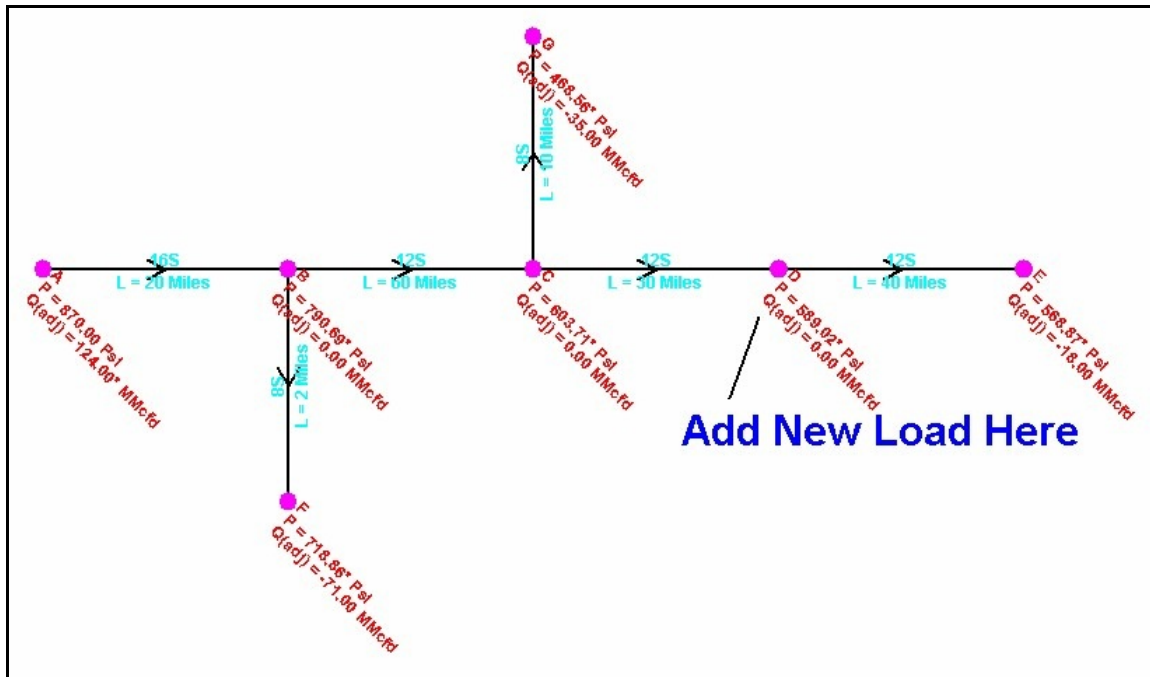


Summary

In this example, a new model will be created for a small transmission line. A new load will be added. The system will not be able to handle the load and various “fixes” will be tried to allow the new load to be adequately served. A schematic of the “base” system is shown below.



Steps

The following assumes that GASWorkS has already been started. If a model is already open, close it now using the *Close* menu item from the *File* menu list. Use the following procedure to work this example...

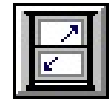
1) Create The New Model

- From the *File* menu list, select the *New* menu item. The File Selection screen will be displayed. Enter a *Filename* for the new model, then select the *Continue* command button.
- The Graphic Data Interface (GDI) Window will be displayed.

Note - If the GDI Window is not automatically displayed, select the *View/Edit* menu item from the *Graphics* menu list to display the GDI Window.



- Resize the GDI Window using the *Maximize GDI Window* icon from the *GDI Window Controls Toolbar*.



2) Set The Default Units & Values

- From the *Utilities* menu list, select the *Set Defaults* menu item. The Default Data Values screen will be displayed.

- On the *Dimensional Units* data tab, set the following values:

Coordinates = **Feet** [Metres]
Customer Load = **Cfh** [M3h]
Diameter = **Inches** [Centimeter]
Efficiency = **Decimal**
Elevation = **Feet** [Metres]
Heating Value = **Btu/cf** [MJoules/m3]
Length = **Miles** [Kilometers]
Node Load = **MMcfd** [MMm3d]
Pipe Flow Rate = **MMcfd** [MMm3d]
Pressure = **Psi** [Bar]
Temperature = **Fahrenheit** [Celsius]
Velocity = **Feet/sec** [Metres/sec]
Viscosity = **Lbm/Ft-sec** [Centipoise]

- On the *Hydraulic Data* tab, set the following values:

Pipe Size/Type = **12S Inches** [12S Centimeter]
Pipe Equation = **Panhandle-A**
Pipe Efficiency = **0.97 Decimal**

Node Pressure = 0 Psi [0 Bar]	Value Is Unknown = Select (Check)
Node Base Load = 0 MMcfd [0 MMm3d]	Value Is Unknown = Unselect (Uncheck)
Node Elevation = 0 Feet [0 Metres]	
Node Temperature = 60 Fahrenheit [15.6 Celsius]	Value Is Unknown = Unselect (Uncheck)

- On the *Gas Properties* data tab, set the following values:

Specific Gravity = **0.6**
Viscosity = **0.000007 Lbm/Ft-sec** [0.0104 Centipoise]
Heating Value = **1000 Btu/cf** [37.25 MJoules/m3]
Specific Heat Ratio = **1.3**



- Select the *Close* command button to close the screen and save the values.

3) Set The Graphic Settings

For convenience, set a few graphic settings before entering the model.

- From the *Graphics* menu list, select the *Settings* menu item. The Graphic Settings screen will be displayed.
 - In the *Settings* section, set the following values:

Node Symbol Size = **2 % Of Display Width**
Piping Symbol Size = **3 % Of Display Width**

Note - When setting the above values, press the *Enter* key after typing the desired value to save the change.

- In the *Options* section, set the following values:

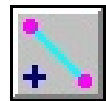
Query During New Feature Entry = **Select** (Check)

- Select the *Close* command button to close the screen and save the values.

4) Enter The Piping System

Note - This model will not be drawn to scale. It will be drawn using relative angle and distances to create a schematic depiction of the system. The true pipe lengths will be set as the system is being entered.

- Enter the first pipe (from Node A to Node B) by selecting the *Add 2-Point Pipe* icon from the *Graphic Construction Commands Toolbar*.



- For the *From Node Location*, enter as an absolute coordinate value by typing **1000,1000** on the GDI Prompt Line and press the *Enter* key. The Node Data will be displayed In the Data Panel. In the *Hydraulic Data Items* section, set the following values:

Node Name = **A**
Pressure = **870** [60]
Pressure Units = **Psi** [Bar]
Pressure Known = **Yes**
Base Load Known = **No**

- Select the *Apply Data Values* command button.



- For the *To Node Location*, enter as a relative coordinate value by typing **@.1<90** [**@.5<90**] on the GDI Prompt Line and press the *Enter* key. The Node Data will be displayed In the Data Panel. In the *Hydraulic Data Items* section, set the following values:

Node Name = **B**
Pressure Known = **No**
Base Load = **0** [0]
Load Units = **MMcfd** [MMm3d]
Base Load Known = **Yes**

- Select the *Apply Data Values* command button.

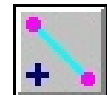
Note - When entering a relative location the syntax is, the “@” symbol indicates that a length value follows, the “<” symbol indicates that an angle value follows. The location is found by moving the indicated length at the indicated direction from the From Node.

- The Pipe Data will be displayed In the Data Panel. In the *Hydraulic Data Items* section, set the following values:

Size/Type Code = **16S** [16S]
Diameter Units = **Inches** [Centimeter]
Hydraulic Length = **20** [32]
Length Units = **Miles** [Kilometers]

- Select the *Apply Data Values* command button.

- Enter the second pipe (Node B to Node C) by selecting the *Add 2-Point Pipe* icon from the *Graphic Construction Commands Toolbar* (or right-click the mouse to repeat the last command).



Note - You may need to pan and zoom to work your way completely around the system.

- For the *From Node Location*, accept the default value by pressing the *Enter* key, or hold down the *Shift* key and click the left mouse button while the mouse pointer is near Node B, this causes the pipe end to be snapped to Node B. The Node Data should not be displayed because Node B already exists. If the Node Data is displayed, it means that the To Node was not correctly selected, cancel the *Add 2-Point Pipe* command and try again.

- For the *To Node Location*, enter as a relative coordinate value by typing **@.1<90** [**@.5<90**] on the GDI Prompt Line and press the *Enter* key. The Node Data will be displayed In the Data Panel. In the *Hydraulic Data Items* section, set the following values:

Node Name = **C**



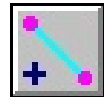
Pressure Known = **No**
Base Load = **0** [0]
Load Units = **MMcfd** [MMm3d]
Base Load Known = **Yes**

- Select the *Apply Data Values* command button. The Pipe Data will be displayed In the Data Panel. In the *Hydraulic Data Items* section, set the following values:

Hydraulic Length = **60** [97]
Length Units = **Miles** [Kilometers]

- Select the *Apply Data Values* command button.

