Getting Started
with the
Simple Hydraulic Calculator

version 2.3.7

Table of Contents

Introduction

Welcome to the *Simple Hydraulic Calculator* (*SHC* for short). *SHC* is a full featured hydraulic calculation program designed from the ground up for automatic sprinkler system designers and engineers *by an automatic sprinkler system designer / computer engineer*.

SHC is a command based data entry program. This approach to data entry provides industry leading flexibility and speed for anyone willing to learn a few simple commands. And *SHC*'s advanced data editor will help.

Many of *SHC's* useful capabilities and program features are:

New in Version 2.3

- Simple Hydraulic Calculator's ability to successfully find a solution has been measurably enhanced.
- Simple Hydraulic Calculator's editor has gained the following abilities:
  - Quickly change selected Node commands to Head commands (menu item **Edit → Change → node to Head**).
  - Quickly change selected Head commands to Node commands (menu item **Edit → Change → head to Node**).
  - Quickly comment / uncomment selected lines (menu item **Edit → Change → toggle comment**).

Philosophical

- *SHC* is shareware. Try it before you buy it - anonymously - we want you to!
- *SHC* **does not expire** and uses **plain text** data files. What this means for you -
  - NO ANNUAL FEES!
  - NO VENDER LOCK-IN! Have you ever been forced to pay a quarterly or annual “maintenance” fee or risk losing access to YOUR data files? Some vendors try this trick. Not Igneus Incorporated. We're on your side!
- Free support via email – support@igneusinc.com

Advanced Hydraulic Calculation Engine

- Hazen-Williams friction loss formula
- Darcy-Weisbach friction loss formula
- BS EN 12845 mode
- Simultaneous Hazen/Darcy mixed formula system calculations.
- Demand calculations (start with the system demand)
- Supply calculation (start with the water supply to the system) with optional safety margin
- Calculate loop, tree, grid, and *completely custom* piping configurations
- Powerful equivalent k-factor calculator/editor fully integrated with data editor and hydraulic calculation report.
- Suitable for many suppression system designs including wet, dry, pre-action, deluge, antifreeze, low, medium and high pressure mist, foam-water, foam concentrate and more!
- Multiple water sources fully supported
- Multiple fire pumps supported.
- Multiple backflow prevention and fixed loss devices supported
- Can adjust water supply and demand to the bottom of riser node for accurate hydraulic demand graphs.
- No artificial limit on number of pipes and nodes (greater than 2000 permitted)

Customizable Reports

- NFPA 13-07/10/16/19 compliance capable
- Automatically adapts to paper size
- Customizable report page header text
- Customizable node analysis information
- Customizable pipe information
- Graphs and text use color to aid readability (optional).
- Export as pdf, html, or plain text - *why mess around with inconvenient custom viewing programs?*

Advanced Syntax Highlighting Data Entry Editor

- Real time error checking
- Automatic "proposals" for fast entry
- Descriptive node and pipe names up to 8 characters long
- "LiveLook" information bar for quick system evaluation
- Robust U.S. and SI unit support – even mixed U.S. and SI units are supported
- Group editing of selected values by type (size, length, elevation, k-factor, etc.)
- Multiple undo/redo
- "Popup" helpers for remembering/using material codes, fitting codes, etc.
- Undefined and unused node list
- User selectable font
- User selectable highlighting colors

Results Window

- All system, node, and pipe calculated information displayed in tabular format for comprehensive system analysis
- Pipe and node information sortable by any value
- User selectable pipe-information columns
- Fully resizable window, displays as much information as it can
- Persistent – you may keep this window open and in view while editing input data!

Pipe Material Editor

- View properties and internal diameters of any defined material
- Edit properties and internal diameters of any material (except default “schedule 40 steel” piping material)
- Enter entirely new pipe materials

Fitting Equivalent Length Editor

- View equivalent lengths for any defined fitting code
- Edit equivalent lengths of any defined fitting code
- Create new global and material specific fitting codes

Liquid Properties Editor (Darcy-Weisbach formula)

- View properties of any defined liquid
- Edit properties of any defined liquid
- Define new liquids

Equivalent K-factor Calculator

- Uses the full power of SHC's solver including Hazen-Williams, Darcy-Weisbach, velocity pressures, k-factor adjustment, and more.
- Can model simple sprigs and drops or entire dead-end branchlines.
- Familiar data input style similar to *SHC*'s data editor – helpers included.
- Full integration in the hydraulic calculation report.

DXF Files

- Import DXF files – the format supported by most CAD applications.
- Automatically define pipes and nodes from drawing's “line” and “lwpolyline” ACAD entities
- Automatically searches “text” entities for nominal pipe sizes
- Full preview of generated commands before committing them to the input data
- Update the DXF file
    - Update nominal pipe size “text” entities to match *SHC*'s data file
    - Add “text” for node and pipe labels
    - Add “text” for node discharge (available after a calculation)
    - Add “text” for pipe flow rates (available after a calculation)
    - Add pipe flow direction arrows (available after a calculation)

Additional

- Quick Start wizards for fast creation of basic tree and gridded systems with water supply
- View hydraulic demand graph and save as jpg, wmf, or bmp file
- View flow diagram and save as jpg, wmf, or bmp file
- Easily and quickly convert existing files to different units
- Backflow prevention device database for easy insertion in the data input file

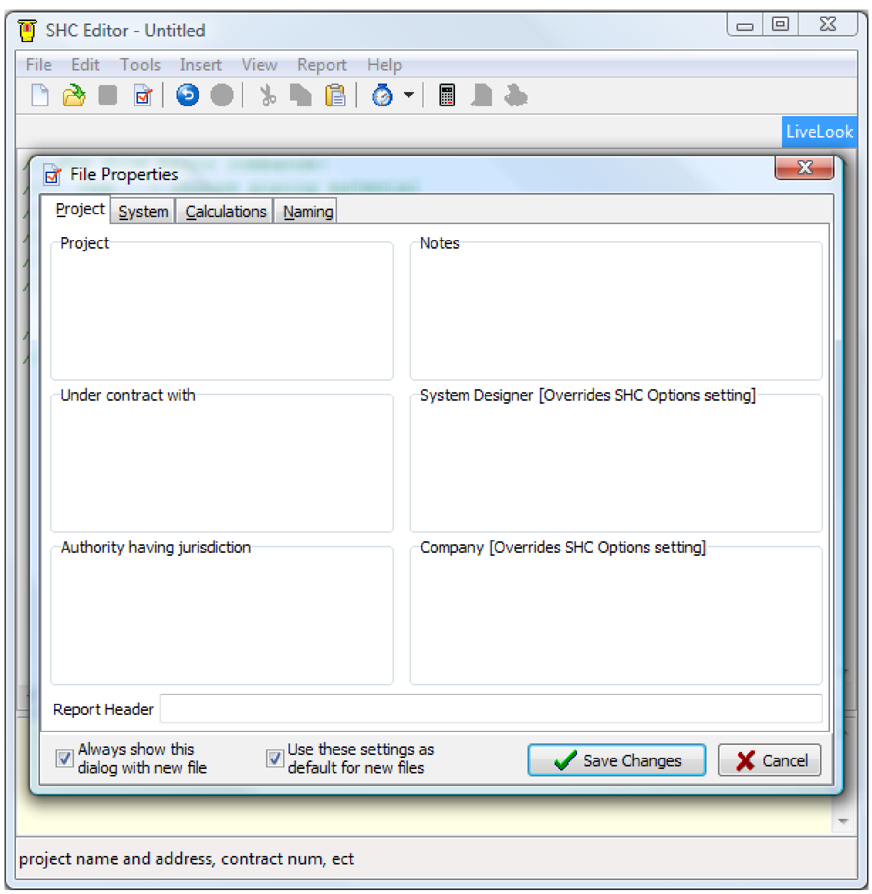
Starting the Simple Hydraulic Calculator

To begin the *Simple Hydraulic Calculator*, double-click the program icon on your Window's desktop.

- or -

Click the Window's start button located on the bottom taskbar.

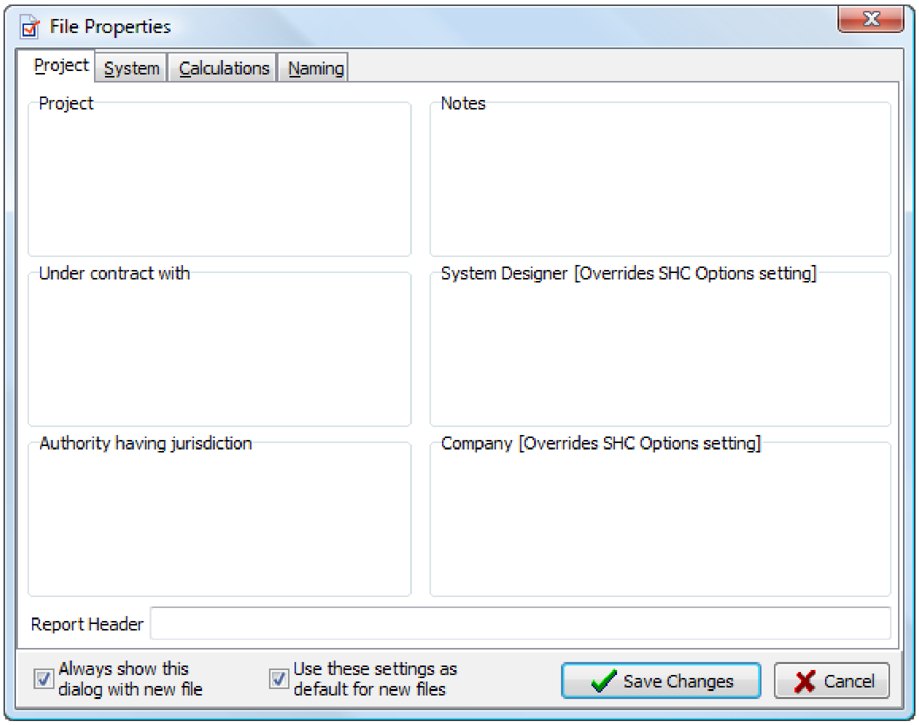
When the start menu appears, select **All Programs** → **SHC** → **SHC**.



File Properties

When first started (or whenever a new file is created) *SHC* presents the **File Properties** screen, with the page-tabs Project, System, Calculations and Naming.

Project (tab)



Use the **Project** page (shown above) to enter project details for inclusion on the hydraulic calculation report summary page. Note that none of this information affects hydraulic calculation results and can be safely left for later entry.

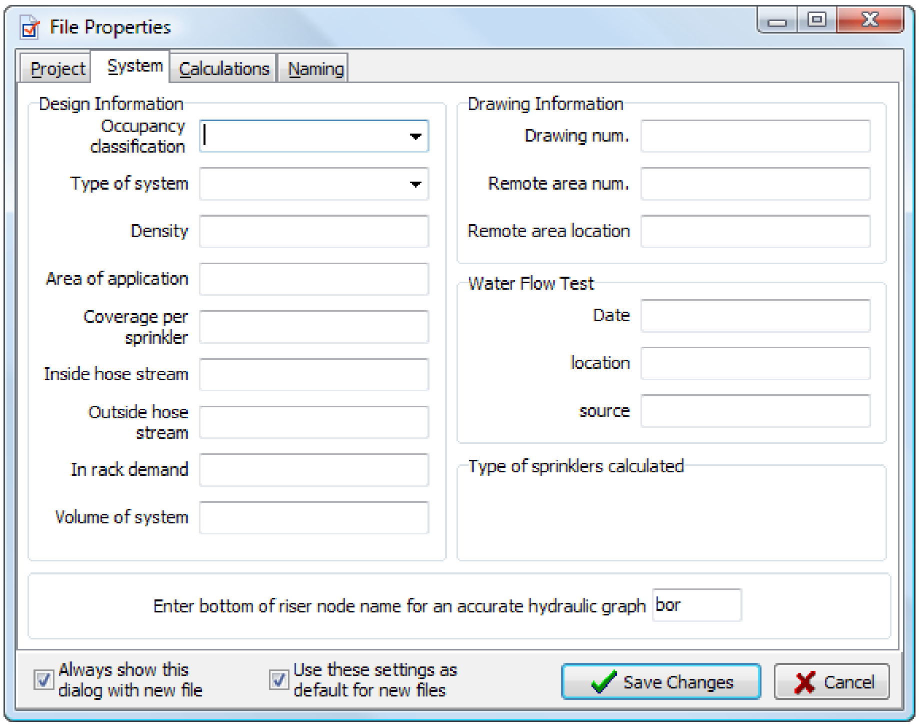
Report Header text will be shown centered at the top of every report page except for the summary page.

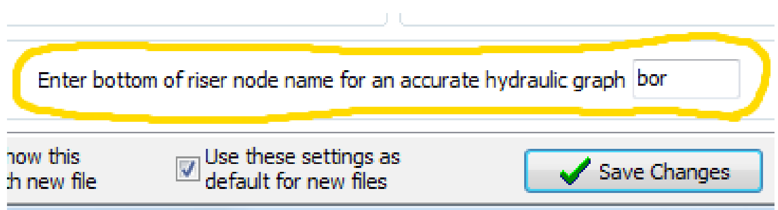
Hint

The **Contractor** field is not part of NFPA 13's mandatory summary page layout. If your AHJ requires strict compliance with the 2007 edition report layout then leave this field blank and it will not be shown.

System (tab)

The **System** page allows entry of important sprinkler system design information. What you enter here, will be included on the hydraulic calculation report's Summary page.





One item on this page can affect reported demand. When a valid node name is entered here – a node actually used in your file – *SHC* will adjust water supply and sprinkler demand graph to this node. This will be illustrated in the [Your First System](#) section of this guide.

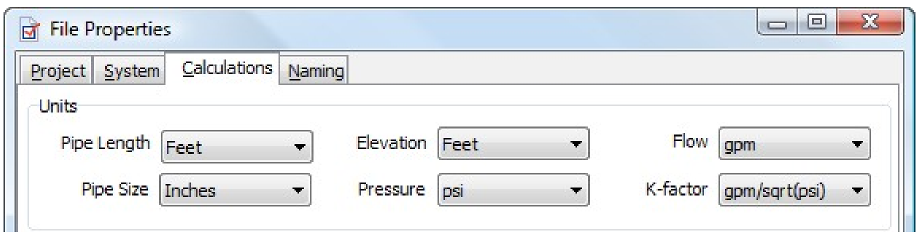
Hint

Use this option whenever possible. An accurate hydraulic demand graph requires the water supply and system demand to be adjusted to the bottom of the sprinkler system riser. But if your AHJ requires strict compliance with the NFPA 13 report layout then leave this field blank and it will not be shown on the report summary page.

Calculations (tab)

The **Calculations** page gives you complete control over how *SHC* interprets values and hydraulically calculates your sprinkler system. It is important to get these settings correct. Let's take it one section at a time:

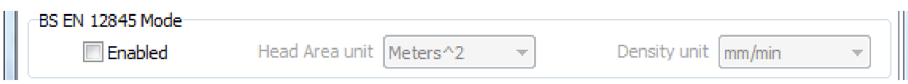
Units



Default unit for every value type may be selected here. Whenever *SHC* sees a value with no unit modifier, like "123", it will use the unit specified here. Any combination of supported units are permitted – even mixed U.S. and SI.

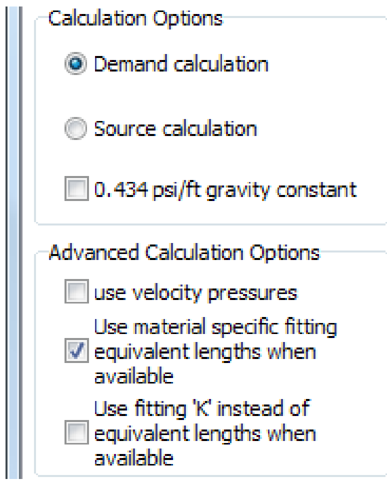
If continuing on to the tutorial, select all U.S. units as shown above.

BS EN 12845 Mode



BS EN 12845 mode may be enabled when compliance with this UK/European standard is required. For instruction on using this mode see the BS EN 12845 section of this guide.

Calculation and Advanced Calculation Options



Select **Demand** or **Source** calculation. **Demand** calculation instructs *SHC* to calculate the supply pressure and flow required to supply the remote-area demand. This may be more or less than the water supply can provide. **Source** instructs *SHC* to use the total water supply to calculate the resulting discharge from the remote-area sprinklers. This can result in a calculation that exceeds or falls short of required sprinkler head discharge rates.

Check **use velocity pressures** to include Pv in the hydraulic calculations.

Check **0.434 psi/ft gravity constant** when a constant of 0.434 psi/ft is required instead of the NFPA 13 value of 0.433 psi/ft.

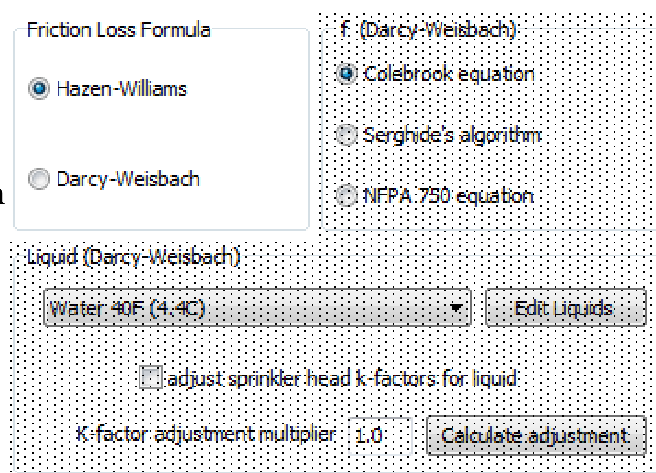
Leave **Use material specific fitting …** checked to use manufacturers' fitting equivalent length data when available. We'll cover the fitting editor and how *SHC* handles custom equivalent length data later in this guide.

Use fitting 'K' … is not needed for sprinkler system design. Leave this unchecked.

Friction Formula

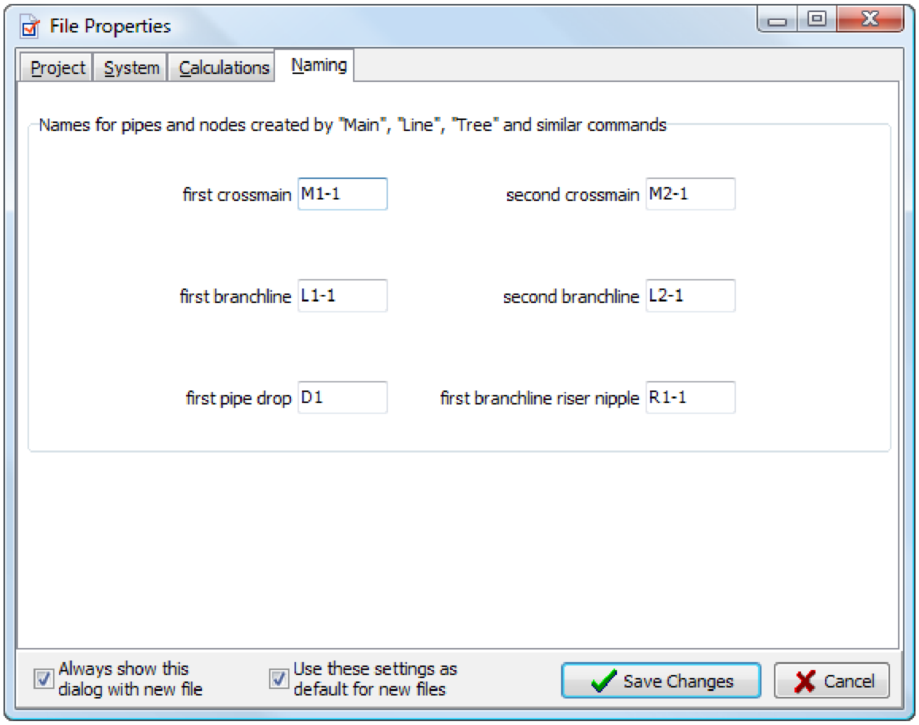
Click **Hazen-Williams** formula. Most automatic sprinkler systems require the Hazen-Williams friction loss formula.

Need to use the **Darcy-Weisbach** equation? Using a liquid other than water (ie: like antifreeze solution or foam concentrate)? We'll cover this and the other shaded options in Calculating with Darcy later in this guide.



Naming (tab)

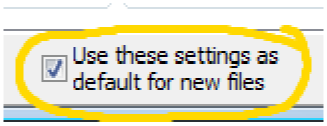
The **Naming** page controls the "system helper" commands naming (labeling) of automatically generated pipes and nodes.



We will discuss this more in the Your First System, Version 2 section of this guide.

Default Properties

Now is a good time to save these settings as your new file defaults. This way, units and normal calculation options will always be set when you begin a new file.



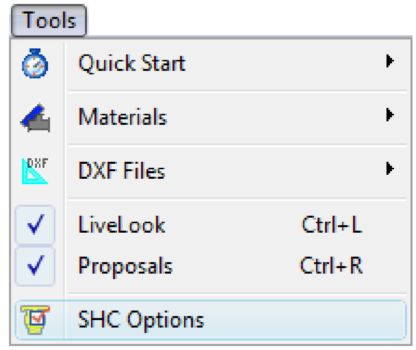
Make sure the **Use these settings ...** check box is checked.

Now click the **Save Changes** button to close the file properties dialog.

Hint

Next time you use the **File Properties** dialog uncheck the **Use these settings ...** box. This will avoid inadvertently changing your file default values when you don't want to. If you want to do this now select the menu item **File → Properties** to re-open the **File Properties** dialog. Uncheck the **Use these settings ...** check box and click the **Keep Changes** button. All done!

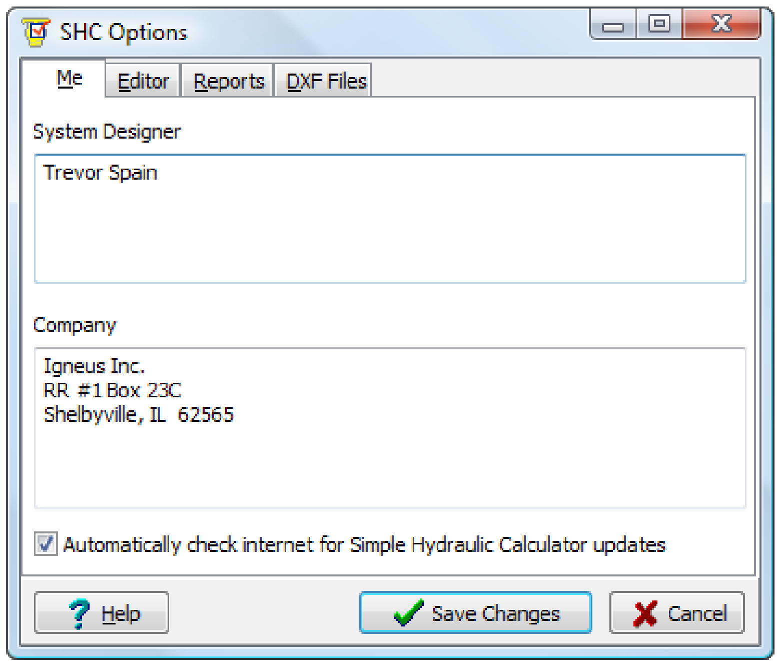
Program SHC Options



The **SHC Options** dialog is where information and program options are set that do not usually change on a file by file or project basis.

Click on the menu item **Tools**, then click **SHC Options**, as shown at right, to open the *SHC* Options dialog.

All About Me … (tab)



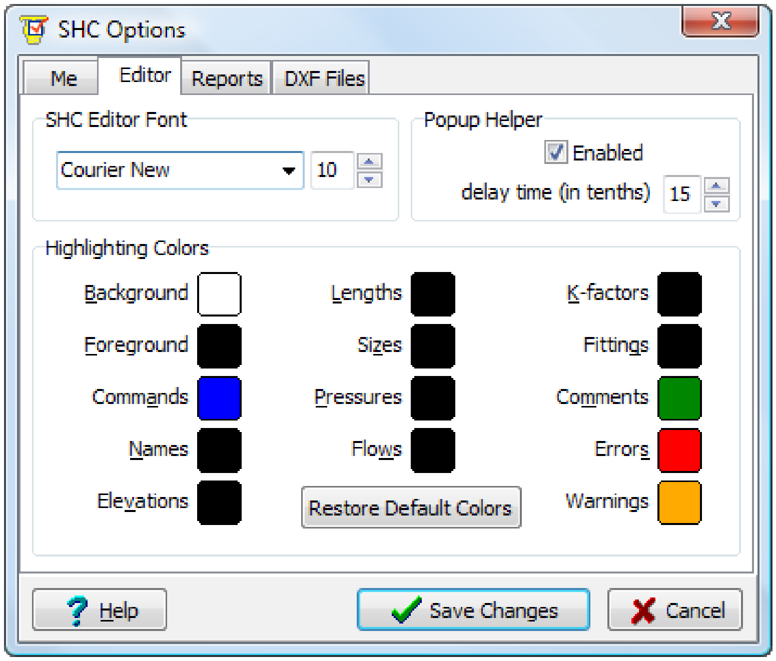
Enter your information on the **Me** page of the **SHC Options** dialog. This information is always included on the hydraulic calculation report's summary page but may be overriden on a file by file basis using the file properties dialog.

If your computer is connected to the internet, leave checked the **Automatically Check …** item. At most once a day, *SHC* will check for an update message at www.igneusinc.com and display it if available.

This is an excellent way to be informed quickly of new updates. No personal information is sent to Igneus Incorporated during this check.

Editor (tab)

The **Editor** page allows changes to *SHC*'s editor behavior and appearance.



