IFL=LCMX-NINV
96      RETURN
97 40   RO=TBLS(LCNT+1)
98      LOC=LCNT+2
99      CALL INV301X(TBLS,LOC,RO,LDS)
100 C . . DOUBLE PACK DEPENDENT VARIABLES
101      LOCP=LCNT+3+NR+NT+NR
102      DO 50 I=1,NRT
103      LOCP=LOCP+1
104      PTEM=TBLS(LOCP)
105      TTEM=TBLS(LOCP+NRT)
106      TBLS(LOCP)=OPACKX(PTEM,TTEM)
107 50   CONTINUE
108 C . . WRAP UP
109      LCFW(IR,IDT)=LCNT
110      LCNT=LCNT+2+LDS-NRT
111      IFL=1
112      RETURN
113      END

```

```

1      SUBROUTINE GETRPOX(IR,MID,IDT,TBLS,LCNT,LU,IFL)
2 C-----
3 C
4 C  SUBROUTINE  GETRPOX(IR,MID,IDT,TBLS,LCNT,LU,IFL)
5 C
6 C  PURPOSE      TO LOAD THE ROSSELAND/PLANCK OPACITY TABLE
7 C
8 C  ARGUMENTS    IR          (INPUT)    REGION NO.
9 C              MID         (INPUT)    SESAME MATERIAL ID
10 C             IDT         (INPUT)    DATA TYPE INDICATOR
11 C             TBLS        (OUTPUT)   ARRAY FOR TABLE STORAGE
12 C             LCNT        (I/O)     POSITION IN ARRAY FOR
13 C                               STORING TABLES
14 C             LU          (INPUT)    SESAME LIBRARY UNIT NO.
15 C             IFL         (OUTPUT)   ERROR FLAG
16 C                               =1 FOR SUCCESSFUL LOADING
17 C                               =0 FOR DATA NOT FOUND
18 C                               =-NO. OF EXTRA WORDS NEEDED
19 C                               TO STORE DATA
20 C
21 C  REMARKS      THE ROSSELAND/PLANCK TABLE IS DOUBLE PACKED ON DISK.
22 C              THIS VERSION OF GETRPOX IS SPECIALLY DESIGNED FOR
23 C              USE IN HYDROX. IF NECESSARY, MODIFICATIONS
24 C              MAY BE MADE HERE FOR ADAPTATION TO OTHER CODES.
25 C
26 C              THIS ROUTINE WAS ORIGINALLY NAMED GETRPO BEFORE THE
27 C              MODIFICATIONS WERE MADE SO IT WOULD INTERFACE WITH EOSMOD
28 C
29 C  EXTERNALS    MATCHKX,TABRANX,DPACKX
30 C              COMMON/EDSCCO/ FROM THE EOSMOD PACKAGE
31 C
32 C  PROGRAMMER    J.ABOALLAH,JR.
33 C
34 C  MODIFIED BY M. KLEIN, GROUP T-7, 11 DECEMBER 1979
35 C
36 C  DATE          24 APRIL 1979
37 C-----
38 C
39 C      LEVEL 2,TBLS
40 C      DIMENSION TBLS(1)
41 C      COMMON/S2DIRX/LCMX,NRS,LCFW(10,3)
42 C
43 C      THE COMMON BLOCK EDSCCO PROVIDES THE UNIT CONVERSION FACTORS
44 C      FROM THE EOSMOD PACKAGE
45 C      COMMON/EDSCCO/ TFACD,RFACD,OFACD,KREPD
46 C
47 C      UNITS..TEMP..DEG.K,RHO IN G/CC,OPACITY IN CM**2/G
48 C      . CHECK TO SEE IF TABLE HAS BEEN LOADED ALREADY
49 C      CALL MATCHKX(MID,NRS,LCFW(1,IOT),TBLS(1),IFL)
50 C      IF(IFL.EQ.0) GO TO 10
51 C      LCFW(IR,IOT)=IFL
52 C      IFL=2
53 C      RETURN
54 C  10  NLEFT=LCMX-LCNT-1
55 C      . . FETCH THE 502 TABLE
56 C      CALL TABRANX(MID,502.,LU,TBLS(LCNT+2),NLEFT,IFL)
57 C      IF(IFL.LE.0) RETURN
58 C      . . CONVERT TO DESIRED UNITS
59 C      . . LINES THROUGH STATEMENT 60 MAY BE DELETED IF NO CONVERSION IS
60 C      . . REQUIRED
61 C      NR=TBLS(LCNT+2)
62 C      NT=TBLS(LCNT+3)

```

```

63      IPT=LCNT+3+NR+NT
64      DO 60 K=1,NT
65      TBLS(LCNT+3+NR+K)=TBLS(LCNT+3+NR+K) + TFACO
66      DO 60 J=1,NR
67      IF(K.GT.1) GO TO 50
68      TBLS(LCNT+3+J)=TBLS(LCNT+3+J)+RFACO
69 50    IPT=IPT+1
70      ROP=TBLS(IPT)
71      POP=SHIFT(ROP,30)
72      ROP=ROP+TBLS(LCNT+3+J)*KREPO+DFACO
73      POP=POP+TBLS(LCNT+3+J)*KREPO+DFACO
74      ROP=DPACKX(ROP,POP)
75      TBLS(IPT)=ROP
76 60    CONTINUE
77      TBLS(LCNT)=FLOAT(MIO)
78      TBLS(LCNT+1)=FLOAT(IOT)
79      LCFW(IR,IDT)=LCNT
80      LCNT=LCNT+IFL+2
81      IFL=1
82      RETURN
83      END

```

```

1      SUBROUTINE INBUFRX(LU,Z,NW,IAD,IFLG)
2 C -----
3 C
4 C SUBROUTINE INBUFRX(LU,Z,NW,IAD,IFLG)
5 C
6 C PURPOSE      RANDOM I/O READ
7 C
8 C ARGUMENTS    LU   (INPUT)  UNIT NO.
9 C              Z    (OUTPUT)  STORAGE AREA WHERE DAT IS RETURNED
10 C             NW   (INPUT)  NO. OF WORDS TO BE READ
11 C             IAD  (INPUT)  STARTING DISK ADDRESS OF DATA
12 C             IFLG (OUTPUT)  0=NORMAL
13 C                          1=EOF ENCOUNTERED
14 C                          -1=ERROR
15 C
16 C REMARKS      NDNE
17 C
18 C EXTERNALS    ROISK
19 C
20 C PROGRAMMER   J.ABDALLAH,JR.
21 C
22 C DATE         1 MAY 1979
23 C -----
24 C
25      LEVEL 2,Z
26      CALL ROISK(LU,Z,NW,IAD)
27      IF(UNIT(LU)) 10,20,30
28 10      IFLG=1
29          RETURN
30 20      IFLG=0
31          RETURN
32 30      IFLG=-1
33          RETURN
34          END

```

```

1      SUBROUTINE INV301X(OSTR,LOC,RO,LDS)
2 C-----
3 C
4 C  SUBROUTINE:  INV301X(DSTR,LOC,RO,LDS)
5 C
6 C  PURPOSE:     INVERT DATA STRING OF TYPE 301 TO TYPE 302.
7 C
8 C  ARGUMENTS:   OSTR (INPUT) - TABLE STORAGE ARRAY
9 C               LOC  (INPUT) - STARTING LOCATION OF DATA STRING
10 C              IN OSTR
11 C              RO   (INPUT) - APPROXIMATE DENSITY OF SOLID
12 C              LOS  (OUTPUT) - LENGTH OF NEW DATA STRING
13 C
14 C  REMARKS:     OSTR CAN BE DECLARED LCM ON THE CDC 7600.
15 C               THIS ROUTINE OVERWRITES LOCATIONS FOLLOWING THE
16 C               DATA STRING. IT EXPANDS THE STRING BY NR WORDS,
17 C               WHERE NR IS THE NUMBER OF DENSITIES. IT ALSO
18 C               USES 3*NT WORDS AS TEMPORARY STORAGE, WHERE NT
19 C               IS THE NUMBER OF TEMPERATURES.
20 C
21 C  EXTERNALS:   ISRCHKX, RATFN1X
22 C
23 C  PROGRAMMER:  G. I. KERLEY, T-4.
24 C
25 C  DATE:        4 OCTOBER 1977
26 C-----
27 C
28      LEVEL 2,OSTR
29      DIMENSION OSTR(1)
30      COMMON/INTOROX/IFN
31      COMMON/RTBLK1X/LOCX,NR,LQCY,KY,JX,NT,INT,ET,Z(2)
32      INT=1
33      IFNS=IFN
34      IFN=0
35      NR = OSTR(LOC)
36      NT = OSTR(LOC+1)
37      LOCT = 2+NR+LOC
38      LCEC = LOCT+NT
39      LOCP = LCEC+NR
40      LOCE = LOCP+NR*NT
41      LOCN = LOCE+NR*NT
42      IMAX = 2*NR*NT
43      DO 1 I=1,IMAX
44 1      OSTR(LOCN-I) = DSTR(LOCN-I-NR)
45      DO 2 I=1,NR
46      JJ = LOCE+I-1
47      Q = 1.E-12*ABS(DSTR(JJ))
48      OSTR(LCEC+I-1) = OSTR(JJ)
49      OSTR(JJ) = 0.
50      DO 2 J=2,NT
51      JJ = JJ+NR
52      OSTR(JJ) = OSTR(JJ)-OSTR(LCEC+I-1)
53      IF(OSTR(JJ)-OSTR(JJ-NR).LT.Q) DSTR(JJ)=DSTR(JJ-NR)+Q
54 2      CONTINUE
55      I = ISRCHKX(RO,DSTR(LOC+3),NR-2,1,0)+1
56      DO 3 J=1,NT
57      OSTR(LOCN+J-1) = OSTR(LOCT+J-1)
58 3      DSTR(LOCT+J-1) = OSTR(LOCE+I-1+NR*(J-1))
59      DO 5 I=1,NR
60      LOCX = LOCE+I-1
61      DO 4 J=1,NT
62      ET = OSTR(LOCT+J-1)

```

```

63      JX = ISRCHKX(ET,OSTR(LOCX+NR),NT-2,NR,0)+1
64      LOCY = LOCP+I-1
65      KY = NR
66      CALL RATFN1X
67      OSTR(LOCN+NT+J-1) = Z(1)
68      LOCY = LOCN
69      KY = 1
70      CALL RATFN1X
71  4    DSTR(LOCN+NT+NT+J-1) = Z(1)
72      DD 5 J=1,NT
73      OSTR(LOCP+I-1+NR*(J-1)) = DSTR(LOCN+NT+J-1)
74  5    OSTR(LOCX+NR*(J-1)) = OSTR(LOCN+NT+NT+J-1)
75      LDS = LOCN-LOC
76      IFN=IFNS
77      RETURN
78      END

```

```

1      FUNCTION ISRCHKX(X,TBLS,N,K,NSFT)
2 C -----
3 C
4 C  FUNCTION:      ISRCHKX(X,TBLS,N,K,NSFT)
5 C
6 C  PURPOSE:      FIND INDEX OF X IN AN ARRAY TBLS.  TABLE VALUES
7 C                NEED NOT BE CONTIGUOUS AND CAN BE IN EITHER
8 C                ASCENDING OR DESCENDING ORDER.
9 C
10 C ARGUMENTS:    X      (INPUT) - VALUE TO BE LOCATED
11 C               TBLS (INPUT) - TABLE TO BE SEARCHED
12 C               N      (INPUT) - NUMBER OF VALUES TO BE SEARCHED
13 C               K      (INPUT) - SPACING BETWEEN VALUES IN TABLE
14 C               THE VALUE OF THE FUNCTION = INDEX I, WHERE
15 C               TBLS(1+K*(I-1)).LE.X.LT.TBLS(1+K*I), OR
16 C               TBLS(1+K*(I-1)).GE.X.GT.TBLS(1+K*I), OR
17 C               I=0 OR I=N IF X IS OUTSIDE RANGE OF TABLE.
18 C               NSFT (INPUT) - NO. OF BITS THE TABLE VALUES ARE
19 C                   TO BE SHIFTED
20 C
21 C REMARKS:      TBLS CAN BE DECLARED LCM ON THE CDC 7600.
22 C
23 C EXTERNALS:    SHIFT.
24 C
25 C PROGRAMMER:   G. I. KERLEY, T-4, J.ABOALLAH, JR.
26 C
27 C DATE:        19 NOVEMBER 1976, REVISED 6 JULY 1979
28 C
29 C -----
30      LEVEL 2, TBLS
31      DIMENSION TBLS(1)
32      ISRCHKX = 0
33      J = N+1
34      KI = 1-K
35      S1=TBLS(1)
36      S1=SHIFT(S1,NSFT)
37      S=TBLS(KI+K*N)
38      S=SHIFT(S,NSFT)
39      S=S-S1
40 1    IF(J-ISRCHKX.EQ.1) RETURN
41      JP = .5*(J+ISRCHKX)
42      S1=TBLS(KI+K*JP)
43      S1=SHIFT(S1,NSFT)
44      IF(S*(X-S1).LT.O.O) GO TO 2
45      ISRCHKX = JP
46      GO TO 1
47 2    J = JP
48      GO TO 1
49      END

```

