Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

LP-Gas Code Handbook

EX1017
HARBOR FREIGHT TOOLS
IPR2025-01272

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

LP-Gas Code Handbook

EIGHTH EDITION

Edited by

Theodore C. Lemoff, P.E.
Principal Gases Engineer, NFPA

With the complete text of the 2008 edition of NFPA® 58, *Liquefied Petroleum Gas Code*

National Fire Protection Association®
Quincy, Massachusetts

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

Product Manager: Debra Rose
Project Editor: Irene Herlihy
Permissions Editor: Josiane Domenici
Copy Editor: Marla Marek
Composition: Modern Graphics, Inc.

Art Coordinator: Cheryl Langway
Cover Designer: Cameron Inc.
Manufacturing Manager: Ellen Glisker
Printer: R.R. Donnelley/Willard

Copyright ©2008
National Fire Protection Association®
One Batterymarch Park
Quincy, Massachusetts 02169-7471

All rights reserved.

Notice Concerning Liability: Publication of this handbook is for the purpose of circulating information and opinion among those concerned for fire and electrical safety and related subjects. While every effort has been made to achieve a work of high quality, neither the NFPA® nor the contributors to this handbook guarantee the accuracy or completeness of or assume any liability in connection with the information and opinions contained in this handbook. The NFPA and the contributors shall in no event be liable for any personal injury, property, or other damages of any nature whatsoever, whether special, indirect, consequential, or compensatory, directly or indirectly resulting from the publication, use of, or reliance upon this handbook.

This handbook is published with the understanding that the NFPA and the contributors to this handbook are supplying information and opinion but are not attempting to render engineering or other professional services. If such services are required, the assistance of an appropriate professional should be sought.

NFPA codes and standards are made available for use subject to Important Notices and Legal Disclaimers, which appear at the end of this handbook and can also be viewed at *www.nfpa.org/disclaimers.*

Notice Concerning Code Interpretations: This eighth edition of *LP-Gas Code Handbook* is based on the 2008 edition of NFPA 58, *Liquefied Petroleum Gas Code.* All NFPA codes, standards, recommended practices, and guides are developed in accordance with the published procedures of the NFPA by technical committees comprised of volunteers drawn from a broad array of relevant interests. The handbook contains the complete text of NFPA 58 and any applicable Formal Interpretations issued by the Association. These documents are accompanied by explanatory commentary and other supplementary materials.

The commentary and supplementary materials in this handbook are not a part of the *Code* and do not constitute Formal Interpretations of the NFPA (which can be obtained only through requests processed by the responsible technical committees in accordance with the published procedures of the NFPA). The commentary and supplementary materials, therefore, solely reflect the personal opinions of the editor or other contributors and do not necessarily represent the official position of the NFPA or its technical committees.

NFPA No.: 58HB08
ISBN-10: 0-87765-753-X
ISBN-13: 978-0-87765-753-8

Library of Congress Control No.: 2007934329

Printed in the United States of America
08 09 10 11 12 5 4 3 2 1

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

This handbook is dedicated to the people who led the NFPA Technical Committee on Liquefied Petroleum Gases from NFPA 58's first edition in 1932 to the present. In the early days the committee truly wrote the standard (it became a code in 1998), with NFPA staff taking a larger role beginning in 1956.

Those who chaired the committee in the past are recognized here for their foresight, dedication, and vision, which shaped the Code into the complete document it is today.

H. E. Newell*, National Board of Fire Underwriters, 1932–1955

Franklin R. Featherston*, Liquefied Petroleum Gas Association, 1956–1967

H. V. Keepers*, Fire Prevention & Engineering Bureau of Texas, 1968–1975

Connor L. Adams*, City of Miami Bldg. Dept., 1976–1996

E. E. (Al) Linder, Watsonville, CA, 1997–2004

NFPA 58 would not be *the* internationally recognized propane code were it not for the work of these dedicated people. Their contributions are appreciated.

*deceased

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

Contents

List of Figures, Tables, and Exhibits xi

Preface xix

About the Contributors xxv

About the Editor xxvii

PART ONE
NFPA 58, *Liquefied Petroleum Gas Code*, 2008 Edition, with Commentary 1

1 Administration 3
1.1 Scope 3
1.2 Purpose. (Reserved) 4
1.3 Application 5
1.4 Retroactivity 11
1.5 Equivalency 12
1.6 Units and Formulas. (Reserved) 13
1.7 Enforcement 13

2 Referenced Publications 15
2.1 General 15
2.2 NFPA Publications 16
2.3 Other Publications 16
2.4 References for Extracts in Mandatory Sections 18

3 Definitions 19
3.1 General 19
3.2 NFPA Official Definitions 19
3.3 General Definitions 21

4 General Requirements 43
4.1 Acceptance of Equipment and Systems 43
4.2 LP-Gas Odorization 44
4.3 Notification of Installations 47
4.4 Qualification of Personnel 49
4.5 Ammonia Contamination 50
4.6 Minimum Requirements 50

5 LP-Gas Equipment and Appliances 57
5.1 Scope 57
5.2 Containers 57
5.3 Reserved 85
5.4 Reserved 85
5.5 Reserved 85
5.6 Reserved 85
5.7 Container Appurtenances and Regulators 85
5.8 Regulators and Regulator Vents 114
5.9 Piping (Including Hose), Fittings, and Valves 120
5.10 Reserved 127
5.11 Internal Valves. (Reserved) 127
5.12 Valves Other Than Container Valves 127
5.13 Hydrostatic Relief Valves 129
5.14 Reserved 130
5.15 Reserved 130
5.16 Reserved 130
5.17 Equipment 131
5.18 Reserved 138
5.19 Reserved 138
5.20 Appliances 139
5.21 Vaporizers, Tank Heaters, Vaporizing Burners, and Gas–Air Mixers 141

