Calculation Module

Overview

The Calculation module includes four sub-modules:

- Control Valve Calculation
- Flowmeter Calculation
- Relief Valve Calculation
- Thermowell Calculation

Each sub-module performs individually, yet is fully integrated within the SmartPlant Instrumentation system.

These sub-modules employ the major international standards (ISA, ANSI, API, ISO, and IEC 60534-2-1 (1998)), to perform complex control valve, flow element, relief valve, and thermowell calculations quickly and effortlessly.

Calculation data for a particular item is collected and taken into account from the Instrument Index module, among others, but mainly from the Process Data module. Control Valve, Flowmeter, Relief Valve, or ThermoWell parameters are then entered, as well as valve flow coefficient, Orifice Diameter, and Required Discharge Area respectively along with other important parameters. After the calculation, the relevant data may then be incorporated into generated reports and specifications.

Notes

- The software does not support calculations for materials for which the state is solid/powder, nor for 2-phase flow.
- If you need to add or modify process data, you can do this in the Calculation module.

Principles of the Calculation Module

This module provides the capabilities to quickly perform calculations for Cv, noise, orifice diameter, required discharge area, and other parameters for Control Valves, Flowmeters, Relief Valves, and Thermowells.

To perform calculations, enter the tag number directly, or use the **Find Tag** utility to open and view the Calculation sheet. The data in these fields originates mainly from the Process Data module and then factored in the Calculation module.

You then open the relevant calculation dialog box, (control valve, flowmeter, relief valves, or thermowell), enter all the parameters required for calculation, and initiate the calculation.

After the results are displayed you can save the results along with the entered data to make them accessible to other modules, mainly the Specifications module. You can also generate reports.

Starting the Calculation Module

This procedure explains how to start the calculation module.

Note

- Before starting this module, check with the Domain Administrator to ensure that you have been granted appropriate access rights for the tasks you will carry out.

➢ To start the Calculation module

- In any SmartPlant Instrumentation window, do one of the following:
  - On the SmartPlant Instrumentation toolbar, lick  .
  - On the **Module** menu, click **Calculation**.

Preparing Process Data for Calculation

Viewing and Editing a Calculation Item

Use this procedure to open individual control valve, flowmeter, relief valve, and thermowell process data sheets for calculation.

Note

- You can also select a batch of instruments of a given process function for calculation.

➢ To open a process data sheet for calculation

1. In the **Calculation Module** window, on the **Edit** menu, point to **Calculation**, and then click one of the following:
   - **Flowmeter**
   - **Thermowell**
   - **Control Valve**
   - **Relief Valve**
2. In the **Enter Tag Number** dialog box, do one of the following:
   - Type the tag number that you want to calculate.
   - Click **Find** to open the **Find Tag** dialog box, where you search for the tag that you want to calculate.
3. Click **OK** to display the calculation **Process Data** window for the instrument that you selected.
4. If you defined multiple process cases, from the **Case** list, select the case that you want to calculate.
5. To edit the process data values, see Editing Instrument Process Data.

Editing Instrument Process Data

This procedure explains how to edit the process data associated with an instrument tag. You can edit instrument process data from the Process Data module or from the Calculation module.

➢ To edit instrument process data

1. Open the process data sheet for an instrument tag from either of the two modules:
   - Process Data module.
   - Calculation module.
2. In the **Process Data** window, modify the process data as needed in the following sections:
   - **GENERAL**
   - **PROPERTIES**
   - **ADDITIONAL PROPERTIES**
   - **ANALYZER COMPONENT/PROPERTY**
   - **ANALYZER COMPONENT/PROPERTY**
   - **BASE CONDITIONS**
   - **SIZING DATA**
   - **ALARM**
   - **API 2540 STANDARD**
   - **USER-DEFINED FIELDS**
   - **NOTE**

    **Notes**

   - If you are creating a multi-case tag, you can enter values for each case that you create.
   - If the Domain Administrator enabled the use of process data custom fields, the above sections can display such fields.
3. On the module toolbar, click  to save the values.

Fluid Definition

When opening a tag in a process data sheet, you are required to define the fluid for which a calculation will be carried out. You define the fluid by selecting the fluid state, entering the fluid name or selecting it from one of the two property databases, and setting the fluid phase.

Notes

- Note that if this is a new tag that you just created in the Calculation module, the **PROPERTIES** section of the window will be blank until you select the required Fluid State.
- The software does not support calculations for materials for which the state is solid/powder, nor for 2-phase flow.