By default, *SHC* uses a 10 point fixed spaced font. If this font is too small or unappealing, use the **SHC Editor Font** box to change it.

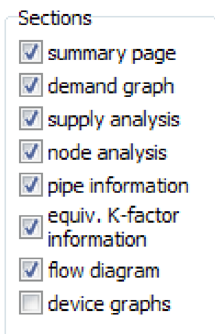
The **Popup Helper** box controls the behavior of this helpful editor feature. Leave these settings alone for now. (The next section, Your First System, will show this in action.)

SHC uses a modern syntax-highlighting editor for entering sprinkler system models. By default only commands, comments, warnings and errors are highlighted. But *SHC* has the ability to highlight many other value types. For now, leave the **Highlighting Colors** alone. When you gain experience with using *SHC*, you may want to revisit these settings and change to meet your needs.

Reports (tab)

SHC also provides much control over its printed report output. These options are shown on the **Reports** page. By default, *SHC* is set for strict compliance with NFPA 13-07. Let's examine each option box individually.

Sections

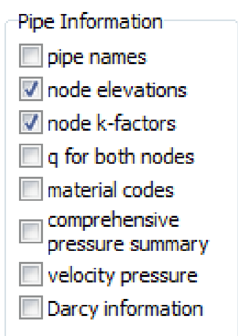


Select which report sections to include in printed reports here. Order of sections may not be changed. *SHC*'s default settings are shown at left.

Flow Diagram will only print when your file uses the "grid" helper commands. In this guide, see First System Version 2 for instruction on using the "grid" helper commands.

Check **device graphs** to include backflow preventer and pump flow curve graphs at the end of the report.

Pipe Information

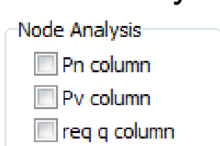


This area controls what information and what columns are included in the **Pipe Information** section of reports. Many options here enable a more comprehensive and/or efficient display of individual pipe characteristics than NFPA 13 offers.

When checked, **velocity pressure** and **Darcy information** will only add columns to the report when velocity pressures or the Darcy-Weisbach equation are actually used in the hydraulic calculation.

SHC will display required information in the "Notes" column of the report when a dedicated column for the information is not available.

Node Analysis

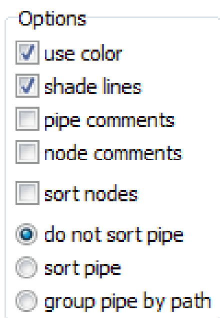


SHC also provides some options for the node analysis section of the report.

When checked **Pn** and **Pv** will add columns for these values to the node analysis section only when velocity pressures are used.

Check **req q column** to include a column for information about the minimum discharge required at each sprinkler head node.

Options



Check **Use Color** and *SHC* will differentiate between labels and values by color while also enhancing the graphs and flow diagram with color. Most monochrome printers will still make a satisfying print with color turned on.

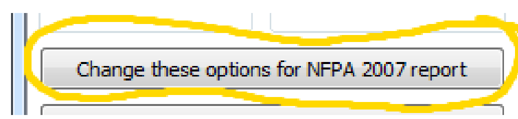
Shade Lines lightly shades every other line in the report's node analysis and pipe information sections.

Check **Pipe** and **Node Comments** to display comments on the same data file line as **Pipe**, **Water**, **Node**, and **Head** commands in the report.

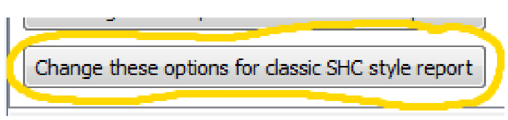
Sort Nodes will sort the node analysis report section by node name. **Sort Pipe** sorts pipe information by pipe name. **Group pipe by path** arranges the pipe information according to the actual calculation paths *SHC* used.

When sorting is not used, pipe and/or node information is reported in the same order as defined in your data file.

Quick Settings



Experiment with report options until you have the report style you want. And do not worry about remembering the exact combinations required for a strict NFPA 13 report. Simply click the **Change … 2007 report** button to quickly set node analysis and pipe information options back to default.



Fans of *SHC*'s original version 1.x report style may simply click the **… classic SHC style report** button to quickly set the pipe information and node analysis options.

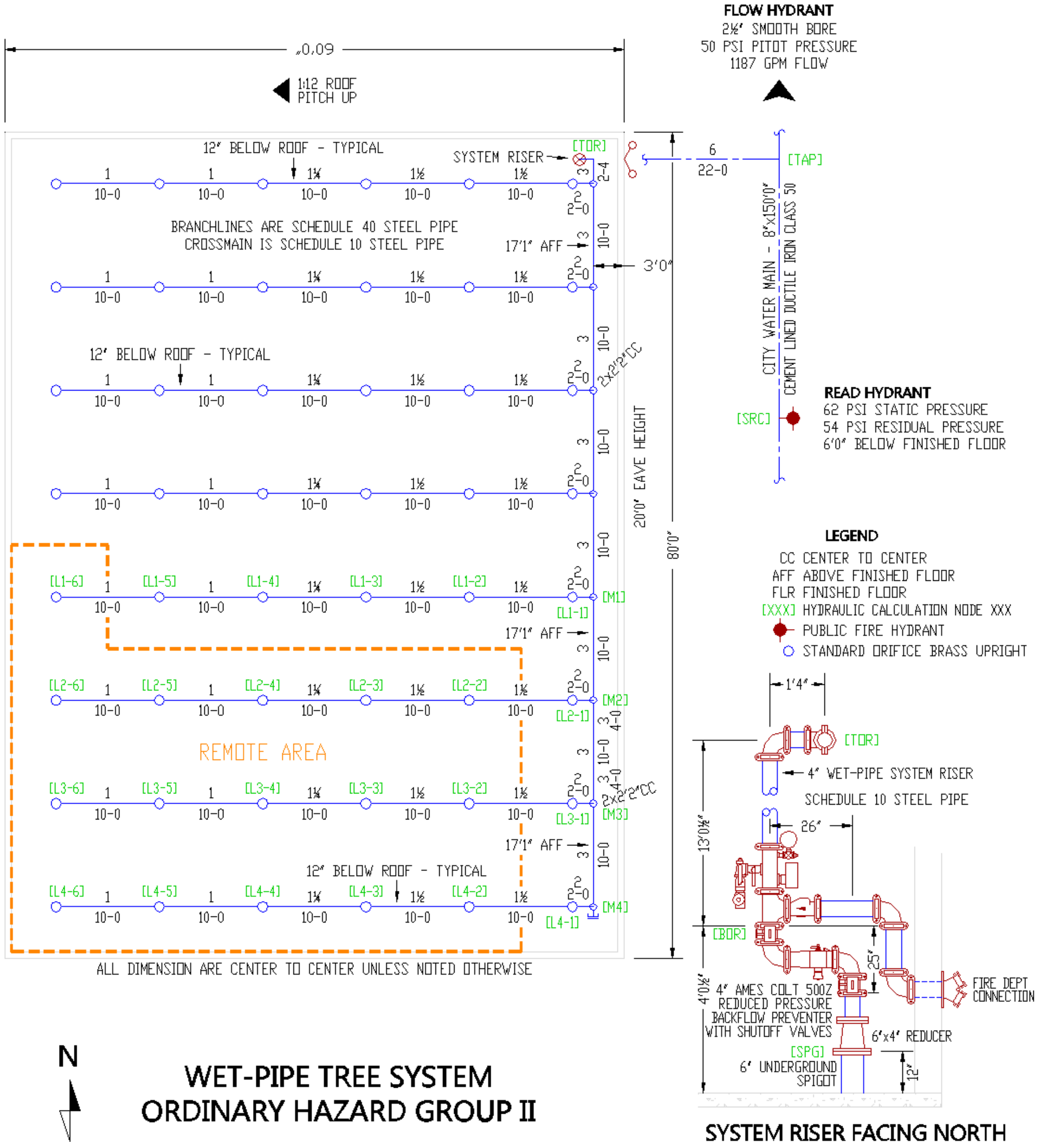
DXF Files (tab)

Importing ascii formatted drawing interchange files is beyond the scope of this guide. See the "Simple Hydraulic Calculator Reference Manual" for a description of these options.

Finished

Now that *SHC's* options are set, click the **Keep Changes** button to save them and close the **SHC Options** dialog.

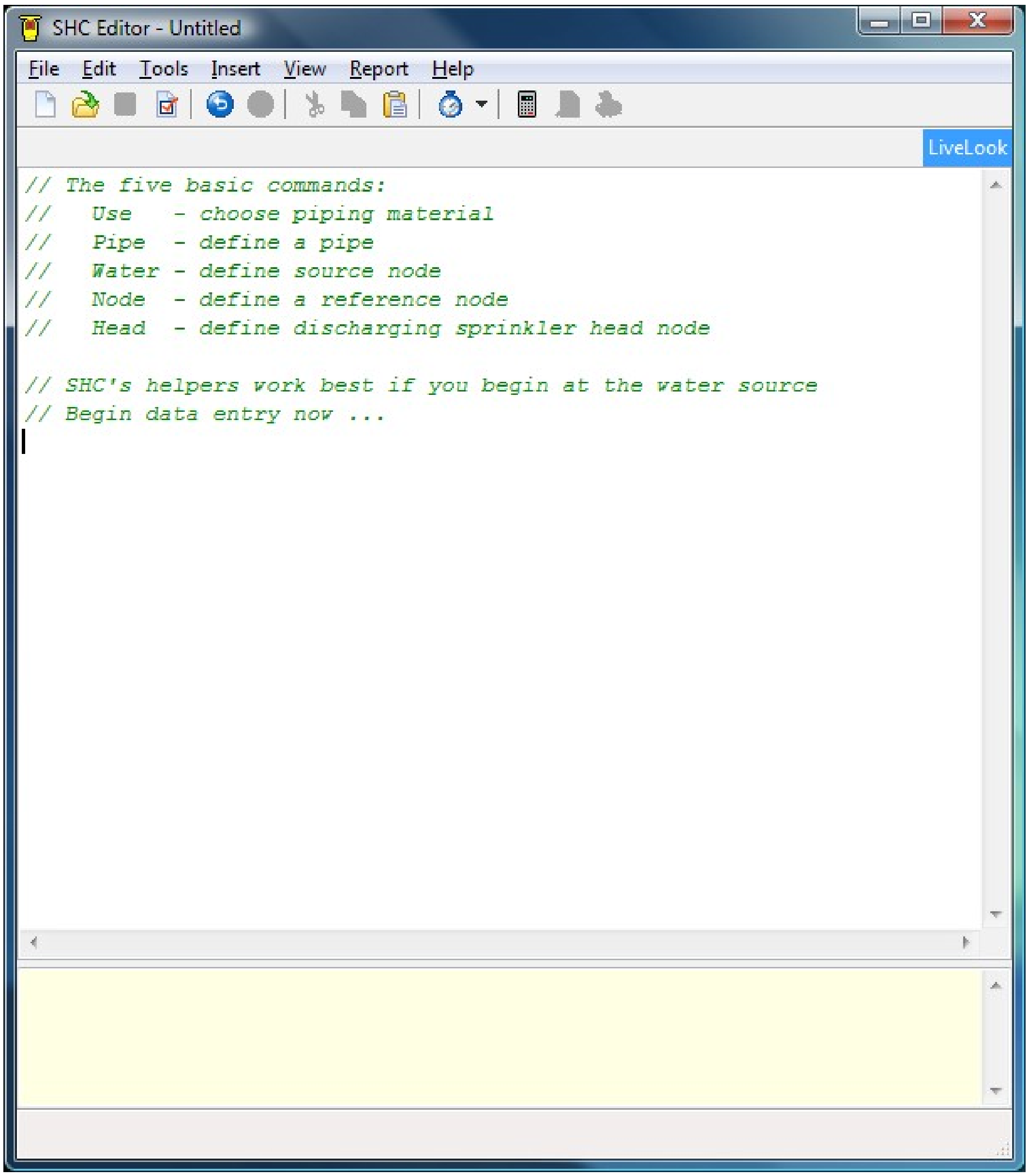
Your First System



PRINT THIS PAGE! (select 'current page' in your print dialog box)

Introduction

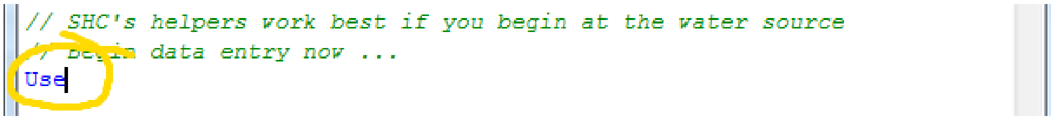
The *Simple Hydraulic Calculator* can hydraulically calculate any system configuration with only a handful of different commands! And so you'll never have trouble remembering how to begin, *SHC* will remind you of the five core commands each time it starts:



Use Command

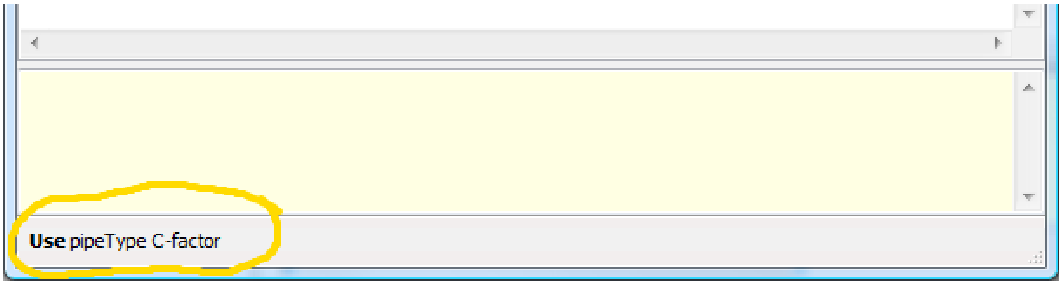
Did you print the basic tree system drawing? If not, please do so now. This tutorial will be referencing that system drawing.

To begin, *SHC* needs to know the piping material. Piping material is specified by the **Use** command. Type **Use** in the *SHC* editor now.



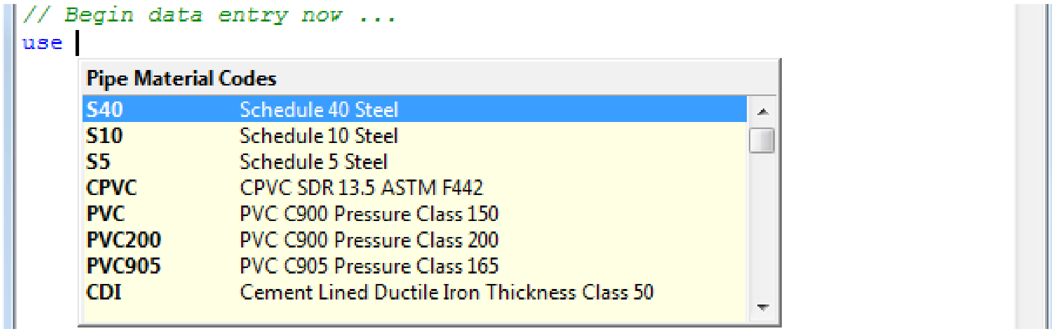
Notice that valid commands are highlighted in blue. This is called syntax highlighting. Visual clues like these help you know when commands and parameters are valid and when there is a problem (ie a different color displays).

Now look at the bottom of the *SHC* window.



When a valid command is entered, this status bar will show expected and optional parameters with your current position shown in bold. The **Use** command requires a pipe material code (*pipeType* parameter) and a *C-factor* value.

Since we are beginning at the water source, we need to know the pipe material code for cement lined ductile iron. *SHC* can help. Press the space bar in preparation for *pipeType* entry and wait a couple of seconds for the **Popup Helper**.



This is the **Popup Helper**. Use your keyboard's up and down arrow keys to scroll through the window or use your mouse. When "CDI" is highlighted, press the ENTER key or double-click using the mouse. *SHC* types the material code in for you.

Press the space bar again. Either type "140" for the *c-factor* or wait and use the **Popup Helper** again.

A command and it's parameters must always be on the same editor line. Individual parameters must be separated by at least one space. Only one command is allowed per editor line. (The only exception is the comment command which may follow the parameters on another command's editor line.) Try commenting your command by pressing the SPACEBAR. Then type "//" with your comment following.

Press the ENTER key to move to the next line. The editor should look similar to this following:

```
// Begin data entry now ...
use CDI 140 // cement lined ductile iron
```

At any time during data entry, if you see **RED**, instead of blue or black, it indicates there has been a mistake:

```
// Begin data entry now ...
use CDI 1x40 // cement lined ductile iron
```

In the above example a typo has been made entering the c-factor.

Hint

Liberally comment your data file (use the // command). You will be very thankful when changes are needed months down the road!

Pipe Command

Pipes are defined with the **Pipe** command. Type "Pipe" on a new line and look at the status bar.

```
Pipe name sNode eNode length size [ [#]Fitting ... ]
```

The Pipe command requires five parameters in the following order:

name A unique label for this pipe - eight characters maximum.

sNode Starting node name (label) – eight characters maximum.

eNode End node name (label) – eight characters maximum.

length Physical length of pipe. (*SHC* assumes the value is in the default unit unless unit modifiers are present. For example *5'10"* will always be five feet ten inches and *1525mm* will always be 1525 millimeters. However *7.625* will be 7.625 of whichever unit is selected on the calculations page of the file properties dialog window.)

size Nominal size of pipe. (See the *length* entry for a note on units.)

After these five values, any number of *fitting* codes may be entered.

Now we are ready to enter all the underground piping. Use a **pipe** command to enter the pipe from read-hydrant to underground tap. Use a pipe name of "City" and the node names shown on the drawing.

But what is this?

```
// Begin data entry now ...
use CDI 140
Pipe City Src srd
```

This is a **proposal**. Whenever *SHC* thinks it can help you type a **proposal** will appear. If it is what you want, press the ENTER key to accept it. Otherwise keep typing and it will be ignored. In this case, you don't want it, so just keep typing and it will disappear. *SHC* will make better guesses when we get to the overhead piping.

Finish typing in the pipe command. When done it should look like this:

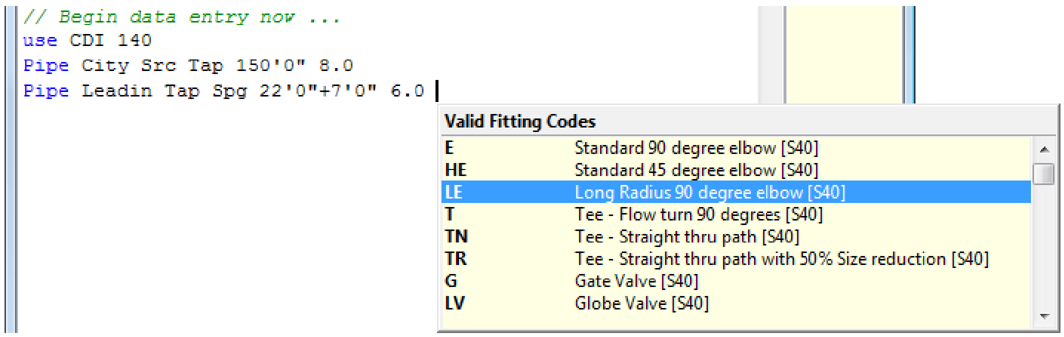
```
// Begin data entry now ...
use CDI 140
Pipe City Src Tap 150'0" 8.0
```

Hint

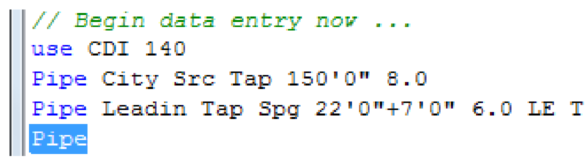
Descriptive pipe and node names (labels) make your data file much easier to read and understand.

Now enter the underground lead-in pipe. Remember to add the length of the spigot to the length of the underground for a total of 29'0". *SHC* will also accept 22'0+7'0 as a valid length value.

Note that this pipe contains two fittings. A tee with a flow turn and an elbow. After typing in the nominal pipe size, press SPACEBAR and let the **popup helper** help you out with the fittings!



Fitting codes must have a space between them. When done, the *SHC* editor should look similar to this:



Continue entering the sprinkler system by creating **pipe** commands for the backflow preventer piping and the system riser. I'll use "rpz" and "riser" for the pipe names (labels). Don't forget the **use** command to change piping material to schedule 10 steel. The **use** command must precede the pipe command(s) to which it is to apply.

Hint

A numeral suffix may be included on a fitting code to denote more than one. For example "3E" would indicate three elbows.

Backflow Prevention Devices

```
// Begin data entry now ...
use CDI 140
Pipe City Src Tap 150'0" 8.0
Pipe Leadin Tap Spg 22'0"+7'0" 6.0 LE T
Use S10 120
Pipe Rpz    Spg Bor  5'2.5" 4.0 2B 2E
Pipe Riser  Bor Tor 14'4.5" 4.0 2E
```

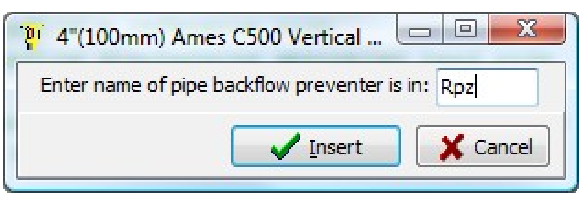
Now that all pipes from city main through system riser are entered into the *SHC* editor ...

... how do we handle pressure loss through the backflow preventer?

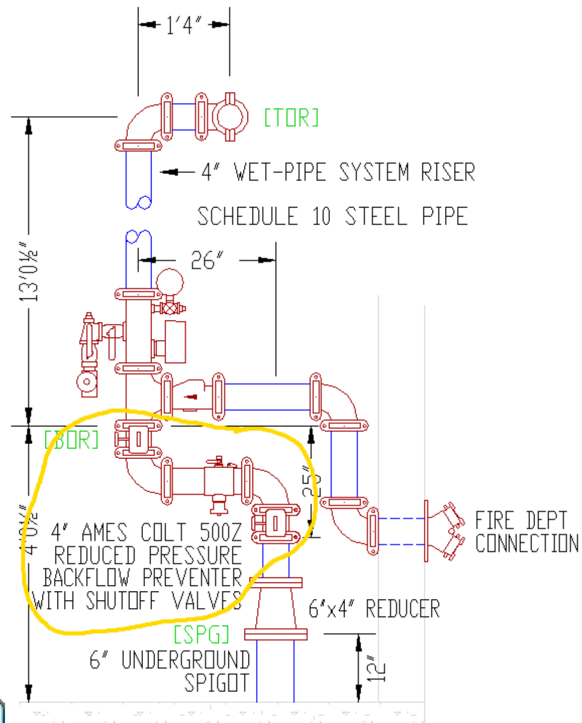
SHC has a command specifically for fixed pressure loss devices. Even better, *SHC* has a built-in database of many common backflow prevention devices.

On *SHC's* menu bar, click **Insert → Backflow → Reduced Pressure Detector → Ames → C500 Butterfly Valves → 4" (100mm) Vertical**

When the prompt appears, type the pipe name for the pipe in which the backflow preventer is located (ie: *rpz*) ...



... and click the **Insert** button.



SYSTEM RISER FACING NORTH

SHC inserts the command and automatically inserts a comment line directly into your file.

```
// Begin data entry now ...
use CDI 140
Pipe City Src Tap 150'0" 8.0
Pipe Leadin Tap Spg 22'0"+7'0" 6.0 LE T
Use S10 120
Pipe Rpz    Spg Bor 0'11.5" 4.0
Pipe Riser  Bor Tor 14'4.5" 4.0 2E
// 4"(100mm) Ames C500 Vertical Reduced Pressure Detector Bac
Bfp Rpz 0.0 12.0 40.0 12.0 110.0 8.0 300.0 8.0 400.0 10.0 500
```

Use the UP ARROW key to move the caret onto the **BFP** command's line. Notice the format for the **BFP** command in the status bar.

```
BFP pipe flow pressure [flow pressure...]
```

The **BFP** command requires, in this order, an existing *pipe*'s name, *flow* rate, and *pressure* loss at the flow rate. Additional "*flow*, *pressure*" pairs may be entered to define a loss that varies with flow rate. The **BFP** command interpolates pressure loss between each defined "*flow, pressure*" pair, linearly.

Published pressure loss for a backflow preventer includes the complete assembly (including valves). Let's take advantage of this by modifying pipe "Rpz". First remove the fitting codes. Next, shorten the pipe's length by the device's take-out dimensions (see drawing). When done, the modified **Pipe** command should look as shown.

```
Use S10 120
Pipe Rpz    Spg Bor 0'11.5" 4.0
Pipe Riser  Bor Tor 14'4.5" 4.0 2E
```

Crossmain

With the underground supply and riser now entered, it is time to work on the crossmain. Start with a pipe name of "M1" and increment for each pipe. Pipe "M1" should go from node "TR" all the way to node "M1". Continue entering all main piping.

Since we are using sequential pipe and node names, the **proposal** system should help you much more than earlier. In fact you should only need to repeatably tap the ENTER key to create all of the last two crossmain **Pipe** command entries!

