API2540 Liquid Volume Correction User Program
(ROC300-Series and FloBoss™ 407 Flow Managers)
(ROCLINK™ for DOS Configuration Software)

User Manual
(QER 03Q008)

Form A6138
May 2004

EMERSON
Process Management

Revision Tracking Sheet

May 2004

This manual may be revised from time to time to incorporate new or updated information. The revision level of each page is indicated at the bottom of the page opposite of the page number. A change in revision level to any page also changes the date of the manual that appears on the front cover. Listed below is the revision level of each page.

Page	Revision
Pages i, 1-1	05/04
All pages	05/03
All pages	01/03

FloBoss and ROCLINK are marks of one of the Emerson Process Management companies. The Emerson logo is a trademark and service mark of Emerson Electric Co. All other marks are the property of their respective owners.

While this information is presented in good faith and believed to be accurate, Fisher Controls does not guarantee satisfactory results from reliance upon such information. *Nothing contained herein is to be construed as a warranty or guarantee, express or implied, regarding the performance, merchantability, fitness or any other matter with respect to the products*, nor as a recommendation to use any product or process in conflict with any patent. Fisher Controls reserves the right, without notice, to alter or improve the designs or specifications of the products described herein.

Table of Contents

1 GETTING STARTED

1.1 Scope of this Manual

This document serves as a user manual for the API2540 Liquid Volume Correction User Program (QER 03Q008), intended for use with the ROC300-series of Remote Operation Controllers (ROCs) with a FlashPAC, version 2.12 or greater, and FloBoss™ 407 Flow Manager, version 1.08 or greater. This manual describes how to download, configure, and monitor the program. The user program is accessed using ROCLINK™ for DOS configuration software version 2.23. The configuration software uses an IBM-compatible computer and Windows® Operating System. For information on use of the API2540 program with ROCLINK 800 configuration software, refer to user manual Form A6167.

1.2 Organization of this Manual

In this manual, the sections are arranged to provide information in the order in which it is required for first-time users. Once you become familiar with the procedures, and the software is running in a ROC or FloBoss 407, use the manual as a reference tool.

The manual is organized into the following major sections:

Section 1   Getting Started
Section 2   Installing the User Program
Section 3   Configuring the User Program
Appendix A Standards
Appendix B Domain Violations
Appendix C Engineering Units

This manual assumes that the user is familiar with the ROC300-series and FloBoss 407 units and their configuration. For additional information, refer to the:

♦ *Type ROC306/ROC312 Remote Operations Controller Instruction Manual* (Form A4630).
♦ *Type ROC364 Remote Operations Controller Instruction Manual* (Form A4193).
♦ *FloBoss 407 Flow Manager Instruction Manual* (Form A6013).
♦ *RL101 ROCLINK Configuration Software User Manual* (Form A6051).

❖ **NOTE:** "ROC" is used in this manual to stand for all ROC and FloBoss devices.

1.3 API2540 Liquid Volume Correction User Program Overview

The Liquid Correction Program is designed for the ROC300-series units equipped with FlashPACs and the FloBoss 407. The Liquid Correction Program corrects the measured flow of crude oils, oil generalized products, LPG, and water by converting values to standard temperature and pressure levels. The Liquid Correction Program monitors the current flow rate, temperature, and pressure, and to calculate a corrected flow value for standard conditions based upon density value, sediment, and water percent value, vapor pressure, and the meter slippage factor.

The Liquid Correction Program accumulates the volume of the flowing fluid and can be configured to perform calculations for up to three different flows in the ROC306 and ROC312, five flows in the ROC364, or four flows in the FloBoss 407.

The Liquid Correction Program tracks two accumulated volumes for each flow. One accumulation is the volume since contract hour or last manual reset and the second accumulation is a running total that rolls over at 9,999,999. At contract hour or manual reset, flow and minutes today are transferred to flow and minutes yesterday.

The Liquid Correction Program supports the following liquids:
- ◆ Crude oil.
- ◆ Generalized oil products (jet fuel, diesel, oil, and gasoline).
- ◆ LPG (Liquefied Petroleum Gas).
- ◆ Water.

The Liquid Correction Program supports the following standards:
- ◆ API2540 Tables 5A, 5B, 6A, 6B, 34, 53, 53A, 53B, 54, API21, API5, AGA3/1992 and was developed according to API/ANSI/AGA standards. Refer to Appendix A for a list of all applicable standards.

The Liquid Correction Program supports the following types of inputs:
- ◆ Pulse (mass or volume).
- ◆ Analog Flow (mass or volume).
- ◆ Analog Differential Pressure (DP).
- ◆ Density.
- ◆ Vapor Pressure.
- ◆ Water and Sediments.

An uncorrected flow can be determined by one of the following inputs:
- ◆ Pulse Input (such as from a turbine).
- ◆ Analog Input (such as from a Vortex or MicroMotion).
- ◆ Differential Orifice Metering (flange taps only).

1.4   Domain Limitations Handling

The Liquid Correction Program application domain is limited, by API standards, to correcting the flow of densities, pressures, and temperatures within a custody transfer degree of accuracy. The domain borders vary according to the product class and parameter values. The calculation automatically adjusts the Liquid Type between LPG and Crude Oil if the input density fluxuates

Whenever a domain violation occurs, an error message displays and stored in the Event Log, with the ERR tag, the Domain Limit as "old value", and the Current Value of the parameter. When the violation clears, "No Error" displays and a clear event is logged with the CLR tag. A real-time stamp is appended to each event. In error mode, calculations use the closest domain formulas.