➢ To define the fluid

1. Open the process data sheet for an instrument tag from either of the two modules:
   - Process Data module
   - Calculation module
2. If you defined multiple process cases, from the **Case** list, select the case that you want to calculate.
3. In the **GENERAL** section of the process data sheet, from the **Fluid state** list, do one of the following:
   - Accept the fluid state that you set when you first opened the tag in the Process Data or Calculation module.
   - Select a different fluid state.
4. From the **Fluid name source** list, select one of the following options, which the software uses to calculate the item properties:
   - Database – activates the Property database after selecting the required fluid from the **Name** list. To learn how to use the Properties database, see Calculating Physical Properties.
   - API2540 – calculates liquid density at operating and base conditions in accordance with the API2540 standard. To learn how to use the **API 2540 Standard Properties** database, see API 2540 Standard for Liquid Density Calculation.
   - User-defined – define the fluid properties according to your own standards.

Note

- If you selected Solid/Powder as the material state, the **Select from** list does not appear.

5. In the **Fluid name** box, enter the fluid name.
6. From the **Fluid phase** list, select the required fluid phase.

API 2540 Standard for Liquid Density Calculation

This feature enables you to calculate liquid density at operating and base conditions in accordance with the API 2540 standard. You can select one of the five product groups:

- Crude Oils and JP 4.
- Jet Fuels, Kerosenes, and Solvents.
- Gasolines and Naphthenes.
- Lubricating Oils.
- Diesel Oil, Heating Oils, and Fuel Oils.

➢ To calculate liquid density according to the API 2540 standard

1. Open the process data sheet for an instrument tag from either of the two modules:
   - Process Data module
   - Calculation module
2. In the process data sheet, make sure that the **Liquid** fluid state is selected.
3. Select the **API 2540** option from the **Fluid name source** list.
4. Select the required product group from the **Fluid name** list.
5. In the **API 2540 STANDARD** section, select one of the following:
   - Density at reference temperature.
   - Specific gravity at reference temperature.
   - ºAPI settings for: minimum/normal/maximum

6. Enter the required values in the appropriate fields according to the selected option.

7. If you selected **Density at reference temperature** or **Specific gravity at reference temperature**, do one of the following:

   - Type the reference temperature value in the **Reference temperature** field.
   - Click **Default** to enter the default reference temperature.

8. Click **Calculate Density** to calculate the density.

Note

- The calculated values for Density and Specific Gravity are entered in the Properties @Minimum, @Normal, and @Maximum fields.

Modifying Instrument Base Conditions

Use this procedure to modify base condition values when entering data for Control Valve, Relief Valve, or Flowmeter calculations, from the Process Data or Calculation modules.

➢ To modify base conditions for an instrument tag

1. Open the process data sheet for an instrument tag from either of the two modules:

   - Process Data module
   - Calculation module

2. Scroll to the **BASE CONDITIONS** section.

3. Select a base pressure unit of measure, and beside **Pressure** type the base pressure.

4. Select a temperature scale, and beside **Temperature**, type the base temperature.

5. According to the state that you selected under **Fluid**, select the required basic property, as follows:

   - If the state is solid/powder, do one of the following:
     - Select Density @base, select a unit of measure, and type the density value.
     - Select Specific Gravity @base, and type the specific gravity value.
   - If the state is liquid, do one of the following:
     - Select Density @base, select a unit of measure, and type the density value.
     - Select Specific Gravity @base, and type the specific gravity value.
   - If the state is water, do one of the following:
     - Select Density @base, select a unit of measure, and type the density value.
     - Select Specific Gravity @base, and type the specific gravity value.
   - If the state is gas/vapor, do one of the following:
     - Select Density @base, select a unit of measure, and type the density value.
     - Select Compressibility @base, and type the compressibility value.
   - If the state is steam, beside Compressibility @base, type the required value.

6. To save your changes, on the module toolbar, click  .

Standard Calculations

Performing Calculations

The calculation dialog boxes comprise the essence of the Calculation module. The values that you enter in these dialog boxes together with the data in the process data sheets serve as the basis of the calculations displayed on the screen. Calculation item reports provide information that is more comprehensive.

Tip

- When you open a **Calculation Item** window and some of the process data values are not filled in, you can click **Highlight Process Data** on the **Options** menu to highlight all the fields that you must fill in to carry out the calculation.

Preparing for Flowmeter Calculation

Use this procedure to enter the values common to all three types of flowmeter calculation:

- Orifice flowmeter calculation
- Tube flowmeter calculation
- Restriction device calculation

When you reach the last step of the current procedure, click the link to the procedure that you require to complete the calculation.

Notes

- By default, SmartPlant Instrumentation updates tag values from the current unit of measure to their value in a new unit of measure that you set. If on the **Options** menu you clear **Automatic Unit Conversion**, the software changes the unit of measure without recalculating the values! Therefore, to protect the integrity of your values, on the **Options** menu, click **Automatic Unit Conversion**.

- To highlight the fields that are required for a calculation, on the **Options** menu, click **Highlight Process Data**.

