Water and Steam Properties Calculations Program (for the FloBoss™ 107) User Manual

Remote Automation Solutions

EMERSON.
Process Management

Revision Tracking Sheet

March 2008

This manual may be revised periodically to incorporate new or updated information. The revision date of each page appears at the bottom of the page opposite the page number. A change in revision date to any page also changes the date of the manual that appears on the front cover. Listed below is the revision date of each page (if applicable):

Page	Revision
Initial release	Mar-08

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Chapter 1 – Introduction

This chapter describes the structure of this manual and presents an overview of the Water and Steam Properties Calculations for the FloBoss™ 107.

1.1　Scope and Organization

This document serves as the user manual for the Water and Steam Properties Calculations program, which is intended for use in a FloBoss 107 (FB107). This manual describes how to download, install, and configure the Water and Steam Properties Calculations user program (referred to as the "Water and Steam program" or "the program" throughout the rest of this manual). You access and configure this program using ROCLINK™ 800 Configuration Software loaded on an IBM-compatible personal computer running Windows® 98, NT 4.0 (with Service Pack 6), 2000 (with Service Pack 2), or XP.

The sections in this manual provide information in a sequence appropriate for first-time users. Once you become familiar with the procedures and the software, the manual becomes a reference tool.

This manual has the following major sections:

- *Chapter 1 – Introduction*
- *Chapter 2 – Installation*
- *Chapter 3 – Configuration*
- *Chapter 4 – Reference*

This manual assumes that you are familiar with the FB107 and its configuration. For more information, refer to the *FloBoss 107 Flow Manager Instruction Manual* (Form A6206) or the *ROCLINK 800 Configuration Software User Manual (for FloBoss 107)* (Form A6217).

1.2　Product Overview

The Water and Steam program allows a FloBoss 107 to calculate density, enthalpy (heating value), entropy, viscosity, and specific heat ratio for water and steam applications in either Metric or English (US) units. Program calculations conform to the International Association for the Properties of Water and Steam, International Formulation 1997 (IAPWS-IF-97) standard. **This program is intended for use with the ISO5167-2003 calculation standard provided by the FB107 firmware or a User C flow calculation program compatible with water and steam properties.**

The Water and Steam program is compatible with FB107 firmware version 1.10 and greater. The user program is downloaded and configured in the FB107 with ROCKLINK™ 800 Configuration Software (version 1.75 or greater).

The components of the Water and Steam program are:

- The Water and Steam user program that loads into FloBoss memory to perform the calculations.
- License Key, containing license(s) enabling the Water and Steam program.
- This manual, Form A6257

1.3   Program Operation

With the program installed, the FB107 reads the current flowing static pressure and temperature once every second. At the completion of each Integral or Base Multiplier Period (or IMP/BMP), the program executes the water and steam properties calculations, using the average flowing static pressure and temperature during the IMP/BMP. The program writes the resulting values to standard FB107 point types and the associated user-defined point type for the water and steam values.

1.3.1   Supported IAPWS Water and Steam Regions
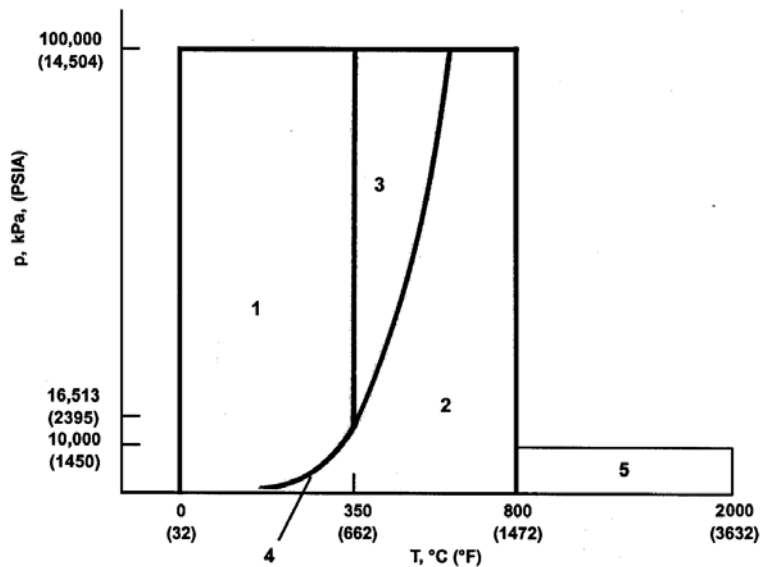
Figure 1. IAPWS Water and Steam Regions 1 through 5

The Water and Steam program supports IAPWS Water and Steam Regions 1, 2, 4, and 5 (see *Figure 1*). **The program does not support IAPWS Water and Steam Region 3.** The water and steam calculations implemented in this user program are valid for pressures between 0.69 and 16513 kPa (0.1 and 2395 PSIA) and temperatures between 0 and 800°C (32 and 1472°F). Calculations of water properties for higher pressures—between 16513 and 100000 kPa (2395 and 14504 PSIA)—are valid for temperatures between 0°C (32°F) and the Region 1 and 3 boundary. Calculations of steam properties for higher pressures—between 16513 and 100000 kPa (2395 and 14504 PSIA)—are valid for temperatures between

the Region 2 and 3 boundary and 800°C (1472°F). The calculations are also valid for higher steam temperatures, when the pressure is between 0.69 and 10000 kPa (0.1 and 1450 PSIA). In these cases the temperature can range from 800 to 2000°C (1472 to 3632 °F).

Note: If the static pressure and temperature lie within Region 3, the program sets all of the thermodynamic properties—including density, viscosity, specific heat ratio, enthalpy, and entropy—to 1.0 to provide an indication of calculation within this unsupported area.

If you know the fluid is saturated water or steam, the phase can be specified along with the choice of pressure or temperature used to determine the properties. In this case, the conditions are set to Region 4 and the quality is set to 0% if the phase is specified as saturated water or 100% if the phase is specified as saturated steam.

