# INTRODUCTION

EnSight provides a powerful capability to derive new variables from existing variables and parts. For example, in a fluids dynamics problem, if you have momentum, density, and stagnation energy you can calculate temperature, Mach number, pressure, or velocity. In addition to the built-in functions, you can also compose your own functions using the equation editor in conjunction with previously defined variables.

This article is divided into the following sections:



# BASIC OPERATION

## Introduction

EnSight provides five distinct types of variables:

| | |
|---|---|
| Constant | A constant variable is a single value. Constants do not vary across a part although a constant can vary over time. Examples include Analysis_Time, Temperature[123] (the value of temperature at node 123), Stress{3}[321] (the value of stress at node 321 at time step 3), or the value of a function that produces a constant (*e.g.* Area). |
| Scalar | A scalar variable is a set of values: one for each node or element of the applicable part(s). Examples include Pressure, Velocity[Z] (the Z component of velocity), Stress{3} (the value of stress at time step 3), or the value of a function that produces a scalar (*e.g.* Flow) |
| Vector | A vector variable is a set of values: three (the X,Y,Z components) for each node or element of the applicable part(s). Examples include Velocity, Velocity{3} (the value of velocity at time step 3), Coordinates (a given variable equal to the XYZ coordinate at a node), or the value of a function that produces a vector (*e.g.* Vorticity). |
| Tensor | A tensor variable is a set of values: six (if symmetric) or nine (if asymmetric), for each node or element of the applicable part(s). Tensor variables can be represented by Tensor Glyphs directly, and within the variable calculator eigenvalues, eigenvectors, determinant, VonMises or Tresca, etc. can be computed. |
| Complex | A complex variable, which within Ensight can be either scalar or vector, includes the real and imaginary portions of the values. The variable calculator allows the user to compute things like modulus, argument, transient response, etc. |

Variables are either *given* (read from the dataset or automatically provided by EnSight) or *computed* (derived from existing variables during an EnSight session). The variable type and whether it is given (shown as “Gvn”) or computed (shown as “Cmp”) are shown in the Variables list in the Feature Detail Editor for Variables. If you have any element-based variables in a model, the variable names in the Main Variables list will be preceded by “(E)” for element-based or “(N)” for node-based.

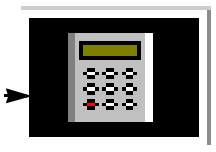
Every non-constant variable (both given as well as computed) has an associated color palette that defines the mapping from variable values to color. These palettes can be edited to change the mapping (see **How To Edit Color Maps** for details). The value of a constant variable can be displayed as a text string in the Graphics Window (see **How To Create Text Annotation** for details).

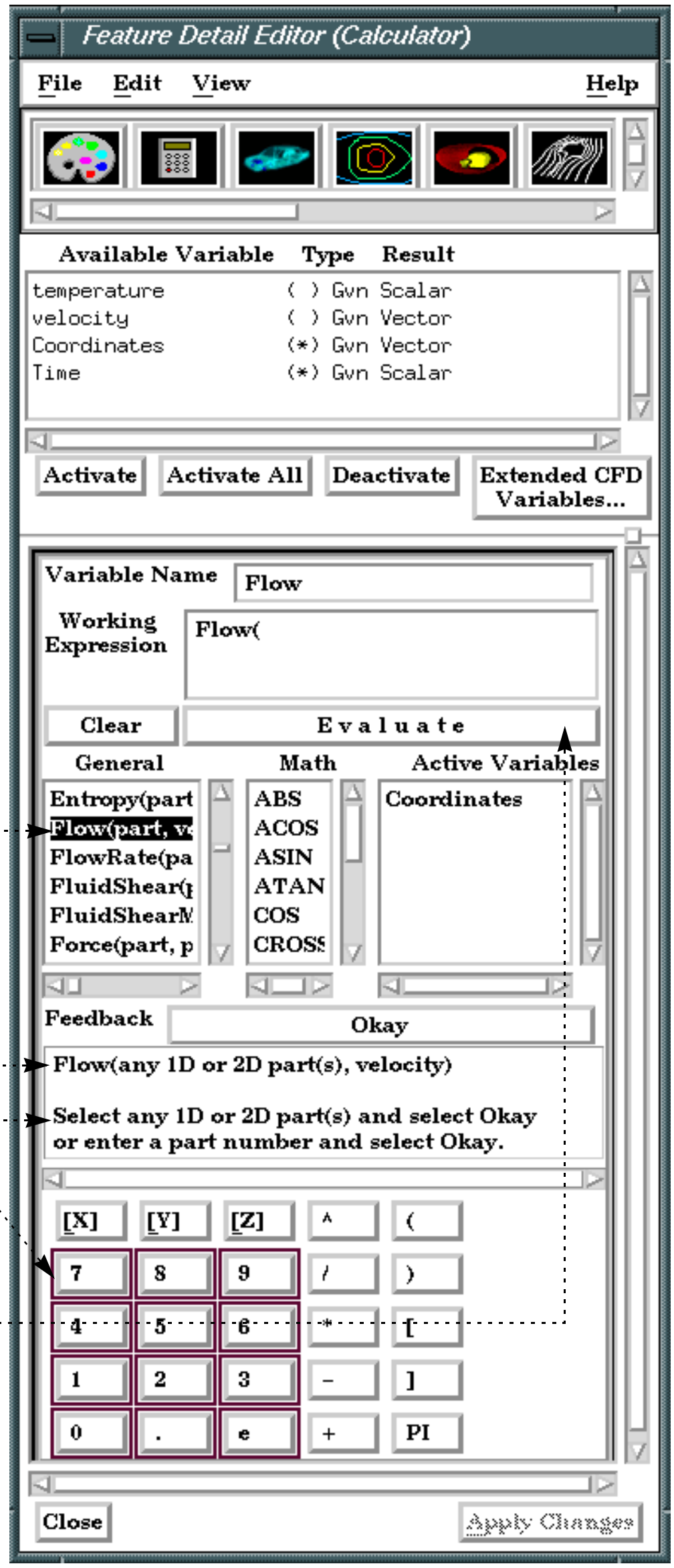
For time-dependent data, calculated variables will automatically recalculate when the current time step is changed.