❖ **NOTE:** Further interpretation of the volumes calculated and accumulated during domain violation periods is the user's sole responsibility.

Because domain limits for flowing pressure corrections and flowing temperature corrections overlap, the Liquid Correction Program assumes temperature-driven domain below 500 kPa (75 PSIA) and pressure-driven domain above 500 kPa. The associated error is less than 50 PPM.

1.5 Program Names and Versions

Program versions and names display in Table 1-1. **You must download two user programs.**

Table 1-1. Versions and Program Names

Program Name	User Task	User Point	Code Blocks	Data Blocks	ROC or FloBoss Version
api_3a.h00	3	28-29	C0000-CFFFF	A0000-ABFFF	ROC306/312/364 FlashPAC versions 2.12 and 2.20
apitbl3a.h00	3	28-29	C0000-CFFFF	A0000-ABFFF	ROC306/312/364 FlashPAC versions 2.12 and 2.20
api_3b.h00	3	28-29	D0000-DFFFF	B4000-BFFFF	ROC306/312/364 FlashPAC versions 2.12 and 2.20
apitbl3b.h00	3	28-29	D0000-DFFFF	B4000-BFFFF	ROC306/312/364 FlashPAC versions 2.12 and 2.20
api3a_ic.h00	3	28-29	A0000-AFFFF	B0000-BBFFF	ROC306/312 FlashPAC versions 2.12 and 2.20 for Industry Canada
ap3tblic.h00	3	28-29	A0000-AFFFF	B0000-BBFFF	ROC306/312 FlashPAC versions 2.12 and 2.20 for Industry Canada
api4a_ic.h00	3	28-29	60000-6FFFF	70000-7BFFF	FloBoss 407 version 1.08 for Industry Canada
ap4tblic.h00	3	28-29	60000-6FFFF	70000-7BFFF	FloBoss 407 version 1.08 for Industry Canada
api_4a.h00	3	28-29	C0000-CFFFF	74000-7FFF	FloBoss 407, version 1.08
apitbl4a.h00	3	28-29	C0000-CFFFF	74000-7FFF	FloBoss 407, version 1.08
api_4b.h00	3	28-29	B0000-BFFFF	60000-6BFFF	FloBoss 407, version 1.08
apitbl4b.h00	3	28-29	B0000-BFFFF	60000-6BFFF	FloBoss 407, version 1.08

2 INSTALLING THE USER PROGRAM

This section describes how to download and install the user program into the ROC306/312/364 with a FlashPAC (version 2.12 or greater) and FloBoss™ 407 Flow Manager (version 1.08 or greater), using ROCLINK for DOS Configuration Software (version 2.23). For additional information on downloading the program, checking memory allocation, and enabling the program, refer to the *RL101 ROCLINK Configuration Software User Manual* (Form A6051).

2.1   Customizing ROCLINK

ROCLINK for DOS requires several files to use the API2540 Liquid Volume Correction User Program:

1.   **Navigate** to the **CD-ROM** directory where the gas flow calculation installation files are located. Program files are typically located in the Program Files/ROCLINK Files folder on the CD-ROM.

2.   **Select** and **Copy** the following files:

- ♦ menu3.txt
- ♦ menu4.txt
- ♦ scl_api1.tpl
- ♦ scl_reg1.tpl
- ♦ tlplist.txt

3.   **Paste** the **files** in to the ROCLINK default working directory.

The default directory is located at:

```
C:\ROCLINK
```

❖ **NOTE:** Select **Yes** if prompted to overwrite existing files.

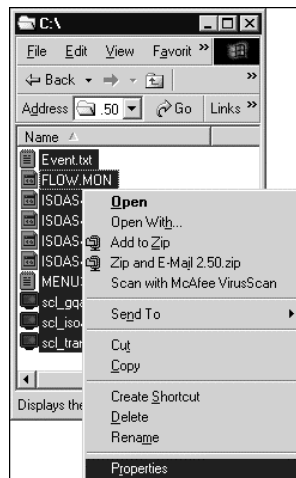4.   **Right-mouse click** on the selected files.

5.   Select **Properties**.

Figure 2-1. Properties

6. **De-select** the **Read-only Attribute** for each program file that has the Read-only Attribute set. If the files remain Read-only, ROCLINK will not connect to the ROC or FloBoss.
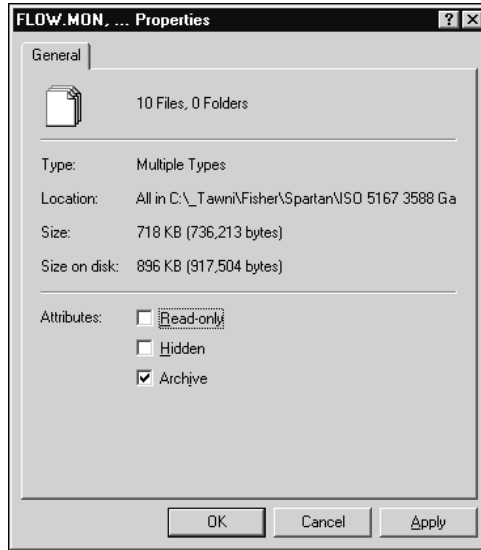

Figure 2-2. Attributes

7. Click **OK**.

❖ **NOTE:** Customize ROCLINK *before* downloading the user program.