➢ To prepare for flowmeter calculation

1. Open a calculation data sheet for the flowmeter tag that you want to calculate.
2. If you defined multiple process cases, from the **Case** list, select the case that you want to calculate.
3. Make sure that you enter process data in all of the fields that are required for calculation, in the following sections of the data sheet (click the links for more details):
   - **GENERAL**
   - **PROPERTIES**
   - **ADDITIONAL PROPERTIES**
   - **BASE CONDITIONS**
   - **ALARM**
   - **API 2540 STANDARD**
   - **USER-DEFINED FIELDS**
   - **NOTE**
4. On the module toolbar, click  .
5. Do one of the following:
   - On the module toolbar, click  .
   - On the **Actions** menu, click **Calculate**.
6. In the **Flowmeter Calculation** dialog box, continue with one of the following procedures:
   - To calculate an orifice flowmeter, see Orifice Flowmeter Calculation.
   - To calculate a tube flowmeter, see Tube Flowmeter Calculation.
   - To calculate a restriction device, see Restriction Device Calculation.

Orifice Flowmeter Calculation

This option enables you to calculate orifice flowmeter parameters based on the fluid state values of the flowmeter and values retrieved from the Process Data module. In a calculation data sheet for a flowmeter item, you can accept or modify these values, or enter additional values. Then, in the **Flowmeter Calculation** dialog box, you calculate orifice flowmeter parameters for a selected orifice flowmeter and view the calculation results.

➢ To calculate orifice flowmeter parameters

1. Open the **Flowmeter Calculation** dialog box for the orifice flowmeter that you want to calculate.

2. From the **Flowmeter type** list, select the required orifice flowmeter.

   Note

   - The Quarter of Circle Orifice sizing is in accordance with the new edition of British Standard (BS 1042: Section 1.2; 1989).

3. From the **Sub type** list, select the required sub type for the current orifice flowmeter.

4. Type the required values in the fields next to the other two calculation options that you haven't selected. SmartPlant Instrumentation will then use these values to calculate the tube flowmeter parameters for the selected option.

5. Under **Pipe**, view the data in the **Material** field and the **Linear expansion coefficient** field.

   Notes

   - The data in the **Pipe material** field is retrieved from the Process Data module.

   - The linear expansion coefficient value for the displayed pipe is the standard value taken from SmartPlant Instrumentation database.

   - From the **Linear expansion coefficient** list of units of measure, you can select a required unit of measure for the current linear expansion coefficient.

6. Under **Orifice**, from the **Orifice material** list, select the orifice material.

Notes

- The **Orifice material** list contains standard options provided with SmartPlant Instrumentation. If the required orifice material is not in the list, select from the list the MATERIAL NOT LISTED option and in the **Linear expansion coefficient** field type the required linear expansion coefficient.

- If you select a standard option from the **Orifice material** list, you cannot change the linear expansion coefficient value for the displayed orifice material because this is the standard value taken from SmartPlant Instrumentation database.

7. In the **Diameter of bleed/vent hole** field, type the required diameter of the bleed/vent hole or accept the given value.

Notes

- When calculating the orifice flowmeter parameters for the **Steam** fluid state, in the **Water in steam, %wt** field, type the percentage of water in steam.

- If the value in the **Full scale flow** field has been changed, you can click  to get the values from the Process Data module.

8. Under **Select calculate field**, select one of the following options to calculate the orifice flowmeter parameters:

- **Orifice diameter**
- **Full scale flow**
- **Differential range**

9. Click **Calculate**.

10. Examine the calculation results and possible calibration error messages.

Notes

- The units of pressure loss derive from the default units for Differential Range (Flow) set in the **Units of Measure and Accuracy** dialog box.

- When sizing flowmeters for Liquids and Water, SmartPlant Instrumentation checks whether **Downstream pressure** is greater than **Vapor pressure**. If it is, the program continues sizing. If it is not, critical flow takes place, and the program advises you to check the input data.

11. To recalculate the orifice flowmeter parameters, enter the new data and click the **Calculate** command button.

12. Click **Close** to return to the calculation data sheet.

Tube Flowmeter Calculation

This option enables you to calculate tube flowmeter parameters based on the fluid state values of the flowmeter and the values retrieved from the Process Data module. In a calculation data sheet for a flowmeter item, you can accept or modify these values, or enter additional values. Then, in the **Flowmeter Calculation** dialog box, you calculate the tube flowmeter parameters for a selected tube flowmeter, view and print out the calculation results.

➢ To calculate tube flowmeter parameters

1. Open the **Flowmeter Calculation** dialog box for the tube flowmeter that you want to calculate.

2. From the **Flowmeter type** list, select the tube flowmeter type.

3. From the **Sub type** list, select the tube flowmeter sub-type, if available.

4. Type the required values in the fields next to the other two calculation options that you haven't selected. SmartPlant Instrumentation will then use these values to calculate the tube flowmeter parameters for the selected option.

5. In the **Tube** group box, view the data in the **Material** field and the corresponding linear expansion coefficient value in the **Linear expansion coefficient** field.

