# GASWorkS™ 10.0 Example   *Calibration*

Summary

In this example, an existing model will be used to demonstrate the process of calibrating a model so that the model results match the field measured values.

For calibration we will use a "measured" field value of 6.4 Psi for Node 120, 8.4 Psi for Node 40, a supply pressure at Node CIG TAP of 19.2 Psi, and a total flow into the system of 8.5 Mcfh.

Steps

The following assumes that GASWorkS has already been started. If a model is already open, close it by selecting the *Close* menu item from the *File* menu list. Use the following procedure to work this example...
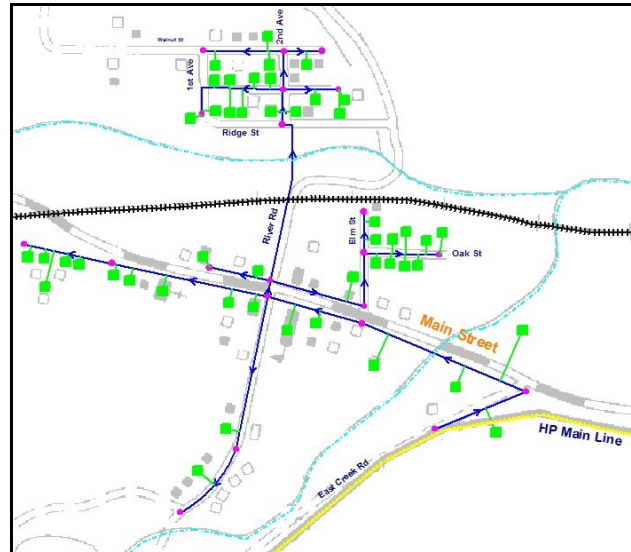
1) Open The Existing Model

● From the *File* menu list, select the *Open* menu item. The File Selection screen will be displayed. Use the *Drives* and *Directories* lists to navigate to the directory containing the desired file - **weston example.hdr**. Select the file, 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*.

● Zoom the GDI Image to fill the GDI Display using the *Zoom To Fit* icon from the lower-left corner of the GDI Window.

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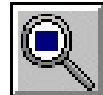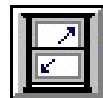
2) Save The Model To A New Name

Before making changes to the model, let's save it to a new name.

● From the *File* menu list, select the *Save As* menu item. The File Selection screen will be displayed. Enter a new *Filename* for the model, then select the *Continue* command button.

3) Reset The Pipe Efficiencies

Before starting a calibration, it is a good idea to reset all of the pipe efficiencies to 1.0 using the Mass Update routine.

● From the *Edit* menu list, select the *Mass Update* menu item. The Mass Update Specifications screen will be displayed. Set the following values:

Set = **Pipe Efficiency**
Equal To = **1.0**
Apply To All Records = **Select**

● Select the *Update* command button to make the changes. A message will be displayed reporting the number of records updated. Select the *OK* command button to clear the message.

● On the Mass Update Specifications screen, select the *Close* command button.

4) Determine The Design Factor

We need to cause the total flow in-to the system to match the field reported value. To do that we will adjust the Design Factor parameter. The Design Factor adjusts the system loads up or down without changing the actual load data values. To determine the appropriate value for the Design Factor, let's first find the total flow in-to the system for a Design Factor equal to 1.0, then we will calculate the Design Factor value that we need to match the field value.

Solve The Model At A Design Factor Of 1.0 -

● Select the *Solve* icon from the lower-right corner of the GDI Window. The Solution Data screen will be displayed.
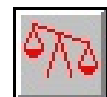
● On the *Solution Data* tab, set the following values:

Design Factor = **1.0**

● Review the other solution parameters. Select the *Solve* command button to solve the model. The Solution Log will be displayed. When the solution is complete, review the results. Select the *Close* command button to close the log.

Determine The Flow Rate At A Design Factor Of 1.0 -

● From the *Report* menu list, select the *System Summary* menu item.

● The System Summary Report Options screen will be displayed. Select (check) the *Supply Nodes Summary* option, and unselect (uncheck) all the other options. Select the *Continue* command button.

● The System Summary Report will be displayed. Note the total flow rate being supplied by **Node CIG TAP**. It should be about 5.7 Mcfh. Select the *Close* command button to close the report screen.

Calculate The Required Design Factor -

● Calculate the Design Factor by dividing the measured flow (8.5 Mcfh) by the current total system flow (5.7 Mcfh).