2.2 Downloading the User Program

To download the user program:

1. **Connect** the ROC or FloBoss to your computer through the **LOI** port.

2. Launch and logon to **ROCLINK for DOS**.

3. Select Utilities > **User Programs**.

Figure 2-3. User Programs

4. Determine the **Unused Memory Blocks**. The memory location must be available for the specific user program that you are loading.

5. Determine whether program **A** or **B** is required. The **A** and **B** programs are identical other than the location in which they load into ROC memory. Refer to Table 1-1.

6. Click **DownLoad** and select the user program file to download from the CD-ROM. Program files are typically located in the Program Files/ROCLINK Files folder. The Open File dialog displays the names of all the files that have the `.H00` extension.

   ❖ **NOTE: You must download two user programs.** Refer to Table 1-1, Versions and Program Names.
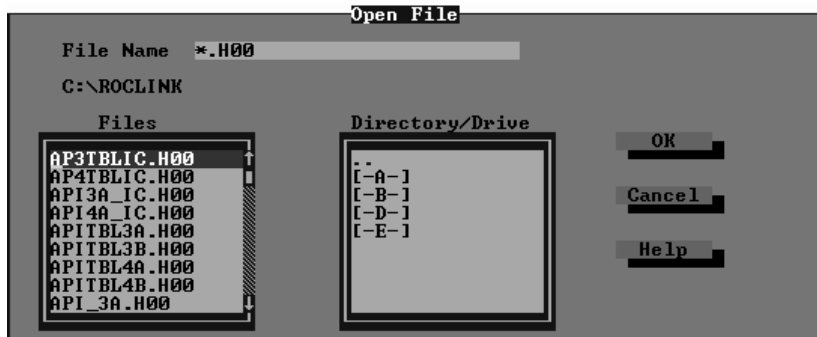

Figure 2-4. Open File

7. Select the **User Program** file you desire to load and click **OK**.

Device	User Program Names
ROC306/312/364	api_3a.h00 and apitbl3a.h00
ROC306/312/364	api_3b.h00 and apitbl3b.h00
ROC306/312 (Industry Canada)	api3a_ic.h00 and ap3tblic.h00
FloBoss 407	api_4a.h00 and apitbl4a.h00
FloBoss 407	api_4b.h00 and apitbl4b.h00
FloBoss 407 (Industry Canada)	api4a_ic.h00 and ap4tblic.h00

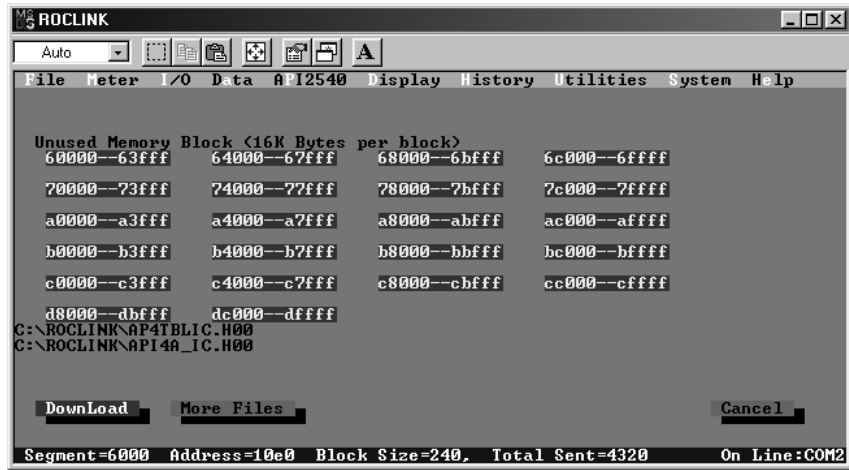8. Click **More Files** to download the second user program.

Figure 2-5. User Programs Ready to Download

9. Select the **User Program** file you desire to load and click **OK**.

10. Click **DownLoad** to download the selected user programs.

After the user program is loaded, the user program is automatically turned on. This automatically enables the program run Flags and performs a Warm Start. The Status field displays ON or OFF indicating the Status of the user program.

❖ **NOTE:** Only one user program displays even though you installed two programs.

Figure 2-6. User Program Downloaded

11. Select System > **Flags**. Refer to Figure 2-7.

Figure 2-7. ROC Flags

10. Select **Active** under the Calc User Program option. Refer to Figure 2-7.

11. Ensure that the **Write to EEPROM** button displays **Yes**. Refer to Figure 2-7.

12. Click **Save**. This ensures that the program automatically restarts after a Cold Start.

 ❖ **NOTE:** Remember to de-select the Read-only Property of all user program files. Refer to Figure 2-2.

2.3   Update Firmware

If the firmware version does not match the recommended version displayed in Table 1-1: Versions and Program Names, proceed with the following firmware update procedure. The firmware is available from your sales representative or from technical support.

Update Firmware updates the internal firmware Flash memory of the FloBoss 407 or the ROC300-series FlashPAC by loading it from a file.

❖ **NOTE:** The Update Firmware procedure clears the configuration of the ROC or FloBoss and reloads configuration from EEPROM after the update procedure is completed. The Event Log, Alarm Log, Audit Log, and History logs are cleared. To preserve the contents of the logs, be sure to save them to a file (Collect ROC Data) before starting. **The Event, Alarm, and History Logs cannot be reloaded.**

1. Create a backup of the log data using File > Collect ROC Data > **All**.

2. **Save** all **FSTs** to a disk file.