```

1      SUBROUTINE MATCHKX(MID,NRS,LOC,TBLS,IFLG)
2 C -----
3 C
4 C   SUBROUTINE   MATCHKX(MID,NRS,LOC,TBLS,IFLG)
5 C
6 C   PURPOSE      TO CHECK IF A MATERIAL HAS BEEN
7 C                 PREVIOUSLY LOADED
8 C
9 C   ARGUMENTS    MID      (INPUT)   SESAME MATERIAL ID
10 C              NRS      (INPUT)   NUMBER OF REGIONS
11 C              LOC      (INPUT)   ARRAY OF FIRST WORD LOCATIONS
12 C                                     IN TABLE STORAGE ARRAY FOR
13 C                                     FOR EACH REGION
14 C              TBLS     (INPUT)   TABLE STORAGE ARRAY
15 C              IFLG     (OUTPUT)  =0 MATERIAL NOT PREVIOUSLY LOADED
16 C                                     GT.0 LOCATION OF TABLE IF LOADED
17 C                                     ALREADY
18 C
19 C   REMARKS      NONE
20 C
21 C   EXTERNALS    NONE
22 C
23 C   PROGRAMMER   J.ABDALLAH,JR.
24 C
25 C   DATE         26 APRIL 1979
26 C -----
27 C
28 C   LEVEL 2,TBLS
29 C   DIMENSION LOC(1),TBLS(1)
30 C   IFLG=0
31 C   DO 100 J=1,NRS
32 C     LC=LOC(J)
33 C     IF(LC.LE.0) GO TO 100
34 C     ITEST=TBLS(LC)
35 C     IF(MID.EQ.ITEST) GO TO 200
36 C 100 CONTINUE
37 C     RETURN
38 C 200 IFLG=LC
39 C     RETURN
40 C   END

```



```

1      SUBROUTINE RATFN1X
2 C -----
3 C
4 C SUBROUTINE: RATFN1X
5 C
6 C PURPOSE: INTERPOLATE FOR A FUNCTION Y(X) AND ITS
7 C DERIVATIVE FROM TABLES LOCATED IN ARRAY TBLS.
8 C
9 C THE ROUTINE ALSO REQUIRES COMMON BLOCKS,
10 C COMMON/RTBLK1X/LOCX,KX,LOCY,KY,I,N,IP,X,Y(2)
11 C LOCX = LOCATION OF X VECTOR
12 C KX = SPACING OF X VECTOR
13 C LOCY = LOCATION OF Y VECTOR
14 C KY = SPACING OF Y VECTOR
15 C I = INDEX OF X AND Y VECTORS
16 C N = LENGTH OF X AND Y VECTORS
17 C X (INPUT) - INDEPENDENT VARIABLE
18 C Y (OUTPUT) - VECTOR OF LENGTH 2, WHERE
19 C Y(1) = VALUE OF FUNCTION
20 C Y(2) = DERIVATIVE OF FUNCTION
21 C IP (INPUT) - BRANCH PARAMETER
22 C IP.EQ.O, USE INPUT COEFFICIENTS IN YY
23 C IP.NE.O, CALCULATE YY VECTOR FIRST
24 C COMMON/INTOROX/IFN
25 C IFN (INPUT) - INTERPOLATION TYPE
26 C IFN.NE.1, RATIONAL FUNCTION
27 C IFN.EQ.1, LINEAR
28 C COMMON/SESQATX/TBLS
29 C TBLS (INPUT) - TABLE STORAGE ARRAY
30 C
31 C
32 C REMARKS: UNLESS LINEAR FORM IS SPECIFIED, ROUTINE
33 C USES RATIONAL FUNCTION METHOD WITH QUADRATIC
34 C ESTIMATE OF DERIVATIVES AT THE MESH POINTS.
35 C TBLS CAN BE DECLARED LCM ON THE CDC 7600.
36 C
37 C EXTERNALS: NONE, BUT A SEARCH ROUTINE MUST BE CALLED
38 C FIRST, TO COMPUTE INDEX I.
39 C
40 C PROGRAMMER: G. I. KERLEY, T-4.
41 C
42 C DATE: 18 JULY 1979
43 C
44 C -----
45 C LEVEL 2,TBLS
46 C DIMENSION YY(6)
47 C COMMON/SESQATX/TBLS(10000)
48 C COMMON/INTOROX/IFN
49 C COMMON/RTBLK1X/LOCX,KX,LOCY,KY,I,N,IP,X,Y(2)
50 C IF(IFN.EQ.1) GO TO 6
51 C IF(IP.EQ.O) GO TO 3
52 C CALCULATE COEFFICIENTS FOR RATIONAL FUNCTION INTERPOLATION
53 C IX = LOCX+KX*(I-1)
54 C IY = LOCY+KY*(I-1)
55 C YY(3) = TBLS(IX)
56 C YY(4) = TBLS(IX+KX)-YY(3)
57 C YY(1) = TBLS(IY)
58 C YY(2) = (TBLS(IY+KY)-YY(1))/YY(4)
59 C IF(I.EQ.N-1) GO TO 1
60 C SP = (TBLS(IY+KY+KY)-TBLS(IY+KY))/(TBLS(IX+KX+KX)-TBLS(IX+KX))
61 C YY(6) = (SP-YY(2))/(TBLS(IX+KX+KX)-YY(3))
62 C IF(I.GT.1) GO TO 1

```

```

63      IF (YY(2)*(YY(2)-YY(4)+YY(6)).LE.O.) YY(6)=YY(2)/YY(4)
64      YY(5) = YY(6)
65      GO TO 2
66 1     DM = YY(3)-TBLS(IX-KX)
67      SM = (YY(1)-TBLS(IY-KY))/DM
68      YY(5) = (YY(2)-SM)/(YY(4)+DM)
69      IF (I.EQ.N-1) YY(6)=YY(5)
70      IF (I.GT.2) GO TO 2
71      IF (SM*(SM-DM+YY(5)).LE.O.) YY(5)=(YY(2)-SM-SM)/YY(4)
72 2     IF (YY(6).NE.O.) YY(5)=YY(5)/YY(6)
73 C    EVALUATE RATIONAL FUNCTION FROM PRECALCULATED COEFFICIENTS
74 3     Q = X-YY(3)
75      R = YY(4)-Q
76      IF (R.NE.O.) GO TO 4
77      W = 1.
78      GO TO 5
79 4     W = 1.-1./(1.+ABS(YY(5)*Q/R))
80 5     F = YY(6)*(W+YY(5)*(1.-W))
81      Y(1) = YY(1)+Q*(YY(2)-R*F)
82      Y(2) = YY(2)+(Q-R)*F+YY(4)*W*(F-YY(6))
83      RETURN
84 C    CALCULATE COEFFICIENTS FOR LINEAR INTERPOLATION
85 6     IF (IP.EQ.O) GO TO 7
86      IX = LOCX+KX*(I-1)
87      IY = LOCY+KY*(I-1)
88      YY(3) = TBLS(IX)
89      YY(1) = TBLS(IY)
90      YY(2) = (TBLS(IY+KY)-YY(1))/(TBLS(IX+KX)-YY(3))
91 C    CALCULATE LINEAR ESTIMATE FROM PRECALCULATED COEFFICIENTS
92 7     Y(1) = YY(1)+YY(2)*(X-YY(3))
93      Y(2) = YY(2)
94      RETURN
95      END

```

```

1      SUBROUTINE TABRANX(MID,TIO,LIB,A,LEN,IFLAG)
2 C -----
3 C
4 C SUBROUTINE TABRANX(MIO,TID,LIB,A,LEN,IFLAG)
5 C
6 C PURPOSE      TO FETCH A GIVEN TABLE FOR A GIVEN MATERIAL
7 C              FROM A SESAME II LIBRARY
8 C
9 C ARGUMENTS    MID      (INPUT)    MATERIAL IO
10 C             TIO      (INPUT)    TABLE NO. - IF 0.0 MATERIAL INDEX
11 C                                     IS RETURNED
12 C             LIB      (INPUT)    LIBRARY FILE UNIT NO.
13 C             A        (OUTPUT)   ARRAY FOR TABLE STORAGE
14 C             LEN      (INPUT)    NO. OF WORDS IN A AVAILABLE
15 C             IFLAG    (OUTPUT)   =0 IF TABLE COULD NOT BE LOCATED
16 C                                     GT. 0=NO. OF WORDS IN TABLE RETURNED
17 C                                     LT. 0 - NO. OF ADDITIONAL
18 C                                     WORDS NEEDED
19 C
20 C REMARKS      A RANDOM I/O TECHNIQUE IS USED TO LOCATE AND LOAD
21 C              THE SPECIFIED TABLE FROM THE SESAME II LIBRARY.
22 C              THE MATERIAL INDEX AND ITS ADDRESS ARE TO SAVED
23 C              TO HASTEN THE FETCHING OF ANOTHER TABLE FOR THE SAME
24 C              MATERIAL AND LIBRARY FILE IN SUBSEQUENT CALLS TO
25 C              TABFCH.
26 C
27 C EXTERNALS    INBUFRX
28 C
29 C PROGRAMMER   J.ABOALLAH.,JR.
30 C
31 C DATE        24 APRIL 1979
32 C -----
33 C
34      LEVEL 2,A
35      DIMENSION A(1),HINDEX(50)
36      DATA HINDEX(1)/0.0/
37      DATA LIBLST/0/
38      IFLAG=0
39 C . . FIND NO. MATERIALS ON LIBRARY
40      IF(LIB.NE.LIBLST) GO TO 50
41      IOLAST=HINDEX(1)
42      IF(IOLAST.NE.MIO) GO TO 50
43      IF(TIO.NE.O.O) GO TO 230
44      NW=HINDEX(5)
45      NW=NW+NW+5
46      IF(LEN.LT.NW) GO TO 999
47      DO 30 J=1,NW
48      A(J)=HINDEX(J)
49 30  CONTINUE
50      IFLAG=NW
51      RETURN
52 50  LIBLST=LIB
53      NW=1
54      IF(LEN.LT.NW) GO TO 999
55      CALL INBUFRX(LIB,A,1,0,IER)
56      N=A(1)
57      NW=N+N+N
58      IF(LEN.LT.NW) GO TO 999
59      CALL INBUFRX(LIB,A,NW,3,IER)
60 C . . FIND ADDRESS OF MATERIAL FILE
61      DO 100 J=1,N
62      ITEST=A(J)

```

```

63      IF(ITEM.NE.MID) GO TO 100
64      NW=A(J+N)
65      IAD=A(J+N+N)
66      GO TO 200
67 100  CONTINUE
68      RETURN
69 C . . GET MATERIAL INDEX
70 200  IF(LEN.LT.NW) GO TO 999
71      IADX=IAD
72      CALL INBUFRX(LIB,A,NW,IAOX,IER)
73      DO 210 J=1,NW
74      HINDEX(J)=A(J)
75 210  CONTINUE
76      IF(TID.EQ.O.O) GO TO 500
77 230  N=HINDEX(5)
78      DO 300 J=1,N
79      IF(TID.NE.HINDEX(5+J)) GO TO 300
80      NW=HINDEX(5+J+N)
81      IAD=HINDEX(5+J+N+N)
82      IAD=IAOX+IAD
83      GO TO 400
84 300  CONTINUE
85      RETURN
86 400  IF(LEN.LT.NW) GO TO 999
87 C . . READ REQUESTED TABLE
88      CALL INBUFRX(LIB,A,NW,IAD,IER)
89 500  IFLAG=NW
90      RETURN
91 999  IFLAG=LEN-NW
92      RETURN
93      END

```

```

1      SUBROUTINE T4DATIX
2 C -----
3 C
4 C SUBROUTINE: T4DATIX
5 C
6 C PURPOSE: SEARCH/INTERPOLATE FOR PRESSURE AND TEMPERATURE
7 C AS FUNCTIONS OF REGION, DENSITY AND ENERGY,
8 C USING PACKED SESAME 2 DATA STRING OF TYPE 302
9 C
10 C COMMON/SESINX/IR,IOT,R,E,IBR,IFL
11 C COMMON/SESOUTX/P(3),T(3)
12 C IR (INPUT) - MATERIAL REGION NUMBER
13 C IOT (INPUT) - DATA TYPE INDICATOR
14 C R (INPUT) - DENSITY
15 C E (INPUT) - INTERNAL ENERGY
16 C P,T (OUTPUT) - PRESSURE, TEMPERATURE VECTORS
17 C P(1),T(1) = PRESSURE AND TEMPERATURE
18 C P(2),T(2) = DENSITY DERIVATIVES
19 C P(3),T(3) = ENERGY DERIVATIVES
20 C IBR (INPUT) - 0=COMPUTE BOTH P AND T
21 C 1=COMPUTE P ONLY
22 C 2=COMPUTE T ONLY
23 C COMMON/SESOUTX/TBLS
24 C TBLS (INPUT) - TABLE STORAGE ARRAY
25 C
26 C REMARKS: ADAPTED FROM T-4 SESAME 2 ROUTINES S2EOSI AND
27 C LA302A. PRESSURE AND TEMPERATURE ARE PACKED.
28 C THE SEARCH INDICES AND INTERPOLATION CONSTANTS
29 C ARE SAVED AND REUSED, IF POSSIBLE.
30 C
31 C ***** SYSTEM DEPENDENT FEATURE. THE CONSTANT NSFT
32 C ***** IN STATEMENT 60 SHOULD BE SET TO 1/2 THE BIT
33 C ***** LENGTH. FOR A CDC 7600, NSFT = 30.
34 C
35 C EXTERNALS: RATFN1X (1-D INTERPOLATION ROUTINE)
36 C T4INTPX (2-D INTERPOLATION ROUTINE)
37 C
38 C PROGRAMMER: G. I. KERLEY AND B. I. BENNETT, T-4.
39 C J. ABOALLAH, JR.
40 C
41 C DATE: 2 AUGUST 1978
42 C
43 C -----
44 C LEVEL 2, TBLS
45 C COMMON/S2DIRX/LCMX,NRS,LCFW(10,3)
46 C COMMON/RTBLK1X/LDCR,KX,LOCE,KY,IRX,N,ISAME,RX1,PX1(2)
47 C COMMON/RTBLK2X/LOCX,IX,NX,LOCY,IY,NY,LOCZ,NZ,NSFT,
48 C $ RX2,ET,PX2(3),INT,IOS,ZZ(96)
49 C COMMON/SESINX/IR,IOT,R,E,IBR,IFL
50 C COMMON/SESOUTX/P(3),T(3)
51 C COMMON/SESOUTX/TBLS(10000)
52 C DATA LOCLST,IP,IT/O,1,1/
53 C LOC IS POINTER TO START OF DATA STRING FOR REGION IR
54 C LOC = LCFW(IR,IOT)+2
55 C . . THE FOLLOWING LINES OF CODE (THRU NZ=1) CAN BE
56 C MOVED AFTER THE IF(LOC.EQ.LOCLST) GO TO 5
57 C STATEMENT TO MAKE THE SUBROUTINE QUICKER FOR CODES WHICH
58 C DO NOT ALSO USE TEMPERATURE BASED EOS TABLES.
59 C NX = TBLS(LOC)
60 C NY = TBLS(LOC+1)
61 C N = NX
62 C LOCR = LOC+2