Required Design Factor = 8.5 / 5.7 = 1.5

● The required Design Factor should be about 1.5.

5) Set The Supply Pressure

We need to set the pressure at the supply point to the field recorded value before we start checking the other system pressures. To do that...

● Left-click on **Node CIG TAP**. *Note* - If you cannot select the node, use the *Edit Node Data* command.

● The Node Data will be displayed in the Data Panel. In the *Hydraulic Data Items* section, set the following values:
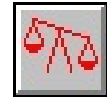
Pressure = **19.2**
Pressure Units = **Psi**

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

6) Solve The Model

Now let's solve the model to calculate the system pressures associated with the new Design Factor and supply pressure.

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

  - ● On the *Solution Data* tab, set the following value:

    Design Factor = **1.5**

  - ● Review the remaining solution parameters. Select the *Solve* command button. The Solution Log will be displayed. When the solution is complete, review the results. Select the *Close* command button to close the log screen.

7) Review The Results

For calibration purposes, we will use a field value of 6.4 Psig for Node 120 and 8.4 Psig for Node 40. It's best to start the "calibration" process by reviewing the results for the node (with a measured value) closest to a supply point with a known value. For our example, let's look at Node 40 first and try to get its calculated pressure to match the field results. The current model results reflect the pressure values associated with a hydraulic efficiency of 1.0.

- ● Select the *Find Node* icon from the *Data Edit Commands Toolbar*.

  - ● For the *Node Search Method*, select **Node Name** from the list.

  - ● For the Node Name, type **40** and press the *Enter* key.

- ● A flag will be placed at the node location.

- ● Left-click on **Node CIG TAP**. *Note* - If you cannot select the node, use the *Edit Node Data* command.

  - ● The Node Data will be displayed in the Data Panel. In the *Hydraulic Data Items* section, take note of the *Pressure* value (about 12.0 Psig). The field measured value was 8.4 Psi. In this case, the model value is higher than the field value indicating that the model is not predicting enough pressure drop.

8) Adjust The Pipe Efficiency

To increase the pressure drop, let's lower the pipe efficiencies along the flow path between the supply point and Node 40. We will use the Trace & Update routine to make the change.

● Select the *Trace & Update Data* item from the GDI Command List. The Trace & Update Data Specifications screen will be displayed. Set the following values:
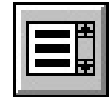
Trace Style = **Trace Upstream**
Start Trace At = **A Node**
Trace Highlight Color = **Red**   (Click in the color box. The Color Palette will be displayed. Select Red, then select the *OK* command button.)

Set = **Pipe Efficiency**
Equal To = **0.8**

● Select the *Trace & Update* command button.

● For the *Starting Node*, select **Node 40** (the flagged node).

● The pipes along the trace route will be highlighted in the selected color and a message will be displayed. Select the *Yes* command button to make the change.

● A message will be displayed reporting the number of records that were updated. Select the *OK* command button to clear the message.

9) Resolve The Model

● Select the *Quick Solve* icon from the lower-right corner of the GDI Window. The model results will be recalculated. A message will appear <u>only</u> if an error occurs during the Solution process. When the solution is complete, the new model results will be displayed.

10) Review The Results

Check the new pressure value for Node 40. If the new value is less than the field value, the pressure drop is now too large, meaning that our pipe efficiency value is too small - increase the pipe efficiency to increase the pressure value. If the new value is higher than the field value, the pressure drop is now too small meaning that our pipe efficiency value is too large - decrease the pipe efficiency to decrease the pressure value.

Continue the process of adjusting the pipe efficiency, solving the model, and reviewing the results until the model and field pressures match within an acceptable tolerance (about 0.1 Psi for this example). The final pipe efficiency for the pipes feeding Node 40 should be about 0.83.

Note - As an alternative to selecting Node 40 and reviewing its pressure value in the Data Panel, you could display its pressure value on the GDI Image by using the Text Display Settings.

11) Check The Pressure At Node 120

After matching the pressure value at Node 40, check the value at Node 120. Left-click on Node 120 to display the Node Data in the Data Panel and check the pressure value. In this case, the model value is higher than the field value (9.3 Psig compared to 6.4 Psig). This indicates that the pressure drop along the flow path to that point needs to be increased. We will do that by decreasing the pipe efficiency along the flow path.

12) Adjust The Pipe Efficiency To Node 120

To increase the pressure drop along the pipes feeding Node 120, let's lower the pipe efficiencies along the flow path to the node, but not for the pipes that we have already adjusted.

