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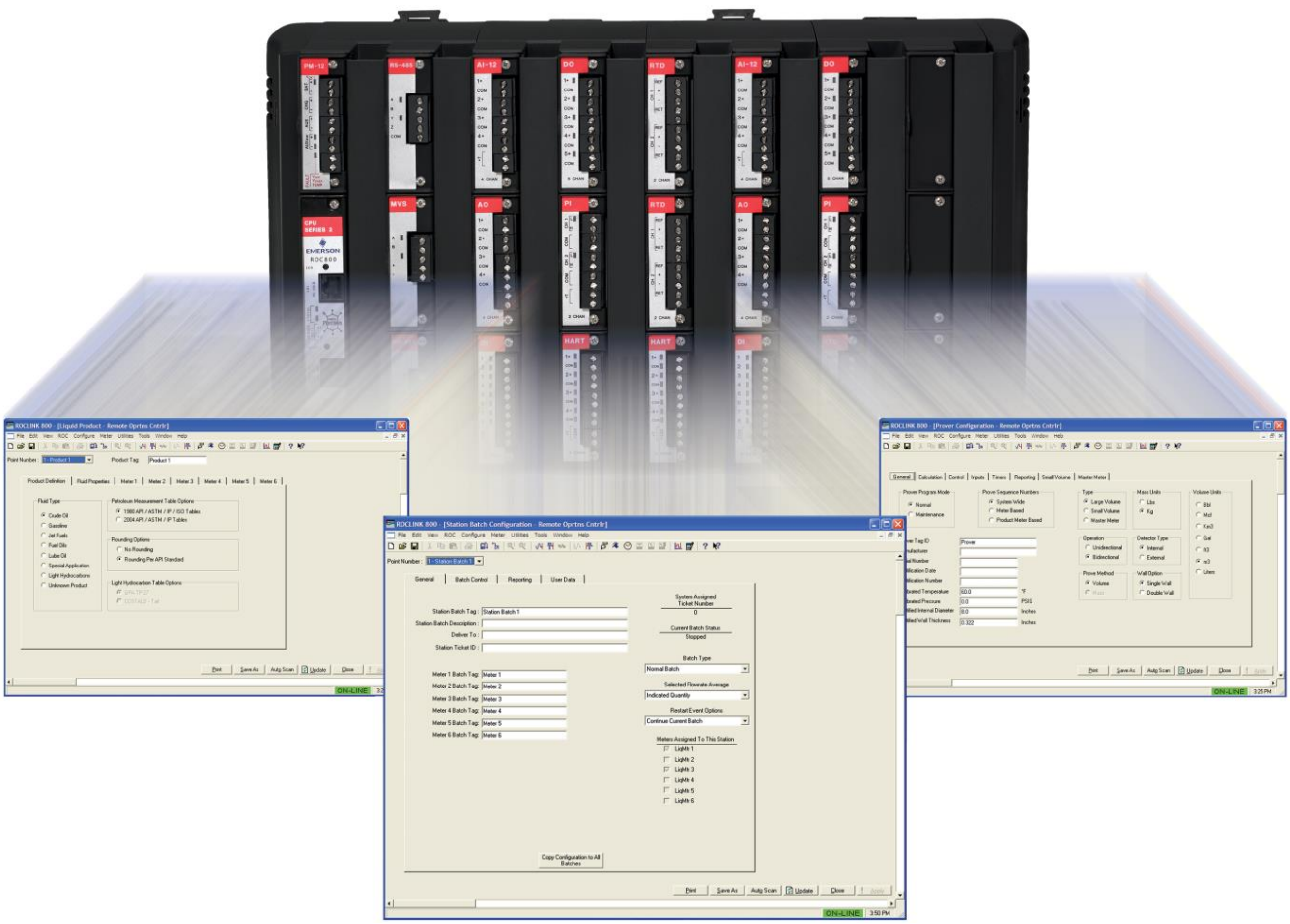
ROC800L Flow Calculations User Manual



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Revision Tracking Sheet

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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
All pages	June-2017
Initial release	March-2016

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Chapter 1 – Overview

This document describes the ROC800L calculations for density, volume correction factors, quantity totals, meter averages, batch averages and totals, and meter factor using volume displacement proving.

Note: Information contained in this document does not cover all described calculations in the ROC800L.

1.1 Scope of Manual

This manual contains the following chapters:

Chapter 1 Overview	A brief description of ROC800L flow calculations.
Chapter 2 Calculation of Densities and Volume Correction Factors	This chapter describes the methods to calculate base density, meter density, and correction factors used to correct the measured volume to a net standard volume of hydrocarbon fluid as described in API Chapter 11.1 (2004).
Chapter 3 Calculation of Quantity Totals	This chapter describes the methods to calculate the hourly, daily averages for meter inputs and calculated values.
Chapter 4 Calculation of Meter Averages	This chapter describes the methods to calculate the hourly, daily averages for meter inputs and calculated values.
Chapter 5 Calculation of Batch Averages and Totals	This chapter describes the calculation and rounding methods to calculate the flow weighted averages and quantity totals over a batch.
Chapter 6 Calculation of Averages and Totals for Batch Tickets	This chapter describes the calculation and rounding methods to calculate a meter factor from a successful prove for both the average data method and the average meter factor method, including rounding.

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Chapter 2 – Calculation of Densities and Volume Correction Factors

In This Chapter

This chapter describes the methods to calculate base density, meter density, and correction factors used to correct the measured volume to a net standard volume of hydrocarbon fluid as described in API Chapter 11.1 (2004).

2.1 Observed to Base Calculations

This section describes the methods to calculate a base density (density at base temperature and atmospheric pressure) from an observed density (density at an observed temperature and pressure). The observed density input and associated observed temperature and pressure must come in to the ROC800L through one of the density interface points which is assigned either to a station or to a meter. If the density interface point is assigned to a station, the base density is calculated at the station and used by all the meters that are part of the station. If the density interface point is assigned to a meter, the base density is calculated and used at that meter only.

The observed to base correction factors are stored as shown in Table 2-1.

Table 2-1. Observed to Base Correction Factors (Base)

Description	TLP	Factor
Correction for Temperature of the Liquid from Observed to Base ($CTL_{obs \rightarrow base}$)	204,x,48	Not rounded
Correction for Pressure of the Liquid from Observed to Base ($CPL_{obs \rightarrow base}$)	204,x,49	Not rounded
Correction for Temp and Press of the Liquid from Observed to Base ($CTPL_{obs \rightarrow base}$)	204,x,42	Not rounded
Compressibility Factor of the Liquid from Observed to Base ($F_{obs \rightarrow base}$)	204,x,51	Not rounded
Thermal Expansion Factor of the Liquid at Base Conditions (Alpha)	204,x,41	Not rounded

Description	TLP	Factor
Density of the Liquid at Base Conditions (RHO_{base})	204,x,23	Not rounded

2.1.1 CTL (observed to base)

The calculation of the temperature correction factor for observed densitometer conditions to base conditions detailed below is performed in accordance with API Manual of Petroleum Measurement Standards (Chapter 11.1, 2004). The correction factors are calculated for a base of 15°C and 0 kPa(g). However, because the CTPL expressions were developed and expressed in terms of a base density at 60°F, this calculation must be done using the following steps:

1. Convert the observed temperature and base temperature from °C to °F and convert the observed pressure in kPa(g) to PSIG (see equations below – reference API section 11.1.5.1).
2. Convert the temperature at ITS-90 to IPTS-68 (reference API section 11.1.5.3) using the following formula.
3. Calculate density at 60°F (RHO60) and associated correction factors (CTL, CPL, CTPL, Fp) for observed →60°F (see equations below - reference API section 11.1.6.2).
4. Using this value of RHO60, calculate density at 15°C and associated temperature correction factor (CTL) 60°F→15°C (see equations below – reference 11.1.6.1).
5. Using this value of RHO60, calculate density at line conditions and associated correction factors (CTL, CPL, CTPL, F) for 60°F→line (see equations below – reference 11.1.6.1).
6. Calculate the CTL for observed temperature to 15°C using:

   CTL(obs→15°C) = CTL (obs→60°F) / CTL (60°F→15°C)

   The calculation for the effect of temperature on the liquid is:

   $$C_{TL} = \exp\{-\alpha_{60}\Delta t[1 + 0.8\alpha_{60}(\Delta t + \delta_{60})]\}$$

   Where:

   C_{TL} = Correction factor for the effect of temperature on the liquid

   α_{60} = Coefficient of thermal expansion of the liquid ($°F^{-1}$)

   Δt = t^* - 60.0068749

   t^* = Temperature of the liquid at the meter (°F)

   δ_{60} = Temperature shift value (a constant 0.01374979547 °F)

The coefficient of thermal expansion of the liquid is calculated as:

$$\alpha_{60} = \left(\frac{K0}{\rho *} + K1\right)\frac{1}{\rho *} + K2$$

Where:

α_{60} = Coefficient of thermal expansion of the liquid ($°F^{-1}$)

K0 = liquid specific constant ((kg^2/m^6)/$°F$) Crude = 341.0957

K1 = liquid specific constant ((kg/m^3)/$°F$) Crude = 0.0

K2 = liquid specific constant ($°F^{-1}$) Crude = 0.0

$\rho *$ = base density corrected to $60°F$ (kg/m^3)

The temperature correction factor is not rounded.

2.1.2 Compressibility (F) (observed to base)

The compressibility of the liquid (F) from observed conditions to base conditions is calculated as:

$$F_{P,\ psi} = \exp(-1.9947 + 0.00013427 \cdot t* + \frac{793920 + 2326.0 \cdot t*}{\rho *^2})$$

Where:

$F_{P,psi}$ = compressibility of the liquid from observed to base (/psi)

$t*$ = observed temperature of the liquid (°F)

$\rho *$ = base density corrected to $60°F$ (kg/m^3)

The compressibility factor is then converted to kPa as follows:

$$F_{P,kPa} = \frac{F_{P,psi}}{6.894757}$$

The compressibility factor for observed to base is not rounded.

2.1.3 CPL (observed to base)

The correction for the effect of pressure on the liquid from observed to base conditions is calculated as:

$$C_{PL} = \frac{1}{1 - 10^{-5} \cdot F_{P,kPa} \cdot P}$$

Where:

C_{PL} = Correction factor for the effect of pressure on the liquid

$F_{P,kPa}$ = Compressibility of the liquid at observed pressure in /kPa

P = Observed pressure of the liquid in kPa

2.1.4 CTPL (observed to base)

The correction for the effect of temperature and pressure on the liquid from observed to base conditions is calculated as:

$$CTPL = C_{TL} \times C_{PL}$$

Where:

$CTPL$ = Correction factor for the effects of temperature and pressure on the liquid – reference API Ch 11

C_{TL} = Correction factor for the effect of temperature on the liquid

C_{PL} = Correction factor for the effect of pressure on the liquid

The CTPL(observed→base) is not rounded.

2.1.5 Base Density

The base density is calculated in an iterative process. An initial guess for base density is made and the CTPL value is calculated using the equations above. A new base density is calculated as:

$$RHO_{base} = \frac{RHO_{obs}}{CTPL_{obs \rightarrow base}}$$

The base density guess is updated and the process is repeated until the base density converges. The final value for base density is not rounded.

2.2 Base to Alternate Calculations

This section describes the methods used to calculate a meter density (density at flowing temperature and pressure) from a base density (density at base temperature and atmospheric pressure) and a volume correction factor to convert volume at flowing conditions to a volume at base conditions. The observed to base correction factors are stored as shown in Table 2-2.

Table 2-2. Observed to Base Correction Factors (Alternate)

Description	TLP	Factor
Correction for Temperature of the Liquid from Base to Alternate ($CTL_{base \rightarrow alt}$)	204,x,44	Not rounded
Correction for Pressure of the Liquid from Base to Alternate ($CPL_{base \rightarrow alt}$)	204,x,45	Not rounded
Correction for Temp and Press of the Liquid from Base to Alternate ($CTPL_{base \rightarrow alt}$)	204,x,43	Not rounded
Compressibility Factor of the Liquid from Base to Alternate ($F_{base \rightarrow alt}$)	204,x,47	Not rounded
Thermal Expansion Factor of the Liquid at Base Conditions (Alpha)	204,x,41	Not rounded
Density of the Liquid at Meter Conditions (RHO_{base})	204,x,21	Not rounded

2.2.1 Coefficient of Thermal Expansion (Alpha)

The coefficient of thermal expansion of the liquid is calculated as:

$$\alpha_{60} = \left(\frac{K0}{\rho *} + K1 \right) \frac{1}{\rho *} + K2$$

Where:

α_{60} = Coefficient of thermal expansion of the liquid ($°F^{-1}$)

K0 = liquid specific constant ((kg2/m6)/ $°F$) Crude = 341.0957

K1 = liquid specific constant ((kg/m3)/ $°F$) Crude = 0.0

K2 = liquid specific constant ($°F^{-1}$) Crude = 0.0

$\rho *$ = base density corrected to $60°F$ (kg/m3)

2.2.2 CTL (base to alternate)

The calculation of the volume correction factors for base to line conditions detailed below are performed in accordance with API Manual of Petroleum Measurement Standards (Chapter 11.1, 2004). The correction factors are calculated from a base of 15°C and 0 barg. However, because the VCF expressions were developed and expressed in terms of a base density at 60°F, this calculation must be done using the following steps:

1. Convert the meter temperature and base temperature from °C to °F and convert the meter pressure in barg to PSIG (reference API section 11.1.5.1).
2. Convert the temperature at ITS-90 to IPTS-68 (reference API section 11.1.5.3).
3. Calculate density at 60°F (RHO60) and associated correction factor (CTL) for 15°C→60°F (reference API section 11.1.6.2).
4. Using this value of RHO60, calculate density at line temperature pressure and associated correction factors (CTL, CPL, CTPL, Fp) 60°F→line (reference 11.1.6.1).
5. Calculate the CTL for 15°C to line temperature using: CTL(15°C→line) = CTL (60°F→line) / CTL (15°C→60°F)

The correction for the effect of temperature on the liquid is calculated as:

$$C_{TL} = \exp\{-\alpha_{60}\Delta t[1 + 0.8\alpha_{60}(\Delta t + \delta_{60})]\}$$

Where:

C_{TL} = Correction factor for the effect of temperature on the liquid

α_{60} = Coefficient of thermal expansion of the liquid ($°F^{-1}$)

Δt = t^* - 60.0068749

t^* = Temperature of the liquid at the meter (°F)

δ_{60} = Temperature shift value (a constant 0.01374979547 °F)

2.2.3 Compressibility (F) (base to alternate)

The compressibility of the liquid (F) from base to alternate conditions is calculated as:

$$F_{P,\,psi} = \exp(-1.9947 + 0.00013427 \cdot t^* + \frac{793920 + 2326.0 \cdot t^*}{\rho^{*2}})$$

Where:

$F_{P,psi}$ = compressibility of the liquid at the meter (/psi)

t^* = temperature of the liquid at the meter (°F)

ρ^* = base density corrected to $60°F$ (kg/m3)

The compressibility factor is then converted to kPa as follows:

$$F_{P,kPa} = \frac{F_{P,psi}}{6.894757}$$

The compressibility factor for base to alternate is not rounded.