3. Select System > **Flags**. Refer to Figure 2-7.

4. Click **Write to EEPROM** and click **Save** and wait for the save process to complete. This may take several minutes for ROC300-series units.

5. Read the **README** text file included with the firmware update.

6. Select File > **Update Firmware**.

7. Navigate to the location of the firmware **File Name** in the Open File dialog box.

   You can change the path to the directory containing the file using the Directory / Drive field using the <Enter> key or by double-clicking on a different drive or directory. Select ".." to move up a directory. The Open File dialog displays the names of all files with the `.LST` extension located in the current directory.
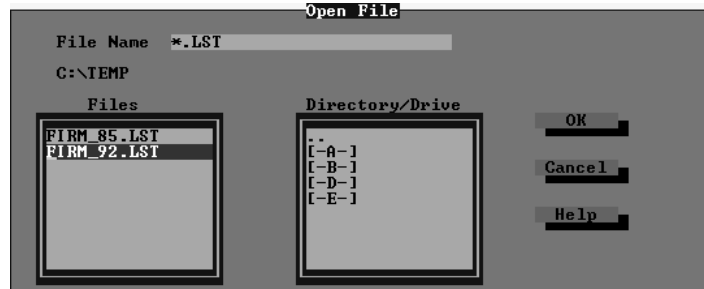

Figure 2-8. Open File

8. Select the desired file in the **Files** list and click **OK** to start the Update Firmware process.

   ❖ **NOTE:** If you receive an error such as "File gas85.fsr is missing or bad," refer to Section 2.3.1, Altering Your .LST File, on page 2-7.

   The file begins loading, with the Status Line displaying the progress in four categories: Segment, Address, Block Size, and Total Sent. While Flash memory is being modified, the I/O is not read, but is held at the last values.

   The loading process typically takes several minutes; do not disturb it during this time. If you are running ROCLINK under Windows 95/98, you can adjust the miscellaneous properties of the ROCLINK window to allow you to leave the window without interrupting the download (Allow Screen Saver and Always Suspend should not be selected, and Idle Sensitivity should be set to Low).

9. Click **OK** in the history lost prompt.

10. Press <**Enter**> after the firmware upgrade is complete.

    When loading of the firmware is complete, the action is recorded in the Event Log and a message line appears saying that the FloBoss has been successfully upgraded. Press <Enter> to return to the ROCLINK menus.

11. Select System > Flags and click **Cold Start**. Refer to Figure 2-7.

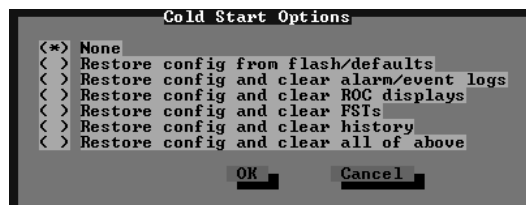12. Select **Restore config from flash/defaults** and click **OK**.

Figure 2-9. Cold Start

13. Click **Save** to reload the configuration from EEPROM. Refer to Figure 2-7.

14. Check the configuration and the **FSTs**. If the configurations are incorrect, reload the configuration and the FSTs from the files previously created.

2.3.1   Altering Your .LST File

You may be required to change the path in your `.lst` file if you copied the firmware files to a different directory than the directory that was specified in the Readme.txt.

To alter the path, follow these steps:

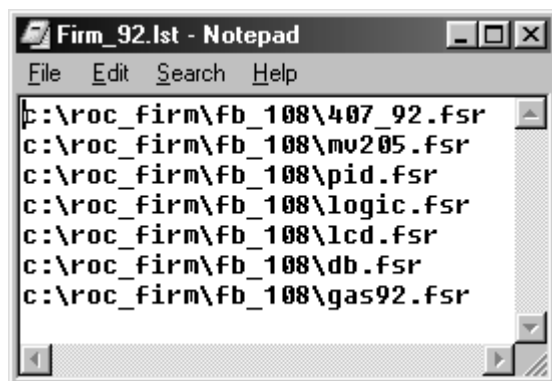1. Open the **.lst** file in a text editor such as **Notepad**.

Figure 2-10. Changing a Directory Path

2. Change the **path** to reflect the same directory where you copied the upgrade files. Be careful not to alter the file names.

3. **Save** your changes and exit **Notepad**.

3 CONFIGURING THE USER PROGRAM

3.1   API2540 Setup

Select API2540 > API 2540 Setup to display the API Setup screen. Refer to Figure 3-1.

Figure 3-1. API 2540 Setup

Point Tag – Enter a ten-character name used to label the meter run upon which the flow computation is performed.

Domain Status – Current Domain Status, such as violations, inactive, or everything within limits. Statuses are archived in Event Log. Refer to Appendix B, Domain Violations, for error messages.

Units – Click to select US (English / Imperial) units or Metric units for calculations. If Metric units are selected, then the calculation expects all inputs to be in terms of the indicated units (such as KPa for the Static Pressure input).

Liquid Type – Select the type of liquid in the meter run:

- ♦ Water.
- ♦ Crude Oil.
- ♦ Gasoline, Condensate.
- ♦ Jet Fuel.
- ♦ Diesel Oil.
- ♦ LPG (Liquefied Petroleum Gas).
- ♦ Transition.