    **Notes**

   - The data in the **Material** field is retrieved from the Process Data module.

   - The linear expansion coefficient value for the displayed pipe is the standard value taken from the SmartPlant Instrumentation database.

   - From the **Linear expansion coefficient** list of units of measure, you can select a required unit of measure for the current linear expansion coefficient.

6. In the **Throat** group box, select the required throat material.

Notes

- The **Material** list contains standard options provided with SmartPlant Instrumentation. If the required throat material is not in the list, select from the list the MATERIAL NOT LISTED option and in the **Linear expansion coefficient** field type the required linear expansion coefficient.
- If you select a standard option from the **Material** list, you cannot change the linear expansion coefficient value for the displayed throat material because this is the standard value taken from the SmartPlant Instrumentation database.
- When calculating the tube flowmeter parameters for the steam fluid state, in the **Water in steam, %wt** field, type the percentage of water in steam.
- If the value in the **Full scale flow** field has been changed, you can click  to retrieve the values from the Process Data module.

7. Under **Select calculate field**, select one of the following options to calculate the tube flowmeter parameters:
   - **Throat diameter**
   - **Full scale flow**
   - **Differential range**
8. Click **OK** to carry out and display the calculation results.
9. Examine the calculation results and possible calibration error messages.

Notes

- The values of pressure loss in the results comes from the default values for differential range flow set in the **Units of Measure and Accuracy** dialog box.
- When sizing flowmeters for Liquids and Water, the software checks whether **Downstream pressure** is greater than **Vapor pressure**. If it is, the program continues sizing. If it is not, critical flow takes place, and the program advises you to check the input data.

10. To recalculate the tube flowmeter parameters, enter the new data and then click **Calculate**.

11. Click **Close** to return to the calculation data sheet, where you can click  to generate a report for the current calculation result. Error messages also appear in a calculation report.

Restriction Device Calculation

This option enables you to calculate the restriction device parameters based on the fluid state values of a flowmeter and values retrieved from the Process Data module. In a calculation data sheet for a flowmeter item, you can accept or modify these values, or enter additional values. Then, in the **Flowmeter Calculation** dialog box, you calculate the restriction device parameters and view the calculation results.

➢ To calculate the restriction device parameters

1. Open the **Flowmeter Calculation** dialog box for the restriction device that you want to calculate.

2. From the **Flowmeter type** list, select Restriction Device.

3. From the **Sub type** list, select the restriction device sub type.

4. Type the appropriate values in the fields next to the other two calculation options that you haven't selected. SmartPlant Instrumentation will then use these values to calculate the tube flowmeter parameters for the selected option.

5. In the **Pipe** group box, view the data in the **Material** field and the corresponding linear expansion coefficient value in the **Linear expansion coefficient** field.

   Notes

   - The data in the **Pipe material** field is retrieved from the Process Data module.

   - The linear expansion coefficient value for the displayed pipe is the standard value taken from the SmartPlant Instrumentation database.

   - From the **Linear expansion coefficient** list of units of measure, you can select a required unit of measure for the current linear expansion coefficient.

6. In the **Orifice** group box, from the **Material** list, select the orifice material of the restriction device.

Notes

- The **Orifice material** list contains standard options provided with SmartPlant Instrumentation. If the required orifice material is not in the list, select from the list the MATERIAL NOT LISTED option and in the **Linear expansion coefficient** field type the required linear expansion coefficient.

- If you select a standard option from the **Material** list, you cannot change the linear expansion coefficient value for the displayed orifice material because this is the standard value taken from the SmartPlant Instrumentation database.

7. In the **Diameter of the bleed/vent hole** field, accept the displayed value, or type the diameter of the bleed/vent hole.

8. If needed, clear the **Calculate discharge coefficient** check box to enable you to type the discharge coefficient.

Notes

- If you leave the **Calculate discharge coefficient** check box selected, the software automatically calculates the discharge coefficient according to the preset values.

- When calculating the restriction device parameters for the **Steam** fluid state, in the **Water in steam, %wt** field, type the percentage of water in steam.

- If the value in the **Full scale flow** field has been changed, you can click  to get the values from the Process Data module.

9. Under **Select calculate field**, select one of the following options to calculate the restriction device parameters:

   - **Orifice diameter**
   - **Full scale flow**
   - **Pressure loss**

   Caution

   - Do not type any values in the field next to the selected calculation option.

10. Click **OK** to carry out and display the calculation results.

11. Examine the calculation results and possible calibration error messages.

    Notes

    - The values of pressure loss in the results comes from the default values for differential range flow set in the **Units of Measure and Accuracy** dialog box.
    - When sizing flowmeters for Liquids and Water, SmartPlant Instrumentation checks whether **Downstream pressure** is greater than **Vapor pressure**. If it is, the program continues sizing. If it is not, critical flow takes place, and the program advises you to check the input data.