1.4   Program Requirements

You download the Water and Steam program to—and then run it from—the Flash and RAM memory on the FB107. The Water and Steam program is compatible with firmware version 1.10 (or greater) of the FB107. Download and configure the program using the ROCLINK 800 Configuration software (version 1.75 or greater).

Program specifics include:

File Name	Target Unit/ Version	User Defined Point (UDP)	Flash Used (in bytes)	DRAM Used (in bytes)	ROCLINK 800 Version	Display Number
WaterAndSteam_3.bin	FB107 1.10	27, 28	27,657	16,384	1.75	28, 29

Note: You must connect a PC to the FB107's LOI port before starting the download.

For information on viewing the memory allocation of user programs, refer to *ROCLINK 800 Configuration Software User Manual (for FloBoss 107)* (Form A6217).

1.4.1   License Keys

Some applications require that you install a license in the CPU to run the application. This license software is specific to these applications and is the property of the individual vendor (shown in the Vendor Name field on the License Key Administrator screens).

RAS (and other authorized vendors) distributes software licenses on security-enhanced universal serial bus (USB) drives.

You must install the following license keys to use the Water and Steam Program.

▪ Water and Steam License Key.

Chapter 2 – Installation

This section provides instructions for installing the Water and Steam program. Read *Section 1.4* of this manual for program requirements.

Note: The program and license key can be installed in any order. The manual shows the installation of the license key first.

2.1   Installing the License Key

A license key is required to use the Water and Steam program. To install a USB key-based license on the FB107:

1. Insert the USB license key in a USB port on your PC.

2. Select **Utilities** > **License Key Administrator** > **Transfer Between Device and Key** from the ROCLINK 800 menu bar. The Transfer Licenses Between a Device and a Key screen displays.
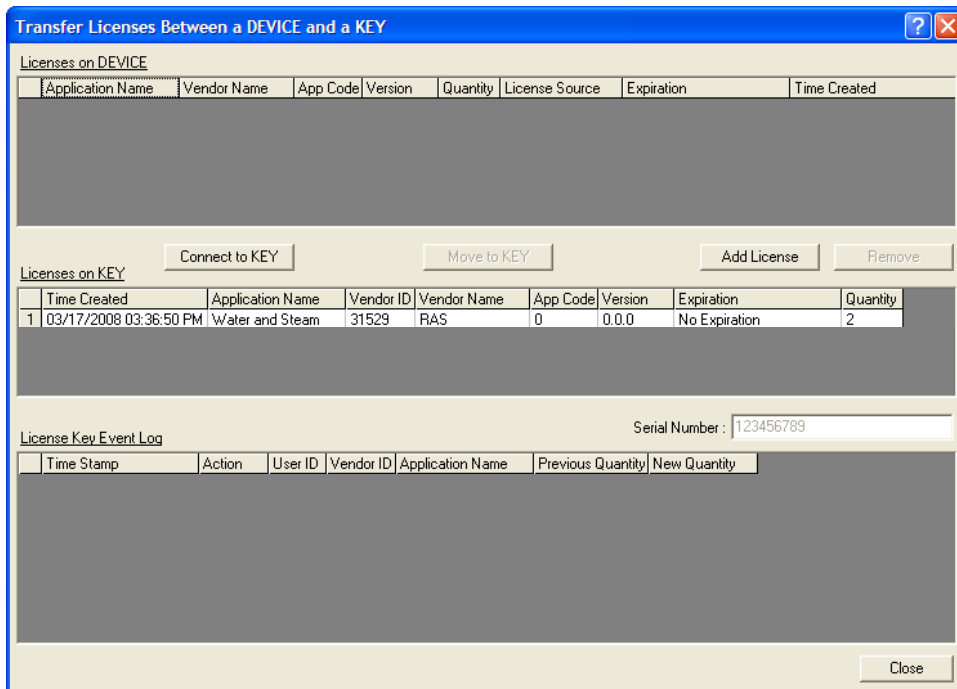
Figure 2. Transfer Licenses Between a Device and a Key

Note: This screen has three sections. The upper portion (Licenses on Device) shows any software licenses installed on the FB107. The middle portion (Licenses on Key) shows software licenses on the license key. The lower portion of the screen (License Key Event Log) provides a rolling log of the last eight events related to this license key.

3. Select the key-based license you want to transfer to the FB107 (Water and Steam, as shown in *Figure 2*).

4. Click **Move to Device**. ROCLINK moves one instance of the license from the key to the FB107 and updates the screen.
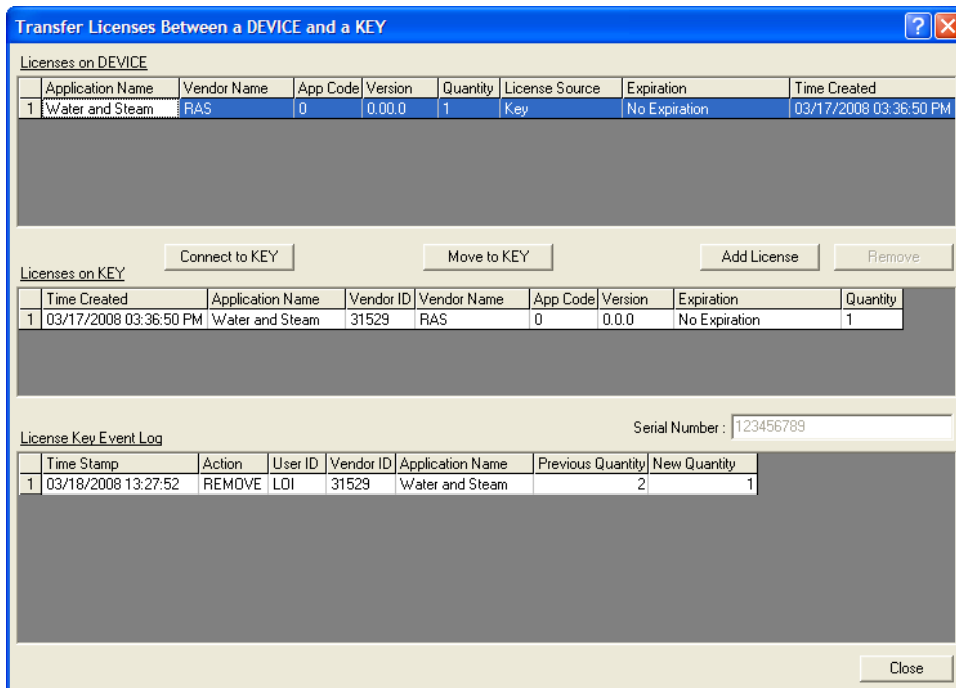
Figure 3. License Installed