Table 3-1. Liquid Types

Liquid Type	Metric		US	
	Low Density	**High Density**	**Low Density**	**High Density**
Crude Oil	below 610.5 kg/m^3	above 1075 kg/m^3	above 100 deg API	below 0 deg API
Gasoline*	below 653 kg/m^3	above 770.5 kg/m^3	above 85 deg API	below 52 deg API
Jet Fuel*	below 787.5 kg/m^3	above 829 kg/m^3	above 48 deg API	below 37 deg API
Diesel*	below 829 kg/m^3	above 1075 kg/m^3	above 40 deg API	below 0 deg API
LPG	below 495 kg/m^3	above 610.5 kg/m^3	above 155 deg API	below 100 deg API
Transition*	below 771 kg/m^3	above 787 kg/m^3	above 52 deg API	below 48 deg API

❖ **NOTE:** *Domain violations are triggered at contract conditions. The program automatically switches to the proper operating range, using the corrected density value, when one of the indicated ranges is selected.

Calc Vapor Prs – Click to unlock (Yes) or lock (No) the calculated vapor pressure feature. When the Liquid Type is Gasoline, Condensate, or LPG, the Calc Vapor Prs option is unlocked (Yes), for all other liquids it is locked (No).

Scan Period – 50-millisecond interval the flow is set to run. When it is set to less than 10ms, the flow does not run, and the "Not Active !!!" message displays. You must reset this parameter with the number of flows, particular configuration of the liquid flow, and general configuration of the ROC.

Scan Time – Value calculated and displayed by the ROC for each scan, in seconds. If an unrealistic setting is in place for the Scan Period, the ROC cannot keep the calculation speed in place with the desired value, so significant differences will occur between the Scan Period and Scan Time, with a correspondent increase in Central Processor Unit (CPU) loading.

Meter Type – Select the type of meter being used:
♦ Pulse.
♦ Analog.
♦ Orifice Plate.

Alarming – Select Enable or Disabled.

♦ **Enabled** – Click the Alarms button to configure alarms for this point. Alarms are logged to the Alarm Log. Refer to Section 3.1.3, Alarms, on page 3-5.

♦ **Disabled** – No alarm generates for this point, regardless of the Alarms configuration.

Meter Input – Select the Meter Input: Volume or Mass. When the Meter Type is Orifice Plate, the Meter Input is always Volume.

Calc Output – Select the Calculation Output: Volume or Mass.

Static Press – Select the Static Pressure mode: Gauge or Absolute.

Static Press Tap – Select if the Static Pressure is Downstream or Upstream of the orifice plate.

Pipe Diam – Internal diameter of the pipe entered in millimeters or inches. Meter Type Orifice Plate only.

Orifice Diameter – Diameter of the orifice entered in millimeters or inches. Meter Type Orifice Plate only.

Viscosity – Viscosity of the flowing fluid at base conditions (cP or Lbm/Ft-s). Meter Type Orifice Plate only.

Contract Temp – Contract Temperature of 15 Deg C or 60 Deg F. An invalid setting generates an error message and is logged. Contract Pressure is always assumed to be 101.325 kPa or 14.73 PSIA.

(F1)Update – Click to refresh the screen with current values.

(F2)Prev – Click to view the previous point.

(F3)Next – Click to view the next point.

(F8)Save – Click to save the changed data.

3.1.1 Calculations

Select API2540 > API 2540 Setup and click Calculations to define the Accum Reset Mode, and also clear the accumulated values. The calculated values of Density and Correction Factors also display.

Figure 3-2. API Calculations

Accum Reset Mode – Select the accumulated reset mode option:
- ♦ **At Contract Hour** – At contract hour the program automatically transfers flow volume and minutes to yesterday values, and resets Flow Minutes Today and Acc Volume Today.
- ♦ **Manual Only** – Contract hour is ignored.

Reset Accum– Select the accumulated reset option:
- ♦ **Idle** – Normal state, no action taken.
- ♦ **Reset Now** – Forces transfer from Flow Minutes Today to Flow Minutes Yesterday, Acc Volume Today to Acc Volume Yesterday, and sets Acc Volume Today and Flow Minutes Today fields to zero.

Densities

Input Value – Displays actual input read (or set) density in kg/m^3, lbm/cft, or Deg API.

Flow Conditions – Displays actual flow density used in calculations in kg/m^3, lbm/cft, or Deg API.

At Contract – Displays actual base density used in calculations in kg/m^3, lbm/cft, or Deg API.

Correction Factors

With Temperature – Temperature Correction factor currently used in flow calculation.

With Pressure – Pressure Correction Factor currently used in flow calculation.

Meter Slippage – Actual Meter Slippage factor used in calculations. The value is read-only and values are calculated and transferred from the Meter Slippage screen. Refer to Section 3.1.5, Slippage Factors, on page 3-7.