12. To recalculate the restriction device parameters, enter the new data and then click **Calculate**.

13. Click **Close** to return to the calculation data sheet, where you can click to generate a report for the current calculation result. Error messages also appear in a calculation report.

Calculating a Relief Valve

Use this procedure to calculate the sizing of a relief valve. This option works for single phase fluids only and for all fluid states, with the exception of Solid/Powder.

Notes

- By default, SmartPlant Instrumentation updates tag values from the current unit of measure to their value in a new unit of measure that you set. If on the **Options** menu you clear **Automatic Unit Conversion**, the software changes the unit of measure without recalculating the values! Therefore, to protect the integrity of your values, on the **Options** menu, click **Automatic Unit Conversion**.

- To highlight the fields that are required for a calculation, on the **Options** menu, click **Highlight Process Data**.

➢ To calculate a relief valve

1. Open a calculation window for a relief valve item.

2. If you defined multiple process cases, from the **Case** list, select the case that you want to calculate.

3. Make sure that you enter process data in all of the fields that are required for calculation (click the links for more details), in the following sections of the data sheet:

   - **GENERAL**
   - **PROPERTIES**
   - **ADDITIONAL PROPERTIES**
   - **BASE CONDITIONS**
   - **SIZING DATA**
   - **API 2540 STANDARD**
   - **USER-DEFINED FIELDS**
   - **NOTE**

   Note

   - Although from the **Pressure/Vacuum** list, you can select Vacuum only or Pressure and vacuum, SmartPlant Instrumentation calculates pressure relief valves only, and not vacuum relief valves or dual mode pressure/vacuum relief valves. The vacuum service set point value that you enter beside **Valve Set Vacuum** is displayed in the process data report for this instrument, but not in the calculation report.

4. Click  .

5. Click  to display the **Relief Valve Calculation** dialog box.

 **Note**

- The default selection for **Use Rupture Disk at the inlet?** is No. Selecting Yes enables the **Combination Capacity factor (Kc)** field below.

6. Select user-defined conditions for the relief valve:

   - ASME Capacity Certification requirement.
   - Sizing basis.
   - Rupture Disk at the inlet use.

7. If you are using the Bellows valve style in liquid or water applications, you can also let SmartPlant Instrumentation calculate the correction factor for back pressure (Kw) by checking the **Calculate** check box.

8. Type the required value for **Effective coefficient of discharge (Kd)** or click **Default** to use the SmartPlant Instrumentation default value.

9. If available, type the required value for **Combination capacity factor (Kc)** or click **Default** to use the SmartPlant Instrumentation default value.

10. Click the **Calculate** command button.

11. Click **Close** to return to the calculation data sheet.

Calculating a Relief Valve in Case of Fire

Use this procedure to calculate the sizing of a relief valve in case of fire.

Notes

- By default, SmartPlant Instrumentation updates tag values from the current unit of measure to their value in a new unit of measure that you set. If on the **Options** menu you clear **Automatic Unit Conversion**, the software changes the unit of measure without recalculating the values. Therefore, to protect the integrity of your values, on the **Options** menu, click **Automatic Unit Conversion**.

- To highlight the fields that are required for a calculation, on the **Options** menu, click **Highlight Process Data**.

➢ To size a relief valve in case of fire

1. With a calculation data sheet open for a relief valve item, scroll to the **SIZING DATA** section.

2. From the **Case (fire/non-fire)** list, select **Fire**.

3. Enter all the required values, especially the Area and Properties @relieving condition values. Some properties vary for the Liquid and Gas fluid states.

4. Complete the **Relief Valve Calculation** dialog box, and click the **Calculate** command button to get the calculation results.

   Note

   - The Sizing basis and other calculation results (the Calculated area, Selected area, and Orifice designation) appear on specifications based on SmartPlant Instrumentation library form # 7.

Calculating a Control Valve

This procedure enables you to enter various values for calculating a control valve. First, you define a CV calculation method and a flow coefficient standard (US or Europe) of CV sizing, then you select a noise calculation method and a CV body type. Next, you enter values, perform the calculation, and view the results.

Notes

- By default, SmartPlant Instrumentation updates tag values from the current unit of measure to their value in a new unit of measure that you set. If on the **Options** menu you clear **Automatic Unit Conversion**, the software changes the unit of measure without recalculating the values! Therefore, to protect the integrity of your values, on the **Options** menu, click **Automatic Unit Conversion**.

- To highlight the fields that are required for a calculation, on the **Options** menu, click **Highlight Process Data**.

➢ To calculate a control valve

1. Open a control valve calculation item.

2. If you defined multiple process cases, from the **Case** list, select the case that you want to calculate.

3. Make sure that you enter process data in all of the fields that are required for calculation (click the links for more details), in the following sections of the data sheet:

   - **GENERAL**
   - **PROPERTIES**
   - **ADDITIONAL PROPERTIES**
   - **BASE CONDITIONS**
   - **API 2540 STANDARD**
   - **USER-DEFINED FIELDS**
   - **NOTE**

4. Click  to save the values.

5. Do one of the following:

   - On the module toolbar, click  .
   - On the **Actions** menu, click **Calculate**.