2.2.4 CPL (base to alternate)

The correction for the effect of pressure on the liquid from base to alternate conditions is calculated as:

$$C_{PL} = \frac{1}{1 - 10^{-5} \cdot F_{P,kPa} \cdot P}$$

Where:

C_{PL} = Correction factor for the effect of pressure on the liquid

$F_{P,kPa}$ = Compressibility of the liquid at observed pressure in /kPa

P = Pressure of the liquid at the meter in kPa

2.2.5 CTPL (base to alternate)

The correction for the effect of temperature and pressure on the liquid from base to alternate conditions is calculated as:

$$CTPL_{base \to alt} = CTL_{base \to alt} \times CPL_{base \to alt}$$

Where:

$CTPL$ = Correction factor for the effects of temperature and pressure on the liquid – reference API Ch 11

C_{TL} = Correction factor for the effect of temperature on the liquid

C_{PL} = Correction factor for the effect of pressure on the liquid

The CTPL(base→alternate) is rounded to 5 decimal places.

2.2.6 Meter Density

The meter density is calculated as:

$$RHO_{meter} = RHO_{base} \times CTPL_{base \rightarrow alt}$$

Where:

RHO_{meter} = Density at meter conditions
RHO_{base} = Density at base conditions
$CTPL_{base \rightarrow alt}$ = Correction factor for temp and pressure

2.2.7 CSW

The correction for sediment and water is calculated as:

$$Csw = 1.0 - \frac{\%S \& W}{100.0}$$

Where:

Csw = Correction for sediment and water
%S&W = Percentage of sediment and water

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Chapter 3 – Calculation of Quantity Totals

In This Chapter

This chapter describes the methods to calculate the hourly, daily, and monthly totals, and averages as well as the non-resettable totals that are not part of a batch. The daily totals rollover at the contract hour defined on the Liquid Preferences display and the monthly totals rollover on the first day of the month at contract hour. Non-resettable totals will rollover at the value defined for all double precision accumulators in the ROC system information (91,0,56). By default, this value is 1,000,000,000,000.

3.1 Pulse Totals

The pulse totals are kept for each meter for current hour, previous hour, current day, previous day, current month, and previous month as well as a non-resettable pulse total. The incremental pulse count for each calculation period is calculated as:

$$Pulse_{incr} = Accum_{Current} - Accum_{Previous}$$

Where:

$Pulse_{Incr}$ = Incremental pulses for the calculation period

$Accum_{Current}$ = PI or APM accumulator at the time of the calculation

$Accum_{Previous}$ = PI or APM accumulator at the time of the previous calculation

Each pulse accumulator is then incremented by the incremental pulses for the calculation period. Pulse totals are not available at the station level. The values are stored as shown in Table 3-1.

Table 3-1. Pulse Total TLP

Description	TLP	Factor
Meter Non-resettable Pulse Total	204,x,184	Not rounded
Meter Current Hour Pulse Total	204,x,178	Not rounded
Meter Previous Hour Pulse Total	204,x,179	Not rounded
Meter Current Day Pulse Total	204,x,180	Not rounded
Meter Previous Day Pulse Total	204,x,181	Not rounded
Meter Current Month Pulse Total	204,x,182	Not rounded

Description	TLP	Factor
Meter Previous Month Pulse Total	204,x,182	Not rounded

3.2 Indicated Quantity Totals

The indicated quantity totals are kept for each meter and for each station for the current hour, previous hour, current day, previous day, current month, and previous month as well as a non-resettable total. The indicated quantity may represent volume or mass, depending on the flow meter type selection at the meter. The incremental indicated quantity for each calculation period is calculated as:

$$IV_{incr} = \frac{Pulse_{incr}}{Kfactor}$$

Where:

IV_{incr} = Incremental indicated quantity for the calculation period

$Pulse_{incr}$ = Incremental pulses for the calculation period

K-factor = Pulses / Volume or Pulses / Mass

Each meter indicated quantity accumulator is incremented by the incremental IV for the calculation period. Each station indicated quantity accumulator is incremented by the incremental IV for the calculation period for all the meters that are part of that station. The values are stored as shown in Table 3-2.

Table 3-2. Indicated Quantity Total TLP

Description	TLP	Factor
Meter Non-resettable IV Total	204,x,145	Not rounded
Meter Current Hour IV Total	204,x,109	Not rounded
Meter Previous Hour IV Total	204,x,115	Not rounded
Meter Current Day IV Total	204,x,121	Not rounded
Meter Previous Day IV Total	204,x,127	Not rounded
Meter Current Month IV Total	204,x,133	Not rounded
Meter Previous Month IV Total	204,x,139	Not rounded
Station Non-resettable IV Total	203,x,71	Not rounded
Station Current Hour IV Total	203,x,35	Not rounded
Station Previous Hour IV Total	203,x,41	Not rounded
Station Current Day IV Total	203,x,47	Not rounded
Station Previous Day IV Total	203,x,53	Not rounded
Station Current Month IV Total	203,x,59	Not rounded
Station Previous Month IV Total	203,x,65	Not rounded

3.3 Gross Volume Totals

The gross volume totals are kept for each meter and for each station for the current hour, previous hour, current day, previous day, current month, and previous month as well as a non-resettable total.

If the indicated quantity represents volume, the incremental gross volume quantity for each calculation period is calculated as:

$$GV_{incr} = IV_{incr} \times MF$$

If the indicated quantity represents mass, the incremental gross volume quantity for each calculation period is calculated as:

$$GV_{incr} = \frac{IV_{incr} \times MF}{RHO_{meter}}$$

Where:

GV_{incr} = Incremental gross volume for the calculation period

IV_{incr} = Incremental indicated quantity for the calculation period

RHO_{meter} = Density of the liquid at meter conditions

MF = Meter Factor

Each meter gross volume accumulator is incremented by the incremental GV for the calculation period. Each station gross volume accumulator is incremented by the incremental GV for the calculation period for all the meters that are part of that station. The values are stored as shown in Table 3-3.

Table 3-3. Gross Volume Total TLP

Description	TLP	Factor
Meter Non-resettable GV Total	204,x,146	Not rounded
Meter Current Hour GV Total	204,x,110	Not rounded
Meter Previous Hour GV Total	204,x,116	Not rounded
Meter Current Day GV Total	204,x,122	Not rounded
Meter Previous Day GV Total	204,x,128	Not rounded
Meter Current Month GV Total	204,x,134	Not rounded
Meter Previous Month GV Total	204,x,140	Not rounded
Station Non-resettable GV Total	203,x,72	Not rounded
Station Current Hour GV Total	203,x,36	Not rounded
Station Previous Hour GV Total	203,x,42	Not rounded
Station Current Day GV Total	203,x,48	Not rounded
Station Previous Day GV Total	203,x,54	Not rounded
Station Current Month GV Total	203,x,60	Not rounded
Station Previous Month GV Total	203,x,66	Not rounded

3.4 Gross Standard Volume Totals

The gross standard volume totals are kept for each meter and for each station for the current hour, previous hour, current day, previous day, current month, and previous month as well as a non-resettable total.

If the indicated quantity represents volume, the incremental gross standard volume quantity for each calculation period is calculated as:

$$GSV_{incr} = IV_{incr} \times CCF_m$$

If the indicated quantity represents mass, the incremental gross standard volume quantity for each calculation period is calculated as:

$$GSV_{incr} = GV_{incr} \times CTPL_{base \rightarrow alt}$$

Where:

GSV_{incr} = Incremental gross standard volume for the calculation period

GV_{incr} = Incremental gross volume for the calculation period

IV_{incr} = Incremental indicated quantity for the calculation period

CCF_m = Combined correction factor for the meter

$CTPL_{base\text{->}alt}$ = Correction for temp and pressure base to alternate conditions

Each meter gross standard volume accumulator is incremented by the incremental GSV for the calculation period. Each station gross standard volume accumulator is incremented by the incremental GSV for the calculation period for all the meters that are part of that station. The values are stored as shown in Table 3-4.