3.1.2   Volume-Time Snapshot

Select API2540 > API 2540 Setup and click Volume-Time Snapshot to view Rates-Volumes and Flow Minutes.
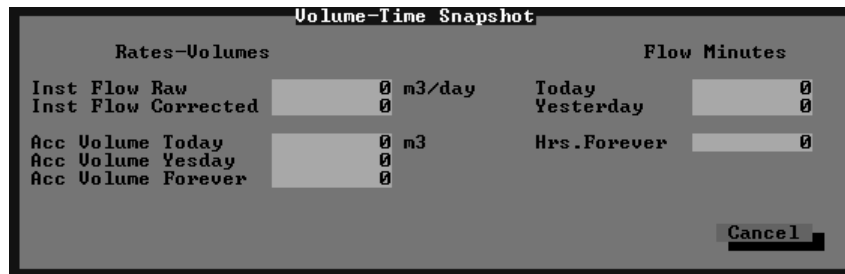

Figure 3-3. Volume-Time Snapshot

Rates-Volumes

Inst Flow Raw – Displays daily flow uncorrected in m^3/day or bbl/day.

Inst Flow Corrected – Displays daily flow corrected to contract conditions in m^3/day or bbl/day.

Acc Volume Today – Accumulated corrected volume since contract hour or last manual reset, flow units. At contract hour or manual reset, values transfer to Flow Minutes Yesterday.

Acc Volume Yesday – Accumulated corrected volume yesterday, flow units.

Acc Volume Forever – Accumulated corrected volume since last rollover, flow units. Rollovers at 9,999,999 (ten million less 1).

Flow Minutes

> **Today** – Flow Minutes Today.

> **Yesterday** – Flow Minutes Yesterday.

> **Hrs. Forever** – Flow Hours Forever.

3.1.3   Alarms

Select API2540 > API 2540 Setup and select Alarms Enabled. Click Alarms to define low, high, low flow alarms and Spontaneous Report-by-Exception (RBX) Alarming. Refer to Figure 3-4.
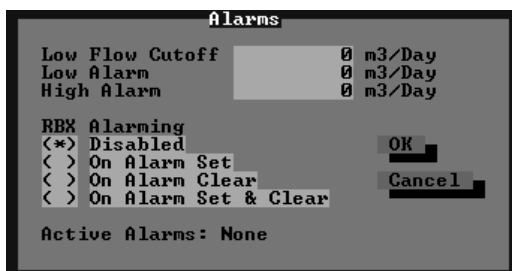
```
                        Alarms
     Low Flow Cutoff            0  m3/Day
     Low Alarm                  0  m3/Day
     High Alarm                 0  m3/Day

     RBX Alarming
     (*) Disabled                     OK
     ( ) On Alarm Set
     ( ) On Alarm Clear               Cancel
     ( ) On Alarm Set & Clear

     Active Alarms: None
```

Figure 3-4. Alarms

Low Flow Cutoff – When the Meter Input value of the metering device is less than the Low Flow Cutoff value, the calculated flow is equal to zero, (m^3/Day or BBL/Day).

Low Alarm – Limit value, in engineering units, to which the calculated flow must fall to generate a Low Alarm, (m^3/Day or BBL/Day).

High Alarm – Limit value, in engineering units, to which the calculated flow must rise to generate a High Alarm, (m^3/Day or BBL/Day).

RBX Alarming – Currently, there are no communication programs available to handle API 2540 notifications. However, the alarms and Spontaneous Report-by-Exception (RBX) tags are logged into the Alarm Log.

> **Disabled** – Select Disabled to turn RBX Alarming Off.

> **On Alarm Set** – When the point enters an alarm condition, the ROC generates a Report-By-Exception message.

> **On Alarm Clear** – When the point leaves an alarm condition, the ROC generates a Report-By-Exception message.

> **On Alarm Set & Clear** – In either condition, an RBX message generates. Note that RBX Alarming also requires the communications port to be properly configured.

Active Alarms – Displays any alarms that are currently active.

3.1.4 Inputs

Select API2540 > API 2540 Setup and click Inputs to define the Meter Input, Temperature Input, Static Prs. Input, Vapor Prs. Input, Density Input, and Sediment & Water inputs.

Figure 3-5. Inputs

Meter Input – Source of the uncorrected measured flow. Typically, this links to a Pulse Input engineering units Value, or the Analog Input Filter engineering unit value. Softpoint parameters, FST Registers, or manual (Undefined) mode are also accepted. The value transferred or set displays as the (Meter) Value field.

When using a Pulse Input, this is typically configured as "rate," but the user program calculates pulse values starting from the Accumulated Pulses (Accum'd Pulses) in the Pulse Input (m^3 or kg for metric and bbl or lbm for US). If the Meter Type is configured as Pulse Input, and the actual value is manual (Undefined), or from a different register in the ROC (such as a Softpoint), the user program interprets the number as a daily rate (kg, m^3, lbm or bbl per day).

When using an Analog Input, such as from a Vortex transmitter, the rate must be m^3/hour or kg/hour in metric, and bbl/hour or lbm/h in US units.

When using a differential Analog Input for orifice metering, the scaling must be kPa in Metric and in. H_2O in US units.

Temperature Input – Location where the process temperature of the fluid is originated. Typically, this floating-point parameter is assigned to the "Filter" engineering units (EU) value of an Analog Input. Softpoint parameters, FST registers, or manual (Undefined) mode are also accepted. The value transferred or set displays as the (Temperature) Value in Deg C or Deg F.

Static Prs. Input – Location where pressure of the fluid is originated. The pressure is assumed to be consistent with the Vapor Pressure. Typically, this floating-point parameter is assigned to the "Filter" EU value of an Analog Input or MVS. Softpoint parameters, FST registers, or manual (Undefined) mode are also valid. The value transferred or set displays as the (Pressure) Value in kPa or PSI.