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63      KX = 1
64      LOCX = LOCR
65      LOCY = LOCX+NX
66      LOCE = LOCY+NY
67      KY = 1
68      LOCZ = LOCE+NX
69      NZ = 1
70 C    TEST TO SEE IF THE MATERIAL IS THE SAME AS LAST CALL
71      IF(LOC.EQ.LOCLST) GO TO 5
72 C    THE FOLLOWING OPERATIONS DO NOT NEED TO BE REPEATED
73 C    UNLESS A NEW REGION HAS BEEN ENTERED
74      LOCLST=LOC
75      IXLAST = 0
76      IYLAST = 0
77      LOCI = LOCX+NX/2-1
78      LOCJ = LOCY+NY/2-1
79      LOCNX=LOCX+NX-2
80      LOCNV=LOCY+NY-2
81 C    SEARCH FOR DENSITY INDEX
82 5     IF(R.LT.TBLS(LOCI)) GO TO 15
83 10    IF(R.LT.TBLS(LOCI+1)) GO TO 20
84      IF(LOCI.EQ.LOCNX) GO TO 20
85      LOCI=LOCI+1
86      GO TO 10
87 15    IF(LDCI.EQ.LOCX) GO TO 20
88      LDCI=LOCI-1
89      IF(R.LT.TBLS(LOCI)) GO TO 15
90 20    IX=LOCI-LOCX+1
91 C    INTERPOLATE FOR ENERGY ON COLD CURVE. IF ISAME = 0, DENSITY
92 C    INDEX IS THE SAME AS IN THE LAST CALL TO THIS ROUTINE
93      IRX = IX
94      ISAME = IABS(IX-IXLAST)
95      RX1=R
96      CALL RATFNIX
97      ET = AMAX1(0.,E-PX1(1))
98      DECOR = PX1(2)
99      RX2=R
100 C   SEARCH FOR ENERGY INDEX
101     IF(ET.LT.TBLS(LOCJ)) GO TO 35
102 30    IF(ET.LT.TBLS(LOCJ+1)) GO TO 40
103     IF(LOCJ.EQ.LOCNV) GO TO 40
104     LOCJ=LOCJ+1
105     GO TO 30
106 35    IF(LDCJ.EQ.LOCY) GO TO 40
107     LOCJ=LOCJ-1
108     IF(ET.LT.TBLS(LOCJ)) GO TO 35
109 40    IY=LOCJ-LOCY+1
110 C   IF ISAME = 0, DENSITY AND TEMPERATURE INDICES ARE
111 C   THE SAME AS IN THE LAST CALL TO THIS ROUTINE
112     ISAME = ISAME+IABS(IY-IYLAST)
113     IP = MINO(1,IP+ISAME)
114     IT = MINO(1,IT+ISAME)
115     IXLAST = IX
116     IYLAST = IY
117     IOS=(IOT-1)*32+1
118     IF(IBR.EQ.2) GO TO 50
119 C   PRESSURE CALCULATION
120     NSFT = 0
121     INT=IP
122     CALL T4INTPX
123     P(1)=PX2(1)
124     P(2)=PX2(2)-DECOR+PX2(3)

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```
125      P(3)=PX2(3)
126      IP = 0
127      IF(IBR.EQ.1) RETURN
128 C    TEMPERATURE CALCULATION
129 50    NSFT = 30
130      INT=IT
131      IOS=IOS+16
132      CALL T4INTPX
133      T(1)=PX2(1)
134      T(2)=PX2(2)-DECOR+PX2(3)
135      T(3)=PX2(3)
136      IT = 0
137      RETURN
138      END
```

```

1      SUBROUTINE T4DATX
2 C -----
3 C
4 C   SUBROUTINE:  T4DATX
5 C
6 C   PURPOSE:     SEARCH/INTERPOLATE FOR ATOMIC DATA AS
7 C               FUNCTIONS OF REGION, DENSITY AND TEMPERATURE,
8 C               USING PACKED SESAME 2 DATA STRING
9 C
10 C              COMMON/SESINX/IR,IOT,AR,AT,IBR,IFL
11 C              IR  (INPUT) - MATERIAL REGION NUMBER
12 C              IOT (INPUT) - DATA TYPE INDICATOR
13 C              AR  (INPUT) - DENSITY
14 C              AT  (INPUT) - TEMPERATURE
15 C              IBR (INPUT) - SPECIFIES VARIABLES REQUIRED
16 C                  IBR = 0, BOTH VARIABLES
17 C                  IBR = 1, FIRST HALF VARIABLE ONLY
18 C                  IBR = 2, SECOND HALF VARIABLE ONLY
19 C              IFL (NOT USED)
20 C              COMMON/SESOUTX/P(3),E(3)
21 C              P,E (OUTPUT) - VARIABLES OF FIRST AND SECOND HALF
22 C                           OF PACKED DATA STRING
23 C                  P(1),E(1) = VALUE OF THE VARIABLES
24 C                  P(2),E(2) = DENSITY DERIVATIVES
25 C                  P(3),E(3) = TEMPERATURE DERIVATIVES
26 C
27 C   REMARKS:     ADAPTED FROM T-4 SESAME 2 ROUTINES S2EOS AND
28 C               LA301A. TABLES OF 2 VARIABLES ARE DOUBLE PACKED.
29 C               THE SEARCH INDICES AND INTERPOLATION CONSTANTS
30 C               ARE SAVED AND REUSED, IF POSSIBLE.
31 C
32 C               ***** SYSTEM DEPENDENT FEATURE.  THE CONSTANT NSFT
33 C               ***** IN STATEMENT 60 SHOULD BE SET TO 1/2 THE BIT
34 C               ***** LENGTH.  FOR A CDC 7600, NSFT = 30.
35 C
36 C   EXTERNALS:   T4INTPX (RATIONAL FUNCTION AND BI LINEAR INTERPOLATION)
37 C               INTERPOLATION COEFFICIENTS FROM A PREVIOUS
38 C               CALL TO THE ROUTINE CAN BE REUSED.
39 C
40 C   PROGRAMMER:  G. I. KERLEY, T-4., J. ABOALLAH, T-4
41 C
42 C   DATE:        11 JULY 1978, REVISED 27 APRIL 1979
43 C -----
44 C
45 C   LEVEL 2, TBLS
46 C   DIMENSION LOCLST(3), IXLAST(3), IYLAST(3),
47 C   1          IPLAST(3), IELAST(3)
48 C   COMMON/S2OIRX/LCMX,NRS,LCFW(10,3)
49 C   COMMON/RTBLK2X/LOCX,IX,NX,LOCY,IY,NY,LOCZ,NZ,NSFT,
50 C   1 R,T,Z(3),INT,IOS,ZZ(96)
51 C   COMMON/SESDATX/TBLS(10000)
52 C   COMMON/SESINX/IR,IOT,AR,AT,IBR,IFL
53 C   COMMON/SESOUTX/P(3),E(3)
54 C   DATA IPLAST/3*0/
55 C   DATA IELAST/3*1/
56 C   DATA LOCLST/3*0/
57 C   LOC IS POINTER TO START OF DATA STRING FOR REGION IR
58 C   LOC = LCFW(IR,IOT)+2
59 C   NZ=1
60 C   NX=TBLS(LOC)
61 C   NY=TBLS(LOC+1)
62 C   LOCX=LOC+2

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63      LOCY=LDCX+NX
64      LOCZ=LOCY+NY
65      LOCNX=LOCX+NX-2
66      LOCNY=LOCY+NY-2
67      IF(LOC.EQ.LOCLST(IOT)) GO TO 2
68      LOCLST(IDT)=LOC
69      IX=NX/2
70      IY=NY/2
71      IXLAST(IOT)=0
72      IYLAST(IOT)=0
73      GO TO 3
74 2     IX=IXLAST(IOT)
75      IY=IYLAST(IOT)
76 3     R=AR
77      T=AT
78 C    SEARCH FOR DENSITY INDEX
79 5     LOCI=LOCX+IX-1
80      IF(R.LT.TBLS(LOCI)) GO TO 15
81 10    IF(R.LT.TBLS(LOCI+1)) GO TO 20
82      IF(LOCI.EQ.LOCNX) GO TO 20
83      LOCI=LOCI+1
84      GO TO 10
85 15    IF(LOCI.EQ.LOCX) GO TO 20
86      LOCI=LOCI-1
87      IF(R.LT.TBLS(LOCI)) GO TO 15
88 20    IX=LOCI-LOCX+1
89 C    SEARCH FOR TEMPERATURE INDEX
90      LOCI=LOCY+IY-1
91      IF(T.LT.TBLS(LOCI)) GO TO 35
92 30    IF(T.LT.TBLS(LOCI+1)) GO TO 40
93      IF(LOCI.EQ.LOCNY) GO TO 40
94      LOCI=LOCI+1
95      GO TO 30
96 35    IF(LOCI.EQ.LOCY) GO TO 40
97      LOCI=LOCI-1
98      IF(T.LT.TBLS(LOCI)) GO TO 35
99 40    IY=LOCI-LOCY+1
100 C   IF ISAME = 0, DENSITY AND TEMPERATURE INDICES ARE
101 C   THE SAME AS IN THE LAST CALL TO THIS ROUTINE
102      ISAME = IABS(IX-IXLAST(IOT))+IABS(IY-IYLAST(IOT))
103      IXLAST(IDT) = IX
104      IYLAST(IDT) = IY
105      IOS=(IOT-1)*32+1
106      IPLAST(IDT)=MINO(1,IPLAST(IOT)+ISAME)
107      IELAST(IDT)=MINO(1,IELAST(IOT)+ISAME)
108      IF(IBR.EQ.2) GO TO 50
109      INT=IPLAST(IOT)
110      NSFT=0
111      CALL T4INTPX
112      P(1)=Z(1)
113      P(2)=Z(2)
114      P(3)=Z(3)
115      IPLAST(IDT)=0
116      IF(IBR.EQ.1) RETURN
117 50    INT=IELAST(IDT)
118      IOS=IOS+16
119      NSFT=30
120      CALL T4INTPX
121      E(1)=Z(1)
122      E(2)=Z(2)
123      E(3)=Z(3)
124      IELAST(IDT)=0

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125  
126

RETURN  
END

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1      SUBROUTINE T4INTPX
2 C-----
3 C
4 C  SUBROUTINE:  T4INTPX
5 C
6 C  PURPOSE:     INTERPOLATE FOR A FUNCTION Z(X,Y) AND ITS
7 C               DERIVATIVES FROM TABLES LOCATED IN ARRAY TBLS.
8 C
9 C               THE ROUTINE REQUIRES COMMON BLOCKS,
10 C              COMMON/RTBLK2X/LOCX,IX,NX,LOCY,IY,NY,LOCZ,NZ,NSFT,
11 C                  X.Y,Z(3),IP,IDS,ZZ
12 C              LOCX = LOCATION OF X VECTOR
13 C              IX  = INDEX OF X VECTOR
14 C              NX  = LENGTH OF X VECTOR
15 C              LOCY = LOCATION OF Y VECTOR
16 C              IY  = INDEX OF Y VECTOR
17 C              NY  = LENGTH OF Y VECTOR
18 C              LOCZ = LOCATION OF Z(X,Y) ARRAY
19 C              NZ  = SPACING OF Z ARRAY
20 C              NSFT = BIT SHIFT PARAMETER
21 C              X,Y (INPUT) - INDEPENDENT VARIABLES
22 C              Z   (OUTPUT) - VECTOR OF LENGTH 3, WHERE
23 C                  Z(1) = VALUE OF FUNCTION
24 C                  Z(2) = X DERIVATIVE OF FUNCTION
25 C                  Z(3) = Y DERIVATIVE OF FUNCTION
26 C              ZZ  (IN/OUT) - COEFFICIENT VECTOR OF LENGTH 16
27 C              IP  (INPUT) - BRANCH PARAMETER
28 C                  IP.EQ.0, USE INPUT COEFFICIENTS IN ZZ
29 C                  IP.NE.0, CALCULATE ZZ VECTOR FIRST
30 C              IDS (INPUT) - DISPLACEMENT INTO ZZ FOR COEFFS.
31 C                  TO BE USED
32 C              COMMON/INTORDX/IFN.
33 C              IFN (INPUT) - INTERPOLATION TYPE
34 C                  IFN.NE.1, RATIONAL FUNCTION
35 C                  IFN.EQ.1, BILINEAR
36 C              COMMON/SESQATX/TBLS
37 C              TBLS IS THE TABLE STORAGE ARRAY
38 C
39 C
40 C  REMARKS:     UNLESS BILINEAR FORM IS SPECIFIED, ROUTINE
41 C               USES RATIONAL FUNCTION METHOD WITH QUADRATIC
42 C               ESTIMATE OF DERIVATIVES AT THE MESH POINTS.
43 C               TBLS CAN BE DECLARED LCM ON THE CDC 7600.
44 C
45 C               ***** SYSTEM DEPENDENT FEATURE.  THE Z-ARRAY CAN BE
46 C               ***** DOUBLE PACKED.  PARAMETER NSFT SPECIFIES THE
47 C               ***** NUMBER OF BITS TO BE SHIFTED WHEN UNPACKING THE
48 C               ***** RIGHT HALF OF THE WORD.  THIS ROUTINE USES
49 C               ***** THE LASL SHIFT FUNCTION
50 C
51 C  EXTERNALS:   NONE, BUT A SEARCH ROUTINE MUST BE CALLED
52 C               FIRST, TO COMPUTE INDICES IX AND IY.
53 C
54 C  PROGRAMMER:  G. I. KERLEY, T-4., J. ABDALLAH,T-4.
55 C
56 C  DATE:        01 AUG 1979
57 C
58 C-----
59      LEVEL 2,TBLS
60      COMMON/RTBLK2X/LOCX,IX,NX,LOCY,IY,NY,LOCZ,NZ,NSFT,X,Y,Z(3),
61      $ IP,IDS,ZZ(96)
62      COMMON/INTORDX/IFN