Your **Pipe** commands should look like these when done.

```
// 4"(100mm) Ames C500 Ver
Bfp Rpz 0.0 12.0 40.0 12.0

// Crossmain
Pipe M1 TOR M1 42'4" 3.0
Pipe M2 M1  M2 10'0" 3.0
Pipe M3 M2  M3 10'0" 3.0
Pipe M4 M3  M4 10'0" 3.0
```

Branchlines

```
// Branchlines
Use s40 120
Pipe L1-1 M1 L1-1  4'2" 2.0 t e
Pipe L1-2 L1-1 L1-2 10'0" 1.5
Pipe L1-3 L1-2 L1-3 10'0" 1.5
Pipe L1-4 L1-3 L1-4 10'0" 1.25
Pipe L1-5 L1-4 L1-5 10'0" 1.00
Pipe L1-6 L1-5 L1-6 10'0" 1.00

Pipe L2-1 M2 L2-1  4'2" 2.0 t e
Pipe L2-2 L2-1 L2-2 10'0" 1.5
Pipe L2-3 L2-2 L2-3 10'0" 1.5
Pipe L2-4 L2-3 L2-4 10'0" 1.25
Pipe L2-5 L2-4 L2-5 10'0" 1.00
Pipe L2-6 L2-5 L2-6 10'0" 1.00

Pipe L3-1 M3 L3-1  4'2" 2.0 t e
Pipe L3-2 L3-1 L3-2 10'0" 1.5
Pipe L3-3 L3-2 L3-3 10'0" 1.5
Pipe L3-4 L3-3 L3-4 10'0" 1.25
Pipe L3-5 L3-4 L3-5 10'0" 1.00
Pipe L3-6 L3-5 L3-6 10'0" 1.00

Pipe L4-1 M4 L4-1  4'2" 2.0 t e
Pipe L4-2 L4-1 L4-2 10'0" 1.5
Pipe L4-3 L4-2 L4-3 10'0" 1.5
Pipe L4-4 L4-3 L4-4 10'0" 1.25
Pipe L4-5 L4-4 L4-5 10'0" 1.00
Pipe L4-6 L4-5 L4-6 10'0" 1.00
```

Now enter pipe for all flowing branchlines. As with the crossmain piping, the **proposal** system should significantly help your input speed.

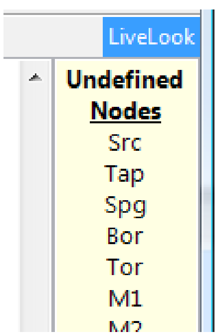
While node and pipe names ultimately are completely up to you, stick with the naming shown at right for this example.

Since the riser nipple and starter piece are the same nominal size, we use one **Pipe** command to model both pipes as "L1-1", as shown (then input pipes "L1-2", "L1-3", etc.).

Also be sure to include the **Use** command for schedule 40 steel pipe or all branchline internal diameters will be wrong. Any pipe creating command (such as **Pipe**) will use material specified in the nearest, preceding, **Use** command.

All done? Looks like the example to the right? Fantastic. You have typed in a lot of pipe! But you are not quite done yet.

Undefined Node List



I'm sure you may have already noticed the 'list' on the right of *SHC's* editor window.

This list reminds you of all the node names that have been used while defining the pipes, but have not yet been defined as nodes. *SHC* needs to know if a node is a sprinkler head node, water source node, or simple reference node. *SHC* needs to know each node's elevation, it's discharge rate, etc.

Let us begin with the water source node.

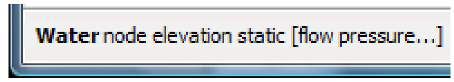
Hint

A "reference node" is simply a non-flowing node (ie: no flow entering the piping system, and no flow leaving the piping system).

Water Command

The **Water** command defines a node as a water source node. On this project, the 'read hydrant' location, on the plan, is our water source – node name “Src”.

Type in “Water” on a blank line below the backflow preventer command (**Bfp**). Then check the command's format in the status bar.



Water expects a *node* name, *elevation*, and *static* pressure. Additionally, *flow* and residual *pressure* value pairs may be entered to define the source's supply curve. The **Water** command interpolates pressure based upon log 1.85 as required by NFPA 13.

Using information available on the drawing, type in all parameters for the **Water** command. Include the measured flow rate and the residual pressure (from the flow test) as shown below.

```
// Underground and riser nodes
Water Src -6'0" 62 1187 54
```

Now that node “Src” is now defined, so it should no longer appear in the undefined nodes list.

> **Hint**
>
> *SHC* does not care in what order you define nodes and pipes. Do you normally want to define all the nodes first? Fine. Want to define some nodes, then some pipe, then some more nodes? Fine. *SHC* does not impose artificial limits on how you like to work.

Node Command

```
Node node elevation [discharge] [minPressure]
```

To define any node that is not a sprinkler head nor a water source use the **Node** command. Below the **Water** command, type "Node" to study the command's format in the status bar.

Node requires a unique *node* name and the node's *elevation*. Optionally, a fixed *discharge* may be specified (good for a node with a hose allowance discharge). And if *discharge* is given, an optional *min*imum *pressure* may also be entered (good for standpipe system calculations).

This sprinkler system is designed to meet ordinary hazard group II occupancy requirements. Therefore we need to include 250 gpm of outside hose allowance in the calculations. Define a node "Tap" with a 250 gpm discharge (shown at right).

```
// Underground and riser nodes
Water Src -6'0" 62 1187 54
Node  Tap -6'0" 250
```

Use **Node** commands to define the nodes "Spg", "Bor", and "Tor".

Then move your cursor below the crossmain's **Pipe** commands and define the crossmain nodes:

```
// Underground and riser nodes
Water Src -6'0" 62 1187 54
Node  Tap -6'0" 250
Node  Spg  1'0"
Node  Bor  4'0.5"
Node  Tor 17'1"

// Crossmain
Pipe M1 TOR M1 42'4" 3.0"
Pipe M2 M1  M2 10'0" 3.0"
Pipe M3 M2  M3 10'0" 3.0"
Pipe M4 M3  M4 10'0" 3.0"

// Crossmain nodes
Node  M1  17'1"
Node  M2  17'1"
Node  M3  17'1"
Node  M4  17'1"
```

> **Hint**
>
> Its a good idea to keep your pipe and node commands together, in the same general area of your input ... easier to read your input data.

Next, move your cursor below the branchlines' **Pipe** commands and enter nodes "L1-1" through "L1-5". Remember, this branchline runs uphill so each node should be 10 inches higher than the previous one.

```
Pipe L4-6 L4-5 L4-6 10'0" 1.00

// branchline nodes
Node L1-1 19'5"
Node L1-2 20'3"
Node L1-3 21'1
Node L1-4 21'11
Node L1-5 22'9
Head
```

But notice that node "L1-6" is in the remote area. How do we define a discharging sprinkler head node? Use the **Head** command (not a **node** command).

Head Command

Type "Head" in *SHC's* editor and examine the status bar.

```
Head node elevation minDischarge k-factor
```

The **Head** command requires a *node* name, *elevation*, required *min*imum *discharge*, and sprinkler head *k-factor*.

Complete the **Head** command entry using information from the drawing (density of 0.2 gpm/sq.ft. and standard orifice heads).

Continue defining the remaining sprinkler nodes, as shown. The **Undefined Node List** should progressively disappear until finished.

We are now ready to calculate the system!

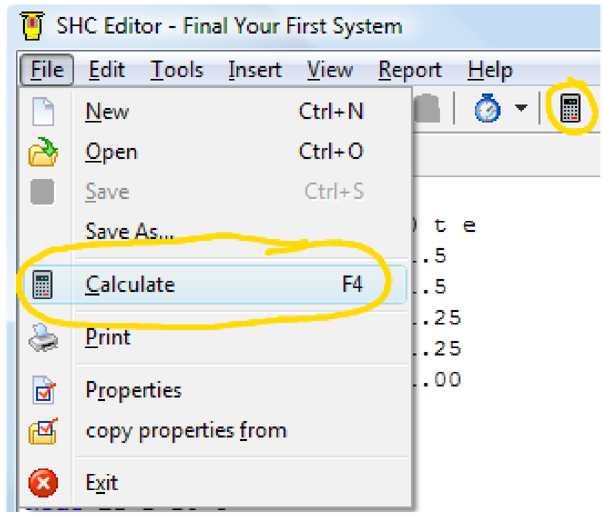
> **Hint**
>
> A negative *minDischarge* parameter will set a minimum pressure discharge instead of flow!

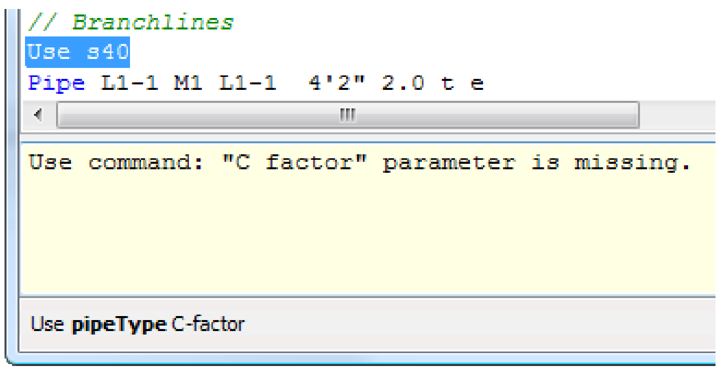
```
Node L1-5 22'9
Head L1-6 23'7  20.0 5.6

Node L2-1 19'5"
Head L2-2 20'3" 20.0 5.6
Head L2-3 21'1  20.0 5.6
Head L2-4 21'11 20.0 5.6
Head L2-5 22'9  20.0 5.6
Head L2-6 23'7  20.0 5.6

Node L3-1 19'5"
Head L3-2 20'3" 20.0 5.6
Head L3-3 21'1  20.0 5.6
Head L3-4 21'11 20.0 5.6
Head L3-5 22'9  20.0 5.6
Head L3-6 23'7  20.0 5.6

Node L4-1 19'5"
Head L4-2 20'3" 20.0 5.6
Head L4-3 21'1  20.0 5.6
Head L4-4 21'11 20.0 5.6
Head L4-5 22'9  20.0 5.6
Head L4-6 23'7  20.0 5.6
```

Calculating

There are three ways to initiate the hydraulic calculations. Select the menu item **File → Calculate,** or press **F4** on the keyboard, or click the calculator button on the toolbar.

If *SHC* can not calculate the sprinkler system, the **message and warning area** (at the bottom of *SHC's* window) will display an appropriate error message. In the example below, the *c-factor* parameter was inadvertently omitted from a **Use** command.



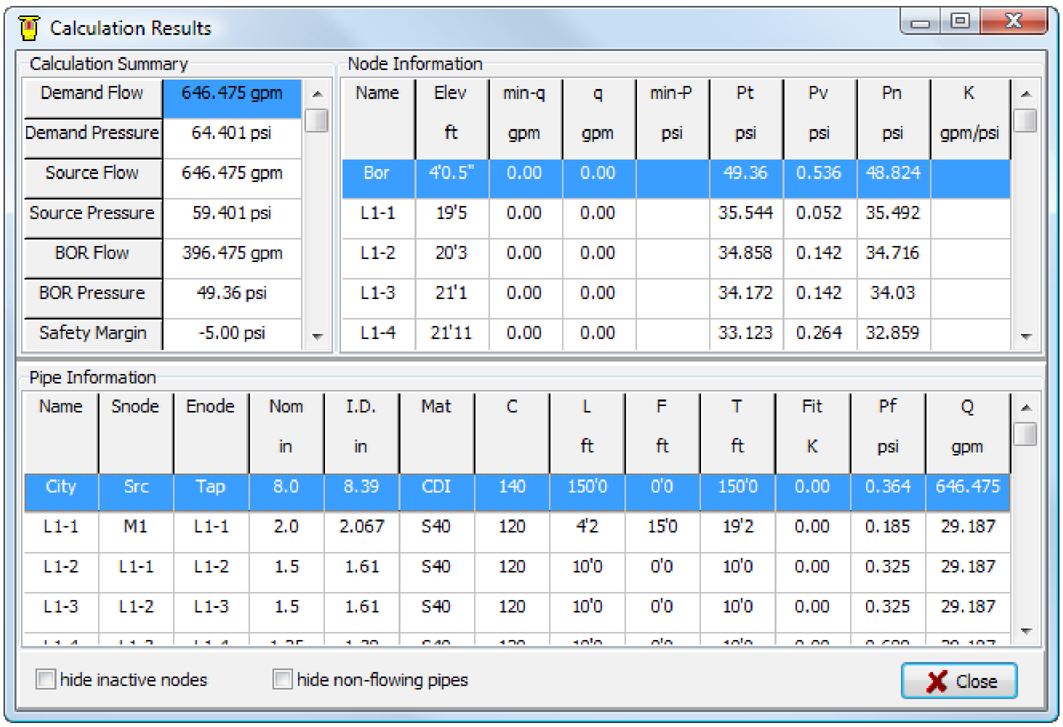


Double-click the error message to highlight the command or parameter containing the error (its up in your data file). In this case, the entire line is highlighted since a parameter is missing. When a specific parameter has an invalid value, only that parameter will be highlighted.

Some errors do not correspond directly to a command. Double-clicking these messages will not highlight anything.

Results Window

After every successful calculation, the **Calculation Results** window appears. This window is your primary tool for evaluating your sprinkler system design.

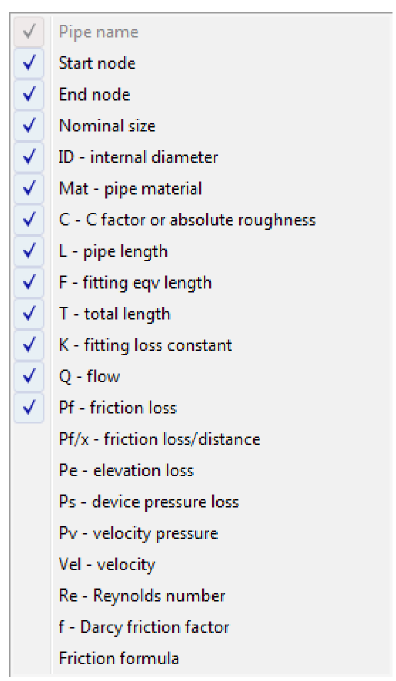


All relevant pipe, node, and system information is displayed here in easily navigable tables.

Can't see enough? Use your mouse to resize the window. The "Pipe Information" table even supports a customized column layout. Right-Click anywhere on this table to see a pop-up menu of selectable columns to display (add the "Pf/x" column now). Click and hold a "Pipe Information" table heading to drag it into a new position. *SHC* remembers how you set this window between program sessions.

Don't know what the heading means? Pause your mouse cursor over any heading to see a description of its values.

Click any node or pipe heading to sort the table by that value. Click the same heading again to reverse the sort.



Changes

BOR Pressure	49.36 psi
Safety Margin	-5.00 psi

Pipe Information

Check the sprinkler system's safety margin in the calculation summary table. The 'negative' margin indicates some design changes are necessary.

Click the "Pf/ft" heading in the pipe information table to sort the pipe by friction loss per foot from low to high. Click it once more to reverse the sort. Pipe with largest friction loss per foot are now shown first.

Pipe Information

Name	Snode	Enode	Nom in	I.D. in	Mat	C	L ft	F ft	T ft	Fit K	Pf psi	Q gpm	Pf/ft psi
L2-5	L2-4	L2-5	1.0	1.049	S40	120	10'0	0'0	10'0	0.00	5.072	41.721	0.507
L3-5	L3-4	L3-5	1.0	1.049	S40	120	10'0	0'0	10'0	0.00	4.991	41.363	0.499
L4-5	L4-4	L4-5	1.0	1.049	S40	120	10'0	0'0	10'0	0.00	4.969	41.263	0.497
L2-2	L2-1	L2-2	1.5	1.61	S40	120	10'0	0'0	10'0	0.00	4.667	123.197	0.467
L3-2	L3-1	L3-2	1.5	1.61	S40	120	10'0	0'0	10'0	0.00	4.596	122.186	0.46

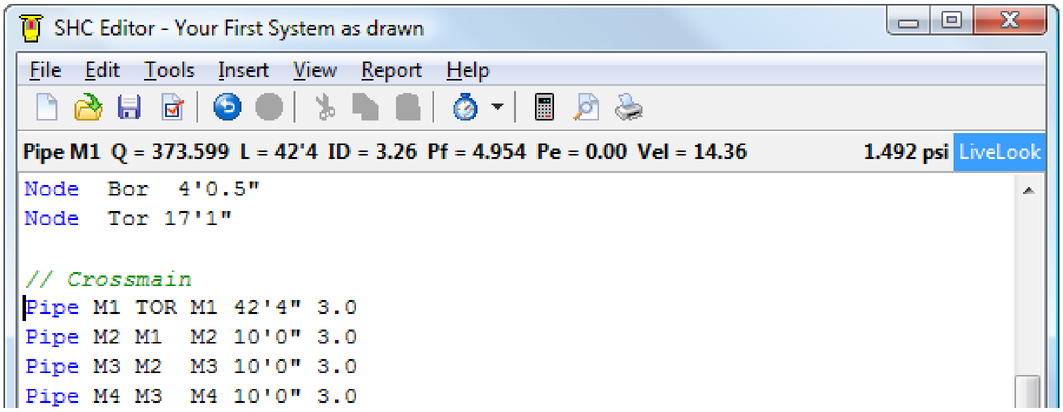
It looks like the first piece of 1" on each branchline is too constricting. Want some corroboration of the "Pf/ft" information? Look at the "Pf" column or add the "Velocity" column to the pipe information table. Both values useful when evaluating a system design in a logical manner.

Let's try changing the 1" branchline pipe. Move the **Calculation Results** window out of the way and click on the *SHC Editor* window (or close the results window). Locate the **Pipe** commands for pipes "L1-5", "L2-5", "L3-5", and "L4-5". Change all their nominal sizes to 1¼" and recalculate (press F4).

BOR Pressure	43.558 psi
Safety Margin	1.492 psi

Now we are getting close! Close the **Calculation Results** window. Move the *SHC Editor* window's cursor up to the first crossmain **Pipe** command.

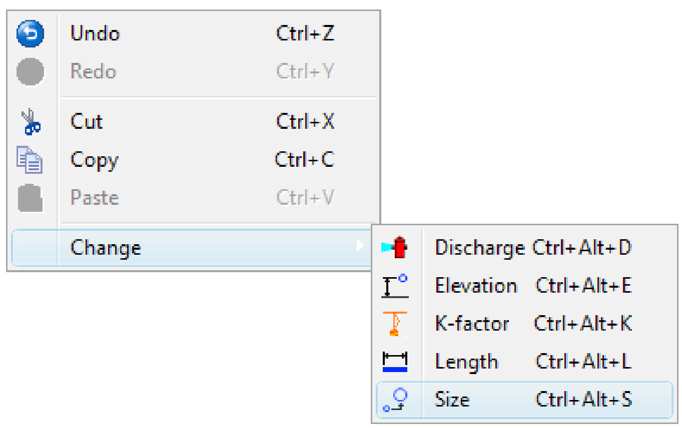
Toward the top of *SHC's* editor window is the **LiveLook** bar. This bar is perfect for quick checks of safety margin and individual pipe and node characteristics. Any command or parameter that *SHC* can show information for will be shown when the mouse pointer crosses it or the editor's cursor is moved to it. Some information, such as fitting equivalent length, is even available before calculating.

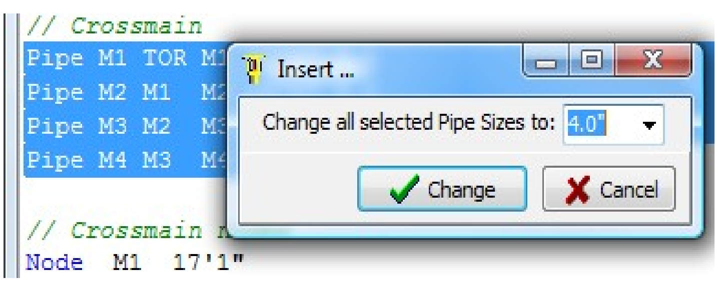


By moving the editor's cursor, as shown above, we can see the crossmain's pressure loss is high. But don't start editing yet! Select all four commands you used to previously define the crossmain. You may do this by holding the mouse's left button and dragging or by holding the SHIFT key down while using the keyboard's arrow keys.

Once all are selected, release the left mouse button and right-click anywhere in the *SHC's* editor window.

On the pop-up menu, select **Change → Size**.



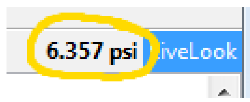


When the prompt appears, use the combo box to select or type in a 4" nominal size. Click the "Change" button when done.

All four commands should now have a 4” nominal pipe size as shown.

```
// Crossmain
Pipe M1 TOR M1 42'4" 4.0"
Pipe M2 M1  M2 10'0" 4.0"
Pipe M3 M2  M3 10'0" 4.0"
Pipe M4 M3  M4 10'0" 4.0"
```

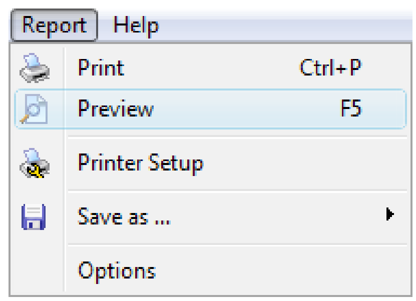
Recalculate by pressing the **F4** key on your keyboard (or select the menu item **File → Calculate**). You now have a suitable safety margin.



Report

To preview the hydraulic calculation report, select the menu item **Report → Preview** (or press F5 on the keyboard).

The **Report** menu item also provides for printing the report and saving the report in plain text, html, and pdf formats.



When done, save your data file! We will be editing this data file in the next section, Your First System Version 2. On the menu bar, select **File → Save**.

Hint

Don't wait until you are finished to save. No one likes to lose even 5 minutes of work. Save often by pressing the **CTRL+S** keys on your keyboard (or select the menu item **File → Save**). It is a good habit.

Conclusion

During this tutorial you have learned *SHC's* basic commands for entering sprinkler system data. These commands can be used to enter ANY sprinkler system piping configuration.

Let's review:

Use - select pipe material

Pipe - define a length of pipe

Water - define a node as a water source

Head - define a node as a discharging sprinkler head node

Node - define a node

Bfp - define a fixed pressure loss such as a backflow preventer

You should now also be familiar with the *SHC Editor* and calculation results windows. If you are not, please review this section again before moving on to Your First System Version 2.

Your First System, Version 2

Introduction

In the previous section, Your First System, you learned how to use *SHC* to enter and evaluate sprinkler system designs. Now you will learn about the "system helper" commands. These commands are designed to speed up data entry on generally uniform and symmetrical tree, grid, or loop systems.

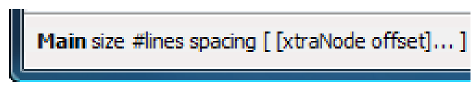
We will be using the sprinkler system design from the first page of the Your First System section. If you do not already have a copy handy, please print one out now, for reference.

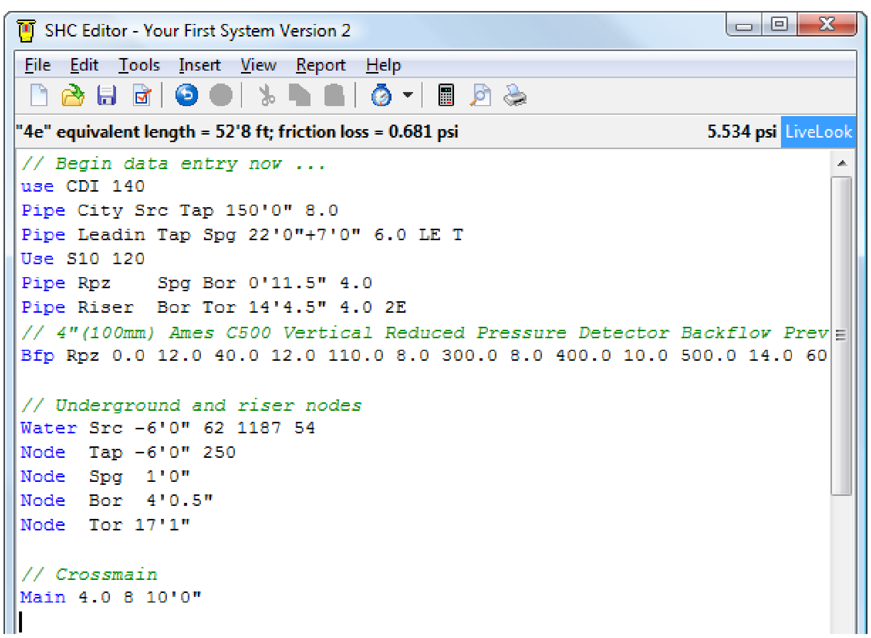
To begin, open your file from Your First System and delete all the crossmain and branchlines pipes and nodes.

Main Command

In the Your First System tutorial, the crossmain and branchlines were defined with twenty-eight Pipe commands. Now, we are going to enter all the branchline and crossmain pipe with just four commands!

To begin, type "Main" in the *SHC Editor* window and look at the status bar.





The **Main** command can be used to define an entire crossmain. It requires the nominal *size*, number of branch*lines*, and *spacing* between branchlines. Finish typing in the **Main** command using the system drawing (ie: 4" main, 8 BL's, 10' o/c).

NOTE: Related commands you may wish to look up in the "Simple Hydraulic Calculator Reference Manual" include **MainV** and **MainCont**.

MainElev Command

Every **Main** command requires a matching **MainElev** command. Type "MainElev" on a new editor line and study the status bar.

```
MainElev startElev [endElev] [offset offsetElev]
```

The **MainElev** command requires a *start*ing *Elev*ation. An optional *end*ing *elev*ation can be entered to slope the main in one direction. And if an end elevation is given, an *offset* distance (from first branchline on main) to a peaked elevation, and the peaked elevation (*offsetElev*) may be entered.

Finish typing in the **MainElev** command.

```
// Crossmain
Main 4.0 8 10'0"
MainElev 17'1"
```

That is all there is to it! Two commands and the crossmain is defined! Think of the **Main** command as the "**Pipe** command for a whole crossmain". And the **MainElev** command is the "**Node** command for a whole crossmain".