6 Installation of LP-Gas Systems 153
6.1 Scope 155
6.2 Location of Containers 155
6.3 Container Separation Distances 156
6.4 Other Container Location Requirements 168
6.5 Location of Transfer Operations 174
6.6 Installation of Containers 178
6.7 Installation of Container Appurtenances 197
6.8 Regulators 201
6.9 Piping Systems 208
6.10 Remote Shutoff Actuation 218
6.11 Internal Valves 219
6.12 Emergency Shutoff Valves 219
6.13 Hydrostatic Relief Valve Installation 226
6.14 Testing Piping Systems 226

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

6.15 Installation in Areas of Heavy Snowfall 227
6.16 Corrosion Protection 228
6.17 Equipment Installation 228
6.18 Bulk Plant and Industrial LP-Gas Systems 232
6.19 LP-Gas Systems in Buildings or on Building Roofs or Exterior Balconies 237
6.20 Installation of Appliances 253
6.21 Vaporizer Installation 255
6.22 Ignition Source Control 265
6.23 LP-Gas Systems on Vehicles (Other Than Engine Fuel Systems) 273
6.24 Vehicle Fuel Dispenser and Dispensing Stations 280
6.25 Fire Protection 285
6.26 Alternate Provisions for Installation of ASME Containers 294

7 LP-Gas Liquid Transfer 301
7.1 Scope 301
7.2 Operational Safety 302
7.3 Venting LP-Gas to the Atmosphere 316
7.4 Quantity of LP-Gas in Containers 319

8 Storage of Cylinders Awaiting Use, Resale, or Exchange 329
8.1 Scope 329
8.2 General Provisions 330
8.3 Storage Within Buildings 332
8.4 Storage Outside of Buildings 336
8.5 Fire Protection 341

9 Vehicular Transportation of LP-Gas 343
9.1 Scope 344
9.2 Electrical Requirements 346
9.3 Transportation in Portable Containers 347
9.4 Transportation in Cargo Tank Vehicles 351
9.5 Trailers, Semitrailers, and Movable Fuel Storage Tenders, Including Farm Carts 358
9.6 Transportation of Stationary Containers to and from Point of Installation 359
9.7 Parking and Garaging Vehicles Used to Carry LP-Gas Cargo 362

10 Buildings or Structures Housing LP-Gas Distribution Facilities 367
10.1 Scope 368
10.2 Separate Structures or Buildings 368
10.3 Attached Structures or Rooms Within Structures 371

11 Engine Fuel Systems 373
11.1 Scope 373
11.2 Training 374
11.3 Containers 375
11.4 Container Appurtenances 379
11.5 Carburetion Equipment 382
11.6 Piping, Hose, and Fittings 384
11.7 Installation of Containers and Container Appurtenances 385
11.8 Installation in the Interior of Vehicles 389
11.9 Pipe and Hose Installation 391
11.10 Equipment Installation 392
11.11 Marking 392
11.12 Industrial (and Forklift) Trucks Powered by LP-Gas 393
11.13 General Provisions for Vehicles Having Engines Mounted on Them (Including Floor Maintenance Machines) 395
11.14 Engine Installation Other Than on Vehicle 397
11.15 Garaging of Vehicles 397

12 Refrigerated Containers 399
12.1 Construction and Design of Refrigerated Containers 400
12.2 Marking on Refrigerated LP-Gas Containers 402
12.3 Container Installation 402
12.4 Refrigerated LP-Gas Container Instruments and Controls 404
12.5 Refrigerated LP-Gas Container Impoundment 406
12.6 Inspection and Testing of Refrigerated LP-Gas Containers and Systems 407
12.7 Container Siting 408
12.8 Relief Devices 409

13 Marine Shipping and Receiving 415
13.1 Scope 415
13.2 Piers 415
13.3 Pipelines 419
13.4 Inspections Prior to Transfer 420

14 Operations and Maintenance 423
14.1 Scope 423
14.2 Operating Requirements 424
14.3 Maintenance 437
14.4 Small LP-Gas Systems (SLGSs) 441

15 Pipe and Tubing Sizing Tables 447
15.1 Tables for Sizing Pipe and Tubing 449

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

Annexes

A Explanatory Material 461
B Properties of LP-Gases 463
C Design, Construction, and Requalification of DOT (ICC) Cylinders 469
D Design of ASME and API-ASME Containers 475
E Pressure Relief Devices 479
F Liquid Volume Tables, Computations, and Graphs 481
G Wall Thickness of Copper Tubing 487
H Procedure for Torch Fire and Hose Stream Testing of Thermal Insulating Systems for LP-Gas Containers 489
I Container Spacing 493
J Sample Ordinance Adopting NFPA 58 497
K Burial and Corrosion Protection for Underground and Mounded ASME Containers 499
L Informational References 501

PART TWO
Supplements 505

1 Guidelines for Conducting a Fire Safety Analysis 507
2 LP-Gas Systems Subject to DOT Pipeline Regulations 511
3 Sizing of Independent Pressure Regulators for Large Propane Systems 527
4 Fire Testing of Composite Propane Cylinders 533
5 Preparing Propane Companies for Natural Disasters 539
6 Technical/Substantive Changes from the 2004 Edition to the 2008 Edition of NFPA 58 543