Table 3-4. Gross Standard Volume Total TLP

Description	TLP	Factor
Meter Non-resettable GSV Total	204,x,147	Not rounded
Meter Current Hour GSV Total	204,x,111	Not rounded
Meter Previous Hour GSV Total	204,x,117	Not rounded
Meter Current Day GSV Total	204,x,123	Not rounded
Meter Previous Day GSV Total	204,x,129	Not rounded
Meter Current Month GSV Total	204,x,135	Not rounded
Meter Previous Month GSV Total	204,x,141	Not rounded
Station Non-resettable GSV Total	203,x,73	Not rounded
Station Current Hour GSV Total	203,x,37	Not rounded
Station Previous Hour GSV Total	203,x,43	Not rounded
Station Current Day GSV Total	203,x,49	Not rounded
Station Previous Day GSV Total	203,x,55	Not rounded
Station Current Month GSV Total	203,x,61	Not rounded
Station Previous Month GSV Total	203,x,67	Not rounded

3.5 Net Standard Volume Totals

The net standard volume totals are kept for each meter and for each station for the current hour, previous hour, current day, previous day, current month, and previous month as well as a non-resettable total.

The net standard volume can optionally be used to account for product shrinkage. A shrinkage factor can be configured under the LiquidCalcs Meter screen (Inputs Tab) (204,x,244), and it will be applied to the Net Standard Volume. By default the shrinkage factor is a value of 1.0, and does not affect the Net Standard Volume.

If the indicated quantity represents volume, the incremental net standard volume quantity for each calculation period is calculated as:

$$NSV_{incr} = IV_{incr} \times CCF_m \times CSW \times SF$$

If the indicated quantity represents mass, the incremental net standard volume quantity for each calculation period is calculated as:

$$NSV_{incr} = GSV_{incr} \times CSW \times SF$$

Where:

NSV_{incr} = Incremental net standard volume for the calculation period

GSV_{incr} = Incremental gross standard volume for the calculation period

IV_{incr} = Incremental indicated quantity for the calculation period

CCF_m = Combined correction factor for the meter

CSW= Correction for sediment and water

SF = The shrinkage factor for the meter, to account for the reduction of product at stock tank conditions.

Each meter net standard volume accumulator is incremented by the incremental NSV for the calculation period. Each station net standard volume accumulator is incremented by the incremental NSV for the calculation period for all the meters that are part of that station. The values are stored as shown in Table 3-5.

Table 3-5. Net Standard Volume Total TLP

Description	TLP	Factor
Meter Non-resettable NSV Total	204,x,148	Not rounded
Meter Current Hour NSV Total	204,x,112	Not rounded
Meter Previous Hour NSV Total	204,x,118	Not rounded
Meter Current Day NSV Total	204,x,124	Not rounded
Meter Previous Day NSV Total	204,x,130	Not rounded
Meter Current Month NSV Total	204,x,136	Not rounded
Meter Previous Month NSV Total	204,x,142	Not rounded
Station Non-resettable NSV Total	203,x,74	Not rounded
Station Current Hour NSV Total	203,x,38	Not rounded
Station Previous Hour NSV Total	203,x,44	Not rounded
Station Current Day NSV Total	203,x,50	Not rounded
Station Previous Day NSV Total	203,x,56	Not rounded
Station Current Month NSV Total	203,x,62	Not rounded
Station Previous Month NSV Total	203,x,68	Not rounded

3.6 Sediment and Water Volume Totals

The sediment and water volume totals are kept for each meter and for each station for the current hour, previous hour, current day, previous day, current month, and previous month as well as a non-resettable total.

The incremental sediment and water volume quantity for each calculation period is calculated as:

$$S\&W_{incr} = GSV_{incr} \times (1.0 - CSW)$$

Where:

$S\&W_{incr}$ = Incremental sediment & water volume for the calculation period

GSV_{incr} = Incremental gross standard volume for the calculation period

CSW = Correction for sediment and water

Each meter sediment and water volume accumulator is incremented by the incremental S&W for the calculation period. Each station sediment and water volume accumulator is incremented by the incremental S&W for the calculation period for all the meters that are part of that station. The values are stored as shown in Table 3-6.

Table 3-6. Sediment and Water Volume Total TLP

Description	TLP	Factor
Meter Non-resettable S&W Total	204,x,149	Not rounded
Meter Current Hour S&W Total	204,x,113	Not rounded
Meter Previous Hour S&W Total	204,x,119	Not rounded
Meter Current Day S&W Total	204,x,125	Not rounded
Meter Previous Day S&W Total	204,x,131	Not rounded
Meter Current Month S&W Total	204,x,137	Not rounded
Meter Previous Month S&W Total	204,x,143	Not rounded
Station Non-resettable S&W Total	203,x,75	Not rounded
Station Current Hour S&W Total	203,x,39	Not rounded
Station Previous Hour S&W Total	203,x,45	Not rounded
Station Current Day S&W Total	203,x,51	Not rounded
Station Previous Day S&W Total	203,x,57	Not rounded
Station Current Month S&W Total	203,x,63	Not rounded
Station Previous Month S&W Total	203,x,69	Not rounded

3.7 Mass Totals

The mass totals are kept for each meter and for each station for the current hour, previous hour, current day, previous day, current month, and previous month as well as a non-resettable total.

If the indicated quantity represents volume, the incremental gross mass quantity for each calculation period is calculated as:

$$Mass_{incr} = GV_{incr} \times RHO_{meter}$$

If the indicated quantity represents mass, the incremental gross mass quantity for each calculation period is calculated as:

$$Mass_{incr} = IV_{incr} \times MF$$

Where:

$Mass_{incr}$ = Incremental gross mass for the calculation period

GV_{incr} = Incremental gross volume for the calculation period

IV_{incr} = Incremental indicated quantity for the calculation period

RHO_{meter} = Density of the liquid at meter conditions

MF = Meter Factor

Each meter gross mass accumulator is incremented by the incremental mass for the calculation period. Each station gross mass accumulator is incremented by the incremental mass for the calculation period for all the meters that are part of that station. The values are stored as shown in Table 3-7.

Table 3-7. Mass Total TLP

Description	TLP	Factor
Meter Non-resettable Mass Total	204,x,150	Not rounded
Meter Current Hour Mass Total	204,x,114	Not rounded
Meter Previous Hour Mass Total	204,x,120	Not rounded
Meter Current Day Mass Total	204,x,126	Not rounded
Meter Previous Day Mass Total	204,x,132	Not rounded
Meter Current Month Mass Total	204,x,138	Not rounded
Meter Previous Month Mass Total	204,x,144	Not rounded
Station Non-resettable Mass Total	203,x,76	Not rounded
Station Current Hour Mass Total	203,x,40	Not rounded
Station Previous Hour Mass Total	203,x,46	Not rounded
Station Current Day Mass Total	203,x,52	Not rounded
Station Previous Day Mass Total	203,x,58	Not rounded
Station Current Month Mass Total	203,x,64	Not rounded
Station Previous Month Mass Total	203,x,70	Not rounded

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Chapter 4 – Calculation of Meter Averages

In This Chapter

This chapter describes the methods to calculate the hourly and daily averages for meter inputs and calculated values. Daily averages restart at the user defined contract hour on the Liquid Preferences display.