TreeLeft Command

SHC provides three commands for defining branchline piping – **TreeLeft**, **TreeRight**, and **Line**. For this example, we will use the **TreeLeft** command.

TreeLeft defines dead-end branchlines connected to the first crossmain (the first **Main** command that was entered).

```
TreeLeft #heads startLength size [length size...]
```

After typing in a **Use** command for schedule 40 steel pipe, type "TreeLeft" on a new line and look at the status bar.

TreeLeft requires the number of *heads* on each branchline, starter pipe length (*startLength*), and branchline nominal *size*. Additional *length* and *size* values (ie: data pairs) may be entered to define a branchline with variable head spacing and/or variable nominal sizes as you proceed with data entry from the crossmain to the end sprinkler on the branchline.

Finish typing in the **TreeLeft** command using pipe sizes initially used in "Your First System".

```
// Branchlines
Use s40 120
TreeLeft 6 2'0 2.0 10'0 1.5 10'0 1.5 10'0 1.25 10'0 1.25 10'0 1.0
```

The length / size pairs may be confusing at first glance but keep in mind – this one command just defined the pipe for all eight branchlines.

LineElev Command

Just as mains have the **MainElev** command, branchlines have the **LineElev** command. Type “LineElev” on a new line and examine it's parameters format.

```
LineElev startElev [endElev] [offset offsetElev]
```

The *startElev* for this sprinkler system will be the end of the branchline. Why? When pipes and nodes are automatically created using the “system helper” commands, *SHC* treats direction similar to traditional x-y graphs – branchlines are layed out from left to right on the x-axis, mains from bottom to top on the y-axis. The first **Main** command creates the leftmost main. The last **Main** command is the rightmost main. **TreeLeft** creates branchlines connected to the *left side* of the leftmost main. Because the branchlines are layed out from left to right, *SHC* uses the left end of the branchline as the branchline's starting point, so our data input will have to conform to this programmed-in methodology.

TreeRight creates branchlines connected to the right side of the rightmost main. We could have used a **TreeRight** command to model our branchlines. Then *SHC* would consider the actual end of the branchlines as the end point. Why didn't we? It would hydraulically calculate the same (mirrored or rotated systems are hydraulically the same). But there is less risk of making mistakes when you and *SHC* think alike in this respect. This drawing has dead-end lines extending to the left so we use the **TreeLeft** command. This will also get *SHC* to draw the flow diagram in the same orientation as our sprinkler system plan.

Complete the **LineElev** command. Keep in mind that the *EndElev* will be the branchline's elevation at the crossmain, not the elevation at the first head from the crossmain.

```
// Branchlines
Use s40 120
TreeLeft 6 2'0 2.0 10'0 1.5 10'0 1.5 10'0 1.25 10'0 1.25 10'0 1.0
LineElev 23'7" 19'3"
```

All branchline pipes and nodes are defined with just these three commands.

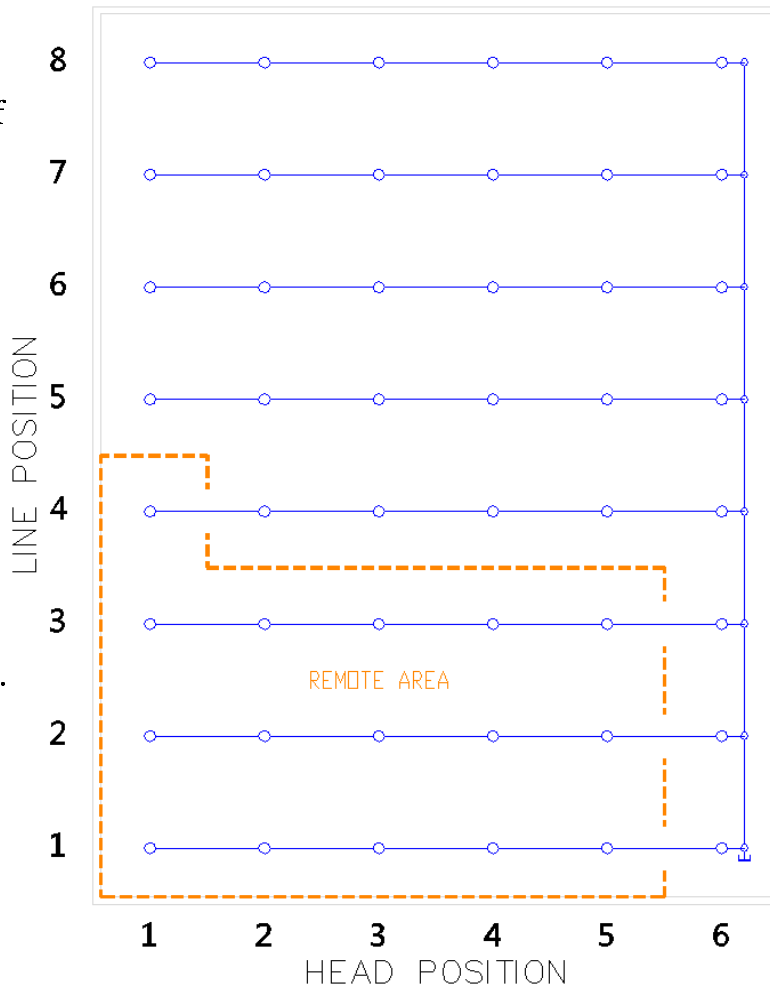
Remote Area

The **Flow** command defines the remote area when using the "system helper" commands to input a sprinkler system. Type "Flow" on a new line to check this command's requirements in the status bar.

Flow wants "coordinates" for two opposite corners of a rectangular region of sprinkler heads – *left-bottom* and *right-top*.

Recall from the previous **LineElev** discussion how *SHC* views branchline and main piping. *SHC* always views branchlines as starting left and going right. *SHC* always views crossmains as starting low and going up. Given this, it is easy to determine the "coordinates" for the remote area (1,1) and (5,3).

After the flowing rectangle's coordinates, **Flow** requires the minimum required sprinkler discharge (*minDischarge*) and the sprinkler *k-factor*.

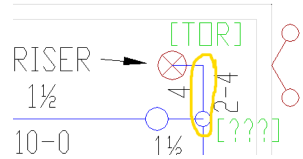


Using the diagram above, define the L-shaped remote area as the sum of two rectangular areas, with two **Flow** commands.

```
// Remote Area
Flow 1 1 5 3 20.0 5.6
Flow 1 4 1 4 20.0 5.6
```

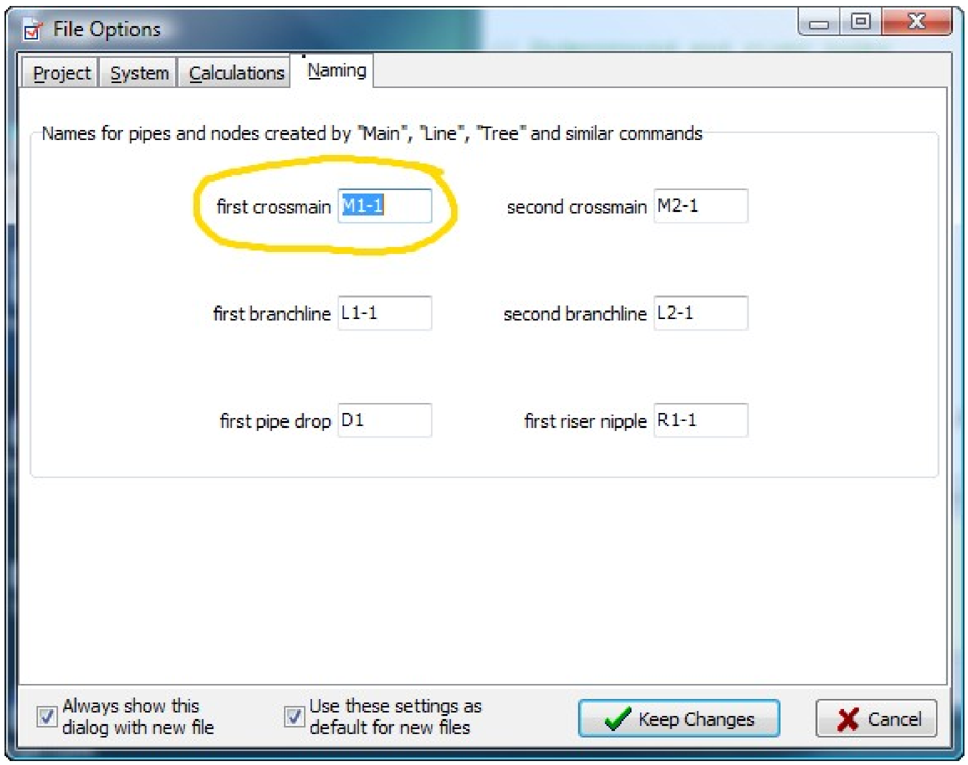
Feeding the Tree

So far we have used just six "system helper" commands to replace over fifty **Pipe**, **Node**, and **Head** commands! But we still have not connected the water source to our tree.



To connect the water source to our tree, we need to figure out the node's name where we wish to connect. (Shown as node "???" here.)

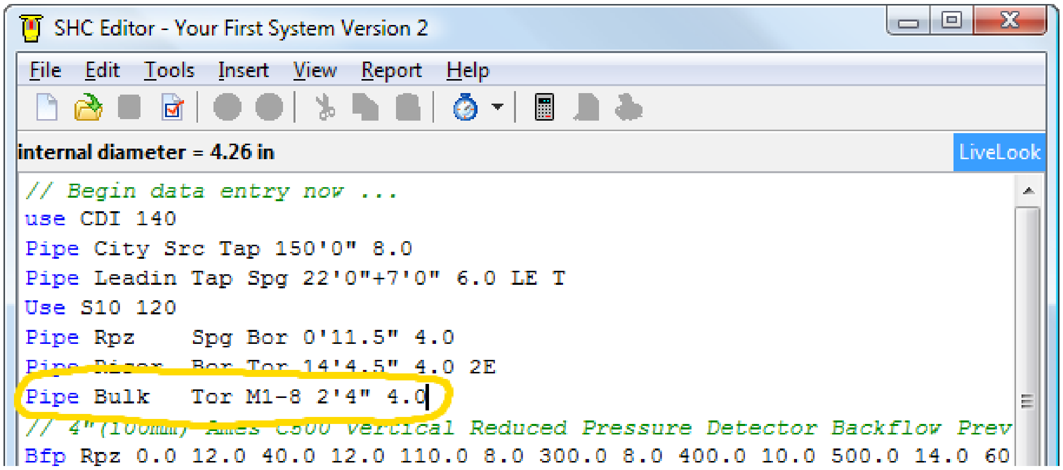
On *SHC's* menu bar select **File → Properties**. Now click on the "Naming" tab.



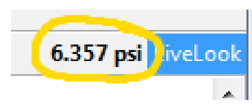
Here is where the automatic naming of pipes and nodes is controlled. By default the first crossmain node is "M1-1" (at the 'bottom' of the crossmain). *SHC* will simply increment this for the second node, third node, and so on. Since we are connecting to the main at the same place as the last of eight branchlines, this will be node "M1-8" (at the 'top' of the crossmain).

Notice that a second crossmain name is also displayed. Is *SHC* limited to two crossmains? No. *SHC* will "guess" a starting name for the third, fourth, fifth, etc. crossmains based upon the first two crossmains' names. With the defaults shown above, *SHC* is smart enough to begin the 3rd crossmain with node name "M3-1".

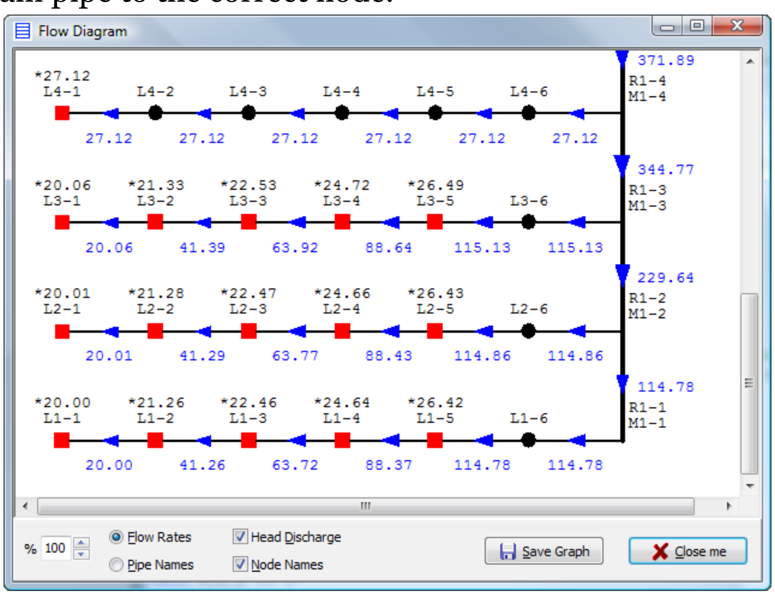
Enter a **Pipe** command for the length of pipe from node "TOR" to node "M1-8".



Now calculate. The results should be the same as the Your First System tutorial. But you accomplished entry of this system using *forty-nine fewer commands*!



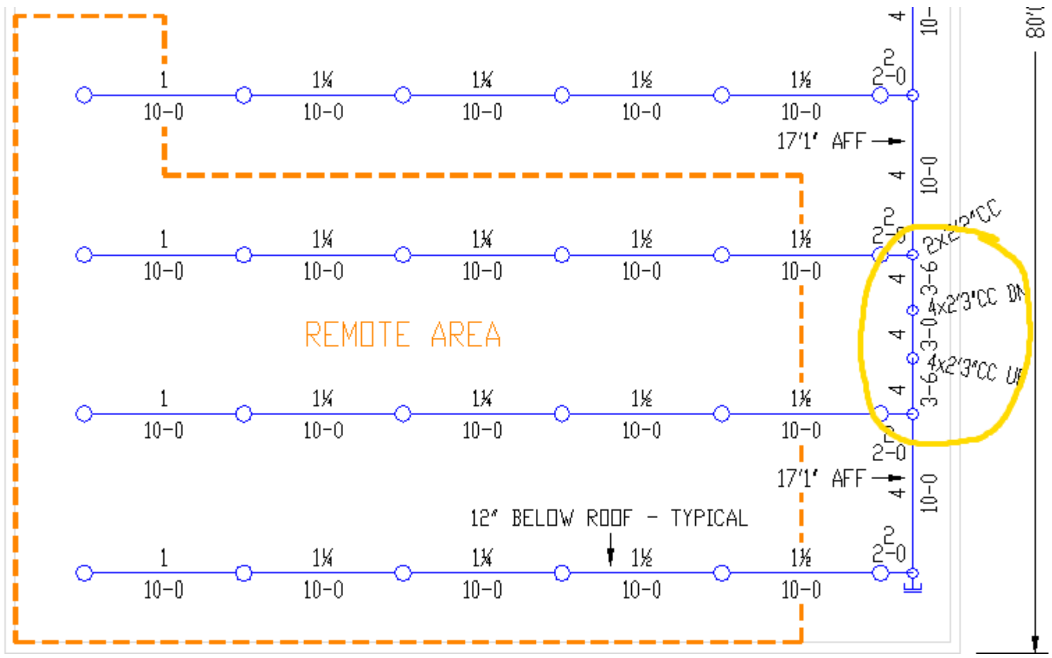
Plus *SHC* can now automatically generate a flow diagram. On the menu bar, select **View → Flow Diagram**. Use the flow diagram to check remote area size and location. Also check crossmain node names to ensure you have connected the feedmain pipe to the correct node.



Flow diagrams are only available when the "system helper" commands are used.

Modifying the Tree

Faster, more compact data input is great but what happens when the system has a small abnormality (ie: its not uniform)? Let's imagine the pipe fitters ran into an unavoidable obstruction when installing the crossmain. You have updated the drawing …



… and need to verify the hydraulic calculations.

This is a simple edit with the previous Your First System data file which defined the crossmain with **Pipe** commands. This is also an easy modification when using the "system helper" **ChangePipe** command.

First use the flow diagram to find the affected pipe's name ("m1-2"). Now type "ChangePipe" on any blank line in the *SHC Editor*.

ChangePipe pipename length size [[#]Fitting …]

ChangePipe is nearly identical to the **Pipe** command. The only difference is **ChangePipe** does not need starting and ending node names. **ChangePipe** modifies the length and/or size and/or fittings of an *existing* pipe. *SHC* already knows the node names for the pipe this command is changing.

Use the **ChangePipe** command to modify the system and calculate. You should still have a suitable safety margin.

```
// Crossmain
Main 4.0 8 10'0"
MainElev 17'1"
ChangePipe M1-2 14'6" 4.0 4e
```

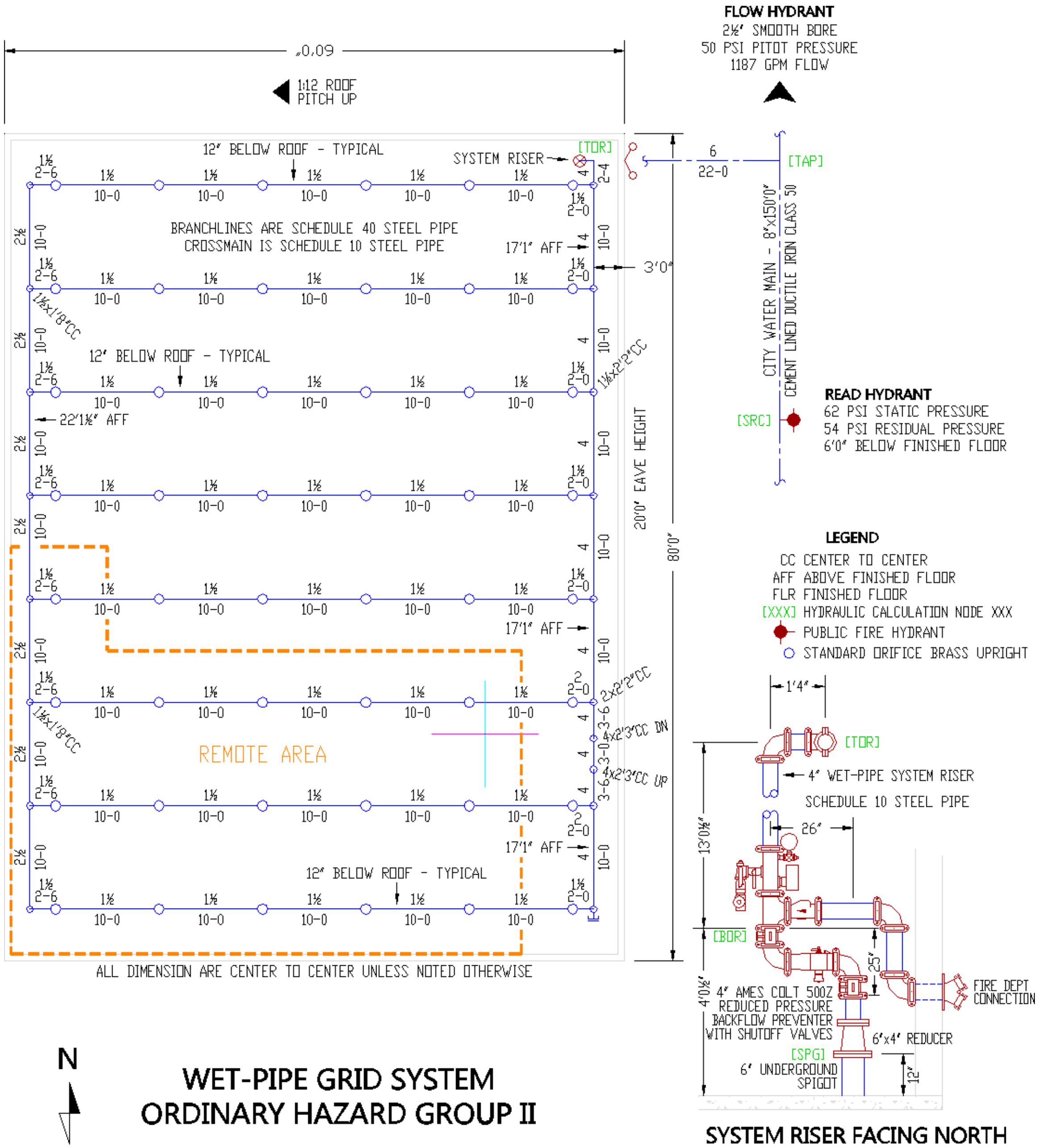
5.534 psi LiveLook

Don't forget to save your file!

Your First System, Version 3

Introduction

In this tutorial, we will evaluate the effect of transforming the tree system from Your First System, Version 2 into a grid. Open your file from Your First System, Version 2 and study the drawing below.



Adding Another Main

Recall that mirrored or rotated systems are hydraulically identical. This leaves us with a choice when adding a crossmain to the file.

Should we treat the new floater main as the second (and therefore 'right') main? If so, we add the **Main** command <u>after</u> the existing **Main** command. But *SHC* always treats the first **Main** command as the 'leftmost' crossmain. Therefore, we would be mirroring the system so we would need to mirror the coordinates in the **Flow** commands and the flow diagram would then be a mirror image of our actual system.

These negatives are avoidable if we add the new **Main** command <u>before</u> the existing **Main** command. Enter a new **Main** and **MainElev** command for the floater main <u>before</u> the existing main's commands (as shown below).

```
// Crossmains
Main 2.5 8 10'0" // floater main
MainElev 22'1.5"
Main 4.0 8 10'0" // feed main
MainElev 17'1"
ChangePipe M1-2 14'6" 4.0 4e

// Branchlines
Use s40 120
TreeLeft 6 2'0 2.0 10'0 1.5 10'0 1.5 10'0 1.25 10'0 1.25 10'0 1.
LineElev 23'7" 19'3"

// Remote Area
Flow 1 1 5 3 20.0 5.6
Flow 1 4 1 4 20.0 5.6
```

mmand has a
nain is the 2nd
e name is "M2-2".
w.

Lastly we must change the dead-end tree branchlines to gridded branchlines. Delete the **TreeLeft** command and type the system helper "Line" command in it's place.

Line #heads size startLength endLength spacing [spacing ...]

Hint

After completing this tutorial, try changing the "Your First System, Version 2" file on your own. Try entering the new floater main as the 2nd (right) crossmain. It requires fewer changes.

Gridded Branchlines

For each crossmain created with the “system helper” commands after the first crossmain, a **Line** command is required to define the gridded branchlines.

Line needs the following branchline information: number of *heads* per branchline, nominal pipe *size*, length from left main to closest head (*startLength*), length from right crossmain to closest head (*endLength*), and typical *spacing* between heads. Additional *spacing* lengths can be entered to define a pattern.

Use the system drawing to complete the **Line** command. Remember, we are viewing the system left to right. The *startLength* will be the starter pipe length from the floater main.

Now the starting elevation in the **LineElev** command needs changed. The new branchlines begin 2½” higher since they start 2'6” farther left.

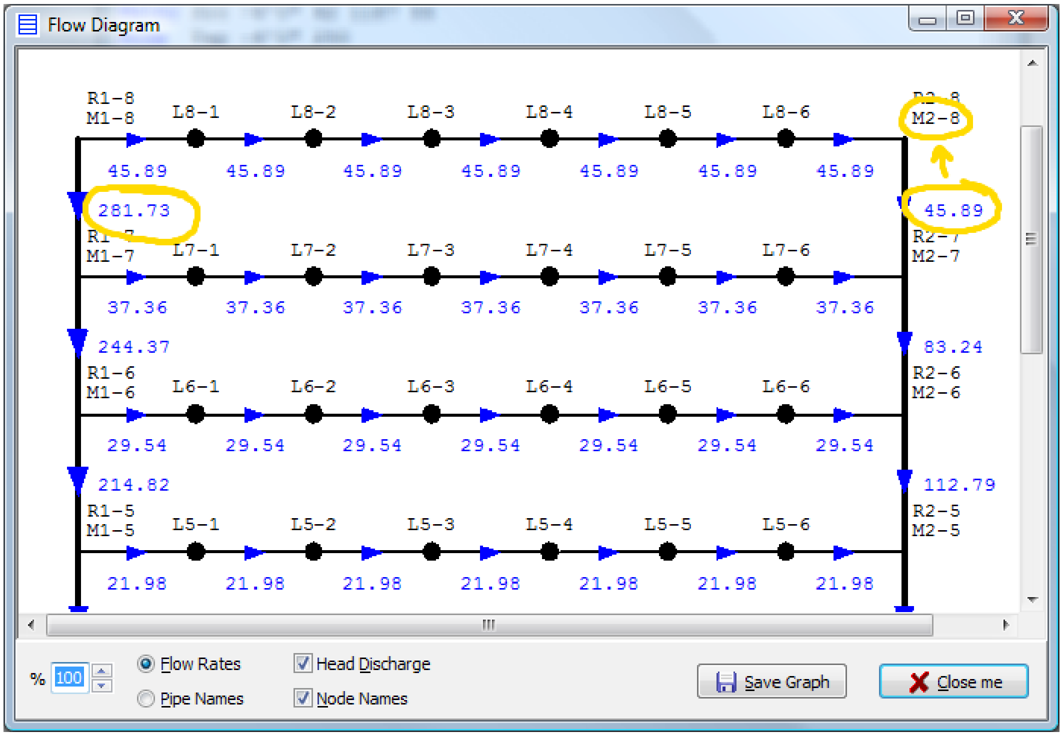
When done, the “system helper” commands in your file should look like this.

```
// Crossmains
Main 2.5 8 10'0" // floater main
MainElev 22'1.5"
Main 4.0 8 10'0" // feed main
MainElev 17'1"
ChangePipe M2-2 14'6" 4.0 4e

// Branchlines
Use s40 120 // Schedule 40 Steel
Line 6 1.5 2'6 2'0 10'0
LineElev 23'7" 19'3"

// Remote Area
Flow 1 1 5 3 20.0 5.6
Flow 1 4 1 4 20.0 5.6
```

Calculate the file. If you have any errors review this section and correct them. When done, you should see a hefty safety margin.