Note: An FB107 can hold up to six different licenses, although you can install only one instance of each license on the FB107. When you click Move to Device, ROCLINK 800 moves only one instance of the license onto the FB107 and automatically decreases the license quantity on the USB key by one.

5. Verify the license name displays in the Licenses on Device section of the screen. Proceed to *Section 2.2* to download the user program.

2.2   Downloading the Program

This section provides instructions for installing the program into the Flash memory on the FB107.

To download the program using ROCLINK 800 software:

1. Connect the FB107 to your computer using the LOI port.

2. Start and logon to ROCLINK 800.

3. Select **Utilities** > **User Program Administrator** from the ROCLINK menu bar. The User Program Administrator screen displays (see *Figure 4*):
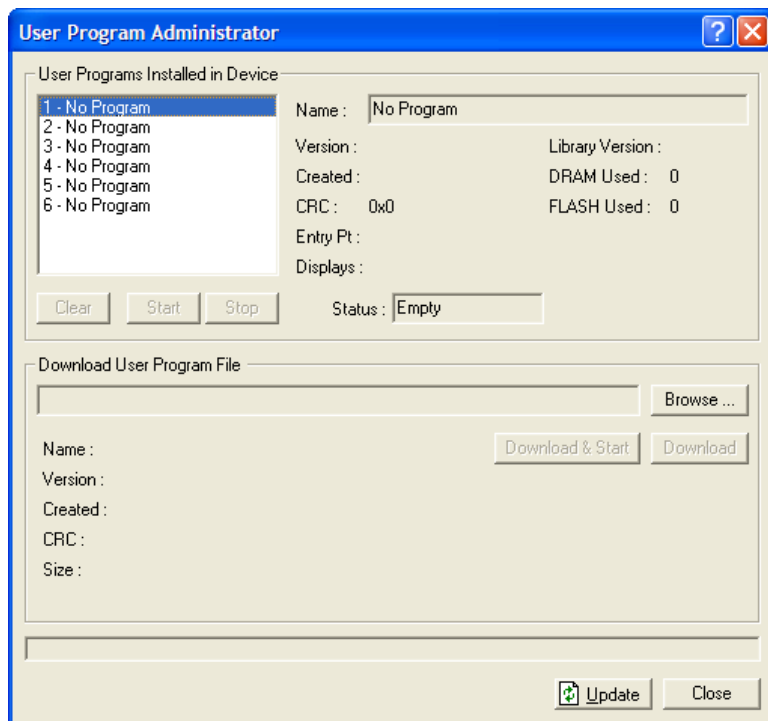
Figure 4. User Program Administrator

4. Click **Browse** in the Download User Program File frame. The Select User Program File screen displays (see *Figure 5*).

5. Select the path and user program file to download from the CD-ROM. (Program files are typically located in the Program Files folder on the CD-ROM). As *Figure 5* shows, the screen lists all valid user program files with the .BIN extension:
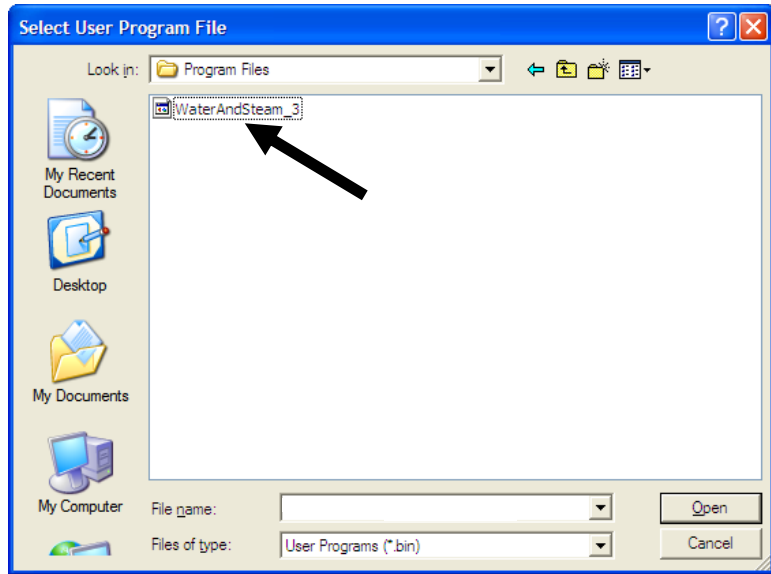
Figure 5. Select User Program File