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63      COMMON/SESOATX/TBLS(10000)
64 C    CALCULATE COEFFICIENTS FOR RATIONAL FUNCTION INTERPOLATION
65      IF(IFN.EQ.1) GO TO 13
66      IF(IP.EQ.0) GO TO 8
67      I = LOCX+IX-1
68      IZ = LOCZ+NZ*(IX-1+NX*(IY-1))
69      KZ = NZ
70      IBR = IX
71      NBR = NX-IX
72      ZZ(10S+4) = TBLS(I)
73      DO 7 K=1,4
74      KI=10S+K-1
75      IF(K.LT.4) GO TO 1
76      IZ = IZ+NZ
77      GO TO 4
78 1     IF(K.LT.3) GO TO 2
79      ZZ(10S+6) = 0
80      I = LOCY+IY-1
81      KZ = KZ*NX
82      IZ = IZ-KZ
83      IBR = IY
84      NBR = NY-IY
85      ZZ(10S+5) = TBLS(I)
86      GO TO 3
87 2     IF(K.LT.2) GO TO 3
88      IZ = IZ+NX*NZ
89      GO TO 4
90 3     O = TBLS(I+1)-TBLS(I)
91 4     ZZ(KI)=SHIFT(TBLS(IZ),NSFT)
92      S=SHIFT(TBLS(IZ+KZ),NSFT)
93      S = (S-ZZ(KI))/O
94      IF(NBR.EQ.1) GO TO 5
95      SP=SHIFT(TBLS(IZ+KZ+KZ),NSFT)
96      SP = (SP-D*S-ZZ(KI))/(TBLS(I+2)-TBLS(I+1))
97      G2 = (SP-S)/(TBLS(I+2)-TBLS(I))
98      IF(IBR.GT.1) GO TO 5
99      IF(S*(S-D*G2).LE.O.) G2=S/O
100     G1 = G2
101     GO TO 6
102 5     OM = TBLS(I)-TBLS(I-1)
103     SM=SHIFT(TBLS(IZ-KZ),NSFT)
104     SM = (ZZ(KI)-SM)/OM
105     G1 = (S-SM)/(O+OM)
106     IF(NBR.EQ.1) G2=G1
107     IF(IBR.GT.2) GO TO 6
108     IF(SM*(SM-OM*G1).LE.O.) G1=(S-SM-SM)/D
109 6     IF(G2.NE.O.) G1=G1/G2
110     ZZ(KI+8) = G1
111 7     ZZ(KI+12) = G2
112     ZZ(10S+7)=0
113     ZZ8=ZZ(10S+7)
114     ZZ7=ZZ(10S+6)
115     ZZ(10S+2)=(ZZ(10S+1)-ZZ(10S))/ZZ8
116     ZZ(10S+1)=(ZZ(10S+3)-ZZ(10S))/ZZ7
117     ZZ(10S+3)=(S-ZZ(10S+2))/ZZ7
118     ZZ(10S+12)=ZZ(10S+12)/ZZ8
119     ZZ(10S+13)=ZZ(10S+13)/ZZ8
120     ZZ(10S+14)=ZZ(10S+14)/ZZ7
121     ZZ(10S+15)=ZZ(10S+15)/ZZ7
122 C    EVALUATE RATIONAL FUNCTION FROM PRECALCULATED COEFFICIENTS
123 8     QX = X-ZZ(10S+4)
124     RX = ZZ(10S+6)-QX

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125      QY = Y-ZZ(IDS+5)
126      RY = ZZ(IDS+7)-QY
127      IF(RX.NE.O.) GO TO 9
128      W1 = 1.
129      W2 = 1.
130      GO TO 10
131 9      W1 = 1.-1./((1.+ABS(ZZ(IDS+8)*QX/RX))
132      W2 = 1.-1./((1.+ABS(ZZ(IDS+9)*QX/RX))
133 10     F1 = ZZ(IDS+12)*(W1+ZZ(IDS+8)*(1.-W1))
134      F2 = ZZ(IDS+13)*(W2+ZZ(IDS+9)*(1.-W2))
135      Z(2) = ZZ(IDS+6)*(RY*(F1-ZZ(IDS+12))*W1+QY*(F2-ZZ(IDS+13))*W2)
136      G1 = RY*F1+QY*F2
137      IF(RY.NE.O) GO TO 11
138      W1 = 1.
139      W2 = 1.
140      GO TO 12
141 11     W1 = 1.-1./((1.+ABS(ZZ(IDS+10)*QY/RY))
142      W2 = 1.-1./((1.+ABS(ZZ(IDS+11)*QY/RY))
143 12     F3 = ZZ(IDS+14)*(W1+ZZ(IDS+10)*(1.-W1))
144      F4 = ZZ(IDS+15)*(W2+ZZ(IDS+11)*(1.-W2))
145      Z(3) = ZZ(IDS+7)*(RX*(F3-ZZ(IDS+14))*W1+QX*(F4-ZZ(IDS+15))*W2)
146      G2 = RX*F3+QX*F4
147      ZZ2=ZZ(IDS+1)
148      ZZ3=ZZ(IDS+2)
149      ZZ4=ZZ(IDS+3)
150      Z(1) = ZZ(IDS)+(ZZ2+ZZ4*QY-RX*G1)*QX+(ZZ3-RY*G2)*QY
151      Z(2) = Z(2)+ZZ2+QY*(ZZ4+RY*(F3-F4))+(QX-RX)*G1
152      Z(3) = Z(3)+ZZ3+QX*(ZZ4+RX*(F1-F2))+(QY-RY)*G2
153      RETURN
154 C    CALCULATE COEFFICIENTS FOR BILINEAR INTERPOLATION
155 13     IF(IP.EQ.O) GO TO 14
156      I=LOCX+IX
157      INO=IOS+4
158      ZZ(INO)=TBLS(I-1)
159      OX=TBLS(I)-ZZ(INO)
160      J=LOCY+IY
161      INO=IOS+5
162      ZZ(INO)=TBLS(J-1)
163      OY=TBLS(J)-ZZ(INO)
164      IZ=LOCZ+NZ*(IX-1+NX*(IY-1))
165      ZZ( IOS)=SHIFT(TBLS(IZ),NSFT)
166      INO=IOS+1
167      ZZ(INO)=SHIFT(TBLS(IZ+NZ),NSFT)
168      ZZ(INO)=(ZZ(INO)-ZZ( IOS))/OX
169      IZ=IZ+NZ*NX
170      INO=IOS+2
171      ZZ(INO)=SHIFT(TBLS(IZ),NSFT)
172      ZZ(INO)=(ZZ(INO)-ZZ( IOS))/OY
173      INO=IOS+3
174      ZZ(INO)=SHIFT(TBLS(IZ+NZ),NSFT)
175      ZZ(INO)=(ZZ(INO)-ZZ( IOS)-ZZ( IOS+1)*OX-ZZ( IOS+2)*OY)/(OX*OY)
176 C    EVALUATE BILINEAR FUNCTION FROM PRECALCULATED COEFFICIENTS
177 14     QX = X-ZZ( IOS+4)
178      QY = Y-ZZ( IOS+5)
179      Z(2) = ZZ( IOS+1)+ZZ( IOS+3)*QY
180      Z(3) = ZZ( IOS+2)+ZZ( IOS+3)*QX
181      Z(1) = ZZ( IOS)+Z(2)*QX+ZZ( IOS+2)*QY
182      RETURN
183      END

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```

1      SUBROUTINE T4PTREX(IR,IOT,TBLS,P,T,R,E,IFL)
2 C-----
3 C
4 C  SUBROUTINE:  T4PTREX(IR,IDT,TBLS,P,T,R,E,IFL)
5 C
6 C  PURPOSE:      FIND DENSITY AND INTERNAL ENERGY AS FUNCTIONS
7 C                OF PRESSURE AND TEMPERATURE FROM A 302
8 C                SESAME TABLE.  USES DOUBLE BINARY SEARCH TO
9 C                FIND INITIAL GUESS OF R AND E, THEN USES
10 C               DOUBLE NEWTONS METHOD.
11 C
12 C  ARGUMENTS:    IR   (INPUT) - REGION NO.
13 C               IOT  (INPUT) - DATA TYPE CORRESPONDING TO E BASED EOS
14 C               TBLS (INPUT) - TABLE STORAGE ARRAY
15 C               P    (INPUT) - PRESSURE
16 C               T    (INPUT) - TEMPERATURE
17 C               R    (OUTPUT) - DENSITY
18 C               E    (OUTPUT) - ENERGY
19 C               IFL  (OUTPUT) - ERROR FLAG
20 C               IFL=1, IF CALCULATION IS SUCCESSFUL
21 C               IFL=0, IF CALCULATION FAILS
22 C
23 C  REMARKS:      TBLS CAN BE DECLARED LCM ON THE COC 7600.
24 C
25 C  EXTERNALS:    T4OATIX, ISRCHKX.
26 C
27 C  PROGRAMMER:   G. I. KERLEY, T-4.
28 C
29 C  DATE:         3 MARCH 1978
30 C
31 C-----
32      LEVEL 2,TBLS
33      DIMENSION TBLS(1)
34      COMMON/S2DIRX/LCMX,NRS,LCFW(10,3)
35      COMMON/SESINX/IRX,IDTX,RX,EX,IBR,IFLX
36      COMMON/SESOUTX/ZP(3),ZT(3)
37      IBR=0
38      IFLX=1
39      IRX=IR
40      IOTX=IOT
41      LOC=LCFW(IR,IDT)+1
42      NR = TBLS(LOC+1)
43      NT = TBLS(LOC+2)
44      ILO = 1
45      IHI = NR
46 1    I = .5*(ILO+IHI)
47      LOCT = LOC+2+NR+NR+NT+I+NR
48      J = ISRCHKX(T,TBLS(LOCT),NT-2,NR,30)+1
49      LOCP = LOC+2+NR+NT+I+NR*(J)
50      IF(IHI-I.EQ.1) GO TO 3
51      IF(P.LT.TBLS(LOCP)) GO TO 2
52      ILO = I
53      GO TO 1
54 2    IHI = I
55      GO TO 1
56 3    RX = TBLS(LOC+2+I)
57      EX = TBLS(LOC+2+NR+J)+TBLS(LOC+2+NR+NT+I)
58      K = 0
59      IFL = 1
60 4    K = K+1
61      IF(K.EQ.50) GO TO 6
62      CALL T4OATIX

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63      R=RX
64      E=EX
65      PTEST = ABS(P-ZP(1))-1.E-05*(ABS(P)+1.E-05)
66      IF(PTEST.GT.0.) GO TO 5
67      TTEST = ABS(T-ZT(1))-1.E-05*(ABS(T)+1.E-02)
68      IF(TTEST.LT.0) RETURN
69  5    DNOMR = ZT(3)*ZP(2)-ZP(3)*ZT(2)
70      IF(DNOMR.EQ.0.) GO TO 6
71      RX = RX+(ZT(3)*(P-ZP(1))-ZP(3)*(T-ZT(1)))/DNOMR
72      ONOMR = ZT(2)*ZP(3)-ZP(2)*ZT(3)
73      IF(ONOMR.EQ.0.) GO TO 6
74      EX = EX+(ZT(2)*(P-ZP(1))-ZP(2)*(T-ZT(1)))/DNOMR
75      GO TO 4
76  6    IFL = 0
77      RETURN
78      END