Mistakes

Let's open the flow diagram and check for mistakes. Check the pipe name for the **ChangePipe** command. Now notice the flow values at the top of the diagram.



Should the floater main have *over six times the flow* of the feed main? NO! When we modified the file we forgot to change the bulk main pipe that connects to the grid. Our water source is connected to the floater main!

```
// Begin data entry now ...
use CDI 140
Pipe City Src Tap 150'0" 8.0
Pipe Leadin Tap Spg 22'0"+7'0" 6.0 LE T
Use S10 120
Pipe Rpz    Spg Bor 0'11.5" 4.0
Pipe Riser  Bor Tor 14'4.5" 4.0 2E
Pipe Bulk   Tor M2-8 2'4" 4.0
```

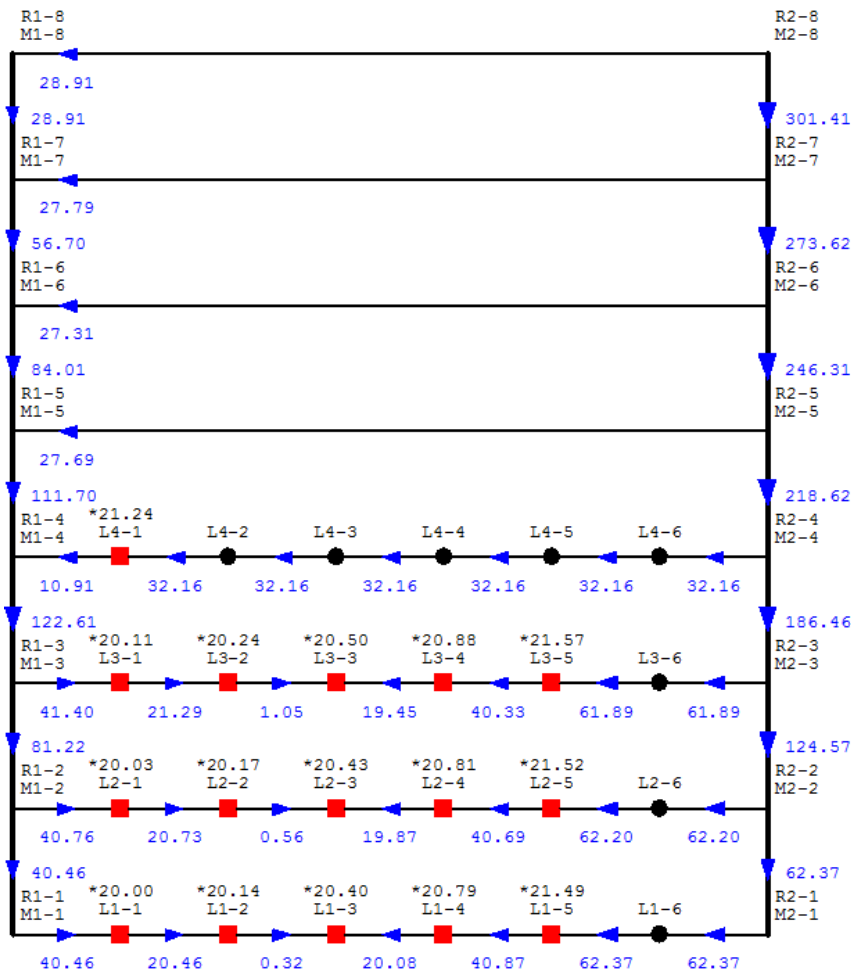
Get the correct node name from the flow diagram and change the "**Pipe** Bulk ..." command. Calculate and check the new safety margin. That simple mistake cost over three psi! Always double check changes to data files!

19.09 psi LiveLook

Reduce Command

Large tree and gridded systems can generate hundreds of pipes and nodes. To help shorten printed reports, *SHC* has the **Reduce** command. **Reduce** removes non-flowing dead-end branchlines from the calculation. **Reduce** also combines all the individual pipes in a gridded branchline into one pipe when there are no discharging heads on the branchline.

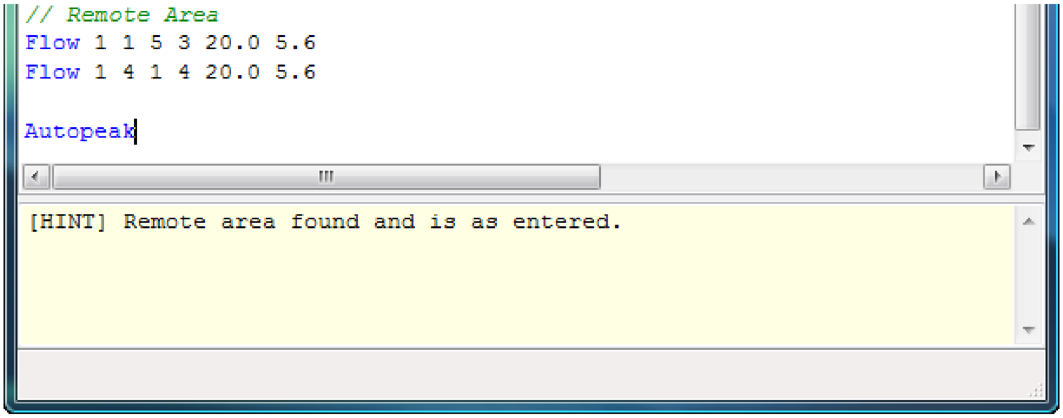
Type "Reduce" on any blank line in your file. Now recalculate and view the flow diagram. Notice how the first four branchlines are modeled as one pipe each.



This saves twenty-four pipe and twenty-four node entries in the printed report – and this is a small system!

Automatic Peaking

SHC can automatically peak systems entered with the "system helper" commands. Type "Autopeak" on any blank line in your file and calculate.



After a calculation, the **message and warning area** at the bottom of the *SHC Editor* window displays remote area information. In this case, the **Flow** commands are entered correctly. But even if the file's remote area is incorrectly placed, *SHC's* results represent the hydraulically most demanding position.

Autopeak works by shifting the remote area heads (defined with **Flow** commands) to every position they fit across all branchlines. But when **Reduce** is used, **AutoPeak** only shifts the remote area left and right along the original branchlines. This can greatly speed up automatic peaking of large gridded systems - another good reason to use the **Reduce** command.

BS EN 12845 Mode

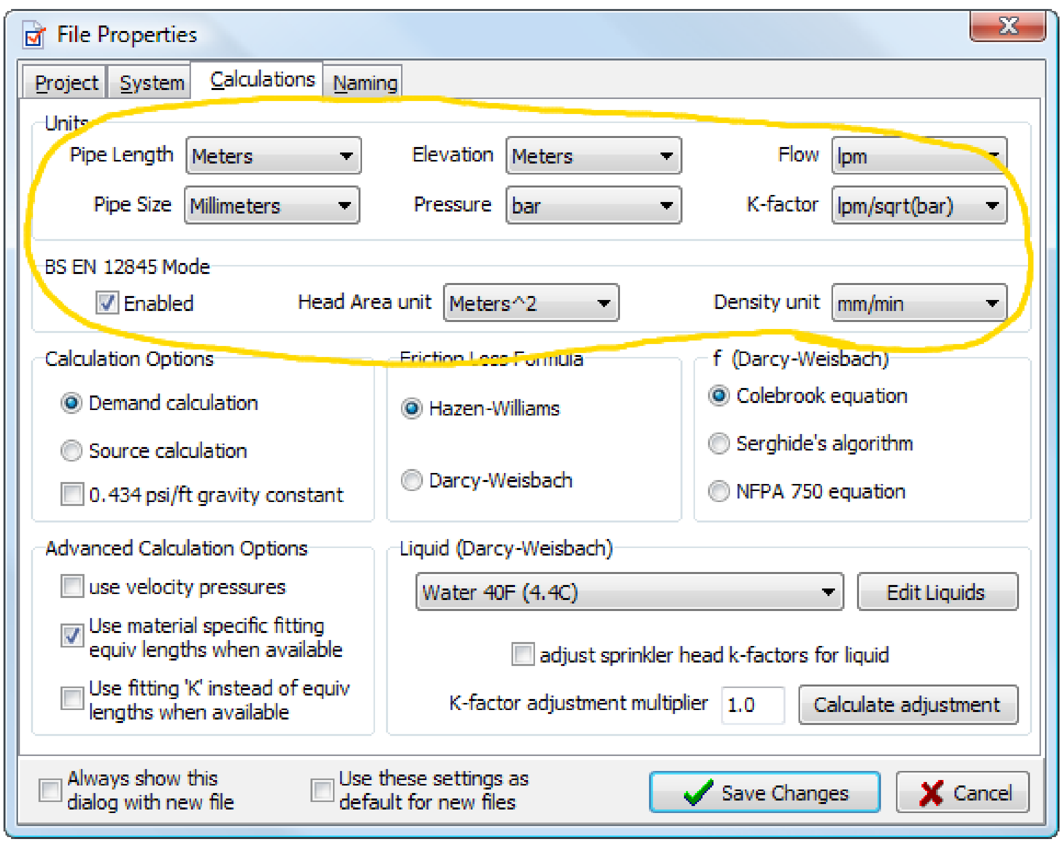
By now, you should have some experience with using *SHC's* editor for entering sprinkler system models. All tutorials up to this point, however, have used the "NFPA" rules. *SHC* may also be used with the "BS EN 12845" rules for fire sprinkler system design. This mode must be explicitly activated and some data entry parameters are different.

This section will highlight *SHC's* differences when entering a sprinkler system using **BS EN 12845** mode.

Enabling

Begin by opening the Your First System Version 2 data file. This file can be found in the *SHC Examples* folder installed on your computer's desktop. Now save the file with a different name by selecting the menu item **File → Save as**.

Open the file properties dialog and click on the calculations tab. In the "BS EN 12845 mode" section, check "Enabled" and select units for density and sprinkler head area. Also change the other units to standard SI values, as shown below. *SHC* will convert the file's parameter values to the selected units when you click the "Save Changes" button.



Remote Area

When in **12845 mode**, **Head** and **Flow** commands require a sprinkler head area parameter instead of a minimum required discharge parameter. Locate the **Flow** commands and change the **area/head** parameter to "9.3" (3.048m head spacing X 3.048m line spacing). Also change the converted k-factor parameter value "80.73" to the standard value of "80" as shown.

```
// Remote Area
Flow 1 1 5 3 9.3  80.0
Flow 1 4 1 4 9.3  80.0
```

A head area parameter alone is not enough information for *SHC* to calculate sprinkler head discharge. For this reason, the **Density** command must be used when **12845 mode** is enabled.

Head and flow commands will use the closest preceding **Density** command to calculate the required minimum discharge from a sprinkler head. Insert "Density" above the **Flow** commands and look at the status bar:

```
Density  minimumDensity  [minimumHeadPressure]
```

The **Density** command requires a **minimum density** parameter and allows an optional **minimum head pressure** parameter. Complete the **Density** command using OH2 hazard class values of "5.0" mm/min for density and "0.35" bar for minimum required head pressure. When done, your command should be similar to the command shown at right.

```
// Remote Area
Density 5.0 0.35
Flow 1 1 5 3 9.3  80.0
Flow 1 4 1 4 9.3  80.0
```

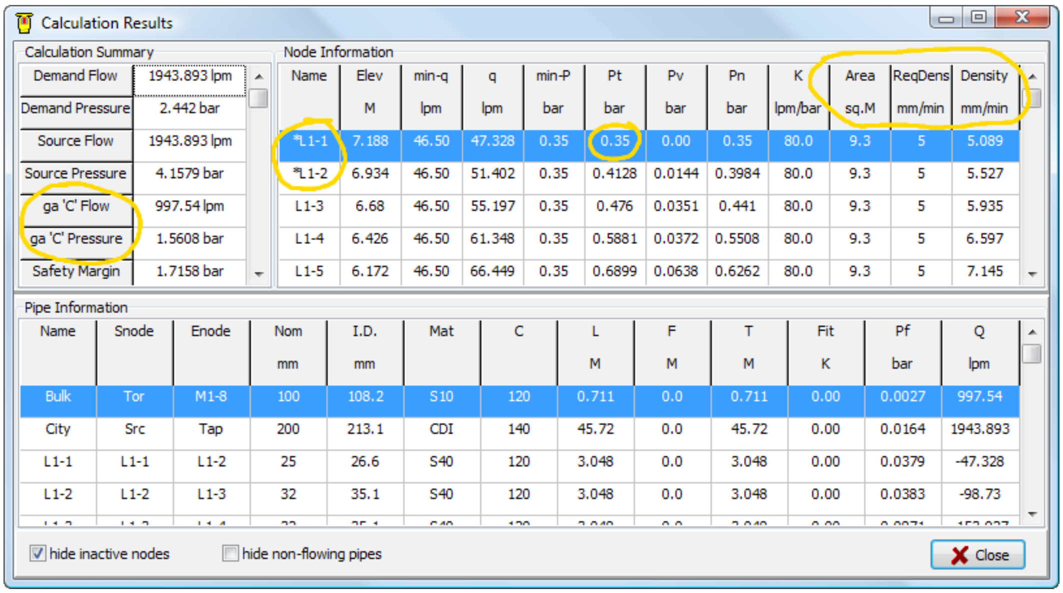
Finally, let's change the Flow commands to represent an EN 12845 compliant shape. Sixteen discharging heads are needed to meet the required 144m² area of operation. This requires two entire branchlines plus four more heads on a third branchline:

```
// Remote Area
Density 5.0 0.35
Flow 1 1 6 2 9.3  80.0
Flow 3 3 6 3 9.3  80.0
```

> **Hint**
>
> Make sure to enter a value for the **Density** command's minimum head pressure parameter whenever a sprinkler head's area of coverage is small enough to result in a discharge pressure below the code required minimum head pressure.

Results Window

Calculate the system by pressing the **F4** key or by selecting menu item **File → Calculate**. In the summary table, note that the "bor" node is considered the control valve gauge 'C' node when in BS EN 1284 mode. This node may be specified in the file properties dialog.



Calculation Summary	
Demand Flow	1943.893 lpm
Demand Pressure	2.442 bar
Source Flow	1943.893 lpm
Source Pressure	4.1579 bar
ga 'C' Flow	997.54 lpm
ga 'C' Pressure	1.5608 bar
Safety Margin	1.7158 bar

Name	Elev M	min-q lpm	q lpm	min-P bar	Pt bar	Pv bar	Pn bar	K lpm/bar	Area sq.M	ReqDens mm/min	Density mm/min
*L1-1	7.188	46.50	47.328	0.35	0.35	0.00	0.35	80.0	9.3	5	5.089
*L1-2	6.934	46.50	51.402	0.35	0.4128	0.0144	0.3984	80.0	9.3	5	5.527
L1-3	6.68	46.50	55.197	0.35	0.476	0.0351	0.441	80.0	9.3	5	5.935
L1-4	6.426	46.50	61.348	0.35	0.5881	0.0372	0.5508	80.0	9.3	5	6.597
L1-5	6.172	46.50	66.449	0.35	0.6899	0.0638	0.6262	80.0	9.3	5	7.145

Name	Snode	Enode	Nom mm	I.D. mm	Mat	C	L M	F M	T M	Fit K	Pf bar	Q lpm
Bulk	Tor	M1-8	100	108.2	S10	120	0.711	0.0	0.711	0.00	0.0027	997.54
City	Src	Tap	200	213.1	CDI	140	45.72	0.0	45.72	0.00	0.0164	1943.893
L1-1	L1-1	L1-2	25	26.6	S40	120	3.048	0.0	3.048	0.00	0.0379	-47.328
L1-2	L1-2	L1-3	32	35.1	S40	120	3.048	0.0	3.048	0.00	0.0383	-98.73

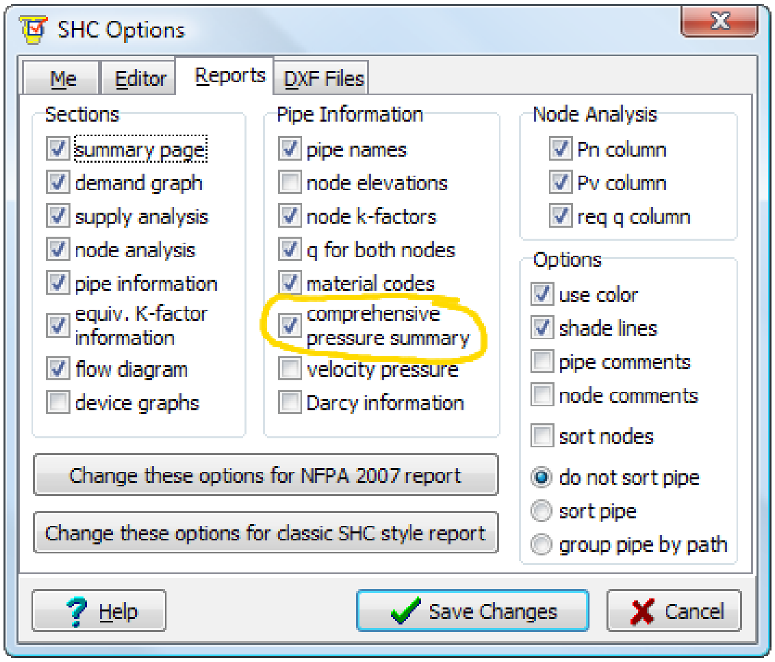
The node information section contains three new columns for head area, required density, and calculated density. Nodes that are part of the most remote four adjacent head area have their names/labels prefixed with an asterisk (*).

Finally note that *SHC* is maintaining the minimum head pressure specified in the **Density** command although this results in a slightly higher delivered density than required.

> **Hint**
>
> If *SHC* improperly determines adjacency, the **FourHeads** command may be used to manually select the most remote adjacent heads. The **FourHeads** command may be abbreviated **FH**.

Report Settings

Open the report options dialog by selecting menu item **Report → Options**. Select the recommended report options shown below.



Most importantly, insure the pipe information option **comprehensive pressure summary** is selected or flow velocity will not always be included in the hydraulic calculation report. Also, the node analysis section of the report will always include columns for sprinkler head area, required density, and calculated density when BS EN 12845 mode is enabled.

Preview the hydraulic calculation report by pressing **F5** on the keyboard or selecting menu item **Report → Preview**. Between the report's "Supply Analysis" and "Node Analysis" sections, *SHC* will include a four head analysis section when in BS EN 12845 mode.

Most Hydraulically Remote Four Heads

Average Density = 197.568 lpm / 37.2 sq.M = 5.311 mm/min

NodeTag	Elev [M]	Type	Pressure [bar]	Req Disch [lpm]	Discharge [lpm]	Area [sq.M]	ReqDensity [mm/min]	Density [mm/min]
L1-1	7.188	K=80.00	0.350	46.500	47.328	9.300	5.000	5.089
L1-2	6.934	K=80.00	0.413	46.500	51.402	9.300	5.000	5.527
L2-1	7.188	K=80.00	0.351	46.500	47.382	9.300	5.000	5.095
L2-2	6.934	K=80.00	0.414	46.500	51.456	9.300	5.000	5.533

Autopeak

The **Autopeak** command works to find the most unfavourable area. (See the Your First System version 3 tutorial.) When in BS EN 12845 mode, however, **Autopeak** may be modified to find the most favourable area by using the **Favourable** command.

Let's use these two commands to find the most favourable remote area in the data file. Start by commenting out the existing **Flow** commands since we need a differently shaped remote area. By commenting out the commands instead of deleting them we can quickly revert to the most unfavourable remote area when needed.

The most square-like shape we can achieve for the 16 head remote area is four branchlines flowing four heads each. Type in a new Flow command for this remote area shape. Remember, *SHC* will automatically peak the system for you so enter the remote area anywhere. Shown below is a **Flow** command with the remote area defined at the most unfavourable position.

```
// Remote Area
Density 5.0 0.35
//Flow 1 1 6 2 9.3  80.0
//Flow 3 3 6 3 9.3  80.0

Flow 1 1 4 4 9.30   80.0
Autopeak
Fav
```

Now enter the **Autopeak** and **Favourable** commands in the SHC editor. The **Favourable** command may be abbreviated **Fav** as shown.

Calculate the system. The message and warning area (at the bottom of *SHC's* window) will display a “hint” on how the remote area was shifted. You can verify the final calculated position with the flow diagram (menu item **View → Flow Diagram**).

Summary

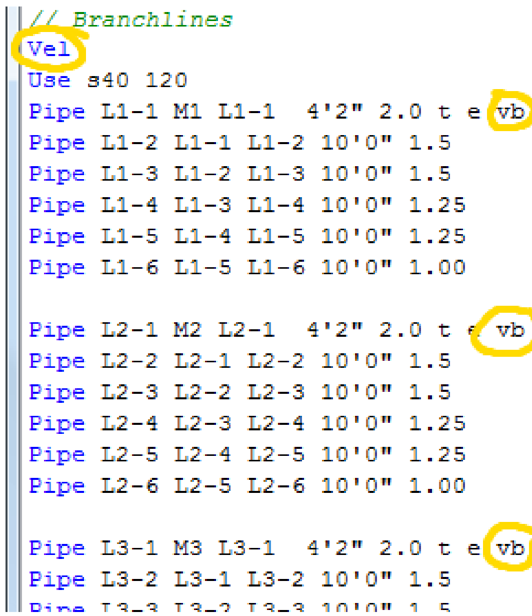
SHC's **BS EN 12845 mode** will help you create code compliant reports whenever the BS EN 12845 rule set is required for automatic sprinkler system design. Please keep the following items in mind when using this mode:

- A **Density** command must precede any **Head** or **Flow** commands in the *SHC* editor. Multiple **Density** commands may be used.
- **Head** and **Flow** commands have a **head area** parameter instead of a **minimum discharge** parameter.
- The **FourHeads** command may be used to manually select the four most unfavorable adjacent sprinkler heads.
- The **Favourable** command may be used with **Autopeak**.
- Clean installations (not upgrades) of *SHC* version 2.2 or later have equivalent lengths from table 23 of EN 12845:2004+A2:2009 entered for material codes “BSM”, “BSH”, “ENM”, and “ENH”.

Velocity Pressures

Adjusting branching flows and head discharge for velocity pressure may make a large difference in the system calculations. To make these calculation adjustments, *SHC* must know where to use velocity pressures.

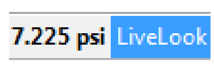
Open the Your First System data file. On any blank line, type “Vel”. The **Vel** command instructs *SHC* to calculate using velocity pressures – regardless of the file properties settings (menu item **File → Properties**, **Calculations** tab).



Locate the first **Pipe** command for the first branchline and add the fitting code “VB”. **VB** instructs *SHC* to adjust flow at the start node (*V*elocity *B*eginning) for velocity pressures. Conversely, *SHC* can be instructed to adjust flow at the ending node with the **VE** fitting code (*V*elocity *E*nding).

Since each branchline that splits the crossmain flow should be adjusted using velocity pressures, add the **VB** fitting code to the first pipe of each branchline except the last. The last branchline does not split the flow so no adjustment is required. If you do add the fitting code **VB** on this pipe it will have no affect.

Calculate the file. Safety margin should rise from 6.36 psi to 7.22 psi.



When using the “system helper” commands, *SHC* places **VB** and **VE** codes where needed on automatically generated pipes. But you must always place these fitting codes where needed on pipes defined with the **Pipe** command.

Load the Your First System, Version 2 file, add the **Vel** command, and calculate. This file should yield an identical safety margin of 7.22 psi with no further work.

> **Hint**
> Velocity pressures make it harder for *SHC* to converge on a solution. If you get a “convergence” error message try calculating without velocity pressures.

Equivalent K-factors

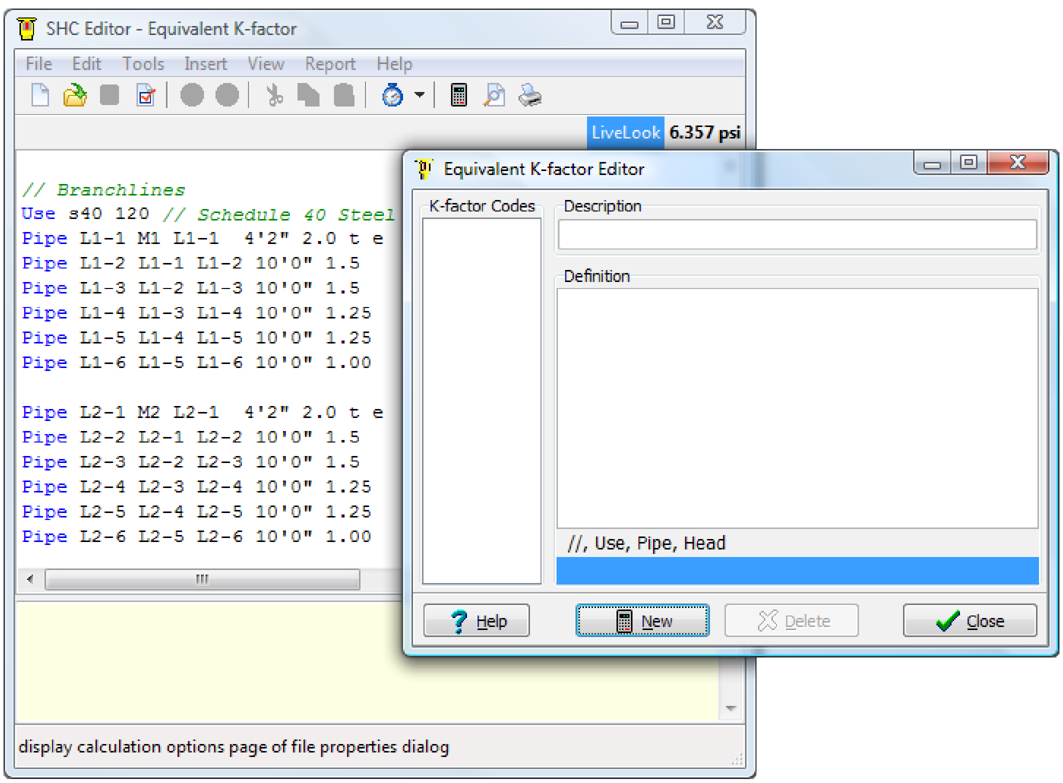
Introduction

The **Equivalent K-factor Editor** window may be used to create, view, and edit equivalent k-factor definitions. Equivalent K-factors can speed up data entry, increase the clarity of your data file, and shorten printed hydraulic calculation reports. The **Equivalent K-factor Editor** may be opened by selecting **Edit → Equivalent K-factors** on *SHC*'s menu bar.