NFPA 58 Index 563

Commentary Index 573

Important Notices and Disclaimers 593

TIAs 595

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

List of Figures, Tables, and Exhibits

NFPA 58 Figures and Tables

Number	Caption
Figure A.3.3.74.5.1	External Pressure Relief Valve.
Figure A.3.3.74.5.2	Flush-Type Full Internal Pressure Relief Valve.
Figure A.3.3.74.5.3	Full Internal Pressure Relief Valve.
Figure A.3.3.74.5.4	Internal Spring-Type Pressure Relief Valve.
Table 4.1.1	Containers
Table 5.2.4.2	Maximum Vapor Pressures and MAWP
Table 5.2.8.5	NOT ODORIZED Label Size
Table 5.7.2.4(A)	Start-to-Leak Pressure Settings of Pressure Relief Valves in Relation to Container Pressure Rating
Table 5.7.2.5	Pressure Relief Valve Flow Capacity as a Function of Container Surface Area
Table 5.7.3.2	Recommended Dip Tube Lengths for Various Cylinders
Table 5.7.4.1	Container Connection and Appurtenance Requirements for Containers Used in Other Than Bulk Plants and Industrial Plants
Table 5.7.4.2	Connection and Appurtenance Requirements for New and Existing Container Installations in Bulk Plants and Industrial Plants
Table 5.9.4.1	Service Pressure Rating of Pipe, Tubing Fittings, and Valves
Table 5.17.1.2	Service Pressure Rating
Table 5.17.1.3	Materials for Equipment Used in LP-Gas Service
Table 6.3.1	Separation Distances Between Containers, Important Buildings, and Line of Adjoining Property That Can Be Built Upon
Table 6.3.9	Separation Distance Between Container Pressure Relief Valve and Building Openings
Table 6.4.2	Maximum Number of Containers in a Group and Their Separation Distances
Table 6.4.5.8	Separation Distances of LP-Gas Containers and Oxygen and Hydrogen Containers
Table 6.5.3	Distance Between Point of Transfer and Exposures
Table 6.6.3.3	Installation of Permanently Installed Horizontal ASME Containers with Attached Supports
Table 6.9.3.5	Types of Metallic Pipe Joints in LP-Gas Service
Table 6.21.3.6	Minimum Separation Distances Between Direct-Fired Vaporizers and Exposures
Table 6.21.4.1	Minimum Separation Between Tank Heaters and Exposures
Table 6.21.5.2	Minimum Separation Distance Between Containers and Vaporizing Burners
Table 6.22.2.2	Electrical Area Classification
Figure A.6.22.2.3	Extent of Electrically Classified Area.
Table 6.23.3.1(E)	Maximum Capacities of Individual LP-Gas Containers Installed on LP-Gas Highway Vehicles
Table 7.4.2.2	Maximum Filling Limit by Weight of LP-Gas Containers (Percent of Marked Water Capacity in Pounds)
Table 7.4.2.3(a)	Maximum Permitted LP-Gas Volume (Percent of Total Container Volume): Aboveground Containers 0 to 1200 gal (0 to 4.5 m^3)
Table 7.4.2.3(b)	Maximum Permitted LP-Gas Volume (Percent of Total Container Volume): Aboveground Containers Over 1200 gal (0 to 4.5 m^3)
Table 7.4.2.3(c)	Maximum Permitted LP-Gas Volume (Percent of Total Container Volume): All Underground Containers
Table 8.3.1(a)	Maximum Allowable Storage Quantities of LP-Gas in Other Than Industrial, Storage, and Mercantile Occupancies
Table 8.3.1(b)	Maximum Allowable Storage Quantities of LP-Gas in Mercantile, Industrial, and Storage Occupancies
Table 8.4.1.2	Distances from Cylinders in Storage and Exposures
Table 9.3.2.9	Orientation of Cylinders on Vehicles
Table 11.6.2.2	Service Pressure Rating of Pipe, Tubing Fittings, and Valves
Figure 11.7.3.4	Container Installation Clearances.
Figure A.11.11.2.2	Example of Vehicle Identification Marking.
Table 12.7.1	Minimum Distances for LP-Gas Containers That Operate Above 15 psi (103 kPa)