Vapor Prs. Input – Location where the vapor pressure of the fluid is originated. The vapor pressure is assumed to be absolute pressure and consistent with the Process Pressure (see above). Typically, this floating-point parameter is assigned to the "Filter" EU value of an Analog Input, Softpoint, FST Register, or manual (Undefined) mode. The value transferred or set displays as the Value in kPa or PSI.

Density Input – Location where the density of the fluid is originated.

There are two typical practical applications:

1. This parameter is manually (Undefined) entered, to a value certified by a laboratory. The Value is assumed to be at base temperature and pressure, except API rounding. No corrections are made on this Value.

2. A flow density meter can be assigned to the "Filter" EU value of an Analog Input. The current Value of the floating-point parameter is assumed at flow conditions, so temperature and pressure corrections are applied. Softpoint and FST registers are also accepted. The value transferred or set displays as the (Density) Value in kg / m^3 or Deg API.

Sediment & Water Input – Analog Input weight percentage, such as from a BS&W device, Softpoint, FST Register, or manual (Undefined) entry. Valid Domain 0-100.

3.1.5 Slippage Factors

Select API2540 > API 2540 Setup and click Slippage Factors to "fine tune" each individual meter, based on proven calibration data described in *API Manual of Petroleum Standards*, Chapter 12. This screen is only accessible for Pulse or Analog Meter Types.

Figure 3-6. Meter Slippage Factors

Up to five different Meter Slippage Factors may be entered for various flow rates.

1. If the first flow rate is set to 0.0, the rest of the table is ignored and a Meter Slippage Factor of 1.0 is used.

2. If only one flow rate / meter factor pair is entered, the program uses that Meter Slippage Factor for all flow rates. Enter a unique Meter Slippage Factor.

3. If more than one flow rate / meter factor pair is entered, the program uses linear interpolation to arrive at the Meter Slippage Factor for the current raw flow rate. Each meter flow rate entered must be higher than the previous flow rate entered, such as:

    Meter Value 1 < Meter Value 2 < Meter Value 3, and so forth.

4. If an error occurs due to improper configuration, such as negative numbers, the program sets the Meter Slippage Factor to 1.0.

Meter Value 1 – First flow rate for 1st Meter Slippage Factor. Typically 20% of maximum flow.

Factor 1 – Meter Slippage Factor for 1st flow rate.

Meter Value 2 – Second flow rate for 2nd Meter Slippage Factor. Typically 40% of maximum flow.

> **Factor 2** – Meter Slippage Factor for 2nd flow rate.

Meter Value 3 – Third flow rate for 3rd Meter Slippage Factor. Typically 60% of maximum flow.

> **Factor 3** – Meter Slippage Factor for 3rd flow rate.

Meter Value 4 – Fourth flow rate for 4th Meter Slippage Factor. Typically 80% of maximum flow.

> **Factor 4** – Meter Slippage Factor for 4th flow rate.

Meter Value 5 – Fifth flow rate for 5th Meter Slippage Factor. Typically 100% of maximum flow.

> **Factor 5** – Meter Slippage Factor for 5th flow rate.

Calculated Factor – Displays the actual calculated meter factor to be used in calculations. The value is transferred to the API Calculations (Figure 3-2) as Meter Slippage Factor.

3.2 Data Transfer

Select API2540 > Data Transfer to configure eight individual register data transfers. The values defined in **Source** definition data 1 to 8 are transferred into target **Destination** data 1 to 8. The actual value for each field displays in the corresponding **Value** field. Only floating-point values can be transferred, even though other data options are selectable.

The Register Transfer screen is set to run by setting the **Scan Period** to a value greater than zero. The actual **Scan Time** is typically 2 seconds.

Figure 3-7. Data Transfer

APPENDIX A STANDARDS

The following API and ASTM standards were used to develop the API2540 Liquid Volume Correction User Program:

ASTM D 1250-80
   Tables 34, 53, 53A, 53B, 54, 54A, and 54B

1980. Manual of Petroleum Measurement Standards
   Chapter 11.1 of Volume Correction Factors Volume X - Background, Development, and Program Documentation. API Standard 2540, first edition.

1984. Manual of Petroleum Measurement Standards
   Chapter 11.2.1 of Compressibility Factors for Hydrocarbons: 638 - 1074 Kilograms per Cubic Meter Range. American Petroleum Institute, first edition.

1986. Manual of Petroleum Measurement Standards
   Chapter 11.2.2M of Compressibility Factors for Hydrocarbons: 350 - 637 Kilograms per Cubic Meter Density (15°C) and -46°C to 60°C Metering Temperature. American Petroleum Institute, first edition.

1981 reaffirmed 1987. Manual of Petroleum Measurement Standards
   Chapter 12 of Calculation of Petroleum Quantities Field Manual. Section 2 of Instructions for Calculating Liquid petroleum Quantities measured by Turbine or Displacement Meters. American Petroleum Institute, first edition.

1993. Manual of Petroleum Measurement Standards
   Chapter 21 of Flow Measurement Using Electronic Metering Systems. American Petroleum Institute, first edition.

1990. American Gas Association. Report No.3 of Orifice Metering
   American Petroleum Institute, third edition. API Manual of Petroleum Measurement Standards. Chapter 11 of Physical Properties Data Addendum to Section 2, Part 2 Correlation for Vapor Pressure for Commercial Natural Gas Liquids.

