

# **KBView**

**Field Precision**

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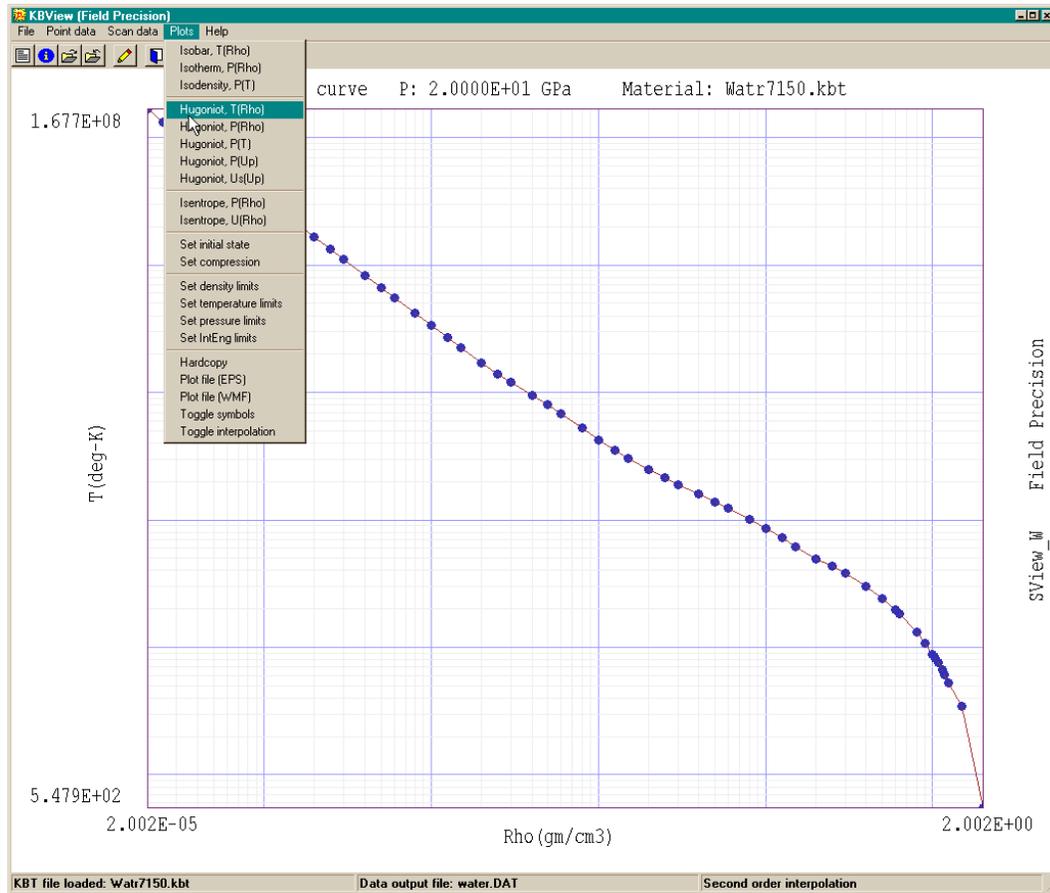


Figure 1. KBView screen shot.

**KBView** is an interactive program that uses the KB Tables to determine and to display the properties of materials over wide ranges of density ( $\rho$ ), temperature ( $T$ ) and pressure ( $P$ ).

**KBView** has the following capabilities:

- Equation-of-state calculator to find  $\rho(P,T)$ ,  $P(\rho,T)$ ,  $T(\rho,P)$ ,  $U(\rho,T)$ ,  $T(\rho,\epsilon)$  and  $c_s(\rho,T)$ , where  $U$  is the internal energy and  $c_s$  is the sound speed.
- Parameter scans over a range of values of the types  $\rho(P,T)$ ,  $P(\rho,T)$ ,  $T(\rho,P)$  and  $u(\rho,T)$ .
- Plots and listings of isobars [ $T(\rho)$ ], isotherms [ $P(\rho)$ ] and isodensity lines [ $P(T)$ ].
- Calculation of Hugoniot curves with plots and listings of  $T(\rho)$ ,  $P(\rho)$ ,  $P(T)$ ,  $P(u_p)$ , and  $u_s(u_p)$ , where  $u_p$  is the material speed behind a shock and  $u_s$  is the shock speed.
- Calculation of isentropes with plots and listings of  $p(\rho)$  and  $U(\rho)$ .

The program has several convenient features including: optional file listings of all calculations, automatic grids and scaling on plots, and hardcopy to any installed Windows printer. You can run `KBVIEW.EXE` directly or from `KB.EXE`, the **KB** program launcher. For ease of use, **KBView** uses a set of practical units rather than the standard SI units used in the **KB Tables**. Table 1 shows a comparison of units.