Tutorial

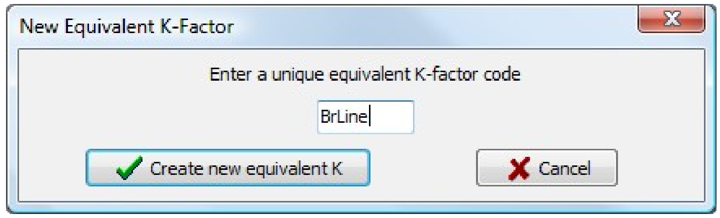
In this tutorial, you are going to learn how to model an entire branchline using an equivalent k-factor. To begin, open the Your First System data file. (If you have not done this previous tutorial, you may find the data file in the "SHC Examples" folder installed on Window's desktop.)

Three typical remote area branchlines on this system each feed five discharging sprinkler heads. Open the Equivalent K-factor Editor window (menu item **Edit → Equivalent K-factors**) and move it so the *SHC* data file editor is still visible.



The **K-factor Codes** list displays all equivalent k-factor codes that have been defined for the current data file. This list is empty since no equivalent k-factors have been defined yet.

Click the **New** button and type in a unique name of six characters or less. For this example, use "BrLine", as shown. Then click the **Create new ...** button.



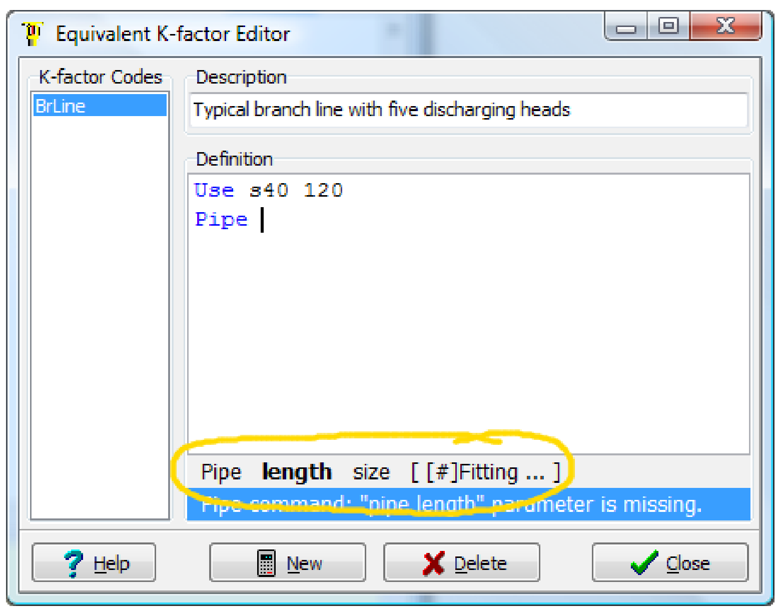
Now you may enter a description for this equivalent k-factor name and define it. The equivalent k-factor name may be used for any **Head** or **Flow** command's k-factor parameter.

Defining the K-factor

How do you define the equivalent k-factor? The equivalent k-factor editor supports the familiar // and **Use** commands along with slightly modified **Head** and **Pipe** commands. The equivalent k-factor editor also supports many of the editor features you are already familiar with including the **Popup Helper** and command format help.

Begin the "BrLine" equivalent k-factor definition with the familiar **Use** command and then continue on to the first **Pipe** command.

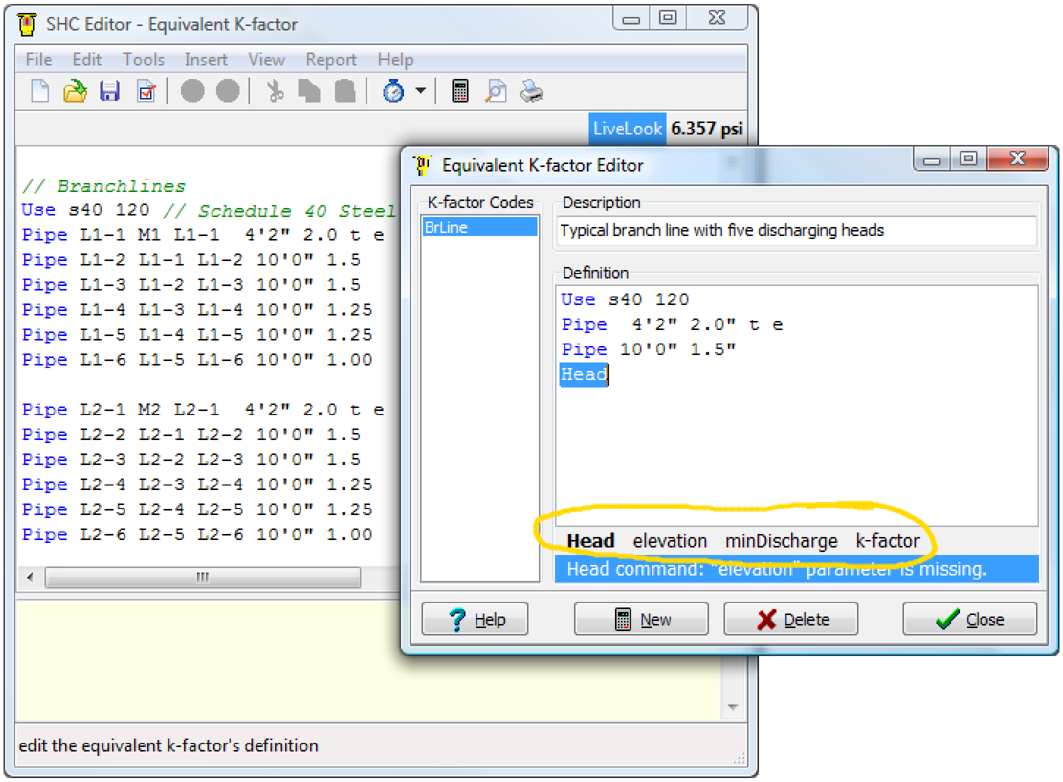
Note the **Pipe** command format at the bottom of the editor window. The equivalent k-factor editor's **Pipe** command does not require a *pipe name* parameter or any *node name* parameters.



Complete the **Pipe** command. Use *length*, *size*, and *fitting* values from the original *SHC* data file.

Now define the second branchline pipe.

When done, the equivalent k-factor editor should look similar to this.



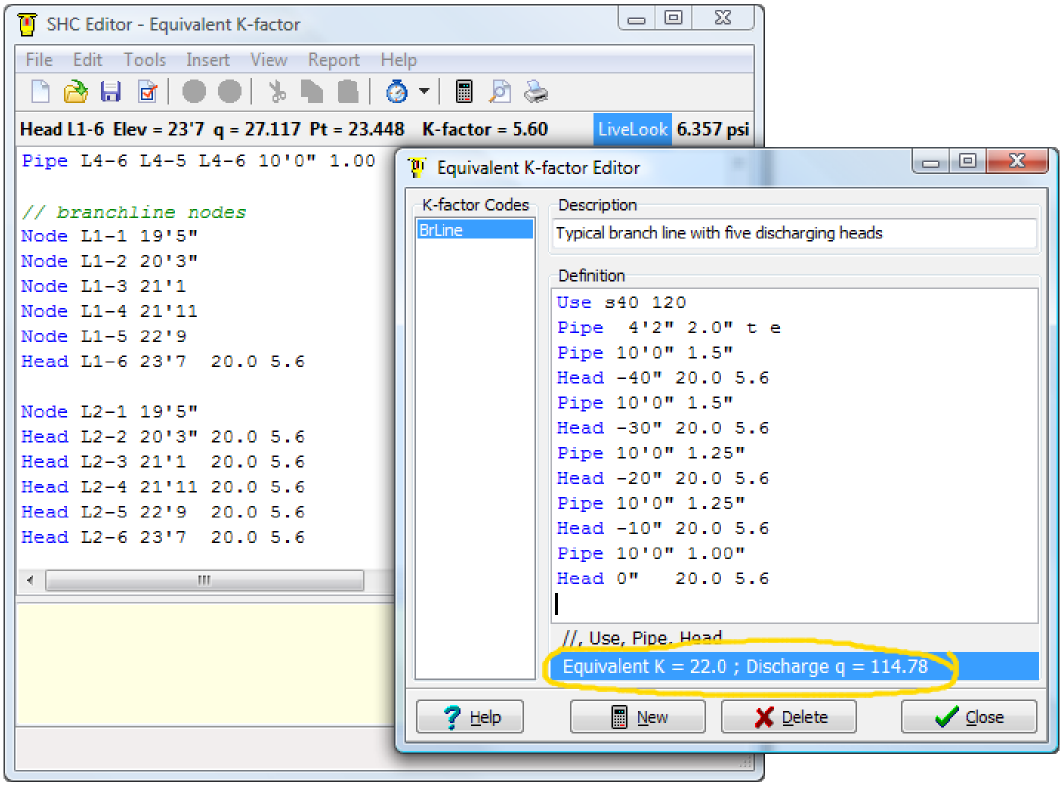
Now you have reached the position of the first discharging sprinkler head on the branchline. A discharging sprinkler head is entered using the **Head** command. Study the **Head** command format. The equivalent k-factor's **Head** command does not use a *node name* parameter. Also, the *elevation* parameter is relative to the node to which the equivalent k-factor is to be applied.

In this example, the node(s) the equivalent k-factor is applied to will use the elevation of the highest discharging sprinkler head. The head we are defining now is 40'0" horizontally from the highest (last) head and the line is pitched one inch per foot. Therefore, this head is 40 inches below the highest head.

Complete the **Head** command using -40" for the *elevation* parameter. Copy *minDischarge* (20) and *k-factor* (5.6) parameters from the *SHC* data file.

Finish the equivalent k-factor definition by entering the remainder of the branchline. Note that each discharging head will be ten inches higher than the previous one.

Equivalent K-factors

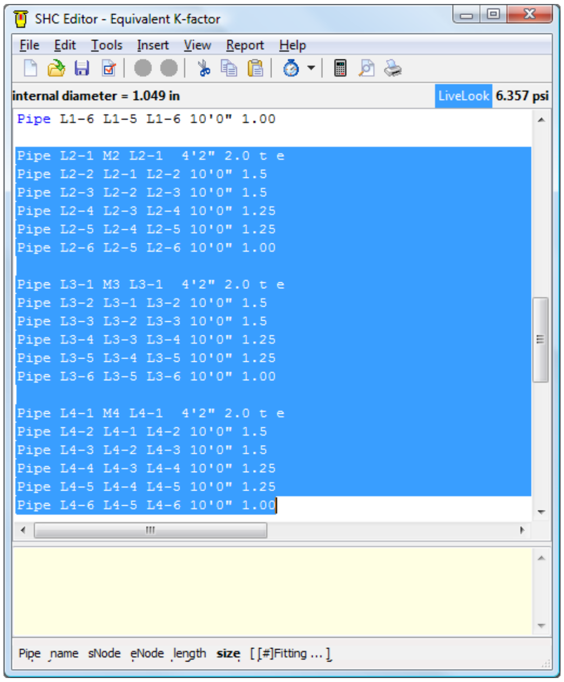


Whenever you stop typing for a short period of time, *SHC* will attempt to calculate the equivalent k-factor. If successful, the equivalent k-factor is displayed on the highlighted bar as shown above. If the calculation fails an error message will be displayed here.

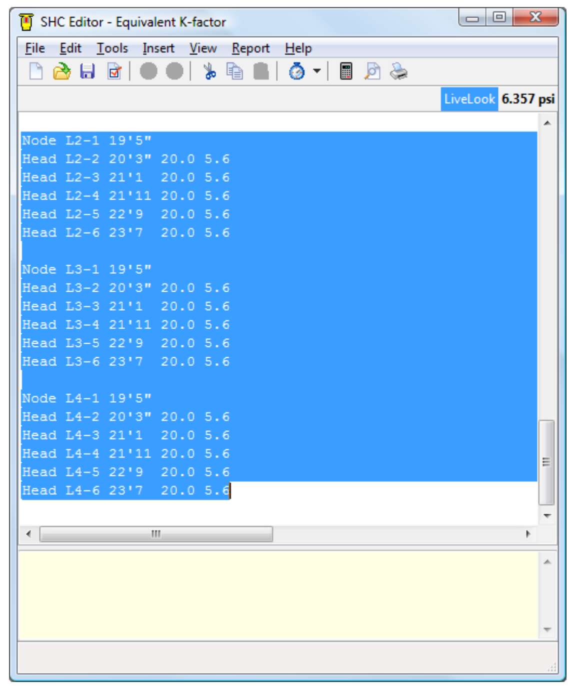
Once your equivalent k-factor is successfully calculated, as shown above, click the **Close** button to exit the **Equivalent K-factor Editor**.

Using an Equivalent K-factor

Now that the equivalent k-factor for an entire branchline has been calculated, we may change the *SHC* data file to use it.

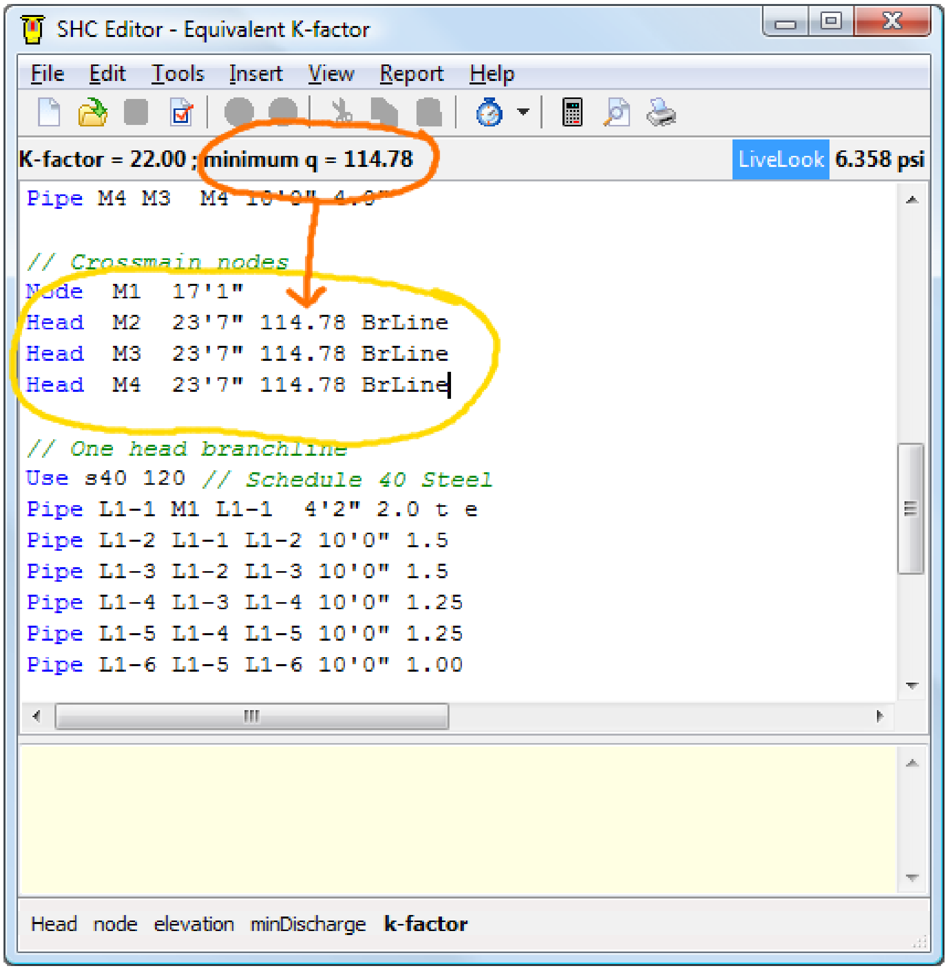


First, delete the branchline **pipe** definitions we will model with equivalent k-factors ...



... then delete the branchline **node** definitions that are no longer needed.

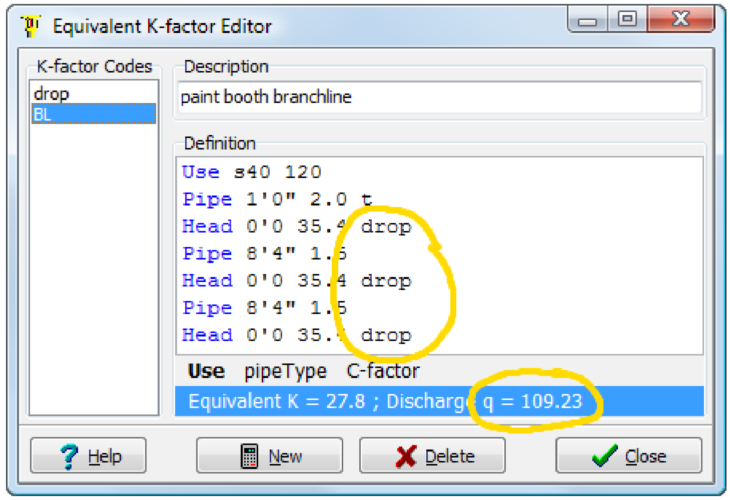
Last, Change the three crossmain **Node** definitions to **Head** commands where the branchlines connect. Change their elevation to the elevation of the highest discharging sprinkler head (23'7"). Use the discharge calculated by the equivalent k-factor editor for the *minDischarge* parameter. Use your k-factor's name ("BrLine") for the *k-factor* parameter, as shown below.



After entering the **Head** commands, verify the minimum discharge value used by placing the editor's cursor or mouse pointer over the "BrLine" k-factor parameter and checking the **LiveLook** bar. Always use the calculated discharge value when modeling multiple sprinkler heads with a singe equivalent k-factor.

Calculate by pressing **F4** on the keyboard or selecting the menu item **File → Calculate**. Results are nearly identical to the "Your First System" data file. Congratulations – you've now learned how to enter and define equivalent k-factors with *Simple Hydraulic Calculator*!

Summary



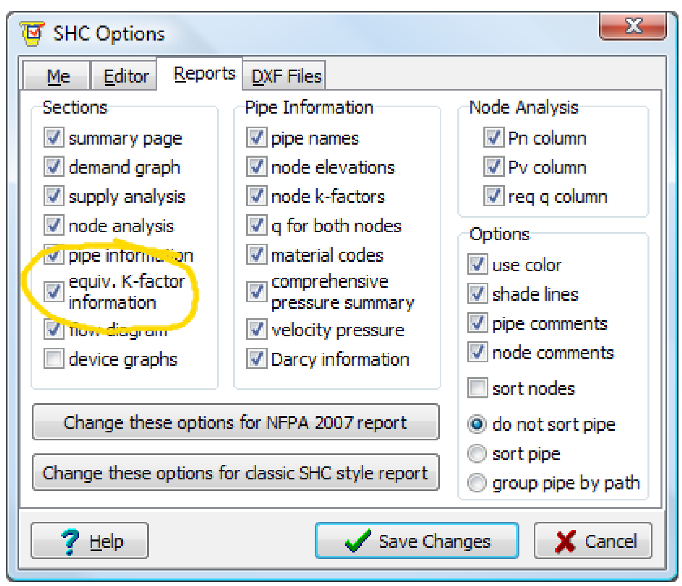
When used correctly, equivalent k-factors can speed up input, increase the clarity of your data file, and shorten printed hydraulic calculation reports.

Use the Equivalent K-factor Editor to create as many equivalent k-factors as needed for your data file.

Use previously defined equivalent k-factors to create more complex equivalent k-factors (as shown at right).

When using an equivalent k-factor modeling multiple head discharge (as shown above) in a **Head** or **Flow** command, use the calculated discharge value for the command's minimum discharge parameter. Do not add up minimum discharge required from each head!

There must always be at least one **Pipe** command between any two **Head** commands in the equivalent k-factor definition. (You may use a zero length **pipe** to separate two sprinkler heads attached at the same point.)

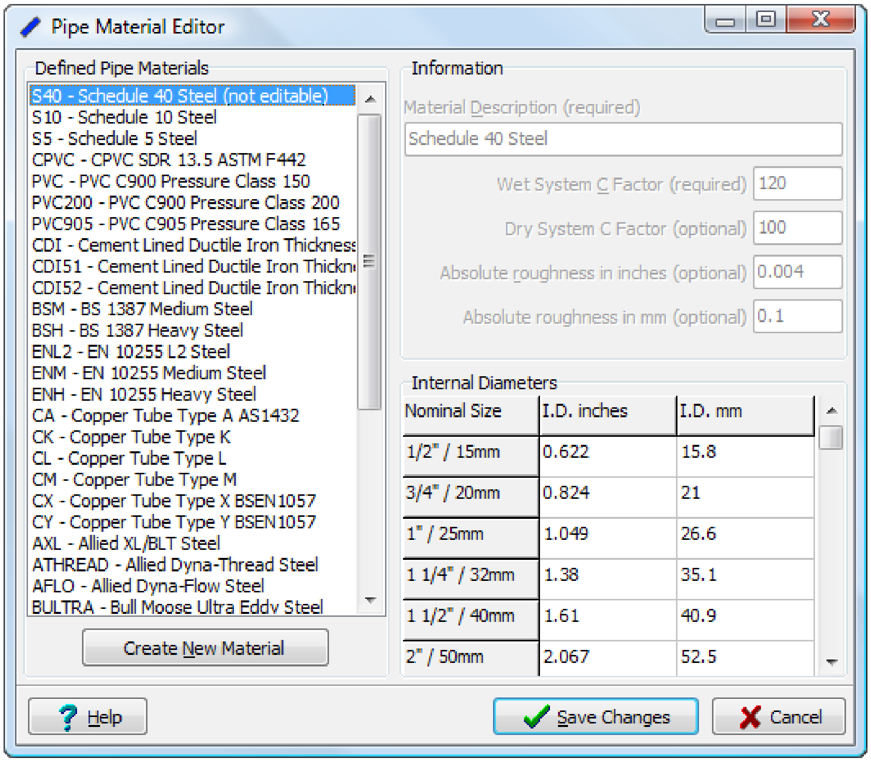


Use the actual head elevation (not main or branchline elevation) and place it on the node the equivalent k-factor attaches to.

Make sure equivalent k-factor calculations are included in the report. Display the Report Options page by selecting **Report → Options** on *SHC*'s menu bar. Verify the "equiv K-factor information" report section item is checked (as shown at right).

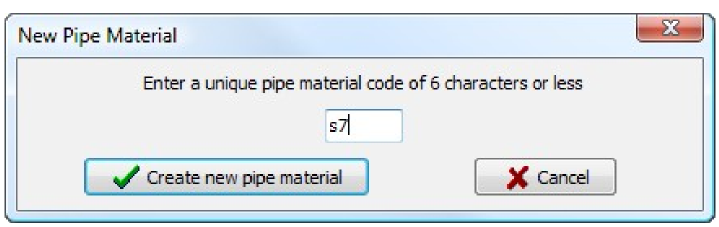
Pipe Material Editor

When your pipe material of choice is not predefined by *SHC* use the **pipe material editor** to add the material. On *SHC's* menu bar select **Tools → Materials → Pipe**.



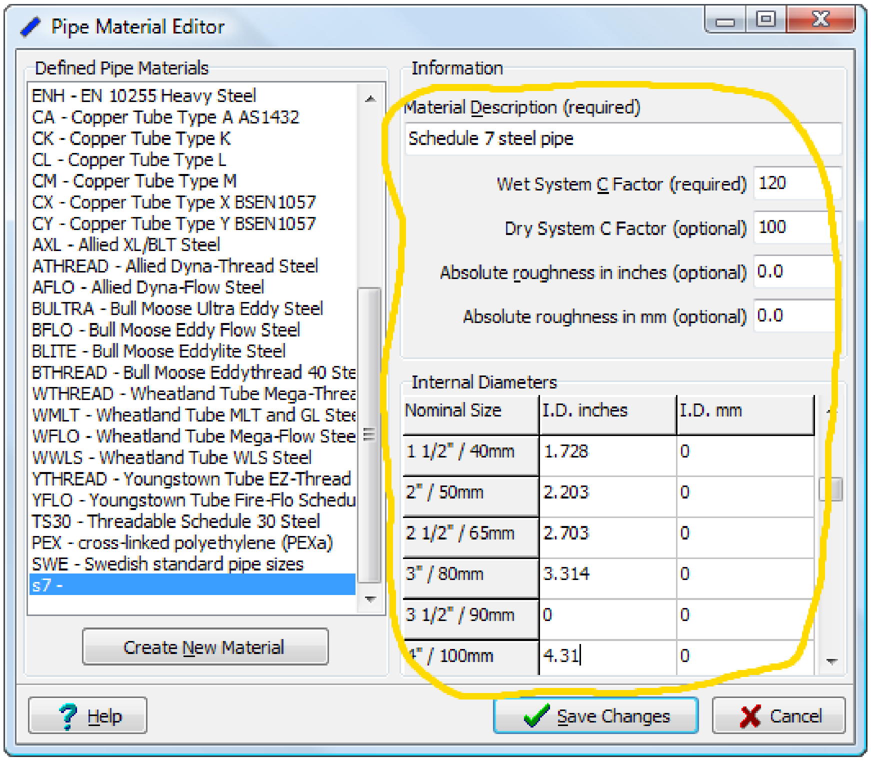
To edit an existing material select it in the **Defined Pipe Materials** list box. Then edit values in the **Internal Diameters** grid.