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

Number	Caption
Table 12.7.2	Minimum Distances for LP-Gas Containers That Operate Below 15 psi (103 kPa)
Table 12.8.4.1	Environmental Factors
Figure 13.2.3.1	Warning Sign to be Placed in Marine Transfer Area.
Table 15.1(a)	Pipe Sizing Between First-Stage and Second-Stage Regulators: Nominal Pipe Size, Schedule 40
Table 15.1(b)	Pipe Sizing Between 2-psi Service Regulator and Line Pressure Regulator: Nominal Pipe Size, Schedule 40
Table 15.1(c)	Pipe Sizing Between Second-Stage Regulator and Appliance: Nominal Pipe Size, Schedule 40
Table 15.1(d)	Pipe Sizing Between First-Stage and Second-Stage Regulators: Nominal Pipe Size, Schedule 80
Table 15.1(e)	Pipe Sizing Between Second-Stage Regulator and Appliance: Nominal Pipe Size, Schedule 80
Table 15.1(f)	Pipe Sizing Between First-Stage and Second-Stage Regulators: Outside Diameter Copper Tubing, Type K
Table 15.1(g)	Copper Tube Sizing Between Second-Stage Regulator and Appliance: Outside Diameter Copper Tubing, Type K
Table 15.1(h)	Copper Tube Sizing Between First-Stage and Second-Stage Regulators
Table 15.1(i)	Copper Tube Sizing Between 2-psi Service Regulator and Line Pressure Regulator: Outside Diameter Copper Tubing, Type L
Table 15.1(j)	Copper Tube Sizing Between Single-Stage or Second-Stage Regulator and Appliance: Outside Diameter Copper Tubing, Type L
Table 15.1(k)	Pipe Sizing Between First-Stage and Second-Stage Regulators: Outside Diameter Refrigeration Tubing
Table 15.1(l)	Copper Tube Sizing Between Second-Stage Regulator and Appliance: Outside Diameter of Copper Refrigeration Tubing
Table 15.1(m)	Maximum Capacity of CSST in Thousands of Btu per Hour of Undiluted Liquefied Petroleum Gases at a Pressure of 2 psig and a Pressure Drop of 1 psi (Based on 1.52 Specific Gravity Gas)
Table 15.1(n)	Maximum Capacity of CSST in Thousands of Btu per Hour of Undiluted Liquefied Petroleum Gases at a Pressure of 11-in. Water Column and a Pressure Drop of 0.5-in. Water Column (Based on 1.52 Specific Gravity Gas)
Table 15.1(o)	Polyethylene Plastic Pipe Sizing Between First-Stage and Second-Stage Regulators: Nominal Outside Diameter (IPS)
Table 15.1(p)	Polyethylene Plastic Tube Sizing Between First-Stage and Second-Stage Regulators: Nominal Outside Diameter (CTS)
Table 15.1(q)	Polyethylene Plastic Tube Sizing Between Second-Stage Regulator and Building: Nominal Outside Diameter (CTS)
Table B.1.2(a)	(English) Approximate Properties of LP-Gases
Table B.1.2(b)	(Metric) Approximate Properties of LP-Gases
Table C.2.3.3	DOT Cylinder Specifications
Table D.2.1.5	Container Pressure and Safety Factors/Design Margin for Various Editions of the ASME Code
Table D.2.4.4	DOT Pressure Specification for Cargo Tanks
Table F.3.3	Liquid Volume Correction Factors
Table G.1(a)	Wall Thickness of Copper Tubing
Table G.1(b)	Wall Thickness of Copper Tubing
Figure I.1(a)	Cylinders.
Figure I.1(b)	Aboveground ASME Containers.
Figure I.1(c)	Underground ASME Containers.

Commentary Exhibits and Tables

Number	Caption
Exhibit 1.1	LP-Gas Marine Storage Terminal. (Courtesy of SEA-3, Inc.)
Exhibit 1.2	Split of Scope Between NFPA 54 and NFPA 58 Showing a 2 psi House Piping System.
Exhibit 3.1	Cutaway View of Riser Assembly. (Courtesy of
Exhibit 3.2	R.W. Lyall & Company, Inc.) Aerial View of a Bulk Plant. (Courtesy of Revere Gas and Appliance)
Exhibit 3.3	Large Bulk Plant. (Courtesy of Eastern Propane
Exhibit 3.4	Corp.) Bobtail. (Courtesy of CENEX a brand name of
Exhibit 3.5	CHS Inc.) Transport Vehicle. (Courtesy of Mississippi
Exhibit 3.6	Tank Co.)
Exhibit 3.7	Fixed Maximum Liquid Level Gauge. Recreational Vehicle Propane Tank. (Courtesy of
Exhibit 3.8	Manchester Tank) Overfilling Prevention Device. (Courtesy of
Exhibit 3.9	Cavagna North America, Inc.) Points of Transfer at a Propane Bulk Plant.
Exhibit 3.10	(Courtesy of National Propane Gas Association) Automatic Changeover Regulator. (Courtesy of
Exhibit 3.11	Sherwood, Harsco Gas & Fluid Control Group.) Cutaway of First-Stage Regulator. (Courtesy of
Exhibit 3.12	Engineered Controls International, Inc.) Integral Two-Stage Regulator. (Courtesy of En-
Exhibit 3.13	gineered Controls International, Inc.) Second-Stage Regulator. (Courtesy of Engi-
C-Table 3.1	neered Controls International, Inc.)
Exhibit 3.14	Regulators Universal Cylinder. (Courtesy of Worthington
Exhibit 3.15	Cylinder Corp.) Internal Valve. (Courtesy of Engineered Controls International, Inc.)