6. Click **Open** to select the program file. The User Program Administrator screen displays. As shown in *Figure 6*, note that the Download User Program File frame identifies the selected program and that the **Download & Start** button is active:
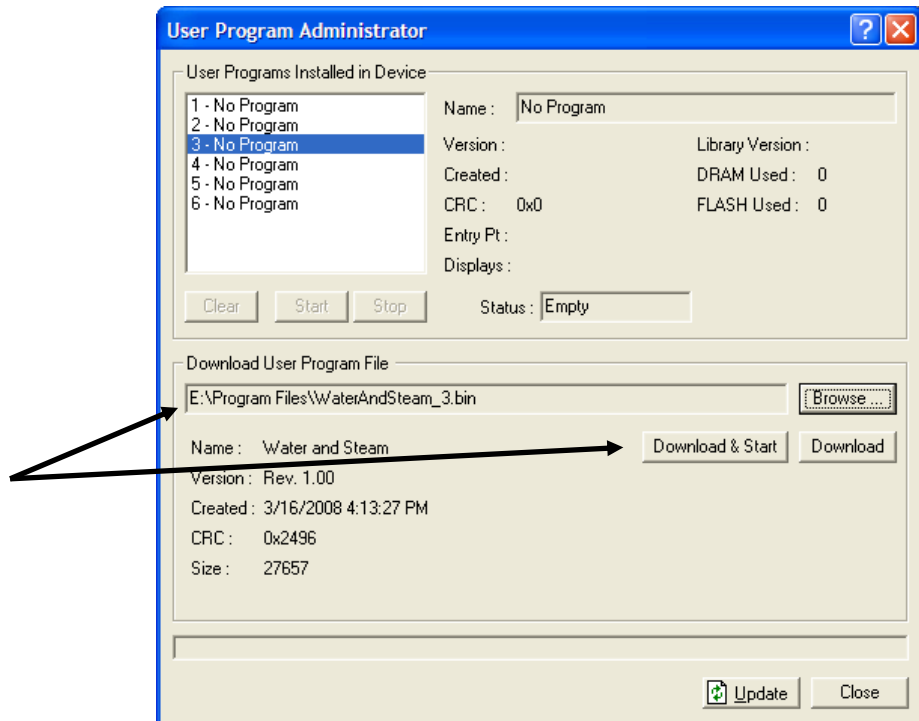
Figure 6. User Program Administrator

7. Click **Download & Start** to begin loading the selected programs. The following message displays:
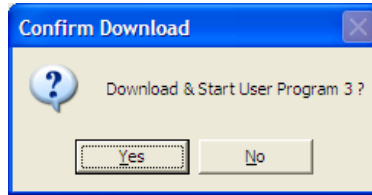
Figure 7. Confirm Download

8. Click **Yes** to begin the download. When the download completes the following message displays:
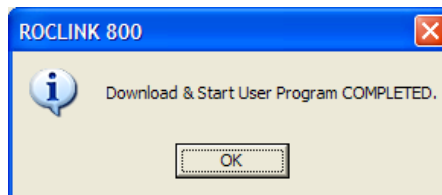
Figure 8. ROCLINK 800 Download Confirmation

9. Click **OK**. The User Program Administrator screen displays (see *Figure 9*). Note that:

   ▪ The User Programs Installed in Device frame identifies the installed program(s).
   ▪ The Status field indicates that the program is running.
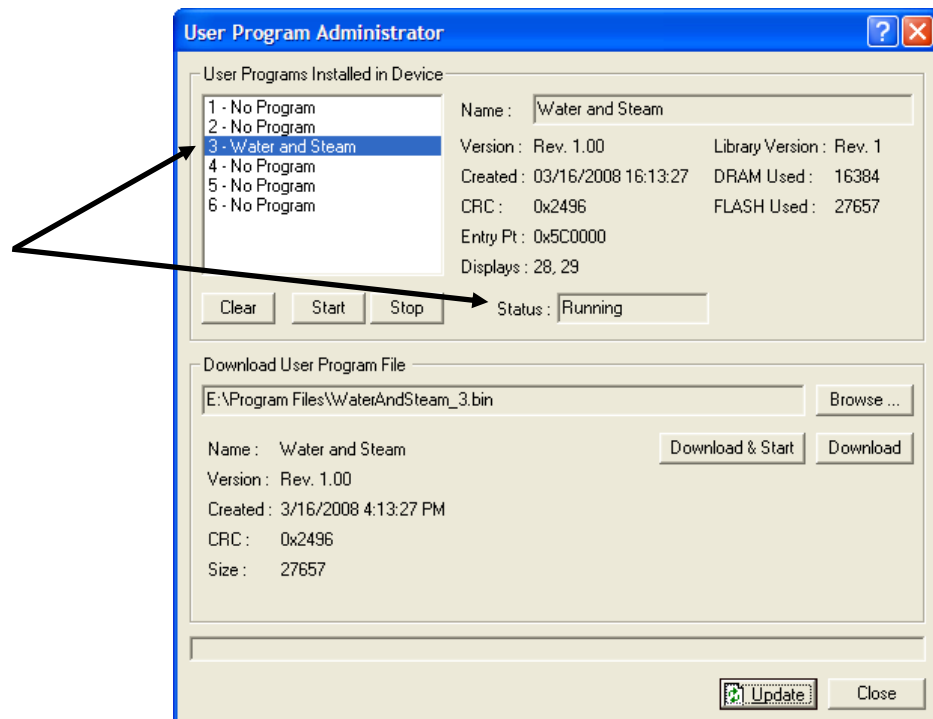
Figure 9. User Program Administrator

> **Note:** If you install the program **before** you install the license key, the Status field reads "License Key Not Found."

10. Click **Close**. The ROCLINK 800 screen displays and the download is complete.

Chapter 3 – Configuration

After you have loaded the Water and Steam program on the FB107 and installed the required license, you configure and monitor the program using two program-specific displays (Water/Steam Setup and Water/Steam Values):

- Use the Water/Steam Setup display to configure the parameters associated with the Water and Steam program.

- Use the Water/Steam Values screen to view results of the Water and Steam program calculations.