- Enter the third pipe (Node C to Node D) by selecting the *Add 2-Point Pipe* icon from the *Graphic Construction Commands Toolbar* (or right-click the mouse to repeat the last command).



- For the *From Node Location*, accept the default value by pressing the *Enter* key, or hold down the *Shift* key and left-click the mouse while the mouse pointer is near Node C. The Node Data should not be displayed because Node C already exists. If the Node Data is displayed, it means that the To Node was not correctly selected, cancel the *Add 2-Point Pipe* command and try again.

- For the *To Node Location*, enter as a relative coordinate value by typing **@.1<90** [**@.5<90**] on the GDI Prompt Line and press the *Enter* key. The Node Data will be displayed In the Data Panel. In the *Hydraulic Data Items* section, set the following values:

Node Name = **D**
Pressure Known = **No**
Base Load = **0** [0]
Load Units = **MMcfd** [MMm3d]
Base Load Known = **Yes**

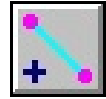
- Select the *Apply Data Values* command button. The Pipe Data will be displayed In the Data Panel. In the *Hydraulic Data Items* section, set the following values:

Hydraulic Length = **30** [48]
Length Units = **Miles** [Kilometers]

- Select the *Apply Data Values* command button.



- Enter the fourth pipe (Node D to Node E) by selecting the *Add 2-Point Pipe* icon from the *Graphic Construction Commands Toolbar* (or right-click the mouse to repeat the last command).



- For the *From Node Location*, accept the default value by pressing the *Enter* key, or hold down the *Shift* key and left-click the mouse while the mouse pointer is near Node D. The Node Data should not be displayed because Node D already exists. If the Node Data is displayed, it means that the To Node was not correctly selected, cancel the *Add 2-Point Pipe* command and try again.
- For the *To Node Location*, enter as a relative coordinate value by typing **@.1<90** [**@.5<90**] on the GDI Prompt Line then press the *Enter* key. The Node Data will be displayed In the Data Panel. In the *Hydraulic Data Items* section, set the following values:

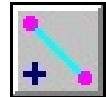
Node Name = **E**
Pressure Known = **No**
Base Load = **-18** [-0.5]
Load Units = **MMcfd** [MMm3d]
Base Load Known = **Yes**

- Select the *Apply Data Values* command button. The Pipe Data will be displayed In the Data Panel. In the *Hydraulic Data Items* section, set the following values:

Hydraulic Length = **40** [64]
Length Units = **Miles** [Kilometers]

- Select the *Apply Data Values* command button.

- Enter the fifth pipe (Node B to Node F) by selecting the *Add 2-Point Pipe* icon from the *Graphic Construction Commands Toolbar* (or right-click the mouse to repeat the last command).



- For the *From Node Location*, hold down the *Shift* key and left-click the mouse while the mouse crosshairs are near Node B. The Node Data should not be displayed because Node B already exists. If the Node Data is displayed, it means that the From Node was not correctly selected, cancel the *Add 2-Point Pipe* command and try again.
- For *To Node Location*, enter as a relative coordinate value by typing **@.1<180** [**@.5<180**] on the GDI Prompt Line and press the *Enter* key. The Node Data will be displayed In the Data Panel. In the *Hydraulic Data Items* section, set the following values:

Node Name = **F**
Pressure Known = **No**
Base Load = **-71** [-2]
Load Units = **MMcfd** [MMm3d]



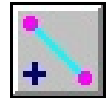
Base Load Known = **Yes**

- Select the *Apply Data Values* command button. The Pipe Data will be displayed In the Data Panel. In the *Hydraulic Data Items* section, set the following values:

Size/Type Code = **8S** [8S]
Diameter Units = **Inches** [Centimeter]
Hydraulic Length = **2** [3]
Length Units = **Miles** [Kilometers]

- Select the *Apply Data Values* command button.

- Enter the last pipe (Node C to Node G) by selecting the *Add 2-Point Pipe* icon from the *Graphic Construction Commands Toolbar* (or right-click the mouse to repeat the last command).