## Variable Creation

Derived variables are easily created using the **Feature Detail Editor Variable Calculator**. To create new variables:

**1. Double-click the Variable Calculator icon in the Feature Icon bar to open the Feature Detail Editor (Calculator).**






**3. Select the desired function from the General list or the Math list.**

When you select a function, the Variable Name field (at the top of the section) is loaded with the name of the function. This will be the name of the variable as seen in the Main Variables list. You can change this name by entering a new value (and pressing return).

A description of the function parameters appears in the feedback section, as well as instructions for properly composing the required parameters.

The expression is built in the Working Expression section. As you insert parameters, they are automatically added to the expression and the instructions for the next parameter will appear. Parameters can be inserted as follows:

**Parts**: by selecting the desired part(s) in the Main Parts list (and clicking Okay) or by entering the part number directly in the Working Expression area. Note that the place holder “plist” appears in the expression denoting the list of currently selected parts.

**Variables**: by clicking on the desired variable in the Active Variables list.

**Constants/other**: by typing the desired constant or other text directly into the Working Expression or by clicking the desired item in the Calculator keypad.

**4. Follow the instructions to build the desired expression and then click Evaluate.**

# Examples of Expressions

The following examples demonstrate usage of the variable calculator. In each case, first enter a name in the Variable Name field and click in the Working Expression area to activate it. The examples assume that Analysis_Time (a given constant variable if the dataset is transient), pressure, density, and velocity are all given variables.

| Expression | Description and How to Build |
|---|---|
| `-13.5/3.5` | A simple constant.<br>To build, either type the text on the keyboard or click in the Calculator keypad. |
| `Analysis_Time/60.0` | A constant variable. Assuming the solution time was given in seconds, this expression will provide a variable giving the time in minutes.<br>To build, select `Analysis_Time` from the Active Variable list and either type or click `/60.0`. |
| `velocity*density` | Momemtum – a vector variable.<br>To build, select `velocity` from the Active Variable list, click or type `*`, and select `density` from the Active Variable list. |
| `SQRT(pressure[73]*2.5) + velocity[X][73]` | Square root of (`pressure` at node 73 * 2.5 + the X component of `velocity` at node 73)<br>To build, select `SQRT` from the Math function list, select `pressure` from the Active Variable list, click or type `[73]*2.5)+`, select `velocity` from the Active Variable list, and click or type `[X][73]`. |
| `pressure{19}` | Scalar variable equal to `pressure` at time 19. This variable *will not* change if the current time step is changed.<br>To build, select `pressure` from the Active Variable list and click or type `{19}`. |
| `MAX(plist, pressure)` | Constant variable equal to the maximum value for `pressure` over all nodes of all parts in `plist`.<br>To build, select `MAX` from the General function list and follow the instructions in the Feedback area. |
| `(pressure/max_pres)^2` | Scalar variable equal to squared normalized `pressure`.<br>To build, first calculate the `MAX` constant variable as described in the preceding example (here named `max_pres`). Click or type `(`, select `pressure` from the Active Variable list, click or type `/`, select `max_pres` from the Active Variable list, and click or type `)^2`. |