6. In the **Control Valve Calculation** dialog box, from the **Calculation method** list, select the required calculation method – ISA or IEC.

   Note

   - The IEC standard is 60534-2-1 (1998)

7. From the **Flow coefficient** list, select the required flow coefficient standard of CV sizing – Cv or Kv.

   Note

   - Kv is a European standard flow coefficient available for an IEC CV calculation method. Kv=Cv*0.865

8. Based on the value that you selected from the **Fluid state** list on the process data sheet, do one of the following:

   - If you set Liquid or Water, select Masoneilan or IEC from the **Noise calculation method** list.
   - If you set Gas/Vapor or Steam, select ISA or IEC from the **Noise calculation method** list.

9. Enter hydrodynamic noise data as necessary.

   Note

   - This option is available only If under **State** you selected Liquid or Water, and under **Noise Calculation Method** you selected IEC.

10. From the **Body type** list, select the required body type.

11. Enter the required critical flow factor values (Fl, Cf) at minimum, normal, and maximum control valve coefficients.

12. To define the required pressure drop ratio factor values (Xt) at minimum, normal, and maximum control valve coefficients, do one of the following:

    - To calculate the values automatically, as a function of critical flow, select **Calculate pressure drop ratio factor**.
    - Type the required values in the **@Minimum**, **@Normal**, and **@Maximum** fields.

13. Type the **Valve style modifier** (Fd) value.

14. To set the **Relative capacity** value, do one of the following:

    - Accept the value that SmartPlant Instrumentation calculates based on the calculation method and on the standard that you selected from the **Flow coefficient** list.
    - Type the value that you require.

15. Type the required **Number of flow passages**.

16. Enter the appropriate **Valve size** and select its unit of measure.

17. To set the outlet pipe diameter, do one of the following:

    - Under **Outlet pipe diameter**, type the value required.
    - Click **Default** to apply the inlet pipe diameter.

18. Click **Calculate** to carry out and display the calculation results.

19. Examine the figures for results that may have to be re-calculated.

20. To recalculate the orifice flowmeter parameters, enter the new data and click the **Calculate** command button.

21. Click **Close** to return to the calculation data sheet.

Note

- You can calculate a control valve and the relevant parameters even if the pipe wall thickness is not defined. In this case, **Noise** is not calculated and a line of text in Notes section of the calculation sheet informs you that Noise will not be calculated because Pipe wall thickness is not defined.

Calculating a Thermowell

A Thermowell, inserted into a pipe, enables you to calculate tag temperature. This procedure shows you how SmartPlant Instrumentation calculates the maximum permissible length of a Thermowell. The calculation is based on the maximum frequency that the Thermowell can withstand. The calculation complies with ASME PTC 19.3 Standard.

Notes

- By default, SmartPlant Instrumentation updates tag values from the current unit of measure to their value in a new unit of measure that you set. If on the **Options** menu you clear **Automatic Unit Conversion**, the software changes the unit of measure without recalculating the values! Therefore, to protect the integrity of your values, on the **Options** menu, click **Automatic Unit Conversion**.

- To highlight the fields that are required for a calculation, on the **Options** menu, click **Highlight Process Data**.

➢ To calculate the maximum permissible Thermowell length

1. Open a thermowell calculation item.

2. If you defined multiple process cases, from the **Case** list, select the case that you want to calculate.

3. Make sure that you enter process data in all of the fields that are required for calculation (click the links for more details), in the following sections of the data sheet:

   - **GENERAL**
   - **PROPERTIES**
   - **ADDITIONAL PROPERTIES**
   - **ALARM**
   - **API 2540 STANDARD**
   - **USER-DEFINED FIELDS**
   - **NOTE**

4. Click  to save the values.

5. Click  to open the **Thermowell Calculation** window.

6. Select the appropriate velocity: minimum, normal, or maximum.

7. Select the required values from the **Nominal size of sensing element** list.

8. Enter additional values as need, and click **Calculate**.

9. When done, click **Cancel** to return to the main calculation window for a Temperature Item.

Special Calculations

Performing a Batch Calculation

This option enables you to perform a calculation for a group of tags, all belonging to one of the following types: Control Valve, Flowmeter, Relief Valve, or Thermowell.

Notes

- You must define process data before calculation.
- After calculating tags, you can change parameters and then use this procedure to recalculate.

➢ To perform a batch calculation

1. On the **Edit** menu, point to **Batch Calculation**, and click the required instrument type. SmartPlant Instrumentation opens the **Batch Calculation** window for instruments of that type.
2. On the **Actions** menu, click **Find Tag**.
3. In the **Find Tag** dialog box, under **Search parameters**, do one of the following:
   - Type and select filter parameters.
   - To display all tags, leave the boxes blank.
4. Click **Find**.

