# Manual of Petroleum Measurement Standards
# Chapter 11—Physical Properties Data

## Section 2, Part 4—Temperature Correction for the Volume of NGL and LPG Tables 23E, 24E, 53E, 54E, 59E, and 60E

**ASTM Technical Publication [Stock No. PETROLTBL-TP27]**
**GPA Technical Publication TP-27**

FIRST EDITION, SEPTEMBER 2007



# Manual of Petroleum Measurement Standards
# Chapter 11—Physical Properties Data

## Section 2, Part 4—Temperature Correction for the Volume of NGL and LPG Tables 23E, 24E, 53E, 54E, 59E, and 60E

**ASTM Technical Publication [Stock No. PETROLTBL-TP27]**
**GPA Technical Publication TP-27**

**Measurement Coordination**

FIRST EDITION, SEPTEMBER 2007

**Prepared for**

**American Petroleum Institute**
**1220 L Street, NW**
**Washington, D.C. 20005**

**ASTM International**
**100 Barr Harbor Drive**
**West Conshohocken, PA 19428**

**Gas Processors Association**
**6526 E. 60th Street**
**Tulsa, OK 74145**

# Foreword

For custody transfer purposes, natural gas liquid (NGL) and liquefied petroleum gas (LPG) volumes are generally stated at a fixed base temperature and saturation pressure. As most volume transfers occur at temperatures and pressures other than standard conditions, these volumes are adjusted to standard conditions through the use of correction factors.

This document presents a new method to calculate temperature correction factors. With the publication of this document, previous API, ASTM and GPA documents containing NGL and LPG temperature correction factors should no longer be used. The document is specifically titled as being suitable for NGL and LPG liquids. Light hydrocarbon mixtures containing significant quantities of methane, carbon dioxide and nitrogen which have density ranges which overlap those contained in these tables can be encountered. However, the two-fluid correlation which is the basis of these tables was not calibrated for such mixtures.

The actual Standard represented by this report consists of the explicit implementation procedures. Sample tables and other examples created from a computerized version of these implementation procedures are presented within. However, these are for examples only and do not represent the Standard.



This document was produced under API standardization procedures that ensure appropriate notification and participation in the developmental process and is designated as an API standard. Questions concerning the interpretation of the content of this publication or comments and questions concerning the procedures under which this publication was developed should be directed in writing to the Director of Standards, American Petroleum Institute, 1220 L Street, N.W., Washington, D.C. 20005. Requests for permission to reproduce or translate all or any part of the material published herein should also be addressed to the director.

Generally, API standards are reviewed and revised, reaffirmed, or withdrawn at least every five years. A one-time extension of up to two years may be added to this review cycle. Status of the publication can be ascertained from the API Standards Department, telephone (202) 682-8000. A catalog of API publications and materials is published annually and updated quarterly by API, 1220 L Street, N.W., Washington, D.C. 20005.

Suggested revisions are invited and should be submitted to the Standards and Publications Department, API, 1220 L Street, NW, Washington, D.C. 20005, standards@api.org.

## API Special Notes

API publications necessarily address problems of a general nature. With respect to particular circumstances, local, state, and federal laws and regulations should be reviewed.

Neither API nor any of API's employees, subcontractors, consultants, committees, or other assignees make any warranty or representation, either express or implied, with respect to the accuracy, completeness, or usefulness of the information contained herein, or assume any liability or responsibility for any use, or the results of such use, of any information or process disclosed in this publication. Neither API nor any of API's employees, subcontractors, consultants, or other assignees represent that use of this publication would not infringe upon privately owned rights.

API publications may be used by anyone desiring to do so. This publication is an updated version of TP-25. Previous editions of this publication were numbered TP-25. Users of this standard should take efforts to ensure they are using the most current version of this publication. Every effort has been made by the Institute to assure the accuracy and reliability of the data contained in them; however, the Institute makes no representation, warranty, or guarantee in connection with this publication and hereby expressly disclaims any liability or responsibility for loss or damage resulting from its use or for the violation of any authorities having jurisdiction with which this publication may conflict.

API publications are published to facilitate the broad availability of proven, sound engineering and operating practices. These publications are not intended to obviate the need for applying sound engineering judgment regarding when and where these publications should be utilized. The formulation and publication of API publications is not intended in any way to inhibit anyone from using any other practices.

Any manufacturer marking equipment or materials in conformance with the marking requirements of an API standard is solely responsible for complying with all the applicable requirements of that standard. API does not represent, warrant, or guarantee that such products do in fact conform to the applicable API standard.

## ASTM Note

This publication does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this publication to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

## GPA Disclaimer

Neither the GPA nor any person acting on behalf of the GPA makes any warranty, guarantee, or representation, express or implied, with respect to the accuracy, completeness, or usefulness of the information contained in this report. The GPA hereby expressly disclaims any liability or responsibility for loss or damage resulting from the use of any apparatus, method, or process disclosed in this report; and for the infringement of any patent or the violation of any federal, state, or municipal law or regulation arising from the use of, any information, apparatus, method, or process disclosed in this report.

