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Bulletin

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Manual Correction of Measured Liquid Volumes to Equivalent Volumes at Reference Conditions

1.0 Scope

This bulletin communicates the policy and outlines the procedures for the manual correction of measured liquid volumes to equivalent volumes at reference conditions.

2.0 Background

2.1 With the exception of the *Weights and Measures Specifications for Propane Dispensers* (SVM-3), which require that propane dispensers approved and/or initially inspected after the establishment of these Specifications (September 11, 1991) be equipped with electronic automatic temperature compensators, the *Weights and Measures Act* does not address the manual correction of volume to a reference temperature or pressure, or the manual conversion from volume to mass. However, such corrections or conversions must be performed using proper and prescribed methods in order to ensure an accurate statement of the net quantity.

2.2 The volume correction tables to be used are those known to be accurate, based on reliable studies, and which are authorized by Measurement Canada. These tables are summarized in Table 1.

3.0 Method for Manual Temperature Correction

3.1 This bulletin was originally created to allow industry to implement temperature compensation throughout their distribution systems at a time when equipment to perform Automatic Temperature Compensation (ATC) was in short supply and relatively expensive. Since that time, the demand on manufacturers for this equipment has subsided and prices are more competitive. Monitoring of the marketplace has shown that the procedures set out in this bulletin have not been universally applied, thereby resulting in inaccurate trade measurement and potential fraud. For these reasons, **the practice of manual temperature compensation, at all levels of trade, will not be permitted after January 1, 2003**. The decision was made and the date was determined in consultation with stakeholders at the Canadian Forum for Trade Measurement held in Montréal by Measurement Canada in November 2000.

3.2 The manual correction of petroleum liquids shall be made to a reference temperature of 15 °C.

3.3 The liquid's temperature should be determined using a thermometer that is traceable to a recognized national or international standard, and that has a suitable range, a minimum graduation size of 0.5 °C and an accuracy of ± 0.5 °C.

3.4 The temperature sensor and test thermal well shall be installed and located as prescribed in the *Specifications for Metering Assemblies Incorporating Electronic Automatic Temperature Compensators* (SVM-2).

3.5 The temperature used, when referring to the reference table, should be the arithmetic mean of at least four temperature measurements taken during the product delivery, the first of which is taken when 10% of the delivery is completed and the final when 90% of the delivery is completed.

3.6 In order to obtain the volume correction factor (VCF) at the mean metering temperature, an authorized table for the applicable liquid should be used. This table is either as prescribed in section 270 of the *Weights and Measures Regulations* or in the appropriate bulletin. Refer to the appropriate column in the table using the known product density at 15 °C. Read the VCF corresponding to the mean liquid temperature. If needed, interpolate the VCF value to the nearest 0.1 °C.

3.7 To determine the net "corrected to 15 °C" meter registration, the VCF is multiplied by the gross meter registration.

3.8 A bill of lading shall be provided and, in addition to the information prescribed in the Regulations, it shall indicate that the gross meter registration has been manually corrected to 15 °C. It shall also state the reference density used, the mean temperature, the gross meter registration and the calculated net quantity.

4.0 Method for Manual Pressure Correction

4.1 The manual correction of petroleum liquids shall be made to a reference pressure of 101.325 kPa in the case of liquids which have equilibrium vapour pressures less than 101.325 kPa at 15 °C, and to the liquid's vapour pressure at 15 °C in the case of liquids which have equilibrium vapour pressures greater than 101.325 kPa.

4.2 The liquid's pressure and/or equilibrium vapour pressure should be determined using a pressure gauge or differential pressure gauge that is traceable to a recognized national or international standard and that has a suitable range and minimum graduation size of 50 kPa.

4.3 The pressure sensor shall meet the accuracy and installation requirements prescribed in the draft *Specifications for Electronic Pressure Transducers*.

4.4 The meter pressure used should be the arithmetic mean of at least 4 pressure measurements taken during the product delivery, the first of which is taken when 10% of the delivery is completed and the final one when 90% of the delivery is completed.

4.5 The temperature used shall be provided by a certified temperature sensor. If the temperature is to be manually determined, the contents of section 3 of this bulletin apply.

4.6 In the case of liquids which have equilibrium vapour pressures greater than 101.325 kPa at 15 °C, a second pressure reading of the vapour pressure at the liquid's temperature is required.

4.7 The equilibrium vapour pressure of the liquid can be determined by measuring the pressure in a vapour bomb in the case of an installation which has a condensation tank or, where a vapour eliminator is employed, by measuring the pressure in the vapour return line.

4.8 Pressure or compressibility correction factors (C_{pl}) can be calculated using data compiled in the table in chapter 11.2.2 M of the American Petroleum Institute's (API) *Manual of Petroleum Measurement Standards* and the equation below.

$$C_{pl} = \frac{1}{1-(P-P_E)\times F}$$

Where:

P = Mean pressure at the meter in kPa gauge.
P_E = Equilibrium vapour pressure in kPa at the measurement temperature of the liquid. P_E is "0" for liquids which have an equilibrium vapour pressure less than 101.325 kPa at 15 ºC.
F = Compressibility factor for hydrocarbons from chapter 11.2.2 M (350 to 637 kg/m^3) and chapter 11.2.1 (638 to 1074 kg/m^3) of the API.