   Notes

   - For tags for which you defined multiple cases, each case is displayed in a separate row, which allows you to select one or more cases of a given tag for calculation.
   - To utilize the entire dialog box to display the results, click **Show more search results**.

5. Select the tags that you want to calculate, and click **OK.**

6. In the **Batch Calculation** window, for each tag for which you want to display or edit calculation parameters, select the tag and do the following:

   a) On the **Actions** menu, click **Type Data**.

   b) Type and select data you want to change for the calculation, and click **OK** to return to the **Batch Calculation** window.

7. Select the tags that you want to calculate, and do one of the following:

   - On the **Actions** menu, click **Calculate**.
   - On the module toolbar, click  .

8. For information on items with status Failed, on the **Reports** menu, click **Batch Calculation Messages**.

9. To display process data for a given tag, in the **Batch Calculation** window, select a tag, and on the **Reports** menu, click **Process Data Report**.

Multiple Process Data Cases

A given instrument or line is often used for more than one operating service. For example, a dual-fuel control system might use a single supply line and control valve to carry various fuels, gas or liquid. Each group of process data settings that you enter for a given instrument or line is called a case.

 **Note**

- Each case has a separate drawing with its own revisions. Each drawing includes the case name as part of the drawing name.

In the Process Data or Calculation modules, use the following procedures to implement multiple process data cases:

- Creating Process Data Cases
- Setting a Governing Case
- Deleting a Process Data Case
- Managing the Cases Supporting Table

Calculating Multiple Cases

A given instrument or line is often used for more than one operating service. For example, a dual-fuel control system might use a single supply line and control valve to carry various fuels, gas or liquid. Each group of process data settings that you enter for a given instrument or line is called a case. For more information, see Multiple Process Data Cases.

Use this procedure to calculate multiple cases of a given tag.

➢ To calculate multiple cases

1. In the Calculation module, create multiple cases for the tag that you want to calculate.

   Note

   - Using the Creating Process Data Cases procedure, you can also create multiple cases in the Process Data module, and later open the tag in the Calculation module.

2. For each case that you want to calculate, do the following:

   a) In the **GENERAL** section of the calculation data sheet, from the **Case** list, select the required case.

   b) Calculate the case (see Performing Calculations).

   c) To generate a calculation report for the current case, on the **Actions** menu, click **Reports**.

Creating a Hybrid Case

For a control valve for which you defined multiple cases, you can create a hybrid case from the minimum, normal, and maximum flow coefficient values (Cv/Kv) that you calculated for the various cases. Use this procedure to create such a hybrid case.

➢ To create a hybrid case

1. In the Process Data module or in the Calculation module, create multiple cases for the control valve for which you want to create a hybrid case.

2. Do one of the following to calculate every one of the cases:

   - In a **Control Valve Calculation** window for the given tag, calculate every one of the cases individually.

   - Using the Performing a Batch Calculation procedure, select and calculate all of the cases of the given control valve tag.

3. In the main window of the Calculation module, on the **Edit** menu, click **Hybrid Case**.

4. In the **Select Tag** dialog box, click **Find**, and then select the tag for which you want to create a hybrid case.

5. In the **Hybrid Case** dialog box, do the following to set values for the hybrid case:

   a) In the **Case selection** data window, select the value that you want to copy for the hybrid flow coefficient at minimum, and then click **Add Minimum**.

   b) In the **Case selection** data window, select the value that you want to copy for the hybrid normal flow coefficient, and then click **Add Normal**.

   c) In the **Case selection** data window, select the value that you want to copy for the hybrid flow coefficient at maximum and then click **Add Maximum**.

    **Notes**

   - Flow coefficients are displayed dynamically as Cv or Kv, depending on the method of calculation that you set for a given control valve in the **Control Valve Calculation** dialog box.

   - The software offers you the flexibility to select any value of a case for any level of the hybrid case — minimum, normal, or maximum.

Calculation Reports

Principles of Generating Calculation Item Reports

SmartPlant Instrumentation generates Calculation item reports by utilizing two predefined report templates: Liquid and Gas, with which the data of an instrument is associated. An instrument may be a Control Valve, Flowmeter, Relief Valve, or Thermowell. This is done through the association of an instrument, and its process function to its predefined template defined in the Process Data module.

Each report is made up of a number of sections depending on the process function. For example: the heading, information gathered from the Process Data module, data entered via the **Body Type** dialog box of the Calculation module, the **Results and Coefficients** section, and an area provided for Notes and Revisions.

Caution

- When generating a report, only those items that include the saved calculation results appear on the list in the **Find Tag** dialog box.