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

Number	Caption
Exhibit 3.16	Typical Vaporizer Installation. (Courtesy of Ransome Manufacturing)
Exhibit 3.17	Waterbath Vaporizer. (Courtesy of Ransome Manufacturing)
Exhibit 4.1	Stain Tubes and Pump. (Courtesy of Sensidyne, Inc. www.Sensidyne.com)
Exhibit 4.2	Odorator®. (Courtesy of Heath Consultants Incorporated)
C-Table 4.1	Changes in Qualification of Personnel Requirement
Exhibit 5.1	DOT/TC Cylinders. Top: Typical Industrial Truck Motor (Engines) Fuel Cylinders; Bottom: Typical Stationary and Portable Cylinders for Residential and Commercial Uses. (Courtesy of Manchester Tank)
Exhibit 5.2	DOT/TC Cylinders. (Courtesy of Manchester Tank)
Exhibit 5.3	Dimensions and Capacities of Typical DOT Cylinders. (Courtesy of Worthington Cylinder Corp.)
Exhibit 5.4	Typical DOT Cylinder Marking. (Courtesy of National Propane Gas Association)
Exhibit 5.5	Small ASME Container Commonly Used in Residential and Commercial Applications. (Courtesy ofTrinity Containers)
Exhibit 5.6	Intermodal Container. (Courtesy of Permagas)
C-Table 5.1	DOT/TC Cylinder Applications
C-Table 5.2	Typical Stationary ASME Container Applications
Exhibit 5.7	ASME Container Damaged by Fire. (Courtesy of Independent Propane Co., Pine, CO)
Exhibit 5.8	National Board "R" Stamp. (The above material is taken from the *National Board Inspection Code* and is reprinted with permission of the National Board of Boiler and Pressure Vessel Inspectors.)
Exhibit 5.9	Actuated Liquid Withdrawal Excess-Flow Valve; Old Style (Left) and Current Style (Center and Right). (Courtesy of Engineered Controls International, Inc.)
Exhibit 5.10	Operation of an Actuated Liquid Withdrawal Excess-Flow Valve. (Courtesy of Fisher Controls Intl, LLC)
Exhibit 5.11	Cylinder Collars. (Courtesy of Manchester Tank)
Exhibit 5.12	Vertical Container.
Exhibit 5.13	DOT Flammable Gas Label (Red).
Exhibit 5.14	DOT Cylinder Marking. (Tank courtesy of Worthington Cylinder Corp.)
Exhibit 5.15	Optional Container Listing on Container Nameplate. (Courtesy of Trinity Containers, LLC)
Exhibit 5.16	Sample Warning Label Intended for Gas Grill Cylinders. (Courtesy of Screen Graphics of Florida)
Exhibit 5.17	Sample Warning Label Intended for Use on Cylinders in Commercial or Industrial Service. (Courtesy of Screen Graphics of Florida)
Exhibit 5.18	ASME Containers Marked NOT ODORIZED.
Exhibit 5.19	Pressure Relief Valve on DOT/TC Cylinder. On these cylinders, the relief valve is part of a fitting that includes the manual shutoff valve. (Courtesy of Engineered Controls International, Inc.)
Exhibit 5.20	Indentations on the Upper Rim Seal of a Listed Butane Cylinder.
Exhibit 5.21	External-Type Pressure Relief Valve for Large Stationary ASME Container for Use with a Relief Valve Manifold. (Courtesy of Engineered Controls International, Inc.)
Exhibit 5.22	External-Type Pressure Relief Valve for Older, Small ASME Container. (Courtesy of Engineered Controls International, Inc.)
Exhibit 5.23	Flush-Type Internal Pressure Relief Valve Used on Cargo Containers. All working parts are within the container or below the container shell. Stacks are not used. (Courtesy of Fisher Controls Intl, LLC)
Exhibit 5.24	Pilot-Operated Relief Valve. (Courtesy of Anderson Greenwood)
Exhibit 5.25	Pilot-Operated Relief Valve in the Closed Position. (Courtesy of Anderson Greenwood)
Exhibit 5.26	Pilot-Operated Relief Valve in the Open Position. (Courtesy of Anderson Greenwood)
Exhibit 5.27	ASME Container Relief Valve Manifolds. [Courtesy of Fisher Controls Intl, LLC (left) and Engineered Controls International, Inc. (right)]
Exhibit 5.28	U.S. Structure Fires Involving Gas Grills, 1997–2003.
Exhibit 5.29	Cylinder Valve with Overfilling Prevention Device. Note the triangle-shaped hand wheel, which identifies the OPD valve. In addition to the unique hand wheel, the valve is also stamped "OPD." (Courtesy of Sherwood, Harsco Gas & Fluid Control Group)
Exhibit 5.30	Lever Operated Internal Valve for Threaded Installation. (Courtesy of Engineered Controls International, Inc.)
Exhibit 5.31	Lever Operated Internal Valve for Flanged Installation. (Courtesy of Engineered Controls International, Inc.)
Exhibit 5.32	Pneumatically Operated Internal Valve. (Courtesy of Engineered Controls International, Inc.)
Exhibit 5.33	Operation of a Pump Pressure-Operated Internal Valve. (Courtesy of Engineered Controls International, Inc.)
Exhibit 5.34	Tank Valve Complying with API 607. (Courtesy of Superior Energy Systems)
Exhibit 5.35	Operation of Excess-Flow Check Valve. After the spring-loaded excess-flow valve has closed due to excessive flow above the manufacturer's flow rating, the closing of the downstream valve will allow pressure on both sides of the excess-flow check mechanism to equalize through the equalizing hole and the spring loading will cause the excess-flow check to reopen. (Courtesy of Fisher Controls Intl, LLC)