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```

1      SUBROUTINE T4RTPEX(IR,IDT,TBLS,R,T,P,E,IFL)
2 C -----
3 C
4 C      SUBROUTINE T4RTPEX(IR,IDT,TBLS,R,T,P,E,IFL)
5 C
6 C      PURPOSE      TO FIND PRESSURE AND ENERGY AS FUNCTIONS
7 C                   OF DENSITY AND TEMPERATURE FROM A
8 C                   SESAME TYPE 302 TABLE USING NEWTONS METHOD.
9 C
10 C     ARGUMENTS     IR          (INPUT)    REGION NO.
11 C                  IDT        (INPUT)    DATA TYPE FOR 302 TABLES
12 C                  TBLS       (INPUT)    TABLE STORAGE ARRAY
13 C                  T          (INPUT)    TEMPERATURE
14 C                  P          (OUTPUT)   PRESSURE
15 C                  E          (OUTPUT)   ENERGY
16 C                  IFL        (OUTPUT)   OUTPUT FLAG
17 C                                     =1 FOR SUCCESS
18 C                                     =0 FOR FAILURE
19 C
20 C     REMARKS       NONE
21 C
22 C
23 C     PROGRAMMER    J. ABOALLAH, JR.
24 C
25 C     DATE          5 JULY 1979
26 C -----
27 C
28      LEVEL 2, TBLS
29      COMMON/S2DIRX/LCMX,NRS,LCFW(10,3)
30      DIMENSION TBLS(1)
31      COMMON/SESINX/IRXX,IDTX,RX,EX,IBR,IFLX
32      COMMON/SESOUTX/ZP(3),ZT(3)
33      IBR=0
34      IFLX=1
35      RX=R
36      IRXX=IR
37      IDTX=IDT
38      LOC=LCFW(IR,IDT)
39      NR=TBLS(LOC+2)
40      NE=TBLS(LOC+3)
41 C . . . GET INITIAL GUESS ON ENERGY
42 C . . . FIND CLOSEST DENSITY INDEX
43      LOCX=LOC+4
44      IRX=1
45      OELS=ABS(R-TBLS(LOCX))
46      IF(NR.EQ.1) GO TO 20
47      DO 10 J=2,NR
48      LDCX=LOCX+1
49      OEL=ABS(R-TBLS(LDCX))
50      IF(OEL.GT.OELS) GO TO 10
51      IRX=J
52      OELS=OEL
53 10   CONTINUE
54 C . . . FIND THE ENERGY INDEX ASSOCIATED WITH THE CLOSEST TEMP
55 20   LOCX=LOC+3+NR+NE+NR+IRX
56      OELS=TBLS(LOCX)
57      OELS=SHIFT(OELS,30)
58      OELS=ABS(T-OELS)
59      IEX=1
60      IF(NE.EQ.1) GO TO 40
61      DO 30 J=2,NE
62      LOCX=LOCX+NR

```



```

63      DEL=TBLS(LOCX)
64      DEL=SHIFT(DEL,30)
65      DEL=ABS(T-DEL)
66      IF(DEL.GT.DELS) GO TO 30
67      IEX=J
68      DELS=DEL
69 30    CONTINUE
70 C . . INITIAL GUESS ON ENERGY
71 40    EX=TBLS(LOC+3+NR+IEX)+TBLS(LOC+3+NR+NE+IRX)
72 C . . ITERATE USING NEWTONS METHOD
73      K=0
74      IFL=1
75 50    K=K+1
76      IF(K.EQ.50) GO TO 90
77      CALL T40ATIX
78      E=EX
79      P=ZP(1)
80      TTEST=ABS(T-ZT(1))-1.OE-05*(ABS(T)+1.OE-02)
81      IF(TTEST.LT.0.) RETURN
82      D=-ZT(3)
83      IF(D.EQ.0.0) GO TO 90
84      EX=EX-(T-ZT(1))/D
85      GO TO 50
86 90    IFL=0
87      RETURN
88      ENO

```

APPENDIX B

CROSS-REFERENCE DIRECTORY OF EOSLIB

NO UNUSED SPACE

	ROUTINE	INDEX	RECORD LENGTH	OSKAD	EXTERNAL SYMBOLS		COMMON BLOCKS	
1.	DPACKX DPACKX	18	15	017113				
2.	EOSEBEG EOSEBEG	5	7	002354			S201RX SESINX EDSC2 EDSC2 EDSC4 EDSC6 EDSCCE	SESOATX INTORDX EDSC1 EDSC3 EDSC5 EDSC7 EDSCC0
3.	EOSCON EOSCON	1	81	000000	EDOSL	GOTDER.	EDSCCE	EDSCC0
4.	EOSORE EOSORE	6	81	005404	T4DATX EOSKUT	EOSGET	S201RX INTORDX SESOUTX EDSC3	SESOATX SESINX EDSC2 EDSC4
5.	EOSORT EOSORT	7	80	006173	T4DATX EOSKUT	EOSGET	S201RX INTORDX SESOUTX EDSCCE EDSC3	SESOATX SESINX EDSC2 EDSC1 EDSC4
6.	EOSDSL EOSDSL	2	6	000454			EDSCCE	EDSCC0
7.	EOSEFD EOSEFD	4	166	001320	OUTCI. EDF REWIND. EOSFAS	DECD01. INPCI. FEXIST	EDSC2 EDSC2 EDSC5	EDSC1 EDSC3 EDSC6
8.	EOSFAS EOSFAS	3	74	000644	ASSIGN GOTDER.	OASSIGN	EDSC2 EDSC2	EDSC1
9.	EOSGET EOSGET	11	231	011374	OUTCI. GETRPDX GOTDER. EOSOFO	GETEOSX GETINX EOSCON EOSEFO	S201RX SESINX EDSC2 EDSC3	SESOATX INTORDX EDSC1 EDSC4
10.	EOSIPT EOSIPT	9	128	007722	OUTCI. EOSGET	T4PTREX EOSKUT	S201RX SESINX EDSC2 EDSC4	SESOATX INTORDX EDSC3
11.	EOSIRT EOSIRT	8	128	007020	OUTCI.	T4RTPEX	S201RX	SESOATX

					EDSGET	EDSKUT	SESINX EDSC2 EDSC4	INTORDX EDSC3
12.	EDSKUT EDSKUT	10	123	010624	OUTCI.	EDSBEG	EDSC2	EDSC3
13.	EDSOFO EDSOFO	12	145	012524	OUTCI. EDF REWIND. EDSFAS	DECD01 INPCI. FEXIST	EDSC2 EDSC2 EDSC7	EDSC1 EDSC3
14.	EDSORT EDSORT	13	106	013464	XTOYS OLOGIO EDSKUT	T4DATX EDSGET OUTCI.	S2DIRX INTORDX SESOUTX EDSCCO EDSC3	SES DATX SESINX EDSC2 EDSC1 EDSC4
15.	GETEOSX GETEOSX	14	171	014330	OPACKX MATCHKX	TABRANX	S2DIRX	EDSCCE
16.	GETINX GETINX	21	201	021107	OPACKX TABRANX	INV30IX MATCHKX	S2DIRX	EDSCCE
17.	GETRPOX GETRPOX	26	139	025611	OPACKX MATCHKX	TABRANX	S2DIRX	EDSCCO
18.	INBUFRX INBUFRX	17	29	016627	UNIT	ROISK		
19.	INV30IX INV30IX	24	166	023711	RATFNIX	ISRCHKX	INTORDX	RTBLKIX
20.	ISRCHKX ISRCHKX	19	55	017303				
21.	MATCHKX MATCHKX	16	22	016437				
22.	RATFNIX RATFNIX	22	128	022237			SES DATX RTBLKIX	INTORDX
23.	T4DATIX T4DATIX	23	124	022770	T4INTPX	RATFNIX	S2DIRX RTBLK2X SESOUTX	RTBLKIX SESINX SES DATX
24.	T4DATX T4DATX	27	130	026551	T4INTPX		S2DIRX SES DATX SESOUTX	RTBLK2X SESINX
25.	T4INTPX T4INTPX	20	289	017702			RTBLK2X SES DATX	INTORDX

26.	T4PTREX T4PTREX	15	156	015403	T4DATIX	ISRCHKX	S2DIRX SESOUTX	SESINX
27.	T4RTPEX T4RTPEX	25	128	024613	T4DATIX		S2DIRX SESOUTX	SESINX
28.	TABRANX TABRANX	28	188	027566	INBUFRX			

1	NO. ENTRY PT:	CALLED BY:				
1	EOSCON	EOSGET				
2	EOSDSL	EOSCON				
3	EOSFAS	EOSEFO	EOSOFO			
4	EOSEFO	EOSGET				
5	EOSBEG	EOSKUT				
6	EOSDRE					
7	EOSDRT					
8	EOSIRT					
9	EOSIPT					
10	EOSKUT	EOSORE	EOSORT	EOSIRT	EOSIPT	EOSORT
11	EOSGET	EOSORE	EOSORT	EOSIRT	EOSIPT	EOSORT
12	EOSOFO	EOSGET				
13	EOSORT					
14	GETEOSX	EOSGET				
15	T4PTREX	EOSIPT				
16	MATCHKX	GETEOSX	GETINVX	GETRPOX		
17	INBUFRX	TABRANX				
18	OPACKX	GETEOSX	GETINVX	GETRPOX		
19	ISRCHKX	T4PTREX	INV301X			
20	T4INTPX	T40ATIX	T4DATX			
21	GETINVX	EOSGET				
22	RATFN1X					

	T4DATIX	INV301X	
23 T40ATIX	EOSORE	T4PTREX	T4RTPEX
24 INV301X	GETINVX		
25 T4RTPEX	EOSIRT		
26 GETRPOX	EOSGET		
27 T40ATX	EOSORT	EOSORT	
28 TABRANX	GETEOSX	GETINVX	GETRPOX

1  
COMMON BLOCK: USED BY:

EOSCCE	EOSCON	EOSDSL	EOSBEG	EOSORT	GETEOSX	GETINVX		
EOSCCO	EOSCON	EOSOSL	EOSBEG	EOSORT	GETRPOX			
EOSCZ	EOSFAS EOSGET	EOSEFD EOSOFD	EOSBEG EOSORT	EOSORE	EOSORT	EOSIRT	EOSIPT	EOSKUT
EOSC1	EOSFAS	EOSEFD	EOSBEG	EOSORT	EOSGET	EOSOFD	EOSORT	
EOSC2	EOSFAS	EOSEFD	EOSBEG	EOSOFD				
EOSC3	EOSEFD EOSOFD	EOSBEG EOSORT	EOSORE	EOSORT	EOSIRT	EOSIPT	EOSKUT	EOSGET
EOSC5	EOSEFD	EOSBEG						
EOSC6	EOSEFD	EOSBEG						
S2DIRX	EOSBEG T4PTREX	EOSORE GETINVX	EOSORT T4DATIX	EOSIRT T4RTPEX	EOSIPT GETRPOX	EOSGET T4DATX	EOSORT	GETEOSX
SES DATX	EOSBEG RATFN1X	EOSORE T4DATIX	EOSORT T4DATX	EOSIRT	EOSIPT	EOSGET	EOSORT	T4INTPX
SESINX	EOSBEG T4DATIX	EOSORE T4RTPEX	EOSORT T4DATX	EOSIRT	EOSIPT	EOSGET	EOSORT	T4PTREX
INTORDX	EOSBEG RATFN1X	EOSORE INV3O1X	EOSORT	EOSIRT	EOSIPT	EOSGET	EOSORT	T4INTPX
EOSC4	EOSBEG	EOSORE	EOSORT	EOSIRT	EOSIPT	EOSGET	EOSORT	
EOSC7	EOSBEG	EOSOFD						
SESOUTX	EOSORE	EOSORT	EOSORT	T4PTREX	T4DATIX	T4RTPEX	T4DATX	
RTBLK2X	T4INTPX	T4DATIX	T4DATX					
RTBLK1X	RATFN1X	T4DATIX	INV3O1X					



APPENDIX C  
TEST PROGRAM

```

1      PROGRAM SES (INPUT,OUTPUT,TAPE6=OUTPUT,TAPE59=TTY,TAPE3)
2 C
3 C      *****
4 C      *
5 C      * PURPOSE-
6 C      *   TO PROVIDE THE APPROPRIATE EOS SCALE FACTORS FOR THE
7 C      *   SYSTEM OF UNITS CHOSEN BY KUNIT (SEE BELOW)
8 C      *
9 C      * INPUT VARIABLES-
10 C      *
11 C      *   LMAT = MATERIAL IN AN A10 FIELD, FOR EXAMPLE- LMAT = "HELIUM"
12 C      *   THE MATERIAL SESAME NUMBER CAN ALSO BE USED TO SPECIFY
13 C      *   THE MATERIAL BY SETTING LMAT TO THE SESAME
14 C      *   NUMBER, FOR EXAMPLE- LMAT = "5760" FOR HELIUM
15 C      *
16 C      *   R = DENSITY (RHO)
17 C      *
18 C      *   E = INTERNAL EN
19 C      *
20 C      *   KEOS = MULTIPLE PARAMETER FLAG TO DESCRIBE HOW TO WRITE
21 C      *   AND RETRIEVE THE DATA FILE. KEOS HAS FOUR DECIMAL DIGITS.
22 C      *
23 C      *   KEOS = 1000*KBR + 100*KUNIT + 10*KREPE + KFN WHERE
24 C      *
25 C      *   KBR = COMPUTATIONAL MODE FLAG TO INDICATE WHICH
26 C      *   QUANTITIES AND THEIR PARTIAL DERIVATIVES ARE TO
27 C      *   BE CALCULATED AND RETURNED BY THE PACKAGE.
28 C      *       = 0  COMPUTE PRESSURE AND TEMPERATURE
29 C      *       = 1  COMPUTE PRESSURE ONLY
30 C      *       = 2  COMPUTE TEMPERATURE ONLY
31 C      *
32 C      *   KUNIT= KIND OF UNITS
33 C      *       0 (SESAMEE) R-G/CC,T-DEG.K,D-CM**2/G,P-GPA,E-MJ/KG
34 C      *       1 (CGS) R-G/CC,T-DEG.K,D-CM**2/GM,P-MUBR,E-ERGS/GM
35 C      *       2 (SIU) R-KG/M**3,T-DEG.K,P-PA,E-J/KG,D-M**2/KG
36 C      *       3 (HYDROXE) R-G/CC,T-DEG.K,P-MBR,E-MBR*CC/GM,D-CM**2/G
37 C      *       4 (HYDROXO) R-G/CC,T-KEV,P-MBR,E-MBR*CC/G,D-CM**2/G
38 C      *       5 (SESAMEO) R-G/CC,T-EV,D-CM**2/G,P-GPA,E-MJ/KG
39 C      *       6 (LASNEX) R-G/CC,T-KEV,D-CM**2/GM,P-JRKS/CC,ED-JRKS/CC
40 C      *
41 C      *   LEGEND-
42 C      *       R = DENSITY
43 C      *       T = TEMPERATURE
44 C      *       D = OPACITY
45 C      *       P = PRESSURE
46 C      *       E = INTERNAL EN
47 C      *
48 C      *       CC = CUBIC CENTIMETER
49 C      *       CM = CENTIMETER
50 C      *       DEG. K = DEGREES KELVIN
51 C      *       EV = ELECTRON VOLT
52 C      *       G = GRAM
53 C      *       GPA = GIGA PASCALS
54 C      *       J = JOULES
55 C      *       JRKS = JERKS
56 C      *       KEV = KILO ELECTRON VOLTS
57 C      *       KG = KILOGRAM
58 C      *       M = METER
59 C      *       MBR = MEGABAR
60 C      *       MUBR = MICROBAR
61 C      *       PA = PASCAL
62 C      *