For this example we will create a new pipe material for schedule 7 steel pipe. Click the **Create New Material** button.



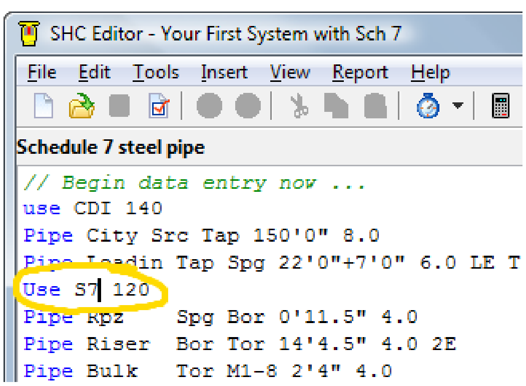
Type "s7" in the edit box. This is the material code that will be associated with our new pipe material.

Ensure the new material is selected in the "Defined Pipe Materials" list box. Then proceed to fill out the required information for this new pipe material as shown below.



After entering the correct values click the **Keep Changes** button and the pipe material is permanently added to *SHC's* material database.

Open the "Your First System, Version 2" data file. Change the **Use** command so all 4" pipe will use the new schedule 7 material:

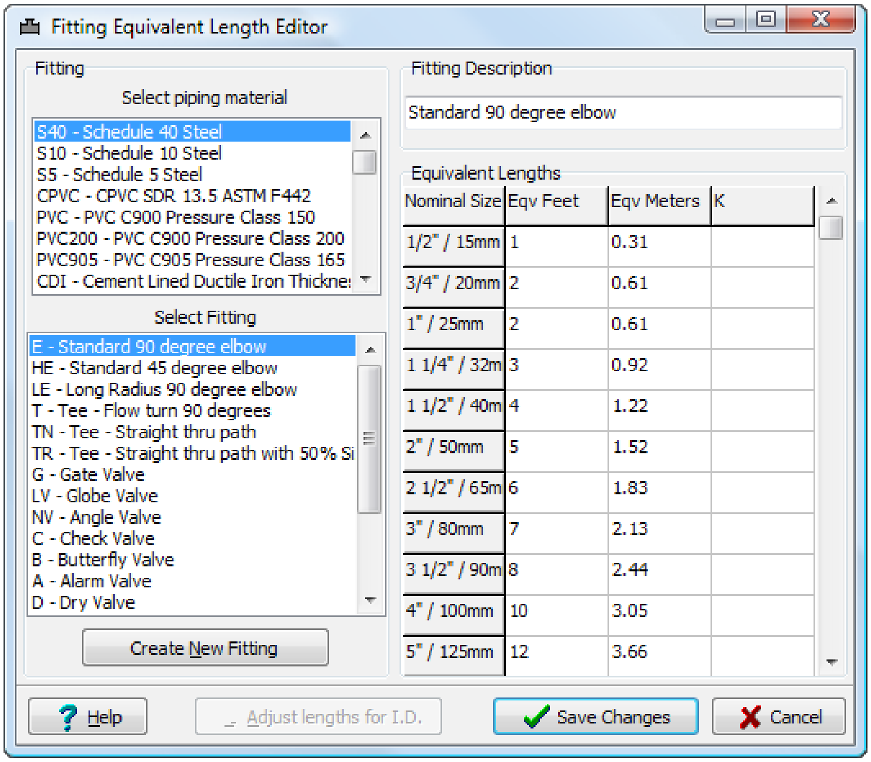


Calculate the file. Safety margin rises from 5.53 psi to 5.66 psi. Internal diameters may be verified in the **Calculation Results** window.

If an internal diameter is wrong, open the **Pipe Diameter Editor** and correct.

Fitting Editor

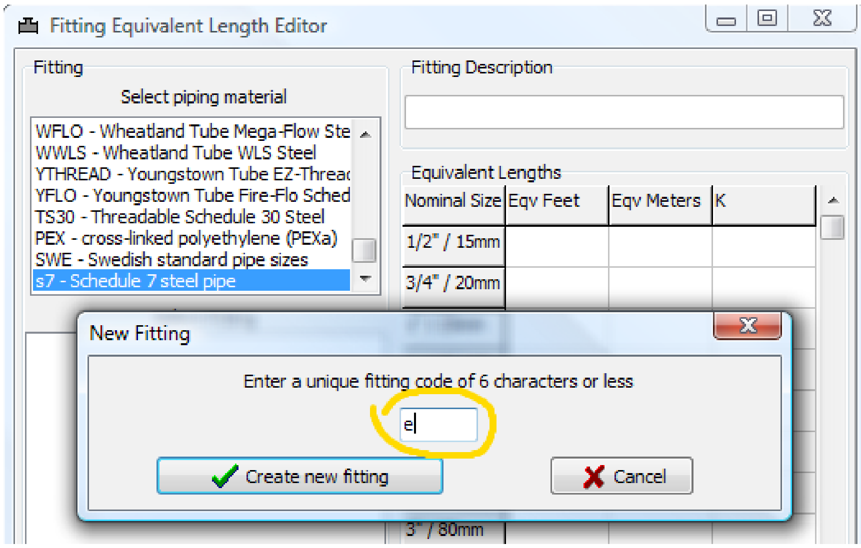
Now that schedule 7 steel pipe is defined we will enter a fitting just for this material. Use the menu bar to select **Tools → Materials → Fittings**. This is the **Fitting Equivalent Length Editor**.



We are going to define a 90° grooved elbow fitting. There are two ways to do this. First, a new fitting code could be created for the schedule 40 steel pipe material. Then the fitting code would be available for use with any pipe material. It's equivalent length would be adjusted in accordance with NFPA 13 for internal diameters different then schedule 40 steel pipe and c-factors other than 120. The disadvantage to this method involves the “system helper” commands. These commands create pipe using the “T” and “E” fitting codes only. A new “GE” or “EG” code would not be used by **Main**, **Line**, or related commands.

Instead of doing this we will add a fitting code just for use with the new schedule 7 steel pipe material entered in the previous section.

Select "s7" in the "Select Piping Material" list box. Then click the "Create New Fitting" button.



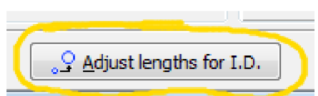
Type "e" in the edit box and click the "Create New Fitting" button. Ensure "s7" pipe and "e" fitting code are selected. Now fill in the description and equivalent length information (from your fitting manufacturer's data sheet).

Note that many data sheets list equivalent length based upon schedule 40 steel pipe diameters. *SHC* expects the equivalent length entered for a material specific fitting code be accurate for that specific material – no adjustment for internal diameter will be made. If your data is for schedule 40 steel pipe equivalent length you must adjust it for the internal diameter of schedule 7 pipe before entering.

My data sheet indicates 6.5 feet equivalent length for a 4" grooved elbow. You could adjust the length manually using the following formula from NFPA 13:

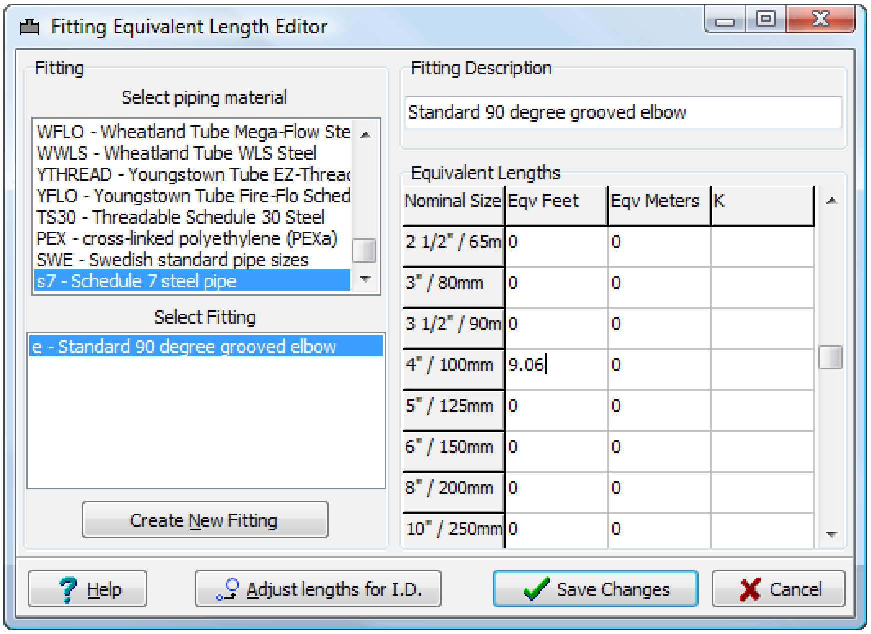
$$\left(\frac{Actual\ inside\ diameter}{Schedule\ 40\ steel\ \ pipe\ inside\ diameter}\right)^{4.87}$$

But *SHC* has an easier way. Enter the unadjusted "6.5" feet value in the **equivalent length** grid. Then click the **Adjust lengths for I.D.** button.



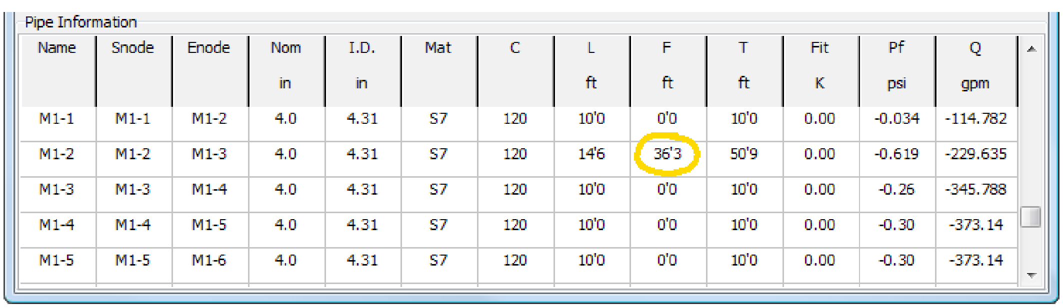
SHC will prompt you to make sure you want to do this. Click "Yes" and all values for the current fitting are adjusted according to the NFPA formula above.

The “6.5” value should be changed to “9.06” as shown below. Click the **Save Changes** button to keep your new fitting definition.



SHC will use this equivalent length whenever the “e” fitting code is used with 4” schedule 7 pipe. If any size is used that does not have an equivalent length, the equivalent length for the “e” fitting code of schedule 40 steel pipe is used and adjusted for the internal diameter.

Open the “Your First System, Version 2” data file. Change the **Use** command so all 4” pipe will use the schedule 7 material and calculate.



Pipe Information

Name	Snode	Enode	Nom in	I.D. in	Mat	C	L ft	F ft	T ft	Fit K	Pf psi	Q gpm
M1-1	M1-1	M1-2	4.0	4.31	S7	120	10'0	0'0	10'0	0.00	-0.034	-114.782
M1-2	M1-2	M1-3	4.0	4.31	S7	120	14'6	36'3	50'9	0.00	-0.619	-229.635
M1-3	M1-3	M1-4	4.0	4.31	S7	120	10'0	0'0	10'0	0.00	-0.26	-345.788
M1-4	M1-4	M1-5	4.0	4.31	S7	120	10'0	0'0	10'0	0.00	-0.30	-373.14
M1-5	M1-5	M1-6	4.0	4.31	S7	120	10'0	0'0	10'0	0.00	-0.30	-373.14

The four elbows used in the **ChangePipe** command accurately equate to an equivalent length of 36'3”.

Hint

Only use the **Adjust length for I.D.** button once for each fitting after entering equivalent lengths for all desired pipe sizes. Don't accidentally adjust an equivalent length twice!

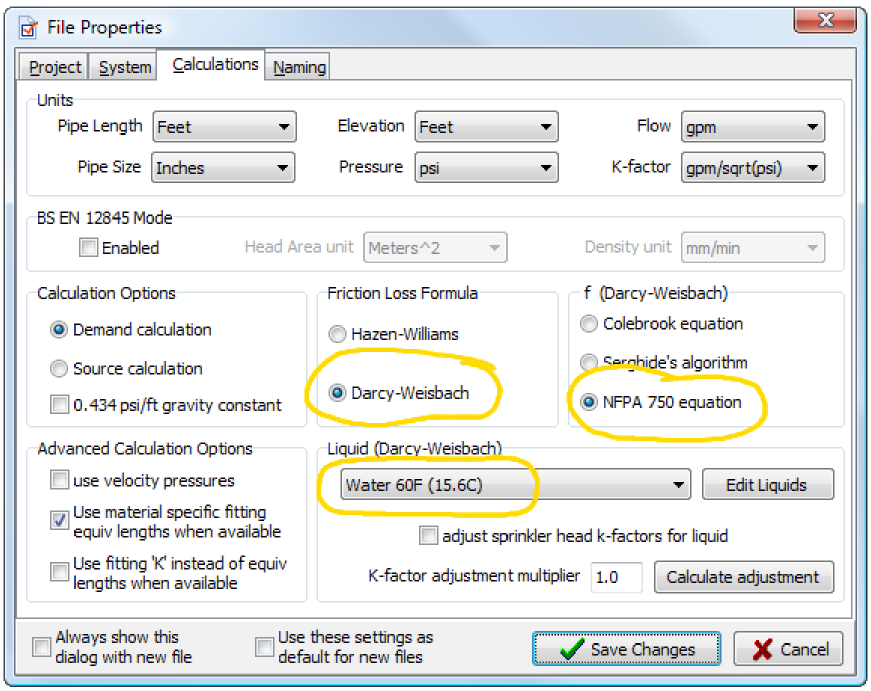
Calculating with Darcy

Introduction

Open the Your First System data file and calculate. Safety margin on this file is approximately 6.3 psi using the default Hazen-Williams friction loss formula. We will now modify this file to use the **Darcy-Weisbach** friction loss equation.

File Properties

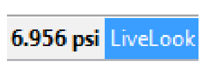
Open the file properties dialog by selecting **File → Properties** on the menu bar. Click on the **Calculations** tab.



As shown above, select **Darcy-Weisbach** for friction loss formula, **NFPA 750 equation** for friction factor (f), and **Water 60F** for the Liquid.

This is the fastest and easiest way to change a file from the Hazen-Williams formula to the Darcy-Weisbach equation. Click the **Save Changes** button then calculate the file.

The change in formula is apparent with the new safety margin.

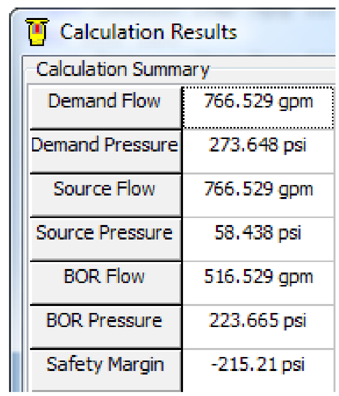


Friction Factor Formulas

Why did we select the **NFPA 750 equation**? This is the only formula that uses Hazen-Williams C-factors. That makes it the easiest formula to select on existing data files – none of the **Use** commands need to be changed. The drawback to this formula is slightly less accuracy. *SHC* provides two other friction factor formulas for when greater accuracy is needed.

Colebrook is the industry standard used to develop the Moody diagram. Absolute roughness values must be used instead of Hazen-Williams C-factors. Use Colebrook if you are not sure which friction factor formula to choose.

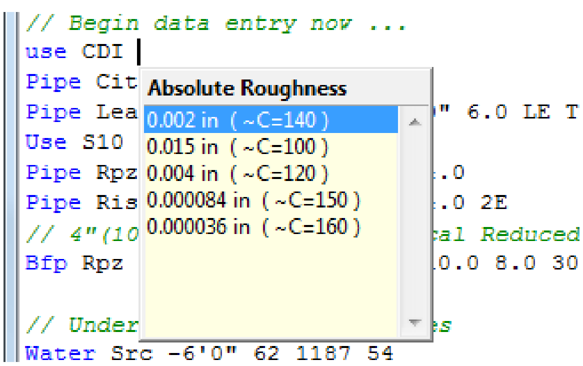
Serghide's algorithm mimics the Colebrook equation very accurately (including the need for absolute roughness values) and calculates modestly faster. This speed gain is not needed for modern computers.



Open the file properties dialog again and change the friction factor formula to **Colebrook**. Click **Keep Changes** and recalculate.

Wow! What happended? The Colebrook equation expects *Absolute Roughness* values instead of C-factors.

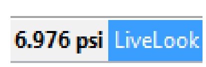
When using a friction factor formula that needs *Absolute Roughness*, all **Use** commands expect an absolute roughness value - in pipe size units - instead of a Hazen-Williams C-factor.



In *SHC's* editor go to the first **Use** command and delete the "140" C-factor. Press the SPACEBAR and wait for the popup helper. Select the absolute roughness value roughly equal to a C-factor of 140.

Replace the C-factor value with appropriate absolute roughness values in the remaining **Use** commands. (There are two more.)

Recalculate. Safety margin will now be accurate and comparable with the NFPA 750 friction factor formula.



Hint

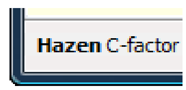
SHC's absolute roughness value sources are documented in the "Simple Hydraulic Calculator Reference Manual".

Mixed Formula Calculations

SHC provides two commands for creating mixed Hazen-Williams and Darcy-Weisbach calculations. Why is this needed? NFPA 13-07 requires Hazen-Williams formula for water but Darcy-Weisbach for antifreeze solutions in systems greater than 40 gallons. With *SHC*, you can calculate the source piping with Hazen-Williams and the system piping with Darcy-Weisbach – all with one data file and one calculation.

To create a mixed-calculation file it must be set for the Darcy-Weisbach equation. Let's use the Your First System data file set for the Darcy-Weisbach equation using the Colebrook friction factor formula (previous page). We will mark pipes "City", "Leadin", and "Rpz" for the Hazen-Williams equation.

To mark a section of pipes for the Hazen-Williams formula, use the **Hazen** command. Below the first **Use** command, type "Hazen" and look at the status bar.



Hazen simply requires a *C-factor* value. Press the SPACEBAR and enter "140".

All pipe defined after a **Hazen** command will use the Hazen-Williams formula up until a **Darcy** command is found.

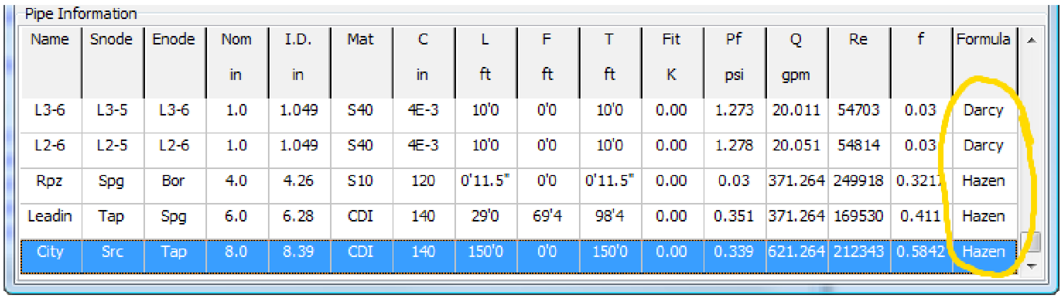
Move to the next **Use** command and change the 0.004 absolute roughness value to "120". This is valid since we have not yet used a **Darcy** command to switch back to the Darcy-Weisbach formula.

After pipe "Rpz" type "Darcy" on a blank line. **Darcy** requires an absolute roughness value (unless the NFPA 750 friction factor is selected). Finish the **Darcy** command with appropriate absolute roughness value. The edited file should look similar to this:

```
// Begin data entry now ...
use CDI 0.002
Hazen 140
Pipe City Src Tap 150'0" 8.0
Pipe Leadin Tap Spg 22'0"+7'0" 6.0 LE T
Use S10 120
Pipe Rpz     Spg Bor 0'11.5" 4.0
Darcy 0.004
Pipe Riser   Bor Tor 14'4.5" 4.0 2E
// 4"(100mm) Ames C500 Vertical Reduced
Bfp Rpz 0.0 12.0 40.0 12.0 110.0 8.0 30
```

Calculate the file. When the **Results Window** appears, right-click on the pipe information area and add the "Friction Formula" column. You may also wish to add columns for Reynolds number and Darcy friction factor.

Verify the correct formula is used for each pipe.



Pipe Information

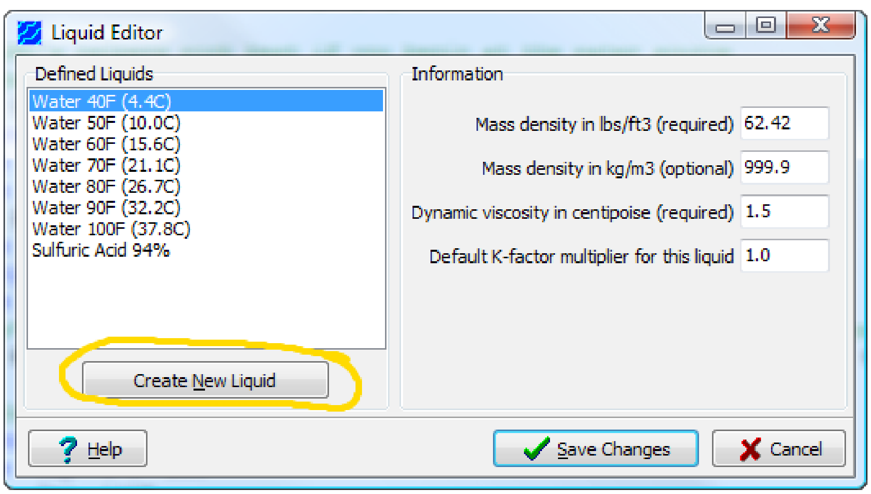
Name	Snode	Enode	Nom	I.D.	Mat	C	L	F	T	Fit	Pf	Q	Re	f	Formula
			in	in		in	ft	ft	ft	K	psi	gpm			
L3-6	L3-5	L3-6	1.0	1.049	S40	4E-3	10'0	0'0	10'0	0.00	1.273	20.011	54703	0.03	Darcy
L2-6	L2-5	L2-6	1.0	1.049	S40	4E-3	10'0	0'0	10'0	0.00	1.278	20.051	54814	0.03	Darcy
Rpz	Spg	Bor	4.0	4.26	S10	120	0'11.5"	0'0	0'11.5"	0.00	0.03	371.264	249918	0.321	Hazen
Leadin	Tap	Spg	6.0	6.28	CDI	140	29'0	69'4	98'4	0.00	0.351	371.264	169530	0.411	Hazen
City	Src	Tap	8.0	8.39	CDI	140	150'0	0'0	150'0	0.00	0.339	621.264	212343	0.5842	Hazen

SHC is not limited to one marked section, either. Multiple **Hazen**/**Darcy** command pairs may be used to mark multiple sections of a data file for Hazen-Williams friction loss formula.

Of course, this calculation is using water at 60°F. Let's define a new antifreeze solution liquid to use instead.

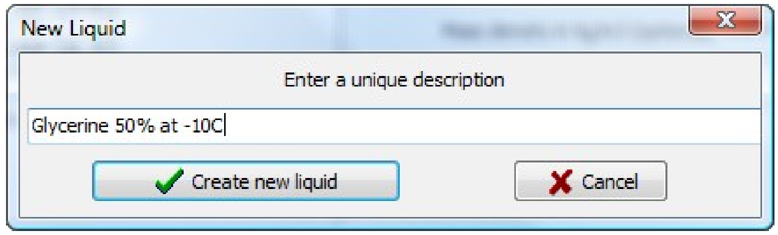
Liquids

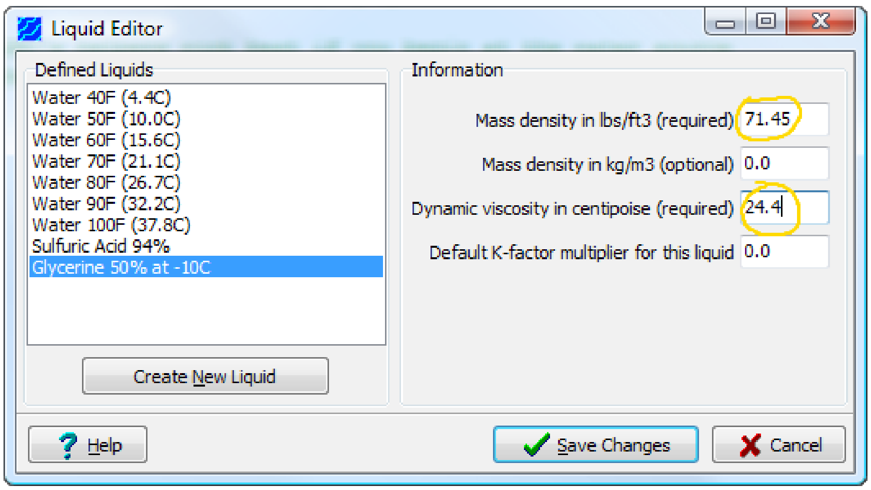
Open the **Liquid Editor** by selecting **Tools → Materials → Liquids** on the menu bar.