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

Number	Caption
Exhibit 5.36	Operation of Backflow Check Valve. (Courtesy of Fisher Controls Intl, LLC)
Exhibit 5.37	Various Excess-Flow Check Valves. (Courtesy of Fisher Controls Intl, LLC)
Exhibit 5.38	Rotary Type of Variable Liquid Level Gauge. (Courtesy of Engineered Controls International, Inc.)
Exhibit 5.39	Float Type of Variable Liquid Level Gauge (Top) and Dial Faces (Bottom). (Courtesy of Gas Equipment Co., Inc. and Rochester Gauges, Inc.)
Exhibit 5.40	Fixed Maximum Liquid Level Gauge. [Courtesy of Fisher Controls Intl, LLC (left) and Engineered Controls International, Inc. (right)]
Exhibit 5.41	Multiple Valve for 100 lb to 200 lb (45 kg to 91 kg) Cylinder with Fixed Maximum Liquid Level Gauge (Dip Tube) and Separate Inlet and Outlet Connections. (Courtesy of Sherwood, Harsco Gas & Fluid Control Group)
Exhibit 5.42	Locations of Fixed Liquid Level Gauges. (Courtesy of Mississippi Tank Company)
Exhibit 5.43	Variable Liquid Level Gauge. (Courtesy of Eastern Propane Corp.)
Exhibit 5.44	ASME Container with Labeled and Color-Coded Connections. (Courtesy of Propane Education and Research Council)
Exhibit 5.45	Regulator Operation. (Courtesy of National Propane Gas Association)
Exhibit 5.46	Operation of Regulator Relief Valve. (Courtesy of National Propane Gas Association)
Exhibit 5.47	Integral Two-Stage Regulator. (Courtesy of Fisher Controls Intl, LLC)
Exhibit 5.48	Mechanical Fitting for PE Tubing. (Courtesy of Elster Perfection)
Exhibit 5.49	Factory-Assembled Risers. (Courtesy of R. W. Lyall & Company, Inc.)
Exhibit 5.50	Two Emergency Cutoff Valves. [Courtesy of Fisher Controls Intl, LLC (left) and Engineered Controls International, Inc. (right)]
Exhibit 5.51	Hydrostatic Relief Valve. (Courtesy of Engineered Controls International, Inc.)
Exhibit 5.52	Sliding Vane Positive Displacement Pump. The cutaway is shown at lefft. (Courtesy of Blackmer, A Dover Company)
Exhibit 5.53	Operation of Sliding Vane Pump. (Courtesy of Blackmer, A Dover Company)
Exhibit 5.54	Gear Pump. (Courtesy of Smith Precision Products Company, Inc.)
Exhibit 5.55	Operation of Gear Pump. (Courtesy of Smith Precision Products Company, Inc.)
Exhibit 5.56	Compressor with Protection Devices. (Courtesy of Blackmer, A Dover Company)
Exhibit 5.57	Compressor Liquid Traps. (Courtesy of Corken, Inc.)
Exhibit 5.58	Positive Displacement Liquid Meter. (Courtesy of Liquid Controls LLC)
Exhibit 5.59	Portable LP-Gas–Fueled Engine-Driven Pump. (Courtesy of Smith Precision Products Company, Inc.)
Exhibit 5.60	Sight Flow Indicator with Backflow Check Valve. (Courtesy of Engineered Controls International, Inc.)
Exhibit 5.61	Flow Indicator with Backflow Check Valve. (Courtesy of Fisher Controls Intl, LLC)
Exhibit 5.62	Direct-Fired Vaporizer. (Courtesy of Ransome Manufacturing)
Exhibit 5.63	Direct-Fired Vaporizer Operating on Demand. (Courtesy of National Propane Gas Association)
Exhibit 5.64	Vaporizing Burner. (Courtesy of Flame Engineering.)
Exhibit 5.65	High-Pressure Orifice Gas–Air Mixer. (Courtesy of Al-Gas SDI)
C-Table 6.1	Maximum Steel Container Surface Temperatures in Contact with Vapor Space Where Exposed to Fire
Exhibit 6.1	Illustration of Separation Distances from Containers to the Line of Adjoining Property That Can be Built Upon.
Exhibit 6.2	Example of Multiple Container Installation and Various Sizes of Containers. (Illustration of the requirement of 6.3.3)
Exhibit 6.3	Manifolded Cylinders Adjacent to Building. (Courtesy of Wilbur Walls)
Exhibit 6.4	Location of Cylinders.
Exhibit 6.5	Illustration of 50% Open Perimeter of the Space Below a Deck.
Exhibit 6.6	Concentration of Propane–Air Mixture Resulting from Discharge of Liquid Propane from a Fixed Liquid Level Gauge on a Cylinder. (Courtesy of Wilbur Walls)
Exhibit 6.7	Distance from ASME Tank Pressure Relief Valve to Building Projections.
Exhibit 6.8	Separation of Mounded or Underground Containers.
Exhibit 6.9	Overhead Electric Power Line Spacing from LP-Gas Containers.
C-Table 6.2	Applicability of Sections 6.3 and 6.5.
Exhibit 6.10	Illustration of the Distance Requirement from Table 6.5.3.
Exhibit 6.11	Typical LP-Gas Domestic Container Installation. (Courtesy of Engineered Controls International, Inc.)
Exhibit 6.12	Domestic ASME Container Installation on Noncombustible Foundation. (Courtesy of National Propane Gas Association)
Exhibit 6.13	ASME Storage Container with Concrete Saddles.
Exhibit 6.14	Installation of a Container with a Snow Stake. (Courtesy of Heritage Propane)
Exhibit 6.15	Vertical 30,000 gal (114 m^3) Containers. (Courtesy of Quality Gas Service)
Exhibit 6.16	Typical Small ASME Container Underground Installation. (Courtesy of National Propane Gas Association)
Exhibit 6.17	Installation of Two Underground Tanks, Showing Placement of Anodes. (Courtesy of H&H Gas)