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63 C      * KREPE = COMPUTATION FLAG TO INDICATE WHETHER E IS
64 C      *      IS TO BE REPRESENTED AS EN PER UNIT MASS OR EN
65 C      *      PER UNIT VOLUME
66 C      *      0 EN IN UNITS OF EN PER UNIT MASS. FOR EXAMPLE-
67 C      *      UNITS OF ERGS/GRAM WHEN KUNIT = 1. THIS IS THE USUAL E.
68 C      *      1 EN IN UNITS OF EN PER UNIT VOLUME. FOR EXAPMLE-
69 C      *      UNITS OF ERGS/CM**3 WHEN KUNIT = 1. THIS IS THE EN
70 C      *      DENSITY RHO*E COMMONLY COMPUTED IN HYDRODYNAMIC
71 C      *      COMPUTER CODES.
72 C      *
73 C      * KFN = KIND OF FUNTION INTERPOLATION IN THE TABLES
74 C      *      = 0 RATIONAL APPROXIMATIONS (ACCURATE)
75 C      *      = 1 BILINEAR APPROXIMATIONS (FAST)
76 C      *
77 C      * IMATE = INDICATES WHETHER TO LOAD THE DATA FILE IF
78 C      *      IT DOES NOT EXIST FOR LMAT OR GO DIRECTLY TO A
79 C      *      PREVIOUSLY LOADED FILE.
80 C      *      =0 CHECK IF THE DATA FILE FOR LMAT HAS BEEN LOADED.
81 C      *      IF NOT, SEARCH FOR THE FILE, CONVERT IT TO THE PROPER UNITS
82 C      *      AND COPY IT INTO LCM USING THE STANDARD SESAME FORMAT.
83 C      *      >0 EQUAL TO THE LMAT TABLE NUMBER. THIS NUMBER WAS RETURNED
84 C      *      BY THE PACKAGE ON A PREVIOUS CALL TO SUBROUTINE EOSDRE.
85 C      *      EOSIPT OR EOSIRT. THIS OPTION IS FASTER THAN IMATE = 0
86 C      *      BECAUSE IT SKIPS SEARCH IN THE DIRECTOR OF THE
87 C      *
88 C      * OUTPUT VARIABLES-
89 C      *
90 C      * P = ARRAY OF DIMENSION 3 CONTAINING THE PRESSURE AND
91 C      *      ITS PARTIAL DERIVATIVES. THIS ARRAY MUST BE DIMENSIONED
92 C      *      EVEN IF THE PARTIAL DERIVATIVES ARE NOT COMPUTED.
93 C      *
94 C      * P(1) = PRESSURE
95 C      * P(2) = DENSITY DERIVATIVE OF THE PRESSURE (DP/DR)
96 C      * P(3) = TEMPERATURE DERIVATIVE OF THE PRESSURE (DP/DE)
97 C      *
98 C      * T = ARRAY OF DIMENSION 3 CONTAINING THE TEMPERATURE AND
99 C      *      ITS PARTIAL DERIVATIVES. THIS ARRAY MUST BE DIMENSIONED
100 C      *      EVEN IF THE PARTIAL DERIVATIVES ARE NOT COMPUTED
101 C      *
102 C      * T(1) = INTERNAL TEMPERATURE
103 C      * T(2) = DENSITY DERIVATIVE OF THE TEMPERATURE (DT/DR)
104 C      * T(3) = EN DERIVATIVE OF THE TEMPERATURE (DT/DE)
105 C      *
106 C      * IMATE = INDICATES THE SUCCESS OR FAILURE OF
107 C      *      LOCATING AND LOADING THE DATA FILE FOR LMAT.
108 C      *
109 C      *      = N>0 MATERIAL TABLE NUMBER (SUCCESS)
110 C      *      0 MATERIAL (LMAT) NOT IN LIBRARY
111 C      *      -N (N>1) INSUFFICIENT STORAGE
112 C      *      THE LCM STORAGE MUST BE INCREASED BY AT LEAST
113 C      *      N STORAGE LOCATIONS. SEE THE EOSMOD MANUAL
114 C      *
115 C      * REMARKS- THIS SUBROUTINE IS PART OF THE EOSMOD PACKAGE
116 C      *
117 C      * SAMPLE DRIVER PROGRAM-
118 C      *
119 C      *      PROGRAM TST(OUTPUT)
120 C      *      DIMENSION P(3),E(3)
121 C      *      LMAT = "HELIUM"
122 C      *      R = 0.001
123 C      *      E = 1.0
124 C      *      KEOS = 110

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125 C      *      IMATE = 0
126 C      *      CALL EOSORE(LMAT,R.E.P.T.KEOS,IMATE)
127 C      *      PRINT 10,P(1)
128 C      *      10 FORMAT(" PRESSURE = ",E10.2," MICROBARS")
129 C      *      CALL EXIT
130 C      *      END
131 C      *
132 C      *      OUTPUT VARIABLES- IN THE COMMON BLOCKS EOSCCE AND EOSCCO
133 C      *      TFACE = TEMPERATURE EOS SCALING FACTOR
134 C      *      RFACE = DENSITY EOS SCALING FACTOR
135 C      *      PFACE = PRESSURE EOS SCALING FACTOR
136 C      *      EFACE = EN EOS SCALING FACTOR
137 C      *
138 C      *      TFACO = TEMPERATURE OPACITY SCALING FACTOR
139 C      *      RFACO = DENSITY OPACITY SCALING FACTOR
140 C      *      OFACO = OPACITY SCALING FACTOR
141 C      *
142 C      *      TBLS = ARRAY FOR STORAGE OF THE EOS TABLES
143 C      *      LCMX = LENGTH OF THE TBLS ARRAY
144 C      *      NRS = UPPER BOUND ON THE NUMBER OF MAT REGIONS LCFW(NRS,)
145 C      *      LCFW = ARRAY USED AS A DIRECTORY BY THE SESAME ROUTINES
146 C      *      IR = MATERIAL REGION NUMBER
147 C      *      IRC = IR (DEFINED TO PERMIT SUBROUTINE CALL
148 C      *      IOS2 = SESAME MATERIAL NUMBER
149 C      *      TBLS = NAME OF AN ARRAY DESIGNATED FOR THE STORAGE OF TABLES
150 C      *      LCNT = CURRENT WORD IN THE ARRAY TBLS
151 C      *      LU41 = UNIT NUMBER ASSIGNED TO THE SESAME INPUT FILE SES2CL
152 C      *      LU42 = UNIT NUMBER ASSIGNED TO THE SESAME INPUT FILE SES2L
153 C      *      LU43 = UNIT NUMBER ASSIGNED TO SES2OP/8 FILES
154 C      *      LU44 = UNIT NUMBER ASSIGNED TO MIXLIB (MIXTURES)
155 C      *      LU45 = UNIT NUMBER ASSIGNED TO MIXLIB DIRECTORY.
156 C      *      KFN = 0 RATIONAL APPROXIMATIONS (ACCURATE)
157 C      *      KFN = 1 BILINEAR APPROXIMATIONS (FAST)
158 C      *      ZB (OUTPUT FROM GETINVX) AT. CHARGE,AT. CHG**2,MASS
159 C      *      IOT = DATA TYPE INDICATOR
160 C      *      MID (ID) MATERIAL ID =1 INVERSE TABLES =2 OPACITY
161 C      *
162 C      *      EXTERNAL FILES TO HANDLE EOS, OPACITIES AND MIXTURES
163 C      *      SES2CL - CLASSIFIED SESAME LIBRARY
164 C      *      SES2L - UNCLASSIFIED SESAME LIBRARY
165 C      *      SES2OP - OPACITY TABLE FROM T4
166 C      *      MIXLIB - PRIVATE (EOS,OPC) TABLES CREATED BY MIXB(OR MIXER)
167 C      *      MIXDIR - DIRECTORY OF MIXTURES ON MIXLIB ( NAME,NO (A10.I3))
168 C      *
169 C      *      EXTERNALS AND COMMON BLOCKS-
170 C      *      SESAME ROUTINES- S2GET,S2EOS
171 C      *      SESAME ROUTINES MATCHKX,TABFCHX,INBUFRX,OPACKX,ISRCHKX,
172 C      *      T4INTPX,GETINVX,RATFN1X,T4DATIX,INV3O1X,T4RTPEX
173 C      *      SESAME COMMON BLOCKS-S2DIRX,RTBLK2X,SESDATX,SESINX,SESOUTX.INTO
174 C      *      EOSMOD COMMON BLOCKS- EDSC1,-7
175 C      *      EOSMOD COMMON (ALSO INSERTED INTO GETINVX) EOSCCE. EOSCCO
176 C      *
177 C      *      LOCAL VARIABLES-
178 C      *      NONE
179 C      *
180 C      *      EXTERNALS AND COMMON BLOCKS-
181 C      *      EOSMOD COMMON BLOCKS- EOSCCE,EOSCCO
182 C      *
183 C      *      REMARKS- THIS SUBROUTINE IS PART OF THE EOSMOD PACKAGE
184 C      *
185 C      *      PROGRAMMER- J. M. HYMAN AND M. KLEIN, GROUP T-7. LASL
186 C      *