## Built-in Function Reference

Although all built-in functions are listed here, consult the **User Manual** in the User Manual for the complete definition of a function. EnSight provides the following built-in general variable calculation functions:

| Function | Abbreviation (if any) | Description |
|---|---|---|
| Area | | Surface area |
| Case Map | CaseMap | Map values of a variable from one case onto the nodes of another case. |
| Coefficient | Coeff | Coefficient |
| Complex | Cmplx | Create complex variable from variables representing the real and imaginary portions. |
| Complex Argument | CmplxArg | Argument of complex variable |
| Complex Conjugate | CmplxConj | Conjugate of complex variable |
| Complex Imaginary | CmplxImag | Imaginary portion of complex variable |
| Complex Modulus | CmplxModu | Modulus of complex variable |
| Complex Transient Response | CmplxTransResp | Complex transient response |
| Complex Real | CmplxReal | Real portion of complex variable |
| Curl | | Curl of a vector |
| Divergence | Div | Divergence |
| Dynamic Pressure | PresDynam | |
| Element to Node | ElemToNode | Make a node-based variable from an element-based variable (via average) |
| Enthalpy | | |
| Entropy | | |

| Function | Abbreviation (if any) | Description |
|---|---|---|
| Flow | | Integrated flow through 1D/2D part |
| Flow Rate | FlowRate | |
| Fluid Shear Stress | FluidShear | Fluid shear stress |
| Fluid Shear Stress Max | FluidShearMax | Max of fluid shear stress |
| Force | | Force Vector |
| Gradient | Grad | 3D gradient of a variable |
| Gradient Approximation | GradApprox | Linear, closed-form gradient approximation |
| Gradient Tensor | GradTensor | 3D tensor gradient |
| Gradient Tensor Approximation | GradTensorApprox | Linear, closed-form tensor gradient approximation |
| Helicity Density | HelicityDensity | |
| Helicity Relative | HelicityRelative | |
| Helicity Relative Filtered | HelicityRelFilter | |
| Iblanking Values | IblankingValues | Scalar that is the iblanking flag per node |
| Kinetic Energy | KinEn | Kinetic energy |
| Length | | Summed length of all 1D elements |
| Line Integral | IntegralLine | Integral over 1D elements |
| Log of Normalized Density | DensityLogNorm | |
| Log of Normalized Pressure | PresLogNorm | |
| Log of Normalized Temperature | TemperLogNorm | |
| Mach Number | | Mach number |
| Make Vector | MakeVect | Build a vector variable from scalars |
| Mass Flux Average | MassFluxAvg | |
| Maximum | Max | Find max of variable over part(s) |
| Minimum | Min | Find min of variable over part(s) |
| Moment | | Moment component of a force component based on the current position of the Cursor Tool |
| Momentum | Momentum | |
| Node To Element | NodeToElem | Make an element-based variable from node-based (via average) |
| Normal | | Surface normal vector |
| Normal Constraints | NormC | NC |
| Normalized Density | DensityNorm | |
| Normalized Enthalpy | EnthalpyNorm | |
| Normalized Pressure | PresNorm | |
| Normalized Stagnation Density | DensityNormStag | |
| Normalized Stagnation Enthalpy | EnthalpyNormStag | |
| Normalized Stagnation Pressure | PresNormStag | |
| Normalized Stagnation Temp. | TemperNormStag | |
| Normalized Temperature | TemperNorm | |
| Normalized Vector | NormVect | Vector field expressed as unit vectors. |
| Offset Variable | OffsetVar | Variable Value that exists offset from the boundary of the part into the field |
| Pitot Pressure | PresPito | |
| Pitot Pressure Ratio | PresPitoRatio | |
| Pressure | Pres | Pressure |
| Pressure Coefficient | PresCoef | |