Click the **Create New Liquid** button.

For this example we will define a 50% glycerine-water solution at -10°C. Type a meaningful description in the dialog box and click the **Create new liquid** button.



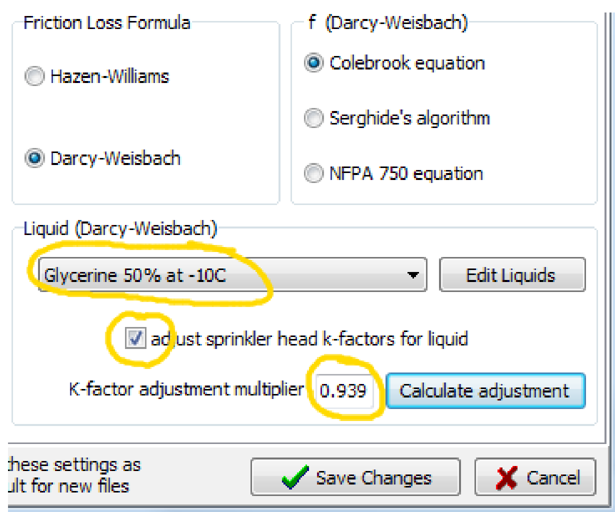


Fill out all required values for this liquid. Then click the **Save Changes** button.

If you have a specific gravity value, multiply by 62.4 lbs/ft³ to obtain a mass density value. In this example 50% glycerine has a specific gravity of 1.145. Multipied by 62.4 this yields a mass density of 71.45 lbs/ft³.

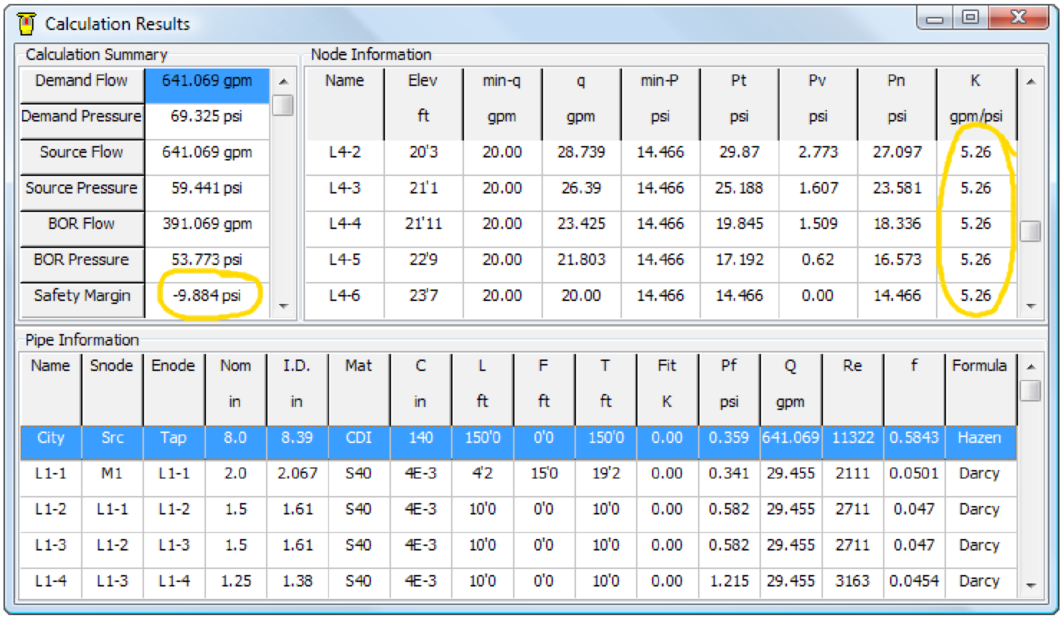
To use this liquid for the calculation, reopen the file properties dialog (**File → Properties**). Click on the **calculations** tab and select "Glycerine 50% ..." as the Darcy-Weisbach formula's liquid.

Make sure the **adjust sprinkler head k-factors for liquid** box is checked then click the **Calculate adjustment** button. Keep the *SHC* computed adjustment of 0.939 for this example.



Click the **Save Changes** button when done.

Calculate the file.



Calculation Results

Calculation Summary

Demand Flow	641.069 gpm
Demand Pressure	69.325 psi
Source Flow	641.069 gpm
Source Pressure	59.441 psi
BOR Flow	391.069 gpm
BOR Pressure	53.773 psi
Safety Margin	-9.884 psi

Node Information

Name	Elev ft	min-q gpm	q gpm	min-P psi	Pt psi	Pv psi	Pn psi	K gpm/psi
L4-2	20'3	20.00	28.739	14.466	29.87	2.773	27.097	5.26
L4-3	21'1	20.00	26.39	14.466	25.188	1.607	23.581	5.26
L4-4	21'11	20.00	23.425	14.466	19.845	1.509	18.336	5.26
L4-5	22'9	20.00	21.803	14.466	17.192	0.62	16.573	5.26
L4-6	23'7	20.00	20.00	14.466	14.466	0.00	14.466	5.26

Pipe Information

Name	Snode	Enode	Nom in	I.D. in	Mat	C in	L ft	F ft	T ft	Fit K	Pf psi	Q gpm	Re	f	Formula
City	Src	Tap	8.0	8.39	CDI	140	150'0	0'0	150'0	0.00	0.359	641.069	11322	0.5843	Hazen
L1-1	M1	L1-1	2.0	2.067	S40	4E-3	4'2	15'0	19'2	0.00	0.341	29.455	2111	0.0501	Darcy
L1-2	L1-1	L1-2	1.5	1.61	S40	4E-3	10'0	0'0	10'0	0.00	0.582	29.455	2711	0.047	Darcy
L1-3	L1-2	L1-3	1.5	1.61	S40	4E-3	10'0	0'0	10'0	0.00	0.582	29.455	2711	0.047	Darcy
L1-4	L1-3	L1-4	1.25	1.38	S40	4E-3	10'0	0'0	10'0	0.00	1.215	29.455	3163	0.0454	Darcy

Results of the new liquid are readily apparent. System demand has risen over 16 psi and the k-factor values are properly adjusted.

Preview the hydraulic calculation report. *SHC* will automatically add important calculation notes to the summary page when needed.

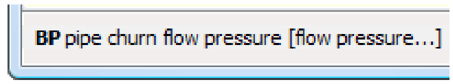
Notes

Darcy-Weisbach and Hazen-Williams friction formulae used in calculations. Liquid used with Darcy formula is "Glycerine 50% at -10C", p=71.45 lb/ft3, u=24.4 Centipoise. Sprinkler head k-factors have been adjusted by a 0.939 multiplier. Adjusted k-factor values are shown in this report.

The correct way to make this system work is to change pipe sizes. But now is a good time to illustrate fire pump input.

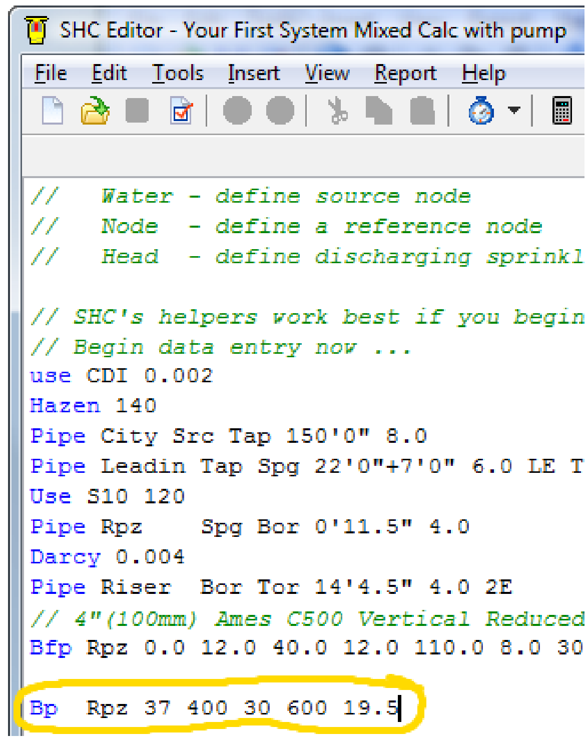
Fire Pump

On any blank line type "BP" and look at the status bar.



The **BP** command (**b**ooster **p**ump) requires a *pipe* name, *churn* pressure, rated *flow*, and rated *pressure*. Additional flow and pressure pairs may be entered to define the curve. Log 1.85 interpolation is used to determine pressure gain between given flows.

Complete the command using a 400 gpm at 30 psi fire pump with a 37 psi churn pressure. Notice that *SHC's* proposal system will help you enter an additional *flow/pressure* pair for 150% flow at 65% pressure. All rated fire pumps must meet this requirement but many flow better than this. Always use manufacturer's data for additional flow points when available.



Recalculate. Safety margin is now over 20 psi.

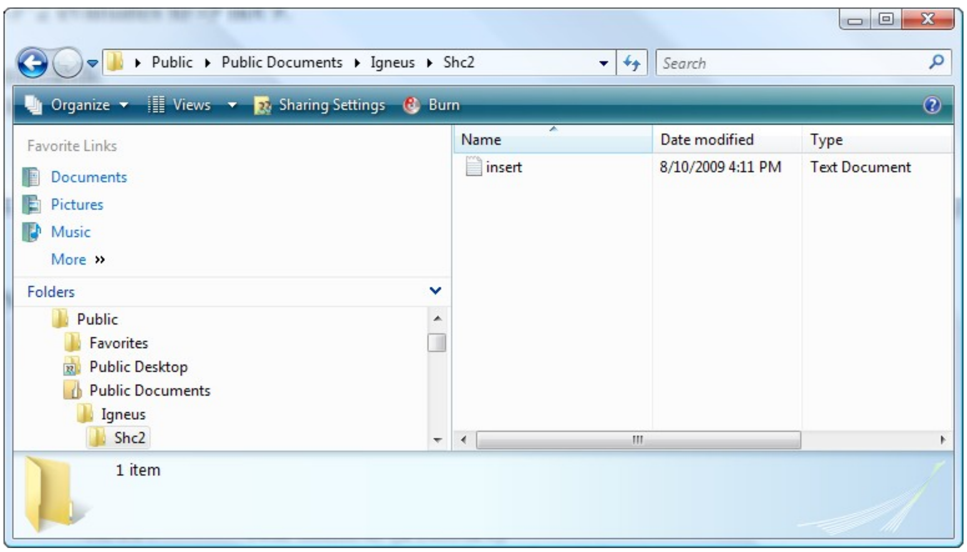
In the hydraulic calculation report the **BP** command is reported as a device loss (negative for gains) in the pipe information "notes" column. In this example device loss for both the fire pump and backflow preventer will be reported for pipe "Rpz".

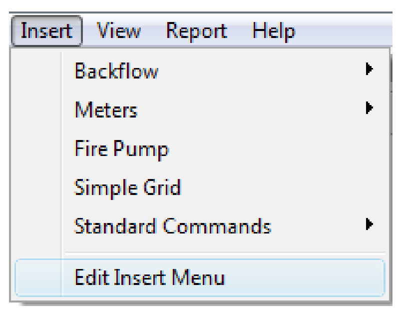
Use the **Pump** command to model the fire pump as a standalone independent device. See the reference manual for details of the **Pump** command.

Insert Menu

The insert menu is a great place to store commonly used commands for easy reuse. When you select an item from the insert menu one, or more, commands are placed in the *SHC Editor* window at the caret's location. But you are not limited to the items provided at program installation. The insert menu may be modified to add items and commands *you* commonly use.

The insert menu is defined by the file "**insert.txt**" located in your computer's public documents folder. To guard against mistakes, make a copy of this file before editing. If you need to, delete the file and the original will be restored next time *SHC* starts.





Since **insert.txt** is a plain text file, you may open it with any text editor you are familiar with. You may also launch your default text editor with this file by selecting **Insert → Edit Insert Menu** on *SHC's* menu bar.

Open the "insert.txt" file now.

```
// TSHC 2.0+ insert menu macro definition file
// See the "SHC Reference Manual" for information
// on modifying this file.

// All predefined items are in U.S. units:
//     length:            feet
//     elevation:         feet
//     nominal size:      inch
//     pressure:          psi
//     flow:              gpm
//     k-factor:          gpm/sqrt(psi)
// Use the METRIC and ENGLISH commands to change
// the units in sections you add to this file.
// Expected metric units are:
//     length:            meter
//     elevation:         meter
//     nominal size:      mm
//     pressure:          bar
//     flow:              lpm
//     k-factor:          lpm/sqrt(bar)

ENGLISH

// Begin Backflow preventers submenu
SUB Backflow
  SUB Double Check
    SUB Ames
      SUB 2000B
        NAME 1/2"(15mm)
          HINT 1/2"(15mm) Ames 2000B Double Check Backflow Pr
          SET x Enter name of pipe backflow preventer is in:
          PUT Bfp x 0 5.0 2 6.0 10 8.0
        NAME 3/4"(20mm)
          HINT 3/4"(20mm) Ames 2000B Double Check Backflow Pr
          SET x Enter name of pipe backflow preventer is in:
          PUT Bfp x 0 5.0 3 5.0 10 4.0 22.5 6.0 30 10.0 45 21
```

The first thing you may notice is the file is command based – just like *SHC* files. Also like *SHC* files, // may be used to leave a comment. Unlike *SHC*, comments must be on their own line – not appended to another command's line.

See the following table for a complete list of commands supported by the **Insert** menu.

Commands

Command	Description
SUB *any text*	Begin a new sub menu. The new sub menu's label is *any text*. All following menu item definitions (**NAME** command) will be placed in the sub menu.
END	End the sub menu created by the closest previous **SUB** command.
NAME *any text*	Start a menu item definition. The menu item's label is *any text*.
HINT *any text*	Set the menu item's hint text. *Any text* will also be inserted into the editor as a comment ("// any text") when the menu item is selected.
SET *var prompt*	Display a data entry dialog box to the user. The *prompt* is displayed with an edit box. Whatever the user enters into the edit box will replace the text in each **PUT** command that matches *var*. Multiple **SET** commands may be used. To have *SHC* mask user input by value type, use any of the following **SET** command derivations:
	SETE — **E**levation (supports unit modifiers)
	SETF — **F**low (zero or positive real number)
	SETI — **I**nteger (zero or positive)
	SETK — **K**-factor (positive real number)
	SETL — **L**ength (supports unit modifiers)
	SETN — **N**ame (8 character limit enforced)
	SETP — **P**ressure (real number)
	SETR — zero or positive **R**eal number
	SETS — nominal pipe **S**ize (supports unit modifiers)
ASSIGN *variable expression*	Set the *variable* equal to *expression*. *Variable* may then be used in subsequent **ASSIGN**, **IF**, and **PUT** commands. Example **ASSIGN** %HeadsPerLine Ceil(1.2*1500/%Spacing)
IF *ConditionalExpression*	Executes trailing PUT command if *ConditionalExpression* is true. *ConditionalExpression* supports ">" (greater than), "<" (less than), and = (equal) comparisons. Example IF %NumHeads>(%FullLines*%HeadsPerLine)
PUT *SHC command*	Define a *SHC* command that will be inserted into the editor when the menu item is selected. When a **SET** command is used, matching text will be replaced by the user's input.
ENGLISH	Assume command values are in U.S. units.
METRIC	Assume command values are in metric units

Expressions, including the right and left sides of *ConditionalExpressions* support the following operators.

Operator	Description	Example
+	Add	6+5
-	Subtract	6-5
*	Multiply	6*5
/	Divide	6/5
^	Power	6^5
Ceil	Raise to nearest whole number.	Ceil(3.01)
Floor	Lower to nearest whole number.	Floor(3.9)
Round	Round to nearest whole number.	Round(7.5*3.25)

Multiple operators may be used in an expression. But there should be no spaces in an expression.

Example

Let's add a menu item that inserts a fire pump. Move to the end of the **insert.txt** file and begin a sub menu.

```
SUB My Stuff
```

Start the pump's menu item and define its' hint.

```
NAME Fire Pump
HINT Fire Pump
```

Now gather the information about the pump from the user.

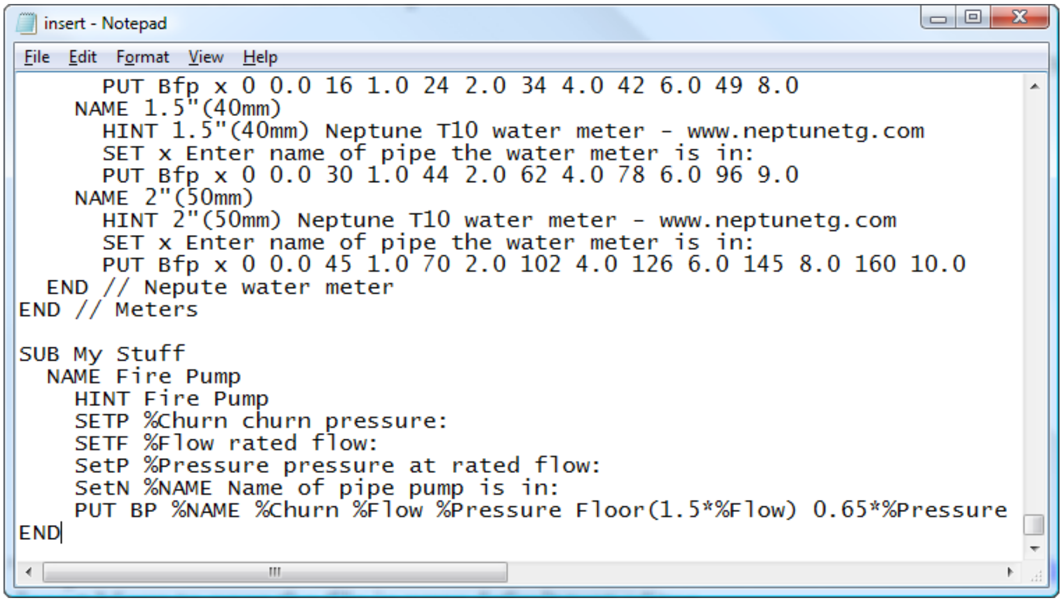
```
SETN %Name pump is in pipe named:
SETP %Churn churn pressure:
SETF %Flow rated flow:
SETP %Pressure pressure at rated flow:
```

Create the actual *SHC* **BP** command from the user input.

```
PUT BP %NAME %Churn %Flow %Pressure Floor(1.5*%Flow) 0.65*%Pressure
```

We are done. Close the sub menu.

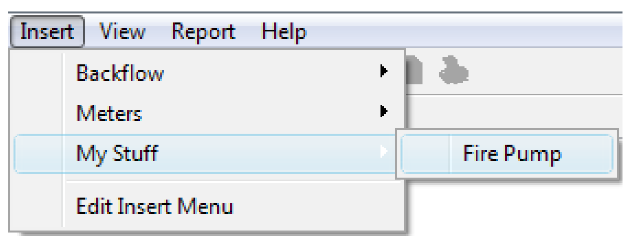
```
END
```



```
      PUT Bfp x 0 0.0 16 1.0 24 2.0 34 4.0 42 6.0 49 8.0
    NAME 1.5"(40mm)
      HINT 1.5"(40mm) Neptune T10 water meter - www.neptunetg.com
      SET x Enter name of pipe the water meter is in:
      PUT Bfp x 0 0.0 30 1.0 44 2.0 62 4.0 78 6.0 96 9.0
    NAME 2"(50mm)
      HINT 2"(50mm) Neptune T10 water meter - www.neptunetg.com
      SET x Enter name of pipe the water meter is in:
      PUT Bfp x 0 0.0 45 1.0 70 2.0 102 4.0 126 6.0 145 8.0 160 10.0
  END // Nepute water meter
END // Meters

SUB My Stuff
  NAME Fire Pump
    HINT Fire Pump
    SETP %Churn churn pressure:
    SETF %Flow rated flow:
    SetP %Pressure pressure at rated flow:
    SetN %NAME Name of pipe pump is in:
    PUT BP %NAME %Churn %Flow %Pressure Floor(1.5*%Flow) 0.65*%Pressure
END
```

The end of the **insert.txt** file should now look similar to this. While indenting is not required, indenting based upon your sub menu depth aids readability and is considered good practice.

Save the modified **insert.txt** file and restart the *Simple Hydraulic Calculator*. The insert menu should now contain your new sub menu. Try it out!



Hint

Why do the example's variable names start with "%"? The insert menu variables work by simple text substitution. By using a character in the variable name that isn't normally used you avoid the potentially confusing mistake of having some text in a **Put** command replaced unintentionally.

Also remember variables are substituted in order – don't make a variable name a superset of a previous variable. For example, %Car will replace part of %CarDriver if %Car is defined first.

Test, test, test!

Quick Reference – Standard Commands

Control	Description
//	Any comment (ignored by *SHC*).
All [*safety_margin*]	Force a source calculation. Specify s*afety_margin* to leave a cushion.
Vel	Force calculation to use velocity pressures.
NoVel	Force calculation to use total pressures.
Pipes	
Use *material_code c-factor/roughness*	Specify piping material.
Pipe *name Snode Enode length size [fitting ...]*	Define a pipe (nodes must be defined elsewhere).
ChangePipe *name size length [fitting ...]*	Redefine a pipe including pipe created with "system helper" commands.
PC *SrcName CopyName Snode Enode [CopyName ...]*	Pipe Copy. Define new pipe(s) same as previously defined pipe.
Nodes	
Water *name elevation static [flow residual ...]*	Define water source node.
Node *name elevation [discharge [minPressure]]*	Define any node that is not source or sprinkler.
NC *SourceName CopyName [CopyName ...]*	Node Copy. Define node(s) same as previously defined node.
Head *name elevation minDischarge k-factor*	Define a discharging sprinkler head node. K-factor of 0 disables. Negative minDischarge is pressure.
HC *SourceName CopyName [CopyName ...]*	Head Copy. Define node(s) same as previously defined node.
Devices	
BFP *PipeName flow pressure [flow pressure ...]*	Add backflow preventer loss or other nonlinear pressure loss device to a pipe. Linear interpolation.
BP *PipeName churn flow pressure [flow pressure ...]*	Add fire pump pressure gain to a pipe. 1.85 log interpolation.
PUMP *inNode outNode elev churn flow pressure [flow pressure ...]*	Add fire pump pressure gain as stand-alone device. Pipe must connect to *inNode* and *outNode*.
Mixed Formula Calculations	
Hazen *c-factor*	Begin using Hazen-Williams friction loss formula. Only valid when doing a Darcy calculation.
Darcy *c-factor/roughness*	End using Hazen-Williams friction loss formula. Only valid when doing a Darcy calculation.
BS EN 12845 Mode	
Density *density [minPressure]*	Set density of discharge for following head and flow commands. Optionally set minimum required head discharge pressure.
FourHeads *head1 [head2] [head3] [head4]*	Specify the 1-4 most unfavorable adjacent heads. Only needed if *SHC* selects adjacent heads incorrectly.
Head *name elevation headArea k-factor*	Enter sprinkler head area instead of minimum required discharge when in BS EN 12845 mode.

Quick Reference – System Helper Commands

Crossmains	Description
Main *size #lines spacing [[extraNode offset] ...]*	Define a crossmain. Requires **MainElev** command and at least one of **TreeRight**, **TreeLeft**, or **Line**.
MainV *size #lines spacing [spacing ...]*	Define a crossmain with variable spacing between branchlines. Requires **MainElev** command and at least one of **TreeRight**, **TreeLeft**, or **Line**.
MainCont *size #lines spacing [spacing ...]*	Continue definition of previous **Main** or **MainV** command.
MainElev *StartElev [EndElev [offset offsetElev]]*	Define elevation of crossmain. One required per **Main**/**MainV** command. Evaluated in order.
BranchLines	
Line *#heads size startLength endLength spacing [spacing ...]*	Define gridded branchlines between two crossmains. Number required equals number of **Main**/**MainV** commands – 1 (i.e. - adjacent mains require branchlines between them be defined).
TreeLeft *#heads startLength size [length size ...]*	Define dead-end branchlines connected to first **Main**/**MainV** crossmain and extending "left".
TreeRight *#heads startLength size [length size ...]*	Define dead-end branchlines connected to last **Main**/**MainV** command and extending "right".
LineElev *startElev [endElev [offset offsetElev ...]]*	Define branchline elevation. Start is leftmost point of branchline. End is rightmost point. One **LineElev** or **LineElev2** command is required.
LineElev2 *startElev [endElev [offset offsetElev ...]]*	Define branchline elevation in crossmain direction. Start is elevation of first (bottom) branchline. End is top branchline elevation. One **LineElev** or **LineElev2** command is required.
RN *size [size ...]*	Set riser nipple size. One *size* parameter allowed per main. Riser nipple defaults to size of largest connecting branchline.
Remote Area	
Flow *left bottom right top minDischarge k-factor*	Define a rectangular area of branchline nodes as discharging sprinkler heads. Multiple **Flow** commands may be used. K-factor of 0 disables. Negative minDischarge is pressure.
Control	
AutoPeak	Automatically find most remote [unfavourable] area defined with **Flow** command(s).
Reduce	Reduce number of pipes and limit **AutoPeak** search to original branchlines in **Flow** command(s).
BS EN 12845 Mode	
Flow *left bottom right top headArea k-factor*	Enter sprinkler head area instead of minimum required discharge when in BS EN 12845 mode.
Favourable	Modifies **AutoPeak** behavior to find most favourable remote area.