4.1 Flow-Weighted Averages

The flow-weighted temperature, pressure, density, correction factor, meter factor, and K-factor averages are kept for each meter for the current hour, previous hour, current day, and previous day. The flow weighted average for each variable is calculated as:

$$FWA = \frac{\Sigma(V_i \times Q_i)}{Q_t}$$

Where:

FWA = Flow weighted average over the period

V_i = Sample of variable at time i

Q_i = Incremental quantity at time i

Q_t = Total quantity over the period

The quantity used is the quantity selected under the LiquidCalcs Station screen (General Tab) for Average Flowrate Option (203,x,99). A sample is taken once per second. The values are stored as shown in Table 4-1.

Table 4-1. Flow Weighted Average Storage

Description	TLP	Factor
FWA CTPL for Current Hour	204,x,190	Not rounded
FWA CTPL for Previous Hour	204,x,191	Not rounded
FWA CTPL for Current Day	204,x,192	Not rounded
FWA CTPL for Previous Day	204,x,193	Not rounded
FWA Meter Pressure for Current Hour	204,x,194	Not rounded
FWA Meter Pressure for Previous Hour	204,x,195	Not rounded
FWA Meter Pressure for Current Day	204,x,196	Not rounded
FWA Meter Pressure for Previous Day	204,x,197	Not rounded
FWA Meter Temperature for Current Hour	204,x,198	Not rounded
FWA Meter Temperature for Previous Hour	204,x,199	Not rounded
FWA Meter Temperature for Current Day	204,x,200	Not rounded
FWA Meter Temperature for Previous Day	204,x,201	Not rounded
FWA CPLm for Current Hour	204,x,202	Not rounded

Description	TLP	Factor
FWA CPLm for Previous Hour	204,x,203	Not rounded
FWA CPLm for Current Day	204,x,204	Not rounded
FWA CPLm for Previous Day	204,x,205	Not rounded
FWA CTLm for Current Hour	204,x,206	Not rounded
FWA CTLm for Previous Hour	204,x,207	Not rounded
FWA CTLm for Current Day	204,x,208	Not rounded
FWA CTLm for Previous Day	204,x,209	Not rounded
FWA Observed Density for Current Hour	204,x,210	Not rounded
FWA Observed Density for Previous Hour	204,x,211	Not rounded
FWA Observed Density for Current Day	204,x,210	Not rounded
FWA Observed Density for Previous Day	204,x,212	Not rounded
FWA Base Density for Current Hour	204,x,213	Not rounded
FWA Base Density for Previous Hour	204,x,214	Not rounded
FWA Base Density for Current Day	204,x,215	Not rounded
FWA Base Density for Previous Day	204,x,217	Not rounded
FWA K-factor for Current Hour	204,x,233	Not rounded
FWA K-factor for Previous Hour	204,x,234	Not rounded
FWA K-factor for Current Day	204,x,235	Not rounded
FWA K-factor for Previous Day	204,x,236	Not rounded
FWA meter factor for Current Hour	204,x,237	Not rounded
FWA meter factor for Previous Hour	204,x,238	Not rounded
FWA meter factor for Current Day	204,x,239	Not rounded
FWA meter factor for Previous Day	204,x,240	Not rounded

4.2 Flow Rate Averages

The flow rate averages are kept for each meter for current hour, previous hour, current day, and previous day. The values are calculated as a straight linear average from one second sample of the selected flowrate under the LiquidCalcs Station screen (General Tab) for Average Flowrate Option (203,x,99). The values are stored as shown in Table 4-2.

Table 4-2. Flow Rate Average Storage

Description	TLP	Factor
Flowrate average for Current Hour	204,x,174	Not rounded
Flowrate average for Previous Hour	204,x,175	Not rounded
Flowrate average for Current Day	204,x,176	Not rounded
Flowrate average for Previous Day	204,x,177	Not rounded

Chapter 5 – Calculations of Batch Averages and Totals

In This Chapter

This chapter describes the calculation and rounding methods to calculate the flow-weighted averages and quantity totals over a batch.

5.1 Opening and Closing Meter Readings

The opening meter reading (MRo) is obtained by reading the non-resettable IV Total (described in Section 2) at the start of the batch. The closing meter reading (MRc) is obtained by reading the non-resettable IV total at the end of the batch. Refer to Table 5-1.

MR_o = ROUND(Non-resettable IV Total @ Batch Start)

MR_c = ROUND(Non-resettable IV Total @ Batch Start)

Table 5-1. Open and Closing Meter Readings

Description	TLP	Bbls	gal	ft3	MCF	m3	Km3	L
Non-resettable IV Total	204,x,145	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Opening Meter Reading (MR_o)	214,x,64	x.xx	x.xx	x.xxx	x.xxxxx	x.xxx	x.xxxxx	xx.0
Closing Meter Reading (MR_c)	214,x,90	x.xx	x.xx	x.xxx	x.xxxxx	x.xxx	x.xxxxx	xx.0

5.2 Indicated Volume Totals

The indicated volume total for the batch is calculated as:

$$IV_{total} = MR_c - MR_o$$

The indicated volume total for the batch is then rounded per Table 5-2.

Table 5-2. Indicated Volume Total

Description	TLP	Bbls	gal	ft3	MCF	m3	Km3	L
Batch IV Total	204,x,16	x.xx	x.xx	x.xxx	x.xxxxx	x.xxx	x.xxxxx	x.x

5.3 Gross Volume Totals

The gross volume total for the batch is calculated as:

$$GV_{total} = GV_c - GV_o$$

Where:

GV_o = Non-resettable Gross Volume Total at batch start

GV_c = Non-resettable Gross Volume Total at batch end

GV_{total} = Gross Volume Total for the batch

Table 5-3. Gross Volume Total

Description	TLP	Bbls	gal	ft3	MCF	m3	Km3	L
Non-resettable GV Total	204,x,146	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Batch Start GV (GV_o)	214,x,65	x.xx	x.xx	x.xxx	x.xxxxx	x.xxx	x.xxxxx	xx.x
Batch End GV (GV_c)	214,x,91	x.xx	x.xx	x.xxx	x.xxxxx	x.xxx	x.xxxxx	xx.x
Batch End GV Total (GV_{total})	214,x,17	x.xx	x.xx	x.xxx	x.xxxxx	x.xxx	x.xxxxx	xx.x

5.4 Gross Standard Volume Totals

The gross standard volume total for the batch is calculated as:

$$GSV_{total} = GSV_c - GSV_o$$

Where:

GSV_o = Non-resettable Gross Standard Volume Total at batch start

GSV_c = Non-resettable Gross Standard Volume Total at batch end

GSV_{total} = Gross Standard Volume Total for the batch

Table 5-4. Gross Standard Volume Total

Description	TLP	Bbls	gal	ft3	MCF	m3	Km3	L
Non-resettable GSV Total	204,x,147	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Batch Start GSV (GSV_o)	214,x,66	x.xx	x.xx	x.xxx	x.xxxxx	x.xxx	x.xxxxx	xx.x
Batch End GSV (GSV_c)	214,x,92	x.xx	x.xx	x.xxx	x.xxxxx	x.xxx	x.xxxxx	xx.x
Batch End GSV Total (GSV_{total})	214,x,18	x.xx	x.xx	x.xxx	x.xxxxx	x.xxx	x.xxxxx	xx.x

5.5 Net Standard Volume Totals

The net standard volume total for the batch is calculated as:

$$NSV_{total} = NSV_c - NSV_o$$

Where:

NSV_o = Non-resettable Net Standard Volume Total at batch start

NSV_c = Non-resettable Net Standard Volume Total at batch end

NSV_{total} = Net Standard Volume Total for the batch

Table 5-5. Net Standard Volume Total

Description	TLP	Bbls	gal	ft3	MCF	m3	Km3	L
Non-resettable NSV Total	204,x,148	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Batch Start NSV (GSV_o)	214,x,67	x.xx	x.xx	x.xxx	x.xxxxx	x.xxx	x.xxxxx	xx.x
Batch End NSV (GSV_c)	214,x,93	x.xx	x.xx	x.xxx	x.xxxxx	x.xxx	x.xxxxx	xx.x
Batch End NSV Total (NSV_{total})	214,x,19	x.xx	x.xx	x.xxx	x.xxxxx	x.xxx	x.xxxxx	xx.x

5.6 Sediment and Water Volume Totals

The sediment and water (S&W) volume total for the batch is calculated as:

$$SW_{total} = SW_c - SW_o$$

Where:

SW_o = Non-resettable Sediment and Water Volume Total at batch start

SW_c = Non-resettable Sediment and Water Volume Total at batch end

SW_{total} = Sediment and Water Volume Total for the batch

Table 5-6. Sediment and Water Volume Total

Description	TLP	Bbls	gal	ft3	MCF	m3	Km3	L
Non-resettable S&W Total	204,x,148	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Batch Start S&W (SWV_o)	214,x,67	x.xx	x.xx	x.xxx	x.xxxxx	x.xxx	x.xxxxx	xx.x
Batch End S&W (SWV_c)	214,x,93	x.xx	x.xx	x.xxx	x.xxxxx	x.xxx	x.xxxxx	xx.x
Batch End S&W Total (SWV_{total})	214,x,19	x.xx	x.xx	x.xxx	x.xxxxx	x.xxx	x.xxxxx	xx.x

5.7 Mass Totals

The mass total for the batch is calculated as:

$$Mass_{total} = Mass_c - Mass_o$$

Where:

$Mass_o$ = Non-resettable Mass Total at batch start

$Mass_c$ = Non-resettable Mass Total at batch start

$Mass_{total}$ = Mass Total for the batch

Table 5-7. Mass Totals

Description	TLP	Lbs	kg	Ton	tonne
Non-resettable Mass Total	204,x,150	N/A	N/A	N/A	N/A
Batch Start Mass ($Mass_o$)	214,x,69	x.x	x.x	x.xx	x.xx
Batch End Mass ($Mass_c$)	214,x,95	x.x	x.x	x.xx	x.xx
Batch Mass Total ($Mass_{total}$)	214,x,21	x.x	x.x	x.xx	x.xx

5.8 Flow-Weighted Temperature Average

The flow-weighted meter temperature average and a flow weighted observed temperature average (if an observed density input is configured) for the batch is calculated as:

$$TWA = \frac{\Sigma(T_i \times Q_i)}{Q_t}$$

Where:

TWA = Flow-Weighted Temperature Average over the batch

T_i = Temperature sample at time i

Q_i = Incremental quantity at time i

Q_t = Total quantity over the batch

The quantity used is the quantity selected under the LiquidCalcs Station screen (General Tab) for Average Flowrate Option (203,x,99). A sample is taken once per second and the final value is rounded per Table 5-8.

Table 5-8. Flow-Weighted Temperature Average

Description	TLP	Deg F	Deg C
Flow-Weighted temperature average	214,x,25	x.x	x.x5
Flow-Weighted observed temperature average	214,x,38	x.x	x.x5

5.9 Flow-Weighted Pressure Average

The flow-weighted meter pressure average and a flow weighted observed pressure average (if an observed density is present) for the batch is calculated as follows:

$$PWA = \frac{\Sigma(P_i \times Q_i)}{Q_t}$$

Where:

PWA = Flow-Weighted Pressure Average over the batch

T_i = Pressure sample at time i

Q_i = Incremental quantity at time i

Q_t = Total quantity over the batch

The quantity used as the flow-weighting factor is the quantity selected under the LiquidCalcs Station screen (General Tab) for Average Flowrate Option (203,x,99). A sample is taken once per second and the final value is rounded per the Table 5-9.

Table 5-9. Flow-Weighted Pressure Average

Description	TLP	PSIG	kPa(g)	barg	kg/cm2
Flow-Weighted pressure average	214,x,24	x.0	x.0	x.x	x.x
Flow-Weighted observed pressure average	214,x,39	x.0	x.0	x.x	x.x

5.10 Flow-Weighted Density Average

The flow weighted base density, observed density, and meter density are calculated over the batch. Each flow-weighted density average for the batch is calculated as:

$$DWA = \frac{\Sigma(D_i \times Q_i)}{Q_t}$$

Where:

DWA = Flow-Weighted Density Average over the batch

D_i = Density sample at time i

Q_i = Incremental quantity at time i

Q_t = Total quantity over the batch

The quantity used as the flow weighting factor is the quantity selected under the LiquidCalcs Station screen (General Tab) for Average Flowrate Option (203,x,99). A sample is taken once per second and the final value is rounded per the Table 5-9.

Table 5-10. Flow-Weighted Density Average

Description	TLP	kg/m3	kg/L	RD	API	gcc	Lb/Bbl	Lb/gal	Lb/ft3
Flow-Weighted base density	214,x,26	x.x	x.xxxx	x.xxxx	x.x	x.xxxx	x.x	x.xxx	x.xx
Flow-Weighted observed density average	214,x,27	x.x	x.xxxx	x.xxxx	x.x	x.xxxx	x.x	x.xxx	x.xx
Flow-Weighted meter density average	214,x,28	x.x	x.xxxx	x.xxxx	x.x	x.xxxx	x.x	x.xxx	x.xx

5.11 Flow Weighted Correction Factor Average

The flow weighted CPL, CTL, CTPL (or VCF), S&W Percent, CSW, CPS, CTS, CCF, Meter Factor, and K-factor are calculated over the batch. Each flow-weighted factor average for the batch is calculated as:

$$FWA = \frac{\Sigma(F_i \times Q_i)}{Q_t}$$

Where:

FWA = Flow Weighted Factor Average over the batch

F_i = Sample of factor at time i

Q_i = Incremental quantity at time i

Q_t = Total quantity over the batch

The quantity used as the flow-weighting factor is the quantity selected under the LiquidCalcs Station screen (General Tab) for Average Flowrate Option (203,x,99). A sample is taken once per second and the final value is rounded per the table below.

Table 5-11. Flow-Weighted Correction Factor Average

Description	TLP	Factor
Flow-Weighted Correction for Pressure on the Liquid (CPL)	214,x,29	x.xxxxx
Flow-Weighted Correction for Temperature on the Liquid (CTL)	214,x,30	x.xxxxx
Flow-Weighted Correction for Temp and Press on the Liquid (CTPL)	214,x,31	x.xxxxx
Flow-Weighted Combined Correction Factor (CCF)	214,x,32	x.xxxxx
Flow-Weighted Meter Factor	214,x,33	x.xxxxx
Flow-Weighted K-factor	214,x,34	x.xxxxx
Flow-Weighted S&W Percentage	214,x,35	x.xxxxx
Flow-Weighted Correction for S&W (CSW)	214,x,36	x.xxxxx
Flow-Weighted Correction for Pressure on the Meter Body (CPS)	214,x,40	x.xxxxx
Flow-Weighted Correction for Temperature on the Meter Body (CTS)	214,x,41	x.xxxxx

Chapter 6 – Calculation of Meter Factor using Volume Displacement Proving

In This Chapter

This chapter describes the calculation and rounding methods used to calculate a meter factor from a successful prove for both average data method and average meter factor method, including rounding.

6.1 Calculation of Gross Standard Prover Volume (GSVp)

The gross standard volume of the prover (volume of the prover at base conditions) is calculated as:

$$GSV_p = BV * CCF_p$$

Where:

GSV_p = Gross Standard Volume of the Prover

BV = Base (Calibrated) Volume of the Prover

CCF_p = Combined Correction Factor of the Prover

The base volume and the gross standard volume of the prover are rounded as shown in Table 6-1.