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187 C      * REFERENCE- J. M. HYMAN, M. M. KLEIN
188 C      *
189 C      *      EOSMOO- A SUBROUTINE PACKAGE FOR CALCULATING
190 C      *      EQUATIONS-OF-STATE AND OPACITIES
191 C      *      LOS ALAMOS SCIENTIFIC LABORATORY RPT.,LA-8502-M,1980
192 C      *
193 C      *      DATE- MARCH 6, 1980
194 C      *
195 C      *****
196 C      LEVEL 2, TBLS
197 C      COMMON /S2DIR/ LCMX, NRS, LCFW(10.3)
198 C      COMMON /SESOTAT/ TBLS(11000)
199 C      COMMON /SESIN/ IRC, IOT, DUM(2), KBR, DUM1
200 C      COMMON /INTORO/ KFN
201 C
202 C      COMMON BLOCKS FOR THE EOSMOO ROUTINES
203 C      COMMON /EOSC1/ LU41, LU42, LU43, LU44, LU45
204 C      COMMON /EOSC2/ LF41, LF42, LF43, LF44, LF45
205 C      COMMON /EOSC3/ INIT, IROIM, IR(60.3), KUT(60.3)
206 C      COMMON /EOSC4/ NTABLE, NTABLO, IFLP, LCNT
207 C      COMMON /EOSC5/ NMAT, LABMAT(60), IOMAT(60)
208 C      COMMON /EOSC6/ NMCL, LABMCL(60), IOMCL(60)
209 C      COMMON /EOSC7/ NMATO, LABMO(60), IOMATO(60)
210 C
211 C      EOSMOO COMMON BLOCKS USED BY THE MODIFIED SESAME ROUTINES
212 C      COMMON /EOSCCE/ TFACE, RFACE, PFACE, EFACE, KREPE
213 C      COMMON /EOSCCO/ TFACO, RFACO, OFACO, KREPO
214 C
215 C      NAMELIST /INP/ KUNIT,KREP,NLMAT,NBR,NFN,IIPT,IIRT,IDRT,IORE,LCMX
216 C      1 ,NRS,DUM,KBR,DUM1,KFN,INIT,IROIM,NTABLE,NTABLO,IFLP,LCNT,NMAT
217 C      2 ,NMCL,NMATO,TFACE,RFACE,EFACE,KREPE,TFACO,RFACO,OFACO,KREPO,RHO
218 C      3 ,TEMP,PR,EN,IRC,IOT,IORT,NGO
219 C      DATA RHO /0.16/, TEMP /5.E4/, PR /19.2/, EN /310./
220 C
221 C      DATA KUNIT /0/, KREP /0/, NLMAT /2/, NBR /1/, NFN /1/
222 C      DATA IIPT /1/, IORT /1/, IIRT /1/, IORE /1/, IORT /1/, NGO /0/
223 C
224 C      WRITE (3,210)
225 C      DO 10 I=1,NMAT
226 C      WRITE (3,220) LABMAT(I),IDMAT(I)
227 C      10 CONTINUE
228 C
229 C      WRITE (3,230)
230 C      DO 20 I=1,NMATO
231 C      WRITE (3,220) LABMO(I),IOMATO(I)
232 C      20 CONTINUE
233 C
234 C      30 CONTINUE
235 C** READ (59,INP)
236 C
237 C      WRITE (6,160)
238 C
239 C      DO 60 LMATP=1,NLMAT
240 C      LMAT=6HHELIUM
241 C      LMATO=LMAT
242 C      IF (LMATP.EQ.2) LMAT="5760"
243 C      IF (LMATP.EQ.2) LMATO="15760"
244 C
245 C      DO 50 KBRP=1,NBR
246 C      KBR=KBRP-1
247 C
248 C      DO 40 KFNP=1,NFN

```

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249      KFN=KFNP-1
250 C
251      KEDS=1000*KBR+100*KUNIT+10*KREP+KFN
252 C
253      CALL ES (LMAT,LMATO,RHO,TEMP,PR,EN,KEOS,IIPT,IORT,IIRT,IOR,IORE,IORT,1
254      1 )
255 C
256      40 CONTINUE
257      50 CONTINUE
258      60 CONTINUE
259 C
260      WRITE (59,170)
261 C**    READ (59,180) LANS
262      IF (LANS.EQ.1HY) GO TO 30
263 C
264      IF (NGO.GT.0) GO TO (70,80,90,100,110,130), NGO
265 C
266 C    CHECK THE ERROR MESSAGES
267 C
268 C    CHANGE UNITS
269      70 CONTINUE
270      KEDS=KEOS+100
271      CALL ES (LMAT,LMATO,RHO,TEMP,PR,EN,KEOS,IIPT,IORT,IIRT,IOR,IORE,IORT,1
272      1 )
273      KEDS=KEOS-100
274 C
275 C    CHANGE TABLE FORMAT FOR THE ENERGY AND OPACITY REPRESENTATION
276      80 CONTINUE
277      KEDS=KEOS+10
278      CALL ES (LMAT,LMATO,RHO,TEMP,PR,EN,KEOS,IIPT,IORT,IIRT,IOR,IORE,IORT,1
279      1 )
280      KEDS=KEOS-10
281 C
282 C    NON MATERIAL TEST
283      90 CONTINUE
284      LMAT="NOMAT"
285      CALL ES (LMAT,LMATO,RHO,TEMP,PR,EN,KEOS,IIPT,IORT,IIRT,IOR,IORE,IORT,1
286      1 )
287 C
288      LMAT="99999"
289      CALL ES (LMAT,LMATO,RHO,TEMP,PR,EN,KEOS,IIPT,IORT,IIRT,IOR,IORE,IORT,1
290      1 )
291 C
292 C    NEGATIVE DENSITY TEST
293      100 CONTINUE
294      R=-RHO
295      CALL ES (LMAT,LMATO,R,TEMP,PR,EN,KEOS,IIPT,IORT,IIRT,IOR,IORE,IORT,1)
296      GO TO 150
297 C
298 C    CHECK IF ALL THE MATERIALS ARE AVAILABLE
299 C
300 C    EOS MATERIALS CHECK
301      110 CONTINUE
302      DO 120 I=1,NMAT
303 C
304      LMAT=LABMAT(I)
305      CALL ES (LMAT,LMATO,RHO,TEMP,PR,EN,KEOS,0.1,0.0,0.0)
306 C
307      ENCODE (4,190,LMAT) IOMAT(I)
308 C
309      CALL ES (LMAT,LMATO,RHO,TEMP,PR,EN,KEOS,0.1,0.0,0.0)
310 C

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311 120 CONTINUE
312 C
313 C      OPACITY MATERIALS CHECK
314 130 CONTINUE
315      DO 140 I=1,NMATO
316 C
317      LMATO=LABMO(I)
318      CALL ES (LMAT,LMATO,RHO,TEMP,PR,EN,KEOS,O,O,O,O,1,O)
319 C
320      ENCODE (5,200,LMATO) IDMATO(I)
321 C
322      CALL ES (LMAT,LMATO,RHO,TEMP,PR,EN,KEOS,O,1,O,O,O,O)
323 140 CONTINUE
324 150 CONTINUE
325 C
326      CALL EXITA (1)
327 C
328 160 FORMAT ("          KEOS IMATE R      T      P      E")
329 170 FORMAT (" CONTINUE?")
330 180 FORMAT (A1)
331 190 FORMAT (I4)
332 200 FORMAT (I5)
333 210 FORMAT (" THE EOS MATERIALS ARE")
334 220 FORMAT (1X,A10,I10)
335 230 FORMAT (" THE OPACITY MATERIALS ARE")
336      END

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1      SUBROUTINE ES (LMAT,LMATO,RHO,TEMP,PR,EN,KEOS,IIPT,IORT,IIRT,IORE
2      ,IORT,IWNL)
3 C
4 C      *****
5 C      *
6 C      * PURPOSE-
7 C      *
8 C      * INPUT VARIABLE-
9 C      *
10 C     * INPUT-OUTPUT VARIABLES IN THE COMMON BLOCKS EDOCC2 AND EDOCCO
11 C     *
12 C     * EXTERNALS AND COMMON BLOCKS-
13 C     *
14 C     * REMARKS- THIS SUBROUTINE IS PART OF THE EOSMOD PACKAGE
15 C     *
16 C     * PROGRAMMER- J. M. HYMAN AND M. KLEIN, GROUP T-7, LASL
17 C     *
18 C     * REFERENCE- J. M. HYMAN, M. M. KLEIN
19 C     *              EOSMOD- A SUBROUTINE PACKAGE FOR CALCULATING
20 C     *              EQUATIONS-OF-STATE AND OPACITIES
21 C     *              LOS ALAMOS SCIENTIFIC LABORATORY RPT..LA-8502-M.1980
22 C     *
23 C     * DATE- MARCH 22, 1981
24 C     *
25 C     *****
26 C
27     DIMENSION R(3), P(3), T(3), E(3)
28 C
29     LEVEL 2. TBLS
30     COMMON /S2OIR/ LCMX, NRS, LCFW(10,3)
31     COMMON /SESDAT/ TBLS(11000)
32     COMMON /SESIN/ IRC, IOT, DUM(2), KBR, DUM1
33     COMMON /INTORD/ KFN
34 C
35 C     COMMON BLOCKS FOR THE EOSMOD ROUTINES
36     COMMON /EOSC1/ LU41, LU42, LU43, LU44, LU45
37     COMMON /EOSC2/ LF41, LF42, LF43, LF44, LF45
38     COMMON /EOSC3/ INIT, IRDIM, IR(60,3), KUT(60,3)
39     COMMON /EOSC4/ NTABLE, NTABLO, IFLP, LCNT
40     COMMON /EOSC5/ NMAT, LABMAT(60), IDMAT(60)
41     COMMON /EOSC6/ NMCL, LABMCL(60), IDMCL(60)
42     COMMON /EOSC7/ NMATO, LABMO(60), IDMATO(60)
43 C
44 C     EOSMOD COMMON BLOCKS USED BY THE MODIFIED SESAME ROUTINES
45     COMMON /EOSCCE/ TFACE, RFACE, PFACE, EFACE, KREPE
46     COMMON /EOSCCO/ TFACO, RFACO, OFACO, KREPO
47 C
48     NAMELIST /INP/ KUNIT,KREP,NLMAT,NBR,NFN,IIPT,IIRT,IDRT,IORE,LCMX
49     1 ,NRS,DUM,KBR,DUM1,KFN,INIT,IRDIM,NTABLE,NTABLO,IFLP,LCNT,NMAT
50     2 ,NMCL,NMATO,TFACE,RFACE,EFACE,KREPE,TFACO,RFACO,OFACO,KREPO,RHO
51     3 ,TEMP,PR,EN,IRC,IOT,IORT
52 C
53     R(1)=RHO
54     T(1)=TEMP
55     P(1)=PR
56     E(1)=EN
57 C     ***** EOSIPT TEST *****
58 C
59     IF (IIPT.EQ.0) GO TO 10
60     WRITE (6,70)
61     WRITE (3,70)
62     IMATE=0

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63      R(1)=R(2)=R(3)=0.0
64      E(1)=E(2)=E(3)=0.0
65      CALL EOSIPT (LMAT,P,T,R,E,KEOS,IMATE)
66      WRITE (6,60) LMAT,KEOS,IMATE,(R(I),T(I),P(I),E(I),I=1,3)
67      WRITE (3,60) LMAT,KEOS,IMATE,(R(I),T(I),P(I),E(I),I=1,3)
68      IF (IWNL.NE.O) WRITE (3,INP)
69      IF (IMATE.LE.O) IMATE=0
70 C
71      R(1)=R(2)=R(3)=0.0
72      E(1)=E(2)=E(3)=0.0
73      CALL EOSIPT (LMAT,P,T,R,E,KEOS,IMATE)
74      WRITE (6,60) LMAT,KEOS,IMATE,(R(I),T(I),P(I),E(I),I=1,3)
75      WRITE (3,60) LMAT,KEOS,IMATE,(R(I),T(I),P(I),E(I),I=1,3)
76      IF (IWNL.NE.O) WRITE (3,INP)
77      IF (IMATE.LE.O) IMATE=0
78 10 CONTINUE
79 C
80 C ***** EOSDRT TEST *****
81 C
82      IF (IORT.EQ.O) GO TO 20
83      WRITE (6,80)
84      WRITE (3,80)
85      IMATE=0
86      P(1)=P(2)=P(3)=0.0
87      E(1)=E(2)=E(3)=0.0
88      CALL EOSDRT (LMAT,R,T,P,E,KEOS,IMATE)
89      WRITE (6,60) LMAT,KEOS,IMATE,(R(I),T(I),P(I),E(I),I=1,3)
90      WRITE (3,60) LMAT,KEOS,IMATE,(R(I),T(I),P(I),E(I),I=1,3)
91      IF (IWNL.NE.O) WRITE (3,INP)
92      IF (IMATE.LE.O) IMATE=0
93 C
94      P(1)=P(2)=P(3)=0.0
95      E(1)=E(2)=E(3)=0.0
96      CALL EOSDRT (LMAT,R,T,P,E,KEOS,IMATE)
97      WRITE (6,60) LMAT,KEOS,IMATE,(R(I),T(I),P(I),E(I),I=1,3)
98      WRITE (3,60) LMAT,KEOS,IMATE,(R(I),T(I),P(I),E(I),I=1,3)
99      IF (IWNL.NE.O) WRITE (3,INP)
100     IF (IMATE.LE.O) IMATE=0
101 20 CONTINUE
102 C
103 C ***** EOSIRT TEST *****
104 C
105      IF (IIRT.EQ.O) GO TO 30
106      WRITE (6,90)
107      WRITE (3,90)
108      IMATE=0
109      P(1)=P(2)=P(3)=0.0
110      E(1)=E(2)=E(3)=0.0
111      CALL EOSIRT (LMAT,R,T,P,E,KEOS,IMATE)
112      WRITE (6,60) LMAT,KEOS,IMATE,(R(I),T(I),P(I),E(I),I=1,3)
113      WRITE (3,60) LMAT,KEOS,IMATE,(R(I),T(I),P(I),E(I),I=1,3)
114      IF (IWNL.NE.O) WRITE (3,INP)
115      IF (IMATE.LE.O) IMATE=0
116 C
117      P(1)=P(2)=P(3)=0.0
118      E(1)=E(2)=E(3)=0.0
119      CALL EOSIRT (LMAT,R,T,P,E,KEOS,IMATE)
120      WRITE (6,60) LMAT,KEOS,IMATE,(R(I),T(I),P(I),E(I),I=1,3)
121      WRITE (3,60) LMAT,KEOS,IMATE,(R(I),T(I),P(I),E(I),I=1,3)
122      IF (IWNL.NE.O) WRITE (3,INP)
123      IF (IMATE.LE.O) IMATE=0
124 30 CONTINUE

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125 C
126 C ***** EOSORE TEST *****
127 C
128 IF (IDRE.EQ.O) GO TO 40
129 WRITE (6,110)
130 WRITE (3,110)
131 IMATE=O
132 P(1)=P(2)=P(3)=O.O
133 T(1)=T(2)=T(3)=O.O
134 CALL EOSORE (LMAT,R,E,P,T,KEOS,IMATE)
135 WRITE (6,60) LMAT,KEOS,IMATE,(R(I),T(I),P(I),E(I),I=1,3)
136 WRITE (3,60) LMAT,KEOS,IMATE,(R(I),T(I),P(I),E(I),I=1,3)
137 IF (IWNL.NE.O) WRITE (3,INP)
138 IF (IMATE.LE.O) IMATE=O
139 C
140 P(1)=P(2)=P(3)=O.O
141 T(1)=T(2)=T(3)=O.O
142 CALL EOSORE (LMAT,R,E,P,T,KEOS,IMATE)
143 WRITE (6,60) LMAT,KEOS,IMATE,(R(I),T(I),P(I),E(I),I=1,3)
144 WRITE (3,60) LMAT,KEOS,IMATE,(R(I),T(I),P(I),E(I),I=1,3)
145 IF (IWNL.NE.O) WRITE (3,INP)
146 IF (IMATE.LE.O) IMATE=O
147 40 CONTINUE
148 C
149 C ***** EOSORT TEST *****
150 C
151 IF (IORT.EQ.O) GO TO 50
152 KOPC=KEOS
153 WRITE (6,100)
154 WRITE (3,100)
155 IMATO=O
156 DPACITY=O.O
157 CALL EOSORT (LMATO,R,T,DPACITY,KOPC,IMATO)
158 WRITE (6,60) LMAT,KOPC,IMATO,R(1),T(1),DPACITY
159 WRITE (3,60) LMAT,KOPC,IMATO,R(1),T(1),DPACITY
160 IF (IWNL.NE.O) WRITE (3,INP)
161 IF (IMATO.LE.O) IMATO=O
162 C
163 DPACITY=O.O
164 CALL EOSORT (LMATO,R,T,DPACITY,KOPC,IMATO)
165 WRITE (6,60) LMATO,KOPC,IMATO,R(1),T(1),DPACITY
166 WRITE (3,60) LMATO,KOPC,IMATO,R(1),T(1),DPACITY
167 IF (IWNL.NE.O) WRITE (3,INP)
168 IF (IMATO.LE.O) IMATO=O
169 50 CONTINUE
170 C
171 RETURN
172 C
173 60 FORMAT (1X,A10,I4,I3,12(1PE9.2))
174 70 FORMAT (" EOSIPT")
175 80 FORMAT (" EOSORT")
176 90 FORMAT (" EOSIRT")
177 100 FORMAT (" EOSORT")
178 110 FORMAT (" EOSDRE")
179 END