● Select the *Edit Multiple Pipes* icon from the *Data Edit Commands Toolbar*.

    ● Select the pipes along the flow path supplying Node 120 by left-clicking on the desired pipe segments. The pipes will be highlighted when they are selected.

    ● When all of the desired pipes have been selected (should be 5), right-click the mouse to end the selection.

        ● The Multiple Edit Specifications screen will be displayed. On the *Model Data Items* data tab, set the following values:

            Set = **Pipe Efficiency**
            Equal To = **0.8**

        ● Select the *Apply* command button to make the change. A message will be displayed reporting how many records were updated. Select the *OK* command button to clear the message.

        ● On the Multiple Edit Specifications screen, select the *Close & Solve* command button to close the specification screen and resolve the model.

> *Note -* When you execute the *Edit Multiple Pipes* command subsequent times, and a group of pipes was previously selected, a "Use Previous Pipe Selection..." message will be displayed, select the *Yes* command button to use the previously selected pipes.

Continue to adjust the efficiencies, resolve, and review the results until the pressures are within 0.1 Psig or so. You will find that the efficiency needs to be set relatively low (about 0.43) to make a match. This could indicate a problem with the measurement, a problem with the data, or an operational problem with the system.

Note- To reset the feature colors (clear the trace colors), type **RESET** on the GDI Command Line. To clear the find flag (or any other flags that may be displayed), type **CLEARALL** on the GDI Command Line.

Notes & Considerations

● In distribution systems, generally only a few values are known compared to the total number of nodes. Discretion and judgment often play as big of a role in the calibration as the actual field values. In other words, do the calculated values look right? If they don't, they probably aren't.

● When calibrating a model, consideration should be given to the accuracy of the field measurements. For example, were the values measured or estimated, were the values taken from a gauge that was only marked in five pound increments, were the values taken from a chart with a fat pen, when was the instrument last calibrated?

● Ideally, the measurements need to correspond to the exact same point in time. In other words, the measurements need to have all been recorded at the same exact time. In distribution systems, where the flow (and consequently the pressure) changes from hour-to-hour and day-to-day, it is very critical that the measurements be taken at the same time.

● In this example, we assumed that the gas properties and flowing temperatures were valid for the calibration period. It is common practice to use average values for normal design and analysis, however using average values during the calibration process can skew and corrupt the calibration results. When performing a calibration use the most accurate data that you have available. Obtain a gas analysis taken near the time the calibration data was taken. Calculate the gas properties associated with the analysis and use these during the calibration.

● Additionally, collect and use temperature values corresponding to the calibration period. Often temperature data can be obtained from measurement data collected at meter stations. However, be careful when using temperatures measured downstream of regulator and compressor stations. The temperature immediately downstream of a regulator will always be lower than the average upstream and downstream gas temperatures. Conversely, the temperature immediately downstream of compressors will almost always be higher than the average upstream and downstream temperatures.

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● For the best results, the calibration data should correspond to a peak flow period. It is impossible to calibrate a system that has little or no pressure drop. The higher the pressure drop across the system, the more accurate the calibration results will be.

● Why don't the model results match the field data values exactly? First, remember that the "model" is just that - it is a model or a scaled representation of the actual system. There are a lot of things that are not known very accurately about the actual system, and there are a lot of things that are not being specifically included in the model. Items not specifically addressed by the model include such items as the affect of taps and pipe joining methods. Unknown items include debris or liquids in the pipe, incorrect pipe sizes, incorrect or inaccurate wall thickness values, crimped, crushed, or dented pipe segments, unusual connections, inaccurate length values - the list goes on and on.

● Ideally, once the pipe efficiencies have been calculated along the flow paths to the known pressure locations, an average pipe efficiency could be calculated and applied to the remaining pipes. In this case the pipe efficiency values required to match the measured pressures at Node 120 were comparatively low, which would generally indicate a problem with either the measured value, with the model data, or could indicate an unusual restriction in the piping system - a partially closed valve, a pinched or partially collapsed main, or maybe debris or liquid in the system. Averaging the pipe efficiency values found in this example would probably not be wise.

● It is absolutely critical that a model be calibrated before it is used as the basis for any decision making. As shown by this example, the calibration process is time consuming. However, usually the reason a model is created is because some sort of decision needs to made. Decisions involving system modifications or system capacity can be quite costly to implement and even more costly to fix after a bad decision has been made. Spending a bit of time calibrating the model to ensure that it is providing accurate results, will nearly always save you time, money, and most of all headaches later.