Table 6-1. Base Volume and Gross Standard Volume

Description	TLP	Bbls or MCF	L or gal or ft3	m3 or km3
Base Prover Volume (BV)	208,0,14	xxx.xxxx xx.xxxx x.xxxxx 0.xxxxxx	xxxxx.x xxxx.xx xxx.xxx xx.xxxx	xx.xxxxx x.xxxxx 0.xxxxxx 0.0xxxxxx
Gross Standard Volume of the Prover (GSVp)	208,0,14	xxx.xxxx xx.xxxx x.xxxxx 0.xxxxxx	xxxxx.x xxxx.xx xxx.xxx xx.xxxx	xx.xxxxx x.xxxxx 0.xxxxxx 0.0xxxxxx

The combined correction factor for the prover is calculated as:

$$CCF_p = CTS_p * CPS_p * CTL_p * CPL_p$$

Where:

CCF_p = Combined Correction Factor of the Prover

CTS_p = Correction for the effect of temperature on the prover body

CPS_p = Correction for the effect of pressure on the prover body

CTL_p = Correction for the effect of temperature on liquid at the prover

CPL_p = Correction for the effect of pressure on liquid at the prover

Refer to section 2.2 for a description of CTL and CPL calculations (base to alternate), using the prover temperature and pressure for the alternate conditions. Refer to sections 6.1.1 and 6.1.2 for a description of CTSp and CPSp calculations, respectively. The interim correction factors are rounded before the combined correction factors are calculated. The correction factors are rounded as shown in Table 6-2.

Table 6-2. Correction Factor

Description	TLP	Factor
Correction for the effect of temperature on liquid at the prover (CTLp)	208,0,41	x.xxxxx
Correction for the effect of pressure on liquid at the prover (CPLp)	208,0,42	x.xxxxx
Correction for the effect of temperature on the prover body (CTSp)	208,0,43	x.xxxxx
Correction for the effect of pressure on the prover body (CPSp)	208,0,44	x.xxxxx
Combined Correction Factor for the prover (CCFp)	208,0,44	x.xxxxx

6.1.1 Calculation of Correction for Temperature on the Prover Body

For small volume provers (external detector switches), the correction for the effect of temperature on the prover body is calculated as:

$$CTSp = \left(1 + \left(T_p - T_{cal}\right)Y_1\right) \times \left(1 + \left(T_d - T_{cal}\right)Y_2\right)$$

Where:

T_p = inlet prover temperatures of the liquid

T_{cal} = calibration temperature of the prover

Y_1 = thermal coefficient of radial expansion of the prover material (/Deg)

T_d = temperature of the displacer shaft

Y_2 = thermal coefficient of linear expansion of the prover material (/Deg)

For large volume provers (internal detector switches), the correction for the effect of temperature on the prover body is calculated as:

$$CTSp = 1 + (T_p - T_{cal})Y$$

Where:

T_p = average of the inlet and outlet prover temperatures of the liquid (/Deg)

T_{cal} = calibration temperature of the prover (/Deg)

Y = thermal coefficient of cubic expansion of the prover material (/Deg)

6.1.2 Calculation of Correction for Pressure on the Prover Body

For single-walled prover, the correction for the effect of pressure on the prover body is calculated as:

$$CPS_p = 1 + (P_p - P_{cal})\frac{D}{E \times t}$$

Where:

P_p = average of the inlet and outlet prover pressures of the liquid

P_{cal} = calibration pressure of the prover

D = inside diameter of the prover tube

E = Youngs modulus of elasticity of the prover tube steel

t = wall thickness of the prover tube

For a double-walled prover, there is no correction for the effect of pressure and CPSp is set equal to 1.0.

6.2 Calculation of the Volume of the Liquid through the Meter at Base Conditions (ISVm)

The indicated standard volume of the liquid at the meter (ISVm) is calculated as:

$$ISV_m = \frac{PulseCount}{K - factor} * CCF_m$$

Where:

ISV_m = Indicated Standard Volume of Liquid at the Meter

Pulse Count = Number of pulses received at the meter (whole or interpolated)

K-factor = pulses / volume

CCF_m = Combined Correction Factor at the Meter

The combined correction factor for the meter (CCFm) is calculated as:

$$CCF_m = CTL_m * CPL_m$$

Where:

CTL_m = Correction for temperature of the liquid at the meter

CPL_m = Correction for pressure of the liquid at the meter

Refer to section 2.2 for a description of CTL and CPL calculations (base to alternate), using the meter temperature and pressure for the alternate conditions. The interim correction factors are rounded before the combined correction factors are calculated. The correction factors are rounded as shown in Table 6-3.

Table 6-3. Correction Factor at the meter

Description	TLP	Factor
Correction for the effect of temperature on liquid at the meter (CTLm)	208,0,39	x.xxxxx
Correction for the effect of pressure on liquid at the meter (CPLm)	208,0,40	x.xxxxx
Combined Correction Factor for the meter (CCFm)	208,0,45	x.xxxxx

The Indicated Volume and Indicated Standard Volume of Liquid at the meter are rounded as shown in Table 6-4.

Table 6-4. Indicated Volume and Indicated Standard Volume

Description	TLP	Bbls or MCF	L or gal or ft3	m3 or km3
Indicated Volume (IV)	208,0,60	xxx.xxxx xx.xxxx x.xxxxx 0.xxxxxx	xxxxx.x xxxx.xx xxx.xxx xx.xxxx	xx.xxxxx x.xxxxx 0.xxxxxx 0.0xxxxxx
Indicated Standard Volume of the Liquid at the meter (ISVm)	208,0,47	xxx.xxxx xx.xxxx x.xxxxx 0.xxxxxx	xxxxx.x xxxx.xx xxx.xxx xx.xxxx	xx.xxxxx x.xxxxx 0.xxxxxx 0.0xxxxxx

6.3 Calculation of Meter Factor and Repeatability using Average Meter Factor Method

If the average meter factor method is selected for calculation of the meter factor and repeatability, a meter factor is calculated for each trial run from the pulse count for that trial run and the average meter temperature and pressure and average prover temperature and pressure over the trial run.

6.3.1 Calculation of Trial Run Meter Factor

The meter factor for each trial run is calculated as follows:

$$MF_i = \frac{GSVp_i}{ISVm_i}$$

Where:

MF_i = Meter factor calculated for Trial Run i

$GSVp_i$ = Gross Standard Volume of Liquid through Prover for Trial i

$ISVm_i$ = Indicated Standard Volume of Liquid through meter for Trial i

Table 6-5. Gross Standard Volume and Indicated Standard Volume for Trial Run i

Description	TLP	Bbls or MCF	L or gal or ft3	m3 or km3
Gross Standard Volume at the Prover for Trial Run i ($GSVp_i$)	207,i,26	xxx.xxxx xx.xxxx x.xxxxx 0.xxxxxx	xxxxx.x xxxx.xx xxx.xxx xx.xxxx	xx.xxxxx x.xxxxx 0.xxxxxx 0.0xxxxxx
Indicated Standard Volume at the Meter for Trial Run i ($ISVm_i$)	207,i,25	xxx.xxxx xx.xxxx x.xxxxx 0.xxxxxx	xxxxx.x xxxx.xx xxx.xxx xx.xxxx	xx.xxxxx x.xxxxx 0.xxxxxx 0.0xxxxxx

The GSVpi and ISVmi for each trial run are calculated using the formulas in sections 6.1 and 6.2. The values of meter and prover temperatures and pressures used in the calculation are average temperatures and pressures over the trial run as described in sections 6.3.2 and 6.3.3. The values of GSVpi and ISVmi are rounded as shown in Table 6-6.