| Function | Abbreviation (if any) | Description |
|---|---|---|
| Rectangular To Cylindrical Vector | RectToCyl | Calculate vector in cylindrical coordinates |
| Shock Plot3d | ShockPlot3d | |
| Sonic Speed | SonicSpeed | |
| Spatial Mean | SpaMean | Mean of a variable over a part |
| Speed | | Magnitude of velocity |
| Stagnation Density | DensityStag | |
| Stagnation Enthalpy | EnthalpyStag | |
| Stagnation Pressure | PresStag | |
| Stagnation Pressure Coefficient | PresStagCoef | |
| Stagnation Temperature | TemperStag | |
| Stream Function | Stream | Stream |
| Surface Integral | IntegralSurface | Integral over 2D elements |
| Swirl | Swirl | |
| Temperature | | Temperature |
| Temporal Mean | TempMean | Mean of a variable over time |
| Tensor Component | TensorComponent | Component of a tensor variable |
| Tensor Determinant | TensorDeterminant | Determinant of a tensor variable |
| Tensor Eigenvalue | TensorEigenvalue | Eigenvalue of a tensor |
| Tensor Eigenvector | TensorEigenvector | Eigenvector of a tensor |
| Tensor Make | TensorMake | Make tensor from variables representing components |
| Tensor Tresca | TensorTresca | Tresca failure theory of a tensor |
| Tensor Von Mises | TensorVonMises | Von Mises failure theory of a tensor |
| Total Energy | TEnergy | Total Energy |
| Total Pressure | TPres | Total pressure |
| Velocity | Velo | Momentum/density |
| Volume | Vol | Volume of 3D elements |
| Volume Integral | IntegralVolume | Integral over 3D elements |
| Vorticity | Vort | Vorticity |

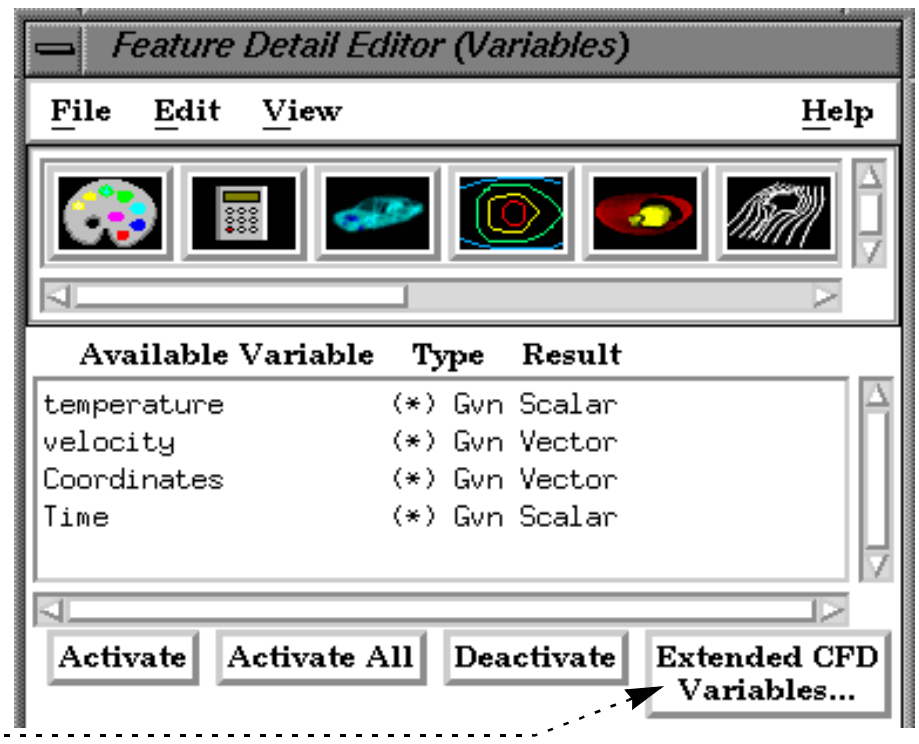
The following standard math functions are also available:

| Function | Abbreviation |
|---|---|
| Absolute Value | ABS |
| Arccosine | ACOS |
| Arcsine | ASIN |
| Arctangent | ATAN |
| Cosine | COS |
| Cross Product | CROSS |
| Dot Product | DOT |
| Exponent | EXP |
| Log Natural | LOG |
| Log Base 10 | LOG10 |
| Root Mean Squared | RMS |
| Sine | SIN |
| Square Root | SQRT |
| Tangent | TAN |

## Extended CFD Variables

Rather than having to individually create the various common CFD variables, EnSight can automatically make them available for use if the appropriate basis variables and constants have been provided. This can be accomplished after loading the model with the Extended CFD Variable Settings Dialog:

1. **From either the Variable or the Calculator Feature Detail Editor, click the Extended CFD Variables... button.**