Generating Calculation Item Reports

Use this procedure to do the following:

- Generate calculation reports for instrument tags.
- Add, edit, and delete calculation report revisions.
- Assign, edit, and delete external drawing numbers assigned to the calculation reports.

➢ To generate a calculation item report

1. In the **Calculation Module** window, on the **Reports** menu, click the report that you require.

   Tip

   - You can also generate a calculation item report when a calculation item window is open. On the module toolbar click  , or on the **Actions** menu, click **Report**.

2. In the **Find Tag** dialog box, under **Search parameters**, do one of the following:

   - Type and select filter parameters.
   - Leave the boxes blank to display all tags.

3. Click **Find**.

4. Select the tags for which you want to generate a report, and click **OK**.

5. At the prompt, click **Yes** to display the calculation item report print preview. You can do any of the following:

   - Adjust the zoom level.
   - Save this report as an external file.
   - Perform, edit, or delete a revision on the calculation report.
   - Assign, edit or delete an external drawing number for the calculation report.

6. On the module toolbar, click  .

Calculation Revisions

The revision feature is used to keep track of the changes made to SmartPlant Instrumentation entities, including calculations. It is important and useful to have a chronological description of the changes, dates of change, and a list of persons who approved them. Use this procedure to add, edit, and delete revisions.

➢ To maintain calculation revisions

1. Generate a report preview for the calculation.

2. In the **Print Preview: Calculation Report** window, on the print preview toolbar, click  .

3. In the **Revisions** dialog box, select one of the revision numbering methods (use **P0, P1, P2**... for preliminary revisions or **0, 1, 2** /**A, B, C** etc. for normal serial revisions).

   Notes

   - When you first select a revision numbering method, several options are available to you, including preliminary revisions (designated by **P0, P1, P2**…). Once you select one of the other revision methods, you will not be able to return to the preliminary revision method and this option will be disabled.
   - If you select any revision method besides Other, SmartPlant Instrumentation successively numbers each new revision.

4. Click **New** to add a new revision data or click **Edit** to update an existing revision data line.

5. Add or edit the revision data in the appropriate data fields.

Note

- The **By** data field contains the current user's initials by default, if the System Administrator has defined it as such.

6. Under **Drawing number**, accept the default drawing number, or edit as required.

7. To delete revisions do the following:

   a) Select the revision you want to delete.

   b) Click **Delete**.

8. Click **OK**.

Note

- You can also maintain revisions in batch mode using global revisions. For more information, see Global Revisions: An Overview.

Service Operations

Creating New Tags in the Calculation Module

You can create new tag numbers directly in the Calculation module, without having to open the Instrument Index module.

➢ To create a new tag in the Calculation module

1. In the **Calculation Module** window, on the **Edit** menu, point to **Calculate**, and then click one of the following:
   - **Flowmeter**
   - **Thermowell**
   - **Control Valve**
   - **Relief Valve**
2. In the **Enter Tag Number** dialog box, type the name of the new tag number, and click **OK**.
3. If the **Select Instrument Type** dialog box opens (because there is more than one record for a given instrument type acronym), select the required instrument type and click **OK**.
4. In the **Loop Name** dialog box, do one of the following:
   - Accept the displayed loop number and click **OK**.
   - Type the loop number that you need and click **OK**.
   - To create the tag number without a loop association, click **Cancel**.
5. In the **Tag Number Properties** dialog box, on the **General** tab, enter the appropriate values.
6. To enter power supply properties, see Entering Power Supply Data for Panels and Instrument Tags.
7. Click **OK**.
8. If the **Process Data** dialog box opens, select a fluid state and then click **OK**.
9. In the process data sheet, enter and save the relevant process data.

Recommended Control Valve Characteristic

This feature allows you to calculate the recommended control valve characteristic. You can determine whether Linear or Equal Percentage valve is more suitable for a specific valve application.

Note

- Make sure that you enter the required pressure drop, pump drop, and system loss values in the process data sheet before performing this procedure.

➢ To calculate the recommended control valve characteristic

1. Open the required calculation item sheet for a control valve calculation.
2. On the **Actions** menu, click the **Recommended Valve Characteristic** option.
3. Enter the required **Critical** value or click **Default** to utilize the default value.
4. Click **Calculate**.

Note

- SmartPlant Instrumentation calculates the recommended valve characteristic and displays the result (**Linear** or **Equal %**) both in this dialog box and the **Notes** window.

Entering Built-Up Back Pressure - Relief Valve

The option enables you to enter a built-up back pressure value, which is taken into account for calculation when sizing the relief valves. The result is displayed in the **NOTES** section of the calculation data sheet, under **General Notes**.

➢ To take built-up back pressure into the calculation account

1. With a calculation data sheet open for a relief valve item, on the **Actions** menu, click **Enter Built-up Back Pressure**.
2. In the **Built-up Back Pressure** dialog box, type the required value, select the unit of measure and click **OK**.