Table 1. Units used in <b>KBView</b> and <b>KB Tables</b>			
Quantity	<b>KBView</b> units	<b>KB Table</b> units	Conversion (to SI)
Density, $\rho$	gm/cm <sup>3</sup>	kg/m <sup>3</sup>	1000.0
Temperature, $T$	°K	°K	1.0
Pressure, $P$	GPa	Pa	10 <sup>9</sup>
Internal energy, $U$	MJ/kg	J/kg	10 <sup>6</sup>
Velocity, $u_p$ or $u_s$	km/s	m/s	1000.0

## File menu

Figure 1 shows the **KBView** screen display. The program is a full-featured Windows utility with pull-down menus, toolbar, status bar and built-in editor. When **KBView** starts only the *File* and *Help* menus are active. The analysis functions become active after a data file is loaded. The *File* menu contains the following commands:

### Load material

The first step in an analysis session is to load a **KB** material file. The program displays a dialog that lists files in the current directory with suffix `KBT`. Pick a file and click *Open*. You can change the working directory from within the dialog. After the material loads the program displays a box with information on the file. Click *OK* to continue. The **KB** tables contain the pressure and internal energy as functions of the material density and temperature. The message box shows the number of entries and the ranges of  $\rho$  and  $T$ . When you exit the dialog all menu functions are active. The first tool on the toolbar performs the *Load material* function. To see the functions of the other tools, suspend the mouse cursor over the tool until a description appears.

### Material file info

If you want to check on parameter ranges in the current table, use this command to display the file information box.

### Open data file

The analysis functions you perform in **KBView** can be recorded permanently in an ASCII data file. Use this command to open a file and store information from subsequent operations. Enter a prefix (1-8 characters) for the file. Information will be written to a file PREFIX.DAT in the current directory until you 1) open a different file, 2) close the file with the *Close data file* command, or 3) exit **KBView**.

### Close data file

This command terminates file listings and closes the current data file. Be sure to close a data file before you attempt to *Edit* it.

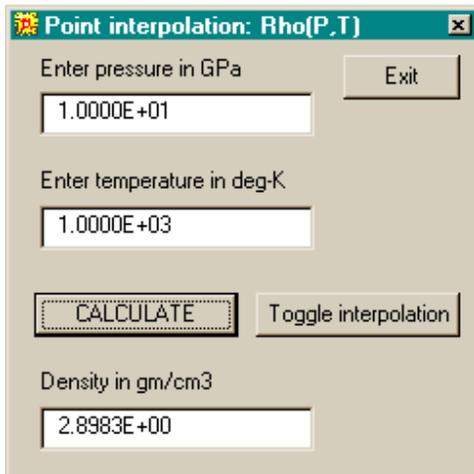
### Edit file

This command brings up Windows editor for ASCII files. You can view **KBView** data files or directly inspect KB Tables.

## Point data menu

The commands in this menu call up a set of equation-on-state calculators that perform single-point interpolations on the KB Tables (Figure 2). A common application is to check whether a choice of  $\rho$  and  $T$  for initial material conditions in **KB1** or **KB2** leads to valid interpolations for  $P$  and  $U$ .

Enter the two known quantities, press *Calculate*, and **KBView** displays the results using the current interpolation method. The *Interpolation* button toggles between first and second order interpolations. Click on *Exit* when you are finished. Note that the  $c_s$  (sound speed) calculation may be inaccurate at low temperatures where some of the tables are coarse. If a data file is open, **KBView** records calculator results. Note that the program also records KB Table information in the listing file when the data file is opened or when a new material is loaded.



```

Point calculation of Rho(P,T)
  Pressure:  1.0000E+01 (Gpa)
  Temperature: 1.0000E+03 (deg-K)
  >> Density: 2.8983E+00 (gm/cm3)

```

**Figure 2**

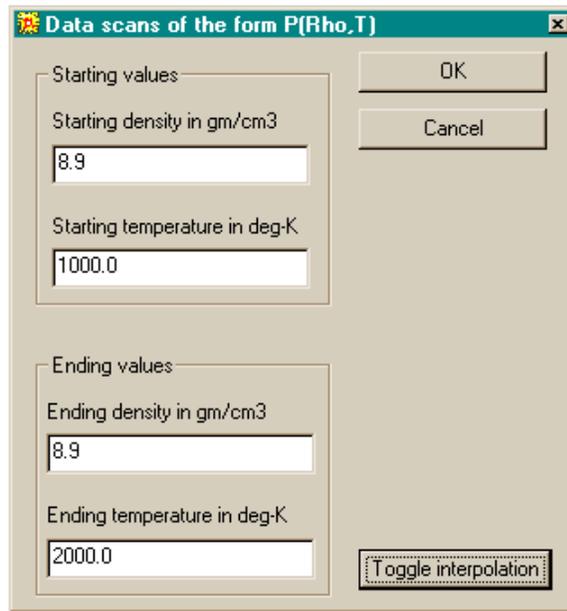
There are six commands that control the type of calculation:

- Rho(P,T)**
- P(Rho,T)**
- T(Rho,P)**
- U(Rho,T)**
- T(Rho,U)**
- Cs(Tho,T)**

The default interpolation method is a least-squares fit of a second-order two-dimensional function. The first order function has reduced accuracy and a shorter calculation time.