- For the *From Node Location*, hold down the *Shift* key and click the left mouse button while the mouse crosshairs are near Node C. The Node Data should not be displayed because Node B already exists. If the Node Data is displayed, it means that the From Node was not correctly selected, cancel the *Add 2-Point Pipe* command and try again.

- For the *To Node Location*, enter as a relative coordinate value by typing **@.1<0** [**@.5<0**] on the GDI Prompt Line and press the *Enter* key. The Node Data will be displayed In the Data Panel. In the *Hydraulic Data Items* section, set the following values:

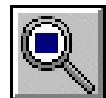
Node Name = **G**
Pressure Known = **No**
Base Load = **-35** [-1]
Load Units = **MMcfd** [MMm3d]
Base Load Known = **Yes**

- Select the *Apply Data Values* command button. The Pipe Data will be displayed In the Data Panel. In the *Hydraulic Data Items* section, set the following values:

Size/Type Code = **8S** [8S]
Diameter Units = **Inches** [Centimeter]
Hydraulic Length = **10** [16]
Length Units = **Miles** [Kilometers]

- Select the *Apply Data Values* command button.

- When all of the pipes are entered - zoom the entire image by selecting the *Zoom To Fit* icon from the lower-left corner of the GDI Window.



5) Review The Data Entry

● Display the node data and pipe data by selecting the *Text Display Settings* icon from the *Display Controls Toolbar*. The Text Display Settings screen will be displayed.



● On the *Pipe Items* data tab, select (check) the *Display Pipe Text Items* option, and the *Display For Pipe Elements Only* option. Then select (check) the following *Items - Length* and *Size/Type Code*.

● On the *Node Items* data tab, select (check) the *Display Node Text Items* option. Set the *Text Rotation* value to **135**. Then select (check) the following *Items - Load (Total Adjusted)*, *Node Name*, and *Pressure*.

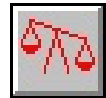
● Select the *Apply* command button to save the changes.

● Check the values on the GDI Window. Revise any incorrect values using the *Edit Node Data* or *Edit Pipe Data* commands.



6) Solve The Model

● Select the *Solve* icon from the lower-right corner of the GDI Window. The Solution Data screen will be displayed.



● On the *Other Settings* data tab, set the following values:

Base Pressure = **14.73 Psi** [1.02 Bar]
Base Temperature = **60 Fahrenheit** [15.6 Celsius]
Upper Dampening Factor = **0**
Lower Dampening Factor = **0**

● On the *Solution Data* tab, set the following values:

Design Factor = **1**
Convergence Tolerance = **0.1 MMcfd** [0.003 MMm3d]

Reset Unknown Node Pressures To Zero = **Select** (Check)
Smart Processing Of One-Way Segments = **Select** (Check)

*Review the remaining solution parameters.

● Select the *Solve* command button. The Solution Log will be displayed. Review the results, then select the *Close* command button to close the log.



7) Review The Results

The solution results should be displayed on the GDI Window. **Node D** is where we will be adding the load - note the pressure at that location. It should be about **589 Psig** [40.5 Bar]. If the value is different, review the previous steps, make any corrections, and re-solve the model. If the value is correct, continue with the example steps.

8) Add The New Load

- Increase the load at **Node D** by left-clicking the mouse pointer on **Node D**. The Node Data will be displayed in the Data Panel. In the *Hydraulic Data Items* section, set the following values:

Base Load = **-106** [-3]

Load Units = **MMcfd** [Mm3d]

- Select the *Apply Data Values* command button to save the changes.

- Select the *Quick Solve Model* icon from the lower-right corner of the GDI Window to execute the Solution routine. The Solution Log will be displayed when the solution is complete. Review the results, then select the *Close* command button.

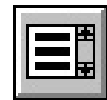


9) Review The Results

Notice that the pressures downstream of **Node C** are inadequate. Let's try to solve the pressure problems by adding a compressor just upstream of **Node C**.

10) Add A Compressor

- Select the *Insert Compressor* item from the GDI Command List.



- For the *Pipe To Insert The Compressor Into*, left-click on the pipe between **Node B** and **Node C**.

- For the *From (Suction/Upstream) Node Location*, left-click a point (on the pipe) to the left of Node C (place the new node about one-fifth of the segment length to the left of Node C). Select the *Yes* command button when prompted whether to tap the pipe. The Node Data will be displayed in the Data Panel. In the Hydraulic Data Items section, set the following values:

Node Name = **Comp_In**



- Select the *Apply Data Values* command button.
- For the *To Node Location*, hold down the *Shift* key and left-click the mouse on **Node C**. If the Node Data is displayed in the Data Panel, it means that the To Node was not correctly selected, cancel the *Insert Compressor* command and try again.