APPENDIX B DOMAIN VIOLATIONS

Error Message	Units	Description
Low Temp. (Water)	Metric	Temperature below 0 Deg C
	US	Temperature below 32 Deg F
Low Temp. (Oil Prod)	Metric	Temperature below -18 Deg C
	US	Temperature below 0 Deg F
Low Temp. (LPG)	Metric	Temperature below -45 Deg C
	US	Temperature below -20 Deg F
High Temp (Water)	Metric	Temperature above saturation curve at actual pressure
	US	Temperature above saturation curve at actual pressure
Critical Temp. LPG	Metric	Temperature above 55 Deg C
	US	Temperature above 120 Deg F
High Temp. (Oil Prod)	Metric	Pressure less than 500 kPa
	Metric	Crude oil or gasoline, density 653-778.5, temperature over 90 Deg C
	Metric	Crude oil or jet fuel, density 779.5-824, temperature over 125 Deg C
	Metric	Crude oil or Diesel oil, density 824.5-1075, temperature over 150 Deg C
	Metric	Pressure over 500 kPa, temperature over 90 Deg C
	US	Pressure less than 75 PSIA
	US	Crude oil or gasoline, density 50.1-100, temperature over 200 Deg F
	US	Crude oil or jet fuel, density 40.1-50, temperature over 250 Deg F
	US	Crude oil or Diesel oil, density 0-40, temperature over 200 Deg F
	US	Pressure exceeding 75 PSIA, temperature greater than 200 Deg F
High Press. (Oil Prod)	Metric	Pressure exceeding 10300 kPa
	US	Pressure exceeding 1450 PSIA
Low Density Oil	Metric	Crude oil, density below 610.5 kg/m^3
Low Dens. Gasoline	Metric	Gasoline, density below 653 kg/m^3
Low Dens. Jet	Metric	Fuel Jet Fuel, density below 787.5 kg/m^3
Low Density Diesel	Metric	Diesel oil, density below 829 kg/m^3
Low Density (P.drv)	Metric	Oil products, press domain, density below 638 kg/m^3
Low Density LPG	Metric	LPG, density below 495 kg/m^3
Low Trans Zone	Metric	Density in transition area below 770.5 kg/m^3
Low Density Oil	US	Crude oil, density above 100 Deg API
Low Dens. Gasoline	US	Gasoline, density above 85 Deg API
Low Density Jet Fuel	US	Jet Fuel, density above 48 Deg API
Low Density Diesel	US	Diesel oil, density above 37 Deg API
Low Density (P.drv)	US	Oil products, press domain, density above 90 Deg API

Error Message	Units	Description
Low Density LPG	US	LPG, density above 155 Deg API
Low Trans. Zone	US	Density in transition area above 52 Deg API
High Density Oil	Metric	Crude oil, density above 1075 kg/m^3
High Dens. Gasoline	Metric	Gasoline, density above 770.5 kg/m^3
High Dens. Jet Fuel	Metric	Jet Fuel, density above 829 kg/m^3
High Density Diesel	Metric	Diesel oil, density above 1075 kg/m^3
High Density (P.dry)	Metric	Oil products, press domain, density above 1075 kg/m^3
High Density LPG	Metric	LPG, density above 610.5 kg/m^3
High Trans Zone	US	Density in transition area below 48 Deg API
High Density Oil	US	Crude Oil, density below 0 Deg API
High Dens. Gasoline	US	Gasoline, density below 52 Deg API
High Dens. Jet Fuel	US	Jet fuel, density below 37 Deg API
High Density Diesel	US	Diesel oil, density below 0 Deg API
High Density (P.drv)	US	Oil products, press domain, density below 0 Deg API
High Density LPG	US	LPG, density below 100 Deg API
High Trans. Zone	Metric	Density in transition area above 787.5 kg/m^3
Low Sed & Water		Sediment & water is negative
High Sed & Water		Sediment & water is greater than 100%
Low Meter Factor		Meter Factor below 0.2
High Meter Factor		Meter Factor above 3
High Vapor Pressure		Vapor Pressure greater than Static Pressure
Invalid Base Temp	Metric	Base Temperature differs from 15 Deg C
	US	Base Temperature different from 60 Deg F
Tables Not Found!		API Tables 34, 53 and 54 not loaded or corrupted
Inside Domain (OK)		All parameters within domain
Not Active!!		Flow not running

APPENDIX C ENGINEERING UNITS

Metric Units		
Inputs	Pulse Meter	kg if mass, m^3 if volume
	Analog Meter	kg/hour if mass, m^3 if volume
	Differential Meter	kPa
	Static Pressure	kPa
	Temperature	Deg C
	Density	kg/m^3
	Viscosity	cP
Outputs	Flow	E3 kg/day if mass, m^3/day if volume
	Density	kg/m^3

US Units		
Inputs	Pulse Meter	lbm if mass, US bbl if volume
	Analog	Meter lbm/hour if mass, bbl/hour if volume
	Differential Meter	inches Water
	Static Pressure	PSI
	Temperature	Deg F
	Density	Deg API if Oil Products, lbm/cuft if water
	Viscosity	lbm / ft*sec
Outputs	Flow	E3 lbm/day if mass, US bbl/day if volume
	Density	Deg API if Oil Products, lbm/cuft if water

INDEX