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

Number	Caption
Exhibit 6.18	Typical Large ASME Container Underground Installation. (Courtesy of Propane Technical Services)
Exhibit 6.19	Corrosion Hole. (Courtesy of Richard A. Hoffmann, Hoffmann & Feige)
Exhibit 6.20	Storage Containers Mounded for Special Protection. (Courtesy of Superior Energy Systems, Inc.)
Exhibit 6.21	Installation of Rooftop Propane Tanks. (Courtesy of Richard Fredenburg, North Carolina Department of Agriculture and Consumer Services)
C-Table 6.3	Fire Resistance Rating (Hours) for Type I and Type II Construction
Exhibit 6.22	A Fixed Fill Line Used for Filling a Rooftop Propane Tank.
C-Table 6.4	Melting Points of Some Metals and Alloys
Exhibit 6.23	Manifolded ASME Containers Served by a Single Pressure Regulator.
Exhibit 6.24	Automatic Changeover Regulator. (Courtesy of Engineered Controls International, Inc.)
Exhibit 6.25	Use of Vent Extension on Underground Container to Protect Regulator Operation from Elements. The termination of the vent assembly must be above grade level. (Courtesy of Fisher Controls Intl, LLC)
Exhibit 6.26	Venting Regulator Installed in a Building. (Courtesy of Fisher Controls Intl, LLC)
C-Table 6.5	Vapor Pressure of Propane at Selected Temperatures
Exhibit 6.27	Corrugated Stainless Steel Tubing. (Courtesy of Gastite Division of Titeflex)
Exhibit 6.28	Installation of Emergency Shutoff Valves at Unloading Station. (Courtesy of Engineered Controls International, Inc.)
Exhibit 6.29	Pneumatically Operated Emergency Shutoff Valve/Unloading Adapter Combination Installation. (Courtesy of Fisher Controls International, Inc.)
Exhibit 6.30	Transfer from a Tank Car. (Courtesy of Superior Energy Systems, Inc.)
Exhibit 6.31	Installation of Pneumatically Operated Emergency Shutoff Valve. (Courtesy of National Propane Gas Association)
Exhibit 6.33	Rail Car Unloading Using Hoses and Bobtail Filling Site with Pull Away Protection. Note that the small tank in the foreground is not part of the liquid transfer operations and note the wheel chock sign at the tank car. (Courtesy of Brian Clayton)
Exhibit 6.34	Automatic Pump Bypass Valve. (Courtesy of Fisher Controls Intl, LLC)
Exhibit 6.35	Typical Pump Installation. (Courtesy of Ely Energy, Inc.)
Exhibit 6.36	Transferring with a Compressor — Liquid Transfer (top) and Vapor Recovery (bottom). (Courtesy of Blackmer, A Dover Company)
Exhibit 6.37	LP-Gas Bulk Plant. (Courtesy of Fisher Controls International, Inc.)
Exhibit 6.38	Typical Bulk Plant Container and Piping Details. (Courtesy of Engineered Controls International, Inc.)
Exhibit 6.39	Mobile Railcar Unloading System. (Courtesy of Superior Energy Systems)
Exhibit 6.40	Butane-Fueled Portable Cooking Appliances. (Top: Courtesy of ChefMaster, a Division of Mr. Bar-B-Q, Inc.)
Exhibit 6.41	Listed Butane Cylinder for Portable Cooking Appliance. (Courtesy of ChefMaster, a Division of Mr. Bar-B-Q, Inc.)
Exhibit 6.42	Prohibited and Permitted Locations of Cylinders on Balconies of a Multiple Family Dwelling with Four Living Units, One Above the Other.
Exhibit 6.43	Permitted Location of Cylinders on Balconies Located One Above the Other in a Two-Unit Dwelling.
Exhibit 6.44	Patio Heaters. (Courtesy of Richard Fredenberg, North Carolina Department of Agriculture and Consumer Services)
Exhibit 6.45	Electric Waterbath Vaporizer. (Courtesy of Ely Energy, Inc.)
Exhibit 6.46	Installation of Multiple Direct-Fired Vaporizers. (Courtesy of Superior Energy Systems)
Exhibit 6.47	LP-Gas–Air Venturi Blending System. (Courtesy of Ely Energy, Inc.)
Exhibit 6.48	Test Flare. (Courtesy of Flame Engineering)
Exhibit 6.49	Plan View Showing Extent of Classified Area. (Courtesy of Superior Energy Systems, Inc.)
Exhibit 6.50	Dispensing Station for Propane Vehicles. (Courtesy of CleanFuel USA)
Exhibit 6.51	Operation of Differential Back Pressure Valve. (Courtesy of Liquid Controls, Inc.)
Exhibit 6.52	Storage Containers with Special Protection. Note fixed water spray nozzles.
Exhibit 6.53	Storage Container with Water Spray Fixed Protection. Note the square tower at the rear of the tanks. This tower is the plant's fire water storage tank.
Exhibit 6.54	Corrosion Caused by Water Trapped Under Insulation. (Courtesy of Propane Technical Services)
Exhibit 6.55	A Low Emission Nozzle for Fueling Propane Vehicles. (Courtesy of CleanFuel USA)
Exhibit 7.1	Transport Trailers Loading at a Pipeline Terminal.
Exhibit 7.2	Filling a Storage Container. (Courtesy of Richard Fredenburg and Ferrellgas)
Exhibit 7.3	Cylinder Filling Room with Automatic Cylinder Filling Scales. When the cylinder (not shown) is filled to its correct filling weight, the automatic shutoff valve on the hose inlet will activate and automatically stop the flow. (Courtesy of Propane Education and Research Council)
Exhibit 7.4	Liquid Transfer by Pressure Differential or Gravity. (Courtesy of National Propane Gas Association)
Exhibit 7.5	Liquid Transfer by Pump. (Courtesy of National Propane Gas Association)