You can access all the program-specific screens from the main ROCLINK 800 screen:
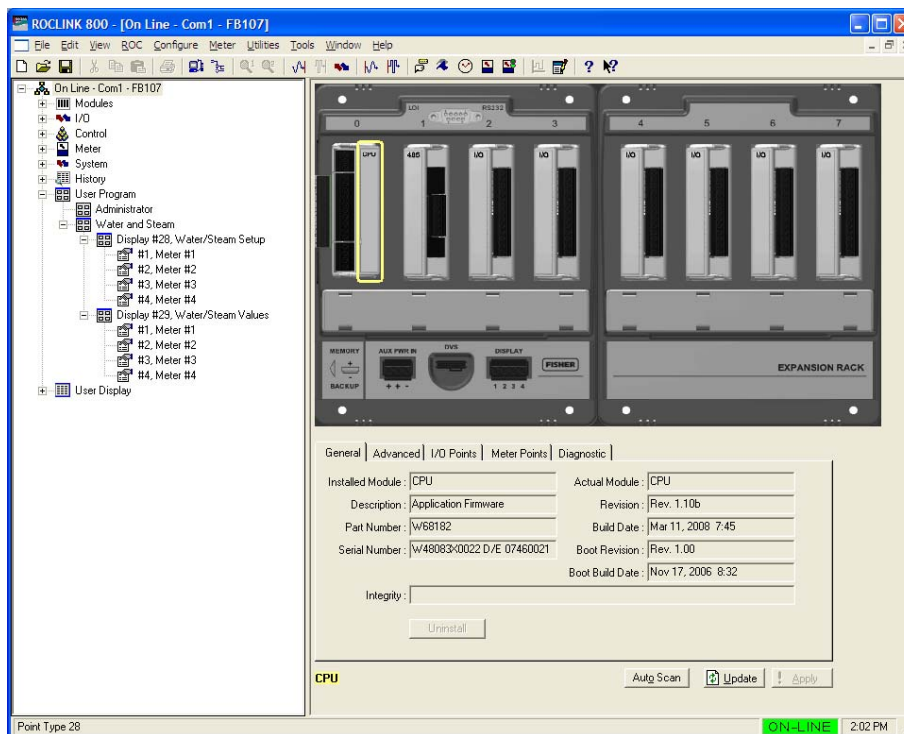
Figure 10. ROCLINK 800

3.1   Water/Steam Setup Screen

Use this screen to enable the Water and Steam program to calculate properties for a meter run and set the option for determining the phase of the water. The phase can either be calculated by the program or specified as saturated water or steam. If saturated water or steam is selected for the phase, you must specify a temperature or pressure input to be used for the properties calculations.

To access this screen:

1. Select **User Program > Water and Steam.**

2. Select **Display #28, Water/Steam Setup**.

3. Double-click **#1, Meter #1**. The Water/Steam Setup screen displays.
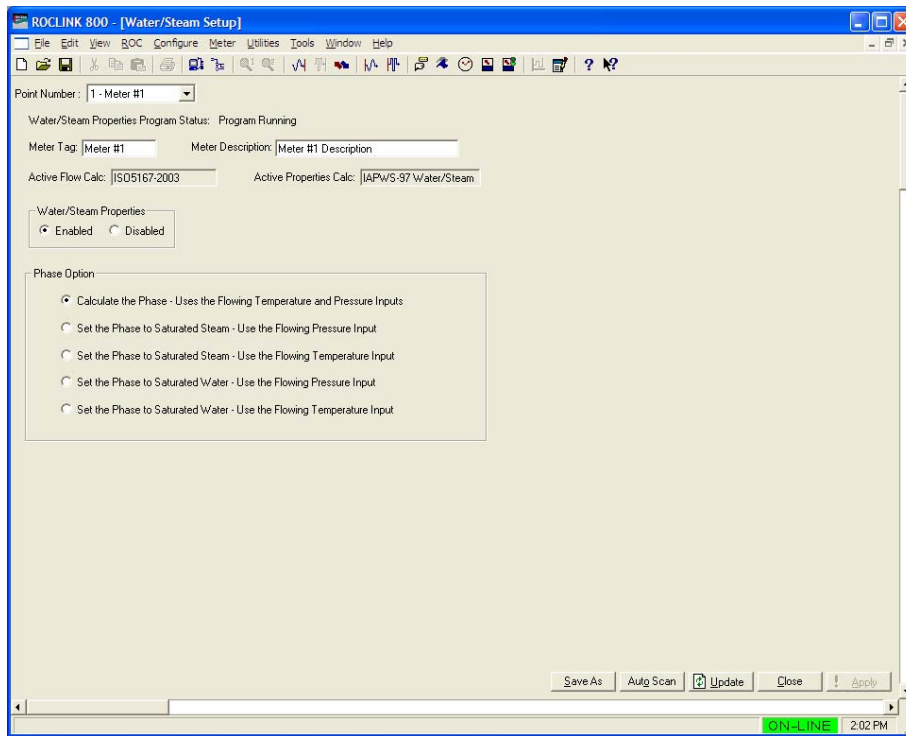
Figure 11. Water/Steam Setup Screen

Note: The Water/Steam Properties Enabled/Disabled selection must be set to Enabled to specify setup parameters.

4. Complete the screen fields based on your organization's requirements.

Field	Description
Point Number	Selects the logical number of the meter run to configure. Click ▼ to display all defined instances.
Water/Steam Properties Program Status	This **read-only** field shows the current state of the user program. Valid values are: **Program Not Loaded**, **Program Loaded – Not Started**, **Program Running**, **Program Shutting Down**, **Not Running – Library Version Error**, **Not Running – License Not Found**, and **Not Running – License Expired**.