## Table of Contents

## Nomenclature

| | |
|---|---|
| $A$, $B$, $C$ | parameters in Section 5.1.2 quadratic equation |
| $C_{TL}$ | temperature correction factor |
| $h_2$ | scaling factor |
| $k_1$, $k_2$, $k_3$, $k_4$ | parameters in saturation density equation |
| $T_B$ | base temperature (60°F, 15°C, or 20°C) |
| $T_{BK}$ | base temperature (288.15 K, or 293.15 K) |
| $T_c$ | fluid critical temperature (K) |
| $T_{c,ref}$ | reference fluid critical temperature (K) |
| $T_F$ | observed measurement temperature (°F or °C) |
| $T_{r,x}$ | reduced observed temperature |
| $T_x$ | observed temperature (K) |
| $V_{60}/V_{Tx}$ | ratio of volume at 60°F to volume at temperature $T_x$. Is the basic definition of $C_{TL}$ |
| $X$ | interpolating factor |
| $Z_c$ | critical compressibility factor |
| $\alpha$, $\beta$, $\phi$ | parameters in Section 5.1.2 quadratic equation |
| $\delta$ | interpolation variable |
| $\tau$ | parameter in saturation density equation |
| $\gamma_x$ | relative density at observed temperature |
| $\gamma_{x,high}$ | relative density at the observed temperature corresponding to the upper bound for the 60° relative density |
| $\gamma_{x,low}$ | relative density at the observed temperature corresponding to the lower bound for the 60° relative density |
| $\gamma_{x,mid}$ | relative density at the observed temperature corresponding to the intermediate 60° relative density used in Section 5.1.2 iteration procedure |
| $\gamma_{x,trial}$ | trial relative density at the observed temperature used in Section 5.1.2 iteration procedure |
| $\gamma_{TB}$ | relative density at the base temperature, $T_B$ |
| $\gamma_{60}$ | relative density at a base temperature of 60°F |
| $\gamma_{Tx}$ | relative density at the observed temperature, $T_x$ |
| $\gamma_{60,high}$ | upper bound for the observed fluid's 60° relative density |
| $\gamma_{60,low}$ | lower bound for the observed fluid's 60° relative density |
| $\gamma_{60,mid}$ | intermediate 60°F relative density value used in Section 5.1.2 iteration procedure |
| $\gamma_{60,trial}$ | trial 60°F relative density value used in Section 5.1.2 iteration procedure |
| $\rho_c$ | critical molar density (gram-mole/L) |
| $\rho_{60}$ | density at a base temperature of 60°F (kg/m$^3$) |
| $\rho_{15}$ | density at a base temperature of 15°C (kg/m$^3$) |
| $\rho_{20}$ | density at a base temperature of 20°C (kg/m$^3$) |
| $\rho^{sat}$ | saturation molar density (gram-mole/L) |
| $\rho_{60}^{sat}$ | saturation molar density at 60°F (gram-mole/L) |
| $\rho_T^{sat}$ | saturation molar density at observed temperature (gram-mole/L) |

# Temperature Correction for the Volume of NGL and LPG Tables 23E, 24E, 53E, 54E, 59E, and 60E

## 0 Implementation Guidelines

This Revised Standard/Technical Publication is effective upon the date of publication and supersedes the ASTM-IP 1952 Petroleum Measurement Tables, GPA 2142, GPA TP-16, Tables 33 and 34 of API MPMS Chapter 11.1-1980 Volumes XI/XI (Adjuncts to ASTM D1250-80 and IP 200/80), API MPMS Chapter 11.2.2/11.2.2M, and API/ASTM/GPA TP-25. However, due to the nature of the changes in this Revised Standard/Technical Publication and the fact that it is or may be incorporated by reference in various regulations, it is recognized that guidance concerning an implementation period may be needed in order to avoid disruptions within the industry and ensure proper application. As a result, it is recommended that this Revised Standard/Technical Publication be utilized on all new and existing applications no later than TWO YEARS after the publication date. An application, for this purpose, is defined as the point where the calculation is applied.

Once the Revised Standard/Technical Publication is implemented in a particular application, the Previous Standard/Technical Publication will no longer be used in that application.

However, the use of API standards and ASTM and GPA technical publications remains voluntary, and the decision on when to utilize a standard/technical publication is an issue that is subject to the negotiations between the parties involved in the transaction.

## 1 Introduction

For custody transfer purposes, natural gas liquid (NGL) and liquefied petroleum gas (LPG) volumes are generally stated at a fixed base temperature and saturation pressure. As most volume transfers occur at temperatures and pressures other than standard conditions, these volumes are adjusted to standard conditions through the use of correction factors. Separate factors for temperature ($C_{TL}$) and pressure ($C_{PL}$) are used to make these corrections. This document presents a new method to calculate temperature correction factors. Pressure correction factors are not within the scope of this document, but can be calculated using American Petroleum Institute *Manual of Petroleum Measurement Standards* (*MPMS*) Chapter 11.1-2004[1] (which superseded Chapter 11.2.1-1984[2] and 11.2.1M-1984[3]), Chapter 11.2.2-1986/GPA 8286-86[4] or Chapter 11.2.2M-1986/GPA 8286-86[5], depending on product type.

Previously, most NGL and LPG temperature correction factors have been obtained from a variety of sources:

- ASTM-IP "Petroleum Measurement Tables"[6], published in 1952. This publication is limited to a 60°F relative density range of 0.500 and higher.