## Scan data menu

The commands in this menu create scan listings of EOS calculations of the following types:  $\rho(P,T)$ ,  $P(\rho,T)$ ,  $T(\rho,P)$  and  $U(\rho,T)$ . When you choose one on these options the program displays a dialog box where you set limits for the independent variables (Figure 3). The program then determines the dependent variable for linear variations of the dependent variables over the ranges and makes a screen listing. **KBView** also records the information if a data file is open.



**Figure 3.** Input dialog for *Scan data* commands.

```

--- Listing of P(Rho,T) ---
Rho(gm/cm3)      T(deg-K)          P(GPa)
=====
8.900000E+00    1.000000E+03     3.152812E+01
8.900000E+00    1.066667E+03     3.192849E+01
8.900000E+00    1.133333E+03     3.233742E+01
8.900000E+00    1.200000E+03     3.275491E+01
8.900000E+00    1.266667E+03     3.319781E+01
8.900000E+00    1.333333E+03     3.361512E+01
8.900000E+00    1.400000E+03     3.403674E+01
8.900000E+00    1.466667E+03     3.446266E+01
8.900000E+00    1.533333E+03     3.475091E+01
8.900000E+00    1.600000E+03     3.521508E+01
8.900000E+00    1.666667E+03     3.571996E+01
8.900000E+00    1.733333E+03     3.626556E+01
8.900000E+00    1.800000E+03     3.685952E+01
8.900000E+00    1.866667E+03     3.744762E+01
8.900000E+00    1.933333E+03     3.806861E+01
8.900000E+00    2.000000E+03     3.872248E+01

```

The following commands appear in the *Scan data* menu:

**Rho(P,T)**

**P(Rho,T)**

**T(Rho,P)**

**U(Rho,T)**

Open a dialog to set scan ranges and then perform the requested number of calculations. Data is listing on the screen and optionally to a listing file.

**Number of points**

Changes the number of calculated points (Default: 25).

## Plot menu

**KBView** generates several two-dimensional plots for hydrodynamic analyses. The plots are normally created on the screen, but can be directed to any hardcopy copy device supported by Windows or plot files in two formats: Encapsulated PostScript (EPS) or Windows Metafile Format (WMF). The Plot menu includes the following commands.

**Isobar, Isotherm, Isodensity**

The first three commands plot the following quantities: isobar ( $T(\rho)$  at constant  $P$ ), isotherm, ( $P(\rho)$  at constant  $T$ ) and isodensity ( $P(T)$  at constant  $\rho$ ). The program prompts for a value of the constant quantity before each plot. Note that it may not be possible to perform the given interpolation over the full range of the table.

The next set of commands plots material properties behind a one-dimensional shock calculated from the Hugoniot equation.

$$\left( \frac{1}{\rho_0} - \frac{1}{\rho_1} \right) \left( \frac{P_1 + P_0}{2} \right) = U_1 - U_0.$$

The equation follows from conservation of mass, momentum and energy across the shock front. The quantities  $\rho_0$ ,  $P_0$  and  $U_0$  are the initial density, pressure and internal energy of the material and the quantities  $\rho_1$ ,  $P_1$  and  $U_1$  represent the state behind the shock. When a material is loaded, **KBView** fills arrays of values for quantities on the Hugoniot curve for a default initial state. The default state is calculated with  $\rho_0$  equal to the normal density entry in the KB Table and  $T_0$  equal to 300 °K. The program attempts to find values of  $P_1$ ,  $T_1$  and  $U_1$  through interpolations at each tabulated value of  $\rho$ . Depending on the initial state, the calculation may not be possible for all density entries. The conservation laws also give values for  $u_s$  (the shock velocity) and  $u_p$  (the velocity of the medium behind the shock called the *particle velocity*). The initial particle velocity of the medium is taken equal to zero. You can apply the results to moving media by making a coordinate transformation. **KBView** updates the Hugoniot arrays under three conditions: 1) a new material is loaded, 2) the interpolation parameters are changed or 3) the initial state is changed.

The following commands plot Hugoniot curves with several choices of dependent and independent variables.