Note - When entering a compressor, the From Node end must be on the upstream (suction) side of the compressor and the To Node must be on the downstream (discharge) side of the compressor.

- For the *Compressor Size & Type*, select **Theoretic** from the GDI Prompt list and press the *Enter* key.
- For the *Discharge Set Pressure*, type **870** [60] on the GDI Prompt Line and press the *Enter* key. The Pipe Data will be displayed in the Data Panel. Accept the default values by right-clicking the mouse.

- After the data entry is complete, a compressor symbol should be displayed for the new compressor. If the symbol is not displayed, select the *Display Piping Symbols* icon from the *Display Controls Toolbar*.



- We need to set the downstream pressure to “known”. Left-click the mouse on **Node C**. The Node Data will be displayed in the Data Panel. In the Hydraulic Data Items section, set the *Pressure Known* item to **Yes**. Select the *Apply Data Values* command button to save the change.

11) Solve The Model

Select the *Solve* icon from the lower-right corner of the GDI Window. The Solution Data screen will be displayed. Review the solution parameters, then select the *Solve* command button. The Solution Log will be displayed. Review the results, then select the *Close* command button to close the log.



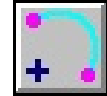
12) Review The Results

Notice that the pressures upstream of the compressor are inadequate. To try to solve the problem let's add a loop line ahead of the compressor, between **Node B** and the inlet to the new compressor.



13) Loop The Line Upstream Of The Compressor

● We will use an “arc” style pipe to represent the loop line. Select the *Add Arc Pipe* icon from the *Graphic Construction Commands Toolbar*.



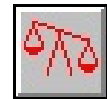
- For the *From Node Location*, move the mouse near **Node B**, hold down the *Shift* key and left-click the mouse.
- For the *To Node Location*, move the mouse crosshairs near the node on the inlet to the compressor, hold down the *Shift* key and left-click the mouse.
- To adjust the arc, left-click the mouse to set the curvature. The Pipe Data will be displayed in the Data Panel. In the *Hydraulic Data Items* section, set the following values:

Size/Type Code = **16S** [16S]
Diameter Units = **Inches** [Centimeter]
Hydraulic Length = **60** [97]
Length Units = **Miles** [Kilometers]

- Select the *Apply Data Values* command button.

14) Solve The Model

Select the *Solve* icon from the lower-right corner of the GDI Window. The Solution Data screen will be displayed. Review the solution parameters, then select the *Solve* command button. The Solution Log will be displayed. Review the results, then select the *Close* command button to close the log.



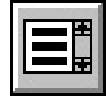
15) Review The Results

- Notice that the pressure on the upstream (suction) side of the compressor is about **255 Psi** [17.6 Bar]. This may or may not be adequate.
- Review the calculated values for the compressor by left-clicking the mouse near the compressor symbol. The Pipe Data will be displayed in the Data Panel. In the *Calculated Values* section, note the Compression Ratio. Depending on the allowable compression ratio, this may or may not indicate that the suction pressure is adequate, however for this example we will assume that it is.



16) Create A Route Profile

- Select the *Show Route Profile* item from the GDI Command List. The Route Profile Options screen will be displayed.



- For the *Items To Include*, select (check) the **Pressure** and **Pipe Flow** items. For the *Selection Style*, select **Trace Upstream**. Select the *Continue* command button.
- For the *Starting Node*, left-click on **Node D**. The Route Profile will be displayed. Select the *Pressure* and *Flow* tabs to view the results. Select the *Close* command button.

Notes & Considerations

- In this example, we input the piping in a schematic style, sometimes this is desirable to make the model more manageable and more attractive from a presentation perspective. The model certainly could have been created “to scale”, however when the model contains long segments (60 Miles) compared to other segments (2 Miles) it can be difficult to efficiently manipulate the data and view the results.
- Compressors must be installed so that the From Node represents the upstream (suction) side of the compressor and the To Node represents the downstream (discharge) side of the compressor. When displayed the compressor symbol is larger on the suction side than on the discharge side.
- If this were an actual design project, we would probably see if we could lower the discharge pressure of the compressor to see if we could reduce the Compression Ratio - and perhaps see if looping alone, without compression could be used to achieve the pressure requirements at Node D.