The correction factors and meter factor for each trial run are rounded as shown in the table below.

Table 6-6. Correction Factorfor each trial run

Description	TLP	Factor
CTLm for Trial Run i	207,i,17	x.xxxxx
CPLm for Trial Run i	207,i,18	x.xxxxx
CTLp for Trial Run i	207,i,19	x.xxxxx
CPLp for Trial Run i	207,i,20	x.xxxxx
CTSp for Trial Run i	207,i,21	x.xxxxx
CPSp for Trial Run i	207,i,22	x.xxxxx
CCFm for Trial Run i	207,i,23	x.xxxxx
CCFp for Trial Run i	207,i,24	x.xxxxx
Meter Factor for Trial Run i	207,i,27	x.xxxxx

6.3.2 Average Trial Run Pressure

The average pressures are calculated as linear averages of one second samples taken over the trial run (in between detector switches) and are rounded as shown in Table 6-7.

Table 6-7. Average Trial Run Pressure

Description	TLP	PSIG	kPa(g)	barg	kg/cm2
Average Meter Pressure for Trial i	207,i,4	xx.0	xx.0	xx.x	xx.x
Average Prover Pressure for Trial i	207,i,12	xx.0	xx.0	xx.x	xx.x

6.3.3 Average Trial Run Temperature

The average temperatures are calculated as linear averages of one second samples taken over the trial run (in between detector switches) and are rounded as shown in Table 6-8.

Table 6-8. Average Trial Run Temperature

Description	TLP	Deg F	Deg C
Average Meter Temperature for Trial i	207,i,3	x.x	x.x5
Average Prover Temperature for Trial i	207,i,11	x.x	x.x5

6.3.4 Repeatability Calculation

The repeatability for each trial run is calculated as:

$$repeatability = \frac{MF_{MAX} - MF_{MIN}}{MF_{MIN}} \times 100.0$$

Where:

MF_{max} = Maximum meter factor from all “good” trial runs

MF_{min} = Minimum meter factor from all “good” trial runs

The repeatability of a trial run may be considered unacceptable compared to earlier trial runs, but may be acceptable if those earlier trial runs are discarded. The ROC800L proving program will compare trial run repeatability in all sequential sets of trial runs to try to find the acceptable number of sequential, repeatable runs. The factors and repeatability for each trial run are rounded as shown in Table 6-9.

Table 6-9. Repeatability for Trial Run i

Description	TLP	Factor
Repeatability for Trial Run i	207,i,28	x.xxxxx

6.3.5 Final Meter Factor Calculation

Once the number of sequential, repeatable trial runs meets the minimum number specified in the prover configuration, the final meter factor is calculated as:

$$MF = \frac{\sum_{i=1}^{n} MF_i}{n}$$

Where:

MF = Final meter factor

MF_i = Meter factor calculated for trial run i

i = First trial of set of sequential, repeatable trial runs

n = Total number of sequential, repeatable trial runs

The final meter factor is rounded as shown in Table 6-10.

Table 6-10. Final Meter Factor

Description	TLP	Factor
Final Meter Factor	208,0,84	x.xxxx

6.4 Calculation of Meter Factor and Repeatability using Average Data Method

If the average data method is selected for calculation of the meter factor and repeatability, the average pulse count, average meter temperature and pressure, and average prover temperature and pressure are calculated across the sequential, repeatable trial runs and a final meter factor calculated using these averages.

6.4.1 Repeatability Calculation

The repeatability for each trial run is calculated as follows:

$$repeatability = \frac{Pulses_{MAX} - Pulses_{MIN}}{Pulses_{MIN}} \times 100.0$$

Where:

$Pulses_{max}$ = Maximum pulse count from all “good” trial runs

$Pulses_{min}$ = Minimum pulse count from all “good” trial runs

The repeatability of a trial run may be considered unacceptable compared to earlier trial runs, but may be acceptable if those earlier trial runs are discarded. The ROC800L proving program will compare trial run repeatability in all sequential sets of trial runs to try to find the acceptable number of sequential, repeatable runs. The repeatability for each trial run is rounded as shown in the table below.

Table 6-11. Repeatability for Trial Run i

Description	TLP	Factor
Repeatability for Trial Run i	207,i,28	x.xxxxx

6.4.2 Average Pulse Calculation

Average pulses are calculated as a linear average of pulse counts from each sequential, repeatable trial run and rounded per Table 6-12.

Table 6-12. Average Pulse

Description	TLP	Pulses (Whole)	Pulses (Pulses Interpolation)
Average Pulse	208,0,38	xx.x	xx.xxxx

6.4.3 Average Pressure Calculation

A linear average of the meter pressure and a linear average of the prover pressure over each trial run are calculated as described in section 5.3. Final averages are calculated as linear averages of the trial run data from each of the sequential, repeatable trial runs. These pressure average values are rounded per Table 6-13.

Table 6-13. Average Pressure

Description	TLP	PSIG	kPa(g)	barg	kg/cm2
Average Meter Pressure	208,0,24	xx.0	xx.0	xx.x	xx.x
Average Prover Pressure	208,0,33	xx.0	xx.0	xx.x	xx.x

6.4.4 Average Temperature Calculation

A linear average of the meter temperature and a linear average of the prover temperature over each trial run are calculated as described in Section 6.3. Final averages are calculated as linear averages of the trial run data from each of the sequential, repeatable trial runs. These temperature average values are rounded per Table 6-14.

Table 6-14. Final Average Temperature

Description	TLP	Deg F	Deg C
Final Average Meter Temperature	208,0,23	x.x	x.x5
Final Average Prover Temperature	208,0,32	x.x	x.x5

6.4.5 Meter Factor Calculation

The final meter factor is calculated as:

$$MF = \frac{GSVp_{avg}}{ISVm_{avg}}$$

Where:

MF = Final Meter Factor

$GSVp_{avg}$= Gross Standard Volume of Liquid through Prover

$ISVm_{avg}$=Indicated Standard Volume of Liquid through Meter

The GSVp and ISVm values are calculated using the formulas in Sections 6.1 and 6.2. The pulse count and values of meter and prover temperatures and pressures used in the calculation are the average values calculated over the sequential, repeatable trial runs as described in Sections 6.4.2, 6.4.3, and 6.4.4. The values are rounded as shown in Tables 6-15 and 6-16.

Table 6-15. Gross Standard Volume and Indicated Standard Volume using Average Data

Description	TLP	Bbls or MCF	L or gal or ft3	m3 or km3
Gross Standard Volume at the Prover using Average Data ($GSVp_{avg}$)	208,0,74	xxx.xxxx xx.xxxx x.xxxxx 0.xxxxxx	xxxxx.x xxxx.xx xxx.xxx xx.xxxx	xx.xxxxx x.xxxxx 0.xxxxxx 0.0xxxxxx
Indicated Standard Volume at the Meter using Average Data ($ISVm_{avg}$)	208,0,78	xxx.xxxx xx.xxxx x.xxxxx 0.xxxxxx	xxxxx.x xxxx.xx xxx.xxx xx.xxxx	xx.xxxxx x.xxxxx 0.xxxxxx 0.0xxxxxx

Table 6-16. Correction Factor using Average Data

Description	TLP	Factor
CTLm using Average Data	208,0,75	x.xxxxx
CPLm using Average Data	208,0,76	x.xxxxx
CTLp using Average Data	208,0,71	x.xxxxx
CPLp using Average Data	208,0,72	x.xxxxx
CTSp using Average Data	208,0,69	x.xxxxx
CPSp using Average Data	208,0,70	x.xxxxx
CCFm using Average Data	208,0,77	x.xxxxx
CCFp using Average Data	208,0,73	x.xxxxx
Final Meter Factor	208,0,84	x.xxxxx

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