**Hugoniot, P(Rho)**

**Hugoniot, T(Rho)**

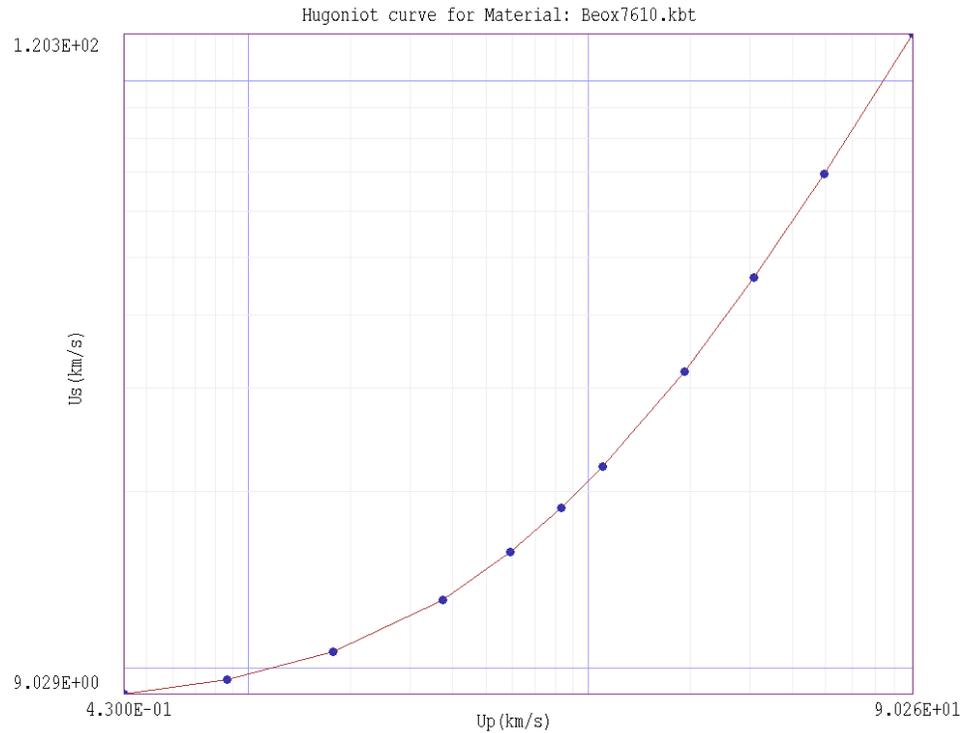
**Hugoniot, P(T)**

**Hugoniot, P(up)**

**Hugoniot, up(us)**

The next set of commands initiates plot of isentropes. Isentropic curves follow changing material properties from an initial state along a path that preserves entropy. In other words, the process is reversible. **KBView** computes *isentropic compressions* where the density changes from an initial value  $\rho_0$  to a final density  $C_f \rho_0$  at constant temperature. Here,  $C_f$  is a compression factor with default value  $C_f = 100$ . The equation for an isentropic compression is

$$dU = - p d(1/\rho) = p d\rho / \rho^2.$$



**Figure 4.** Hugoniot curve calculation

**KBView** solves the equation and fills isentrope arrays using table interpolations and a two-step integration method. The integration starts from the initial material state and proceeds to the final compressed density. Ideally the temperature remains close to *TempInit*. The arrays are updated under the same circumstances as the Hugoniot arrays.

The following commands plot isentropic compression curves with two choices of dependent and independent variables.

**Isentrope, P(Rho)**

**Isentrope, U(Rho)**

The final set of commands control plot parameters and initiates hardcopy.

### **Set initial state**

Hugoniot and isentropic calculations start from an initial state of the material. Use this command if you want to change the default values. The program displays the EOS calculator (Figure 2). Supply values of  $\rho_o$  and  $T_o$ . You can use the *Calculate* button to check that the values give a valid interpolation for the pressure. Change the interpolation method if necessary. Click on *Exit* to set the values.

### **Set compression**

Set the quantity  $C_f$  to define the density range of the isentropic calculation.

### **Hardcopy**

#### **Plot file (EPS)**

#### **Plot file (WMF)**

These commands initiate output of the current screen plot. They will not function unless you have created a screen plot. The *Hardcopy* option sends the plot to the Windows Default Printer. If you want to pick a different printer driver, you must change the Windows default. You can call up the *Control Panel* while program is operating. For plot files, **KBView** prompts for the file prefix and creates the file in the current directory. PostScript files have the suffix EPS and Windows Metafiles have the suffix WMF.

## **Help menu**

You can display an HTML text version of this manual within the program using the *KBView manual* command or tool. The command calls up your default browser and loads the file KBVIEW.HTM. This file should be located in the same directory as the executable program KBVIEW.EXE.