```

## OUTPUT

	KEOS	IMATE	R	T	P	E												
EOSIPT																		
HELIUM	0	11	1.59E-01	5.00E+04	1.92E+01	3.10E+02	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
HELIUM	0	11	1.59E-01	5.00E+04	1.92E+01	3.10E+02	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
EOSORT																		
HELIUM	0	11	1.59E-01	5.00E+04	1.91E+01	3.10E+02	0.	0.	1.15E+02	-1.62E+02	0.	0.	4.73E-04	1.13E-02				
HELIUM	0	11	1.59E-01	5.00E+04	1.91E+01	3.10E+02	0.	0.	1.15E+02	-1.62E+02	0.	0.	4.73E-04	1.13E-02				
EOSIRT																		
HELIUM	0	11	1.59E-01	5.00E+04	1.92E+01	3.10E+02	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
HELIUM	0	11	1.59E-01	5.00E+04	1.92E+01	3.10E+02	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
EOSDRE																		
HELIUM	0	11	1.59E-01	5.00E+04	1.92E+01	3.10E+02	0.	1.43E+04	1.23E+02	0.	0.	8.86E+01	3.82E-02	0.				
HELIUM	0	11	1.59E-01	5.00E+04	1.92E+01	3.10E+02	0.	1.43E+04	1.23E+02	0.	0.	8.86E+01	3.82E-02	0.				
EOSORT																		
HELIUM	0	10	1.59E-01	5.00E+04	1.27E+07													
HELIUM	0	10	1.59E-01	5.00E+04	1.27E+07													
EOSIPT																		
5760	0	11	1.59E-01	5.00E+04	1.92E+01	3.10E+02	0.	1.43E+04	1.23E+02	0.	0.	8.86E+01	3.82E-02	0.				
5760	0	11	1.59E-01	5.00E+04	1.92E+01	3.10E+02	0.	1.43E+04	1.23E+02	0.	0.	8.86E+01	3.82E-02	0.				
EOSORT																		
5760	0	11	1.59E-01	5.00E+04	1.91E+01	3.10E+02	0.	1.43E+04	1.15E+02	-1.62E+02	0.	8.86E+01	4.73E-04	1.13E-02				
5760	0	11	1.59E-01	5.00E+04	1.91E+01	3.10E+02	0.	1.43E+04	1.15E+02	-1.62E+02	0.	8.86E+01	4.73E-04	1.13E-02				
EOSIRT																		
5760	0	11	1.59E-01	5.00E+04	1.92E+01	3.10E+02	0.	1.43E+04	0.	0.	0.	8.86E+01	0.	0.				
5760	0	11	1.59E-01	5.00E+04	1.92E+01	3.10E+02	0.	1.43E+04	0.	0.	0.	8.86E+01	0.	0.				
EOSDRE																		
5760	0	11	1.59E-01	5.00E+04	1.92E+01	3.10E+02	0.	1.43E+04	1.23E+02	0.	0.	8.86E+01	3.82E-02	0.				
5760	0	11	1.59E-01	5.00E+04	1.92E+01	3.10E+02	0.	1.43E+04	1.23E+02	0.	0.	8.86E+01	3.82E-02	0.				
EOSORT																		
5760	0	10	1.59E-01	5.00E+04	1.27E+07													
15760	0	10	1.59E-01	5.00E+04	1.27E+07													
EOSIPT																		
THE UNITS HAVE CHANGED SINCE THE LAST USE OF THE TABLE																		
THE CURRENT VALUES OF KUNIT AND KREP ARE 1 0																		
THE PREVIOUS VALUES OF KUNIT AND KREP WERE 0																		
5760	100	-8	0.	5.00E+04	1.92E+01	0.	0.	1.43E+04	1.23E+02	0.	0.	8.86E+01	3.82E-02	0.				
THE UNITS HAVE CHANGED SINCE THE LAST USE OF THE TABLE																		
THE CURRENT VALUES OF KUNIT AND KREP ARE 1 0																		
THE PREVIOUS VALUES OF KUNIT AND KREP WERE 0																		
5760	100	-8	0.	5.00E+04	1.92E+01	0.	0.	1.43E+04	1.23E+02	0.	0.	8.86E+01	3.82E-02	0.				
EOSORT																		
THE UNITS HAVE CHANGED SINCE THE LAST USE OF THE TABLE																		
THE CURRENT VALUES OF KUNIT AND KREP ARE 1 0																		
THE PREVIOUS VALUES OF KUNIT AND KREP WERE 0																		
5760	100	-8	0.	5.00E+04	0.	0.	0.	1.43E+04	0.	0.	0.	8.86E+01	0.	0.				
THE UNITS HAVE CHANGED SINCE THE LAST USE OF THE TABLE																		
THE CURRENT VALUES OF KUNIT AND KREP ARE 1 0																		
THE PREVIOUS VALUES OF KUNIT AND KREP WERE 0																		
5760	100	-8	0.	5.00E+04	0.	0.	0.	1.43E+04	0.	0.	0.	8.86E+01	0.	0.				
EOSIRT																		
THE UNITS HAVE CHANGED SINCE THE LAST USE OF THE TABLE																		
THE CURRENT VALUES OF KUNIT AND KREP ARE 1 0																		
THE PREVIOUS VALUES OF KUNIT AND KREP WERE 0																		
5760	100	-6	0.	5.00E+04	0.	0.	0.	1.43E+04	0.	0.	0.	8.86E+01	0.	0.				
THE UNITS HAVE CHANGED SINCE THE LAST USE OF THE TABLE																		
THE CURRENT VALUES OF KUNIT AND KREP ARE 1 0																		
THE PREVIOUS VALUES OF KUNIT AND KREP WERE 0																		
5760	100	-8	0.	5.00E+04	0.	0.	0.	1.43E+04	0.	0.	0.	8.86E+01	0.	0.				
EOSDRE																		
THE UNITS HAVE CHANGED SINCE THE LAST USE OF THE TABLE																		
THE CURRENT VALUES OF KUNIT AND KREP ARE 1 0																		
THE PREVIOUS VALUES OF KUNIT AND KREP WERE 0																		

5760	100 -8 0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
THE UNITS HAVE CHANGED SINCE THE LAST USE OF THE TABLE													
THE CURRENT VALUES OF KUNIT AND KREP ARE 1 0													
THE PREVIOUS VALUES OF KUNIT AND KREP WERE 0													
5760	100 -8 0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
EDSORT													
THE DENSITY = 0.		OR THE TEMPERATURE = 0.		IS NONPOSITIVE									
5760	100 -1 0.	0.	0.										
THE DENSITY = 0.		OR THE TEMPERATURE = 0.		IS NONPOSITIVE									
15760	100 -1 0.	0.	0.										
EDSIPT													
THE UNITS HAVE CHANGED SINCE THE LAST USE OF THE TABLE													
THE CURRENT VALUES OF KUNIT AND KREP ARE 0 1													
THE PREVIOUS VALUES OF KUNIT AND KREP WERE 0													
5760	10 -8 0.	5.00E+04	1.92E+01	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
THE UNITS HAVE CHANGED SINCE THE LAST USE OF THE TABLE													
THE CURRENT VALUES OF KUNIT AND KREP ARE 0 1													
THE PREVIOUS VALUES OF KUNIT AND KREP WERE 0													
5760	10 -8 0.	5.00E+04	1.92E+01	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
EDSORT													
THE UNITS HAVE CHANGED SINCE THE LAST USE OF THE TABLE													
THE CURRENT VALUES OF KUNIT AND KREP ARE 0 1													
THE PREVIOUS VALUES OF KUNIT AND KREP WERE 0													
5760	10 -8 0.	5.00E+04	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
THE UNITS HAVE CHANGED SINCE THE LAST USE OF THE TABLE													
THE CURRENT VALUES OF KUNIT AND KREP ARE 0 1													
THE PREVIOUS VALUES OF KUNIT AND KREP WERE 0													
5760	10 -8 0.	5.00E+04	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
EDSIPT													
THE UNITS HAVE CHANGED SINCE THE LAST USE OF THE TABLE													
THE CURRENT VALUES OF KUNIT AND KREP ARE 0 1													
THE PREVIOUS VALUES OF KUNIT AND KREP WERE 0													
5760	10 -8 0.	5.00E+04	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
THE UNITS HAVE CHANGED SINCE THE LAST USE OF THE TABLE													
THE CURRENT VALUES OF KUNIT AND KREP ARE 0 1													
THE PREVIOUS VALUES OF KUNIT AND KREP WERE 0													
5760	10 -8 0.	5.00E+04	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
EDSDRE													
THE UNITS HAVE CHANGED SINCE THE LAST USE OF THE TABLE													
THE CURRENT VALUES OF KUNIT AND KREP ARE 0 1													
THE PREVIOUS VALUES OF KUNIT AND KREP WERE 0													
5760	10 -8 0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
THE UNITS HAVE CHANGED SINCE THE LAST USE OF THE TABLE													
THE CURRENT VALUES OF KUNIT AND KREP ARE 0 1													
THE PREVIOUS VALUES OF KUNIT AND KREP WERE 0													
5760	10 -8 0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
EDSORT													
THE DENSITY = 0.		OR THE TEMPERATURE = 0.		IS NONPOSITIVE									
5760	10 -1 0.	0.	0.										
THE DENSITY = 0.		OR THE TEMPERATURE = 0.		IS NONPOSITIVE									
15760	10 -1 0.	0.	0.										
EDSIPT													
MATERIAL LMAT = NOMAT		NOT FOUND											
NOMAT	0 -1 0.	5.00E+04	1.92E+01	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
MATERIAL LMAT = NOMAT		NOT FOUND											
NOMAT	0 -1 0.	5.00E+04	1.92E+01	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
EDSDRT													
MATERIAL LMAT = NOMAT		NOT FOUND											
NOMAT	0 -1 0.	5.00E+04	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
MATERIAL LMAT = NOMAT		NOT FOUND											
NOMAT	0 -1 0.	5.00E+04	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
EDSIPT													

MATERIAL LMAT = NOMAT	NOT FOUND											
NOMAT 0 -1 0.	5.00E+04 0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
MATERIAL LMAT = NOMAT	NOT FOUND											
NOMAT 0 -1 0.	5.00E+04 0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
EOSDRE												
MATERIAL LMAT = NOMAT	NOT FOUND											
NOMAT 0 -1 0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
MATERIAL LMAT = NOMAT	NOT FOUND											
NOMAT 0 -1 0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
EOSORT												
THE DENSITY = 0.	OR THE TEMPERATURE = 0.											
NOMAT 0 -1 0.	0.											
THE DENSITY = 0.	OR THE TEMPERATURE = 0.											
15760 0 -1 0.	0.											
EOSIPT												
UNABLE TO LOCATE MATERIAL 99999												
IN SUBROUTINE EOSGET												
99999 0 -2 0.	5.00E+04 1.92E+01 0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
UNABLE TO LOCATE MATERIAL 99999												
IN SUBROUTINE EOSGET												
99999 0 -2 0.	5.00E+04 1.92E+01 0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
EOSDRT												
UNABLE TO LOCATE MATERIAL 99999												
IN SUBROUTINE EOSGET												
99999 0 -2 0.	5.00E+04 0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
UNABLE TO LOCATE MATERIAL 99999												
IN SUBROUTINE EOSGET												
99999 0 -2 0.	5.00E+04 0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
EOSIRT												
UNABLE TO LOCATE MATERIAL 99999												
IN SUBROUTINE EOSGET												
99999 0 -2 0.	5.00E+04 0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
UNABLE TO LOCATE MATERIAL 99999												
IN SUBROUTINE EOSGET												
99999 0 -2 0.	5.00E+04 0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
EOSORE												
UNABLE TO LOCATE MATERIAL 99999												
IN SUBROUTINE EOSGET												
99999 0 -2 0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
UNABLE TO LOCATE MATERIAL 99999												
IN SUBROUTINE EOSGET												
99999 0 -2 0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
EOSORT												
THE DENSITY = 0.	OR THE TEMPERATURE = 0.											
99999 0 -1 0.	0.											
THE DENSITY = 0.	OR THE TEMPERATURE = 0.											
15760 0 -1 0.	0.											
EOSIPT												
UNABLE TO LOCATE MATERIAL 99999												
IN SUBROUTINE EOSGET												
99999 0 -2 0.	5.00E+04 1.92E+01 0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
UNABLE TO LOCATE MATERIAL 99999												
IN SUBROUTINE EOSGET												
99999 0 -2 0.	5.00E+04 1.92E+01 0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
EOSDRT												
UNABLE TO LOCATE MATERIAL 99999												
IN SUBROUTINE EOSGET												
99999 0 -2 0.	5.00E+04 0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
UNABLE TO LOCATE MATERIAL 99999												
IN SUBROUTINE EOSGET												
99999 0 -2 0.	5.00E+04 0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
EOSIRT												

```

UNABLE TO LOCATE MATERIAL 99999
IN SUBROUTINE EOSGET
99999      0 -2 0.      5.00E+04 0.      0.      0.      0.      0.      0.      0.      0.      0.
UNABLE TO LOCATE MATERIAL 99999
IN SUBROUTINE EOSGET
99999      0 -2 0.      5.00E+04 0.      0.      0.      0.      0.      0.      0.      0.
EOSORE
UNABLE TO LOCATE MATERIAL 99999
IN SUBROUTINE EOSGET
99999      0 -2 0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
UNABLE TO LOCATE MATERIAL 99999
IN SUBROUTINE EOSGET
99999      0 -2 0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
EOSORT
THE DENSITY, = 0.      OR THE TEMPERATURE = 0.      IS NONPOSITIVE
99999      0 -1 0.      0.      0.
THE DENSITY = 0.      OR THE TEMPERATURE = 0.      IS NONPOSITIVE
18760      0 -1 0.      0.      0.

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