Field	Description		
Meter Tag	Sets the unique identifier for the selected meter.		
Meter Description	Sets the description of the selected meter.		
Active Flow Calc	This **read-only** field shows the flow calculation standard currently performing flow calculations for the selected meter run.		
Active Properties Calc	This **read-only** field shows the properties calculation standard currently performing properties calculations for the selected meter run.		
Water/Steam Properties	Enables or disables the Water and Steam program to perform calculations for the selected meter run. Valid values are **Enabled** or **Disabled**.		
Phase Option	Sets the method used to determine the phase of the fluid. Valid values are:		
		Calculate the Phase – Uses the Flowing Temperature and Pressure Inputs	The phase is calculated based on the flowing pressure and temperature inputs. If the flowing temperature is within 1.8 Deg F (1.0 Deg C) of the saturation temperature for the current flowing pressure, the conditions are considered saturated and the phase is set to gas (steam). This is the **default** selection.
		Set the Phase to Saturated Steam – Use the Flowing Pressure Input	The phase is set to saturated steam and the properties are calculated using the flowing pressure.
		Set the Phase to Saturated Steam – Use the Flowing Temperature Input	The phase is set to saturated steam and the properties are calculated using the flowing temperature.
		Set the Phase to Saturated Water – Use the Flowing Pressure Input	The phase is set to saturated water and the properties are calculated using the flowing pressure.
		Set the Phase to Saturated Water – Use the Flowing Temperature Input	The phase is set to saturated water and the properties are calculated using the flowing temperature.

5. Click **Apply** to save any changes you have made to this screen.

6. Proceed to *Section 3.2* to view the Steam/Water Properties Values screen.

3.2   Water/Steam Properties Values Screen

Use this screen to view the calculation results of the Water and Steam program.

To access this screen:

1. Select **User Program** > **Water and Steam**.

2. Select **Display #29, Water/Steam Values**.

3. Double-click **#1, Meter #1**. The Water/Steam Values screen displays.
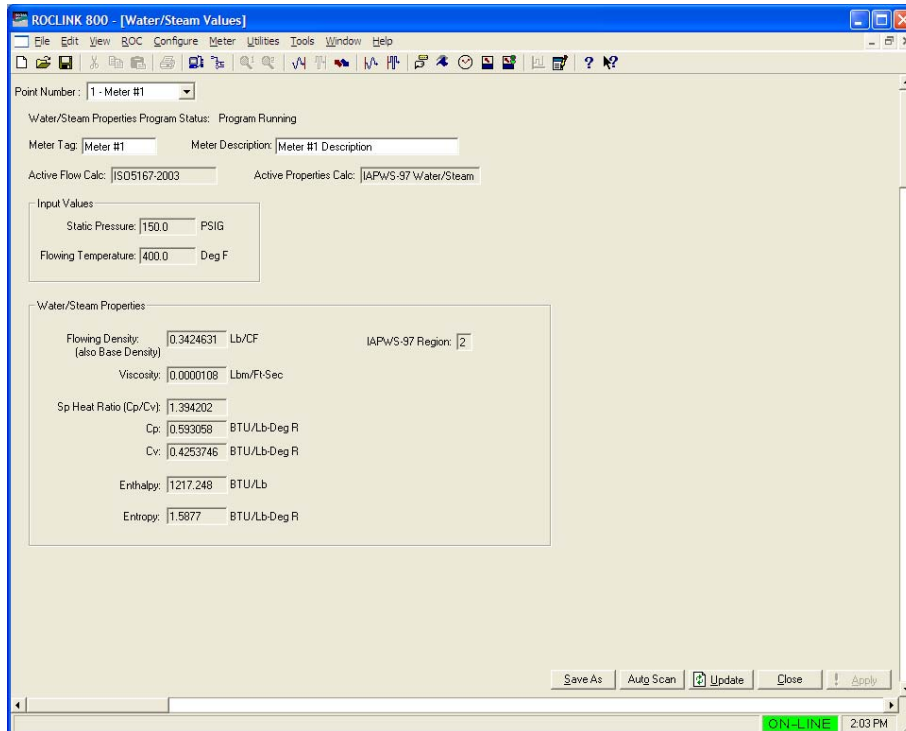
Figure 12. Water/Steam Values Screen

Note: The Water/Steam Properties Enabled/Disabled selection on the Water/Steam Setup screen must be set to Enabled to view calculation values.

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4. Review the values in the following fields:

Field	Description
Point Number	Selects the logical number of the meter run to view. Click ▼ to display all defined instances.
Water/Steam Properties Program Status	This **read-only** field shows the current state of the user program. Valid values are: **Program Not Loaded**, **Program Loaded – Not Started**, **Program Running**, **Program Shutting Down**, **Not Running – Library Version Error**, **Not Running – License Not Found**, and **Not Running – License Expired**.
Meter Tag	Sets the unique identifier for the selected meter.

Field	Description
Meter Description	Sets the description of the selected meter.
Active Flow Calc	This **read-only** field shows flow calculation standard currently performing flow calculations for the selected meter run.
Active Properties Calc	This **read-only** field shows the properties calculation standard currently performing property calculations for the selected meter run.
Static Pressure	This **read-only** field displays the flowing static pressure. Units are PSIG, PSIA, or kPa.
Flowing Temperature	This **read-only** field displays the current flowing temperature. Units are Deg F or Deg C.
Flowing Density (also Base Density)	This **read-only** field displays the fluid density at the average flowing pressure and temperature during the previous IMP/BMP. Density units are Lb/CF or Kg/M^3. The program sets the density at base conditions to the density at flowing conditions, since setting base conditions for water and steam flow rate measurements is not a common practice.
Viscosity	This **read-only** field displays the calculated viscosity at the average flowing pressure and temperature during the previous IMP/BMP. Units are Lbm/Ft-Sec or Cp.
Specific Heat Ratio (Cp/Cv)	This **read-only** field displays the calculated ratio of specific heats (Cp/Cv) at the average flowing pressure and temperature during the previous IMP/BMP.
Cp	This **read-only** field displays the specific heat (constant pressure) at the average flowing pressure and temperature during the previous IMP/BMP. Units are BTU/Lb-Deg R or kJ/Kg-Deg K.
Cv	This **read-only** field displays the specific heat (constant volume) at the average flowing pressure and temperature during the previous IMP/BMP. Units are BTU/Lb-Deg R or kJ/Kg-Deg K.
Enthalpy	This **read-only** field displays the enthalpy (heating value) at the average flowing pressure and temperature during the previous IMP/BMP. Units are BTU/Lb or MJ/Kg.
Entropy	This **read-only** field displays the entropy at the average flowing pressure and temperature during the previous IMP/BMP. Units are BTU/Lb-Deg R or kJ/Kg-Deg K.