4.9 The correction factors for propane (density = 505 kg/m^3 @ 15 °C) have been calculated and can be found in Table 2.

4.10 The C_{pl} is then multiplied by the temperature-compensated net meter reading to provide a net "corrected to reference conditions of 15 °C and vapour pressure at 15 °C" reading.

4.11 The bill of lading shall be provided and, in addition to the information prescribed in the Regulations, it shall indicate that the volume has been manually corrected to 15 °C and manually corrected to a reference pressure. It shall also state the reference pressure used, the reference density used, the mean temperature, mean pressure as well as the net and gross meter registrations.

5.0 Prohibition of Composite Meter Factors

5.1 A composite meter factor is the result of multiplying the meter factor determined during the proving by an additional pressure factor, which is the C_{pl}, at the time of proving.

5.2 As a result, composite meter factors do not allow for any change in system pressures during system operation.

5.3 Therefore, **the use of composite meter factors is not acceptable in trade applications**. In situations where pressure compensation is desirable, additional dynamic pressure sensing elements must be provided in the metering installation.

6.0 Revisions

The purpose of revision 1 was to:

- amend Table 1 of the bulletin to include a separate category for Jet B Fuel;
- add standard density values in the Volume Correction Factor column; and
- make minor changes to the text.

The purpose of revision 2 was to set a date after which the practise of manual temperature compensation will not be allowed.

The purpose of revision 3 was to update the format of the bulletin to meet web accessibility requirements.

7.0 Additional Information

For additional information regarding this bulletin, please contact the Senior Program Officer responsible for volume. For more information regarding Measurement Canada and its programs, visit our website.

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Appendix - Table 1: Summary of authorized tables for the manual correction of volume

Product Description	**Equilibrium Vapour Pressure at 15 °C**	**Density Correction Factor**	**Volume Correction Factor (VCF)**	**Pressure Correction Factor (C_{pl})**
Propane, butane	>101.325 kPa	ASTM-IP Table 53	ASTM-IP Table 54 (mean density .510)	API chapter 11.2.2 M
Gasoline, diesel	<101.325 kPa	API chapter 11.1 Table 53B	API chapter 11.1 Table 54B (mean density .730/gas and .840/diesel)	API chapter 11.2.1 M
Jet A fuel	<101.325 kPa	API chapter 11.1 Table 53B	API chapter 11.1 Table 54B (mean density .800)	API chapter 11.2.1 M
Jet B fuel	<101.325 kPa	API chapter 11.1 Table 53A	API chapter 11.1 Table 54A (mean density .760)	API chapter 11.2.1 M
Lubricating oils	<101.325 kPa	API chapter 11.1 Table 53D	API chapter 11.1 Table 54D (mean density .880)	API chapter 11.2.1 M
Other products	Please refer to the applicable bulletin for tables approved for specific non petroleum-based products.			

Table 2: Correction factors for the effect of pressure (C_{pl}) on propane liquid volume (Source: API, chapter 11.2.2M)

Pressure kPa *	Temperature					
	-20.0 to -10.1 °C	-10.0 to -0.01 °C	0.0 to +9.9 °C	+10.0 to +19.9 °C	+20.0 to +29.9 °C	+30.0 to +39.9 °C
50	1.000	1.000	1.000	1.000	1.000	1.000
100	1.000	1.000	1.000	1.001	1.001	1.001
150	1.000	1.001	1.001	1.001	1.001	1.001
200	1.001	1.001	1.001	1.001	1.001	1.002
250	1.001	1.001	1.001	1.001	1.002	1.002
300	1.001	1.001	1.001	1.002	1.002	1.002
350	1.001	1.001	1.002	1.002	1.002	1.003
400	1.001	1.001	1.002	1.002	1.003	1.003
450	1.001	1.002	1.002	1.002	1.003	1.004
500	1.002	1.002	1.002	1.003	1.003	1.004
550	1.002	1.002	1.002	1.003	1.004	1.004
600	1.002	1.002	1.003	1.003	1.004	1.005
650	1.002	1.002	1.003	1.003	1.004	1.005
700	1.002	1.002	1.003	1.004	1.004	1.005
750	1.002	1.003	1.003	1.004	1.005	1.006
800	1.002	1.003	1.003	1.004	1.005	1.006
850	1.003	1.003	1.004	1.004	1.005	1.007
900	1.003	1.003	1.004	1.005	1.006	1.007
950	1.003	1.003	1.004	1.005	1.006	1.008
1000	1.003	1.004	1.004	1.005	1.006	1.008
1050	1.003	1.004	1.004	1.005	1.007	1.008
1100	1.003	1.004	1.005	1.006	1.007	1.009
1150	1.003	1.004	1.005	1.006	1.007	1.009
1200	1.004	1.004	1.005	1.006	1.008	1.009

* The pressure indicated in this table is the difference between the operating pressure and the equilibrium vapour pressure at that particular temperature.