2. **Select the variable name in the list and then click the appropriate SET button.**

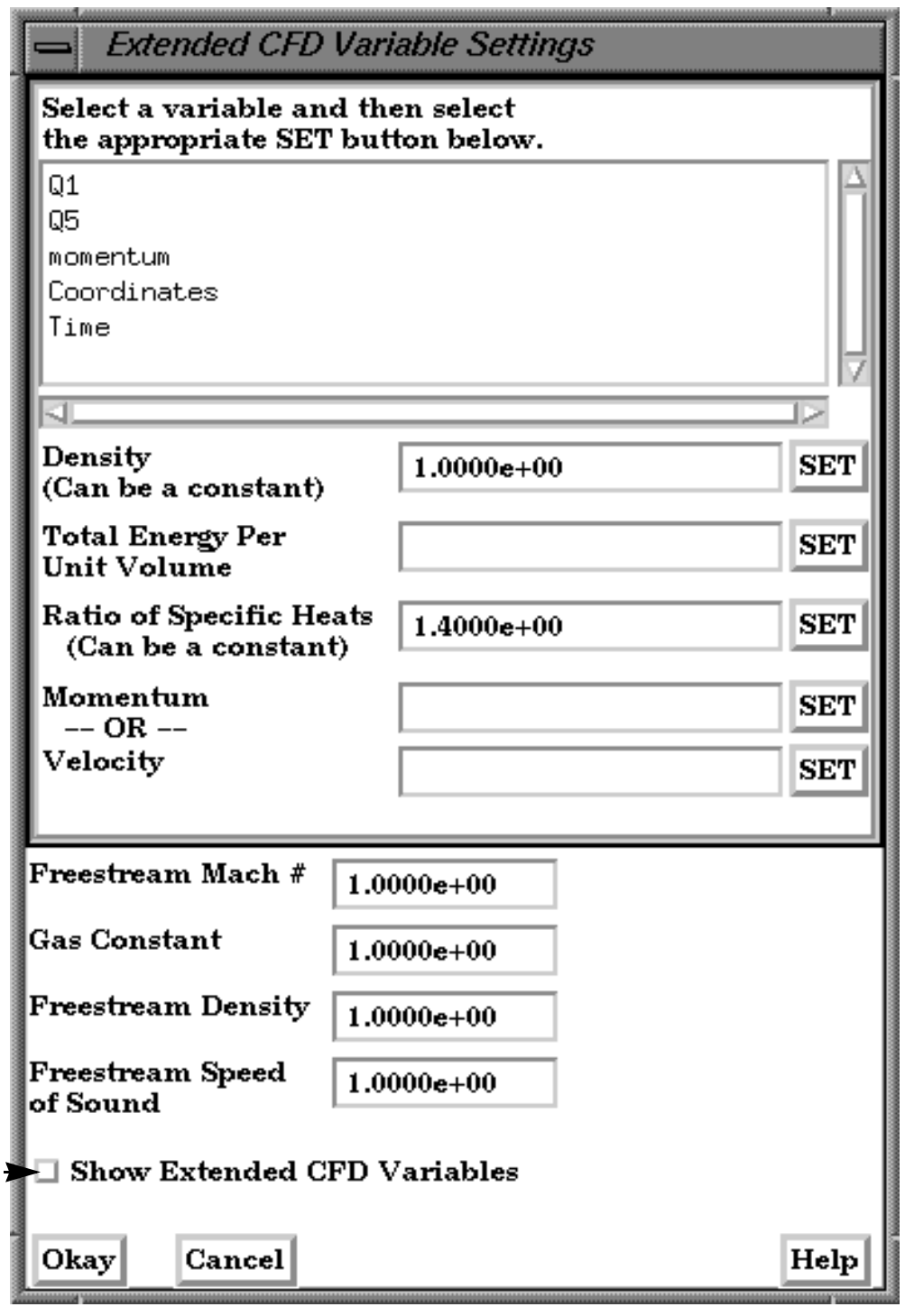
For example, select Q1 in the list and then click the SET button to right of the Density field.

3. **After all variables and constants have been specified, click Show Extended CFD Variables.**

4. **Click Okay.**

The common CFD variables will now be listed in the main variables list. Note that they will NOT actually be computed until activated.

If you have a “standard” PLOT3D Q file, the above process can be accomplished automatically by starting EnSight with the “`-cfd`” option on the command line.




## See Also

**How to Edit Color Maps**

User Manual: **Variable Creation**