Field	Description
IAPWS-97 Region	This **read-only** field displays the region (1, 2, 3, 4, or 5, as defined by the standard presented by the International Association for the Properties of Water and Steam, International Formulation 1997) in which the average flowing pressure and temperature resided during the previous IMP/BMP.
	Notes:
	▪ If conditions reside in Region 3, the message "Region 3 is Not Supported" displays and the program sets the properties values to 1.0.
	▪ If conditions reside in Region 4, three additional fields display including either Saturated Steam or Saturated Water (depending on the Phase), Pressure, and Temperature.

5. Proceed to *Section 3.3* to save your configuration.

3.3 Saving the Configuration

Whenever you modify or change the configuration, it is a good practice to save the final configuration to memory. To save the configuration:

1. Select **ROC** > **Flags**. The Flags screen displays:
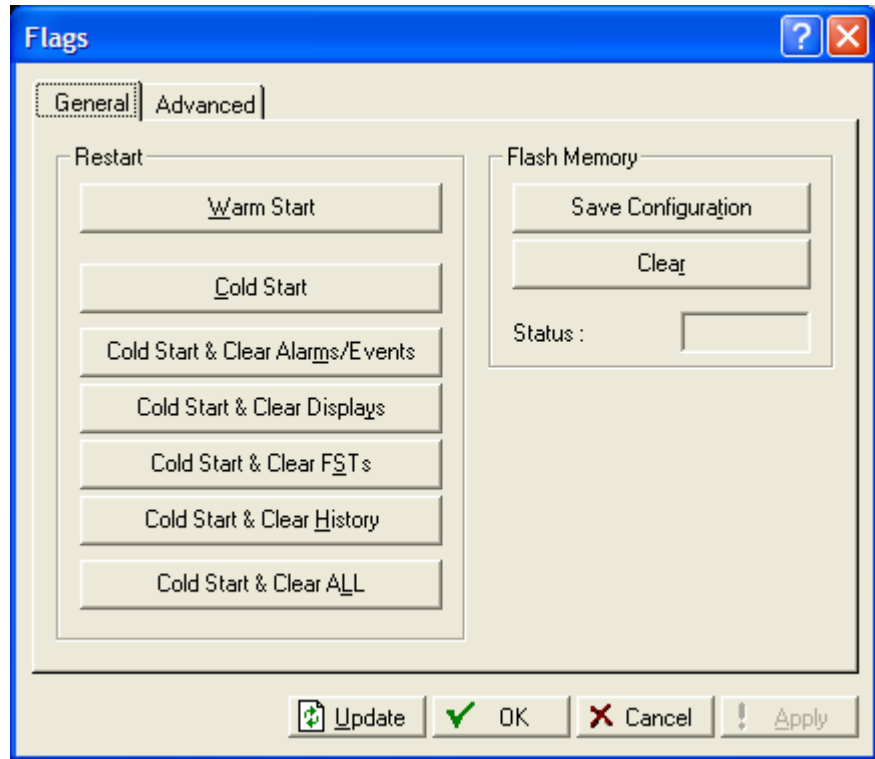
Figure 13. Flags

2. Click **Save Configuration**. A verification message displays:
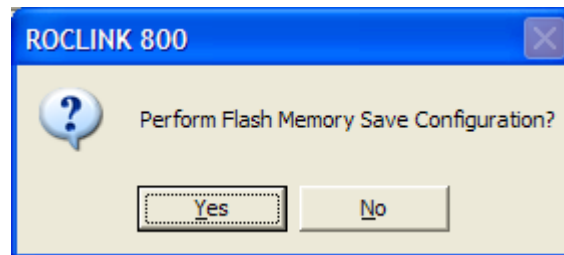
Figure 14. Save Verification

3. Click **Yes.** When the save process completes, a confirmation message displays:
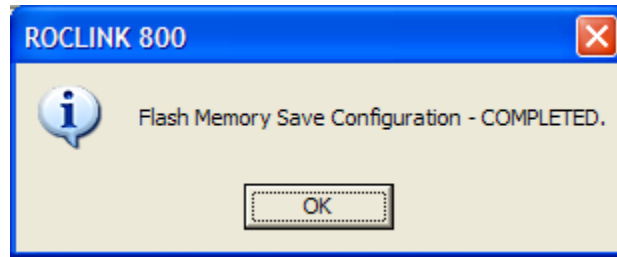
Figure 15. Confirmation

Note: Depending on the size and complexity of the user program, this process may take several minutes. When the process ends, the Status field on the Flags screen displays *Completed*.

4. Click **Update** on the Flags screen. This completes the process of saving your new configuration.

Note: For archive purposes, you should also save this configuration to your PC's hard drive or a removable media (such as a diskette or a flash drive) using the **File** > **Save Configuration** option on the ROCLINK 800 menu bar.

Chapter 4 – Reference Materials

This section provides tables of information on the user-defined point types used by the Water/Steam Properties program.

- Calculation Details
- Point Type 27: Water/Steam Setup
- Point Type 28: Water/Steam Values

4.1 Calculation Details

The calculations performed to determine the thermodynamic properties for Regions 1, 2, 4, and 5 are shown in the standard presented by the International Association for the Properties of Water and Steam, International Formulation 1997 (IAPWS-IF-97). Table 1 shows the parameters and the associated TLPs used as inputs to the calculations. Table 2 shows the parameters and the associated TLPs where the results are stored. The parameters in which the program stores the calculated properties are available to the flow calculation of the meter run.