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

Number	Caption
Exhibit 7.6	Transferring Liquid with a Compressor. Liquid transfer is shown in the top illustration and vapor recovery is shown in the bottom illustration. (Courtesy of Blackmer, A Dover Company)
Exhibit 7.7	Truck Unloading Station. (Courtesy of Eastern Propane Corp.)
Exhibit 7.8	Stop and Derail on a Track. (Courtesy of Eastern Propane Corp.)
Exhibit 7.9	Wheel Chocks in Use During Unloading from a Tank Car. (Courtesy of Propane Education and Research Council)
Exhibit 7.10	Tank Car Loading/Unloading Facility. Note the swing arm connected to tank car dome. (Courtesy of Eastern Propane Corp.)
Exhibit 7.11	Close-Up of Tank Car Dome. (Courtesy of Eastern Propane Corp.)
Exhibit 7.12	Rail Car Unloading Tower. (Courtesy of Ely Energy)
Exhibit 7.13	Passive Transport Shut-Down System. (Courtesy of Mississippi Tank Co.)
Exhibit 7.14	Hose Swivel End Fitting. (Courtesy of Full Circle)
Exhibit 7.15	Some Burner Arrangements for Flaring LP-Gas. (Courtesy of National Propane Gas Association)
Exhibit 7.16	In-Line Hygrometer for Measuring the Specific Gravity of Propane.
Exhibit 7.17	Electronic LP-Gas Cylinder Filling Carousel. (Courtesy of Kosan Crisplant)
Exhibit 8.1	Cylinder Used for Portable Appliance (Camp Stove).
Exhibit 8.2	Cylinder Exchange Cabinets at a Retail Location. (Courtesy of Amerigas)
Exhibit 8.3	Storage Rack for Engine Fuel (Industrial Truck) Containers.
Exhibit 9.1	Typical MC-331 LP-Gas Transport Trailer Features. (Courtesy of Mississippi Tank Company)
Exhibit 9.2	Typical Retail Delivery Cargo Tank Vehicle (Bobtail). (Courtesy of Lin's Propane Trucks)
Exhibit 9.3	Internal View of a Cutaway Retail Delivery Vehicle (Bobtail). Note the float gauge, internal piping connections, and internal baffle and support. (Courtesy of Lin's Propane Trucks)
Exhibit 9.4	Cylinders in an Open Portable Container Cargo Vehicle (Delivery Truck). (Courtesy of Eastern Propane Corp.)
Exhibit 9.5	Placard for Propane Truck. (Courtesy of U. S. Department of Transportation)
Exhibit 9.6	A DOT Specification 51 Container. (Courtesy of Texas Trailer Corp.)
Exhibit 9.7	Typical Cargo Tank Vehicle (Bobtail) Transfer System for Retail Delivery. (Courtesy of National Propane Gas Association)
Exhibit 9.8	Typical Retail Delivery Cargo Tank Vehicle (Bobtail) Transfer System. (Courtesy of Eastern Propane Corp.)
Exhibit 9.9	Typical Semitrailer Cargo Tank Vehicle. (Courtesy of Engineered Controls International, Inc.)
Exhibit 9.10	Internal Valve in Cargo Tank Vehicle Container. [Courtesy of Fisher Controls Intl., LLC (top) and Engineered Controls International, Inc. (bottom)]
Exhibit 9.11	Separation Distances for Internal Combustion Engines During Transfer Operations.
Exhibit 9.12	Farm Cart. (Courtesy of ILPGA)
Exhibit 9.13	Saddle Trailer Used to Transport Stationary Container. (Courtesy of H&H Gas)
Exhibit 9.14	Removing Liquid from Container to Comply with 5 Percent Provision. (Courtesy of National Propane Gas Association)
Exhibit 9.15	Parking of LP-Gas Delivery Vehicles Flow Chart. (Courtesy of National Propane Gas Association)
Exhibit 9.16	Servicing LP-Gas Cargo Vehicles Indoors Flow Chart. (Courtesy of National Propane Gas Association)
Exhibit 10.1	Lightweight Construction Requirements.
Exhibit 10.2	Heavy Construction Requirements.
Exhibit 11.1	Typical Propane Fuel System on a Passenger Car. (Courtesy of National Propane Gas Association)
C-Table 11.1	Maximum Capacities of Individual LP-Gas Containers Installed on LP-Gas Highway Vehicles
Exhibit 11.2	Typical Engine Fuel Container and Appurtenances. (Courtesy of National Propane Gas Association)
Exhibit 11.3	Container Shown in Exhibit 11.2 Installed and Arranged for Remote Filling and for External Pressure Relief Valve Discharge. (Courtesy of Engineered Controls International, Inc.)
Exhibit 11.4	Two-Stage Pressure Regulator Converter. (Courtesy of IMPCO Technologies Inc.)
Exhibit 11.5	Air–Gas Valve Carburetor. (Courtesy of IMPCO Technologies Inc.)
Exhibit 11.6	Vacuum Fuel Lock. (Courtesy of IMPCO Technologies Inc.)
Exhibit 11.7	Pressure Relief Valve Discharge Line Extended Above the Roof of a Truck Cab. (Courtesy of Eastern Propane Corp.)
Exhibit 11.8	LP-Gas Container Inside an Enclosed Pickup Truck Bed. The pressure relief valve discharge line runs from the container to the roof of the topper. (Courtesy of Eastern Propane Corp.)

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

Number	Caption
Exhibit 11.9	Trunk-Mounted Fuel Container. A vapor barrier must be created between the passenger and luggage compartments. The barrier must be 100 percent gastight so no propane vapor can enter the car. (Courtesy of National Propane Gas Association)
Exhibit 11.10	Gastight Box Built Around the Container to Provide a Vapor Barrier in Van-Type Vehicles. (Courtesy of Manchester Tank)
Exhibit 11.11	Gastight Box Installed over the Valve Fittings on the Tank Itself, Which Also Provides a Vapor Barrier. (Adapted from original artwork from National Propane Gas Association)
Exhibit 11.12	Remote Filling Connection with Fixed Maximum Liquid Level Gauge. (Courtesy of National Propane Gas Association)
Exhibit 11.13	Typical LP