Table 1. Calculation Input Parameters

Parameter	Definition	TLP
Average Flowing Pressure (Pf)	The average pressure during the previous IMP/BMP. Units are PSIA or kPa. The program uses this pressure for the water/steam properties calculations.	47,x,22
Average Flowing Temperature (Tf)	The average temperature during the previous IMP/BMP. Units are Deg F or Deg C. The program uses this temperature for the water/steam properties calculations.	47,x,23
Units of Measurement	Specifies the units the program uses to express the results of the water/steam properties calculations. Valid values are 0 (US) or 1(metric).	46,x,2,Bit 3 and 15,x,25
Integral or Base Multiplier Period (IMP/BMP)	The time period, in minutes, over which the program averages the flowing static pressure and temperature. At the completion of the IMP/BMP period, the program uses these averages to calculate the fluid properties.	46,x,6
Enable Water and Steam	Specifies if the Water and Steam program is to be enabled for the meter run.	27,x,1

Phase Option	Specifies the option used for determining the phase of the fluid and calculating the properties. Valid values are:	27,x,2
	0 The phase is calculated based on the flowing pressure and temperature inputs. If the flowing temperature is within 1.8 Deg F (1.0 Deg C) of the saturation temperature for the current flowing pressure, the conditions are considered saturated and the phase is set to gas (steam).	
	1 The phase is set to saturated steam and the properties are calculated using the flowing pressure.	
	2 The phase is set to saturated steam and the properties are calculated using the flowing temperature.	
	3 The phase is set to saturated water and the properties are calculated using the flowing pressure.	
	4 The phase is set to saturated water and the properties are calculated using the flowing temperature.	

Table 2. Calculation Results Parameters

Parameter	Definition	TLP
IAPWS-IF-97 Region in which the flowing conditions of the fluid reside.	Valid regions are 1, 2, 4, and 5. If conditions reside in Region 3, the program sets the value of each of the properties to 1.0.	28,x,0
Entropy	The entropy during the previous IMP/BMP. Units are BTU/Lb-Deg R or kJ/Kg-Deg K.	28,x,1
Cp	The specific heat (constant pressure) during the previous IMP/BMP. Units are BTU/Lb-Deg R or kJ/Kg-Deg K.	28,x,2
Cv	The specific heat (constant volume) during the previous IMP/BMP. Units are BTU/Lb-Deg R or kJ/Kg-Deg K.	28,x,3
Temperature Used for Properties	The average temperature used to determine the properties. Units are Deg F or Deg C.	28,x,4

Pressure Used for Properties	The average pressure used to determine the properties. Units are PSIA, PSIG, or kPa.	28,x,5
Enthalpy (Heating Value)	The enthalpy during the previous IMP/BMP. Units are BTU/Lb or MJ/Kg.	46,x,17
Viscosity, in Cp	The viscosity during the previous IMP/BMP. Units are Lbm/Ft-Sec or Cp.	46,x,18
Specific Heat Ratio, Cp/Cv	The ratio of specific heats (Cp/Cv) during the previous IMP/BMP.	46,x,19
Density at flowing conditions	The density during the previous IMP/BMP. Units are Lb/CF or Kg/M^3.	47,x,24
Density at base conditions	The program sets the density at base conditions to the density at flowing conditions, since setting base conditions for water and steam flow rate measurements is not a common practice. Units are Lb/CF or Kg/M^3.	47,x,25

4.2 Point Type 27: Water/Steam Setup

Point type 27 contains the parameters for configuring the Water and Steam program. There are four logicals of this point type (one logical for each meter run).

Parm #	Name	Access	Data Type	Length	Range	Default	Description of functionality and meaning of values
0	Point Tag ID	R/O	AC	10	0x20 → 0x7E for each ASCII character	" "	Point tag identification. This value is copied from point type 46, parameter 0.
1	Enable Water Props	R/W	UINT8	1	0 → 1	0	Enable/disable status of the water and steam properties calculation for the meter run. Valid values are: 0 = Disable 1 = Enable.
2	Phase Option	R/W	UINT8	1	0 → 4	0	The phase option allows you to specify the method for determining the phase of the fluid and calculating the properties. Valid values are: 0 = Calculate the phase based on the flowing pressure and temperature inputs. If the flowing temperature is within 1.8 Deg F (1.0 Deg C) of the saturation temperature for the current flowing pressure, the conditions are considered saturated and the phase is set to gas (steam). 1 = The phase is set to saturated steam and the properties are calculated using the flowing pressure. 2 = The phase is set to saturated steam and the properties are calculated using the flowing temperature. 3 = The phase is set to saturated water and the properties are calculated using the flowing pressure. 4 = The phase is set to saturated water and the properties are calculated using the flowing temperature.

4.3   Point Type 28: Water/Steam Values

Point type 28 contains the parameters for the results (not stored to the meter run point types) of the Water and Steam program. There are four logicals of this point type (one logical for each meter run).

Parm #	Name	Access	Data Type	Length	Range	Default	Description of functionality and meaning of values
0	Point Tag ID	R/O	AC	10	0x20 → 0x7E for each ASCII character	" "	Point tag identification. This value is copied from point type 46, parameter 0.
1	IAPWS-IF97 Region	R/O	UINT8	1	1 → 5		The IAPWS-IF97 region of the water/steam during the previous IMP/BMP.
2	Entropy	R/O	FLP	4	Any positive floating point number		The entropy during the previous IMP/BMP. Units are BTU/Lb-Deg R or kJ/Kg-Deg K.
3	Cp	R/O	FLP	4	Any positive floating point number		The specific heat (constant pressure) during the previous IMP/BMP. Units are BTU/Lb-Deg R or kJ/Kg-Deg K.
4	Cv	R/O	FLP	4	Any positive floating point number		The specific heat (constant volume) during the previous IMP/BMP. Units are BTU/Lb-Deg R or kJ/Kg-Deg K.
5	Temp Used for Props	R/O	FLP	4	Any positive floating point number		The average temperature used to determine the properties. Units are Deg F or Deg C.
6	Press Used for Props	R/O	FLP	4	Any positive floating point number		The average pressure used to determine the properties. Units are PSIA, PSIG, or kPa.

If you have comments or questions regarding this manual, please direct them to your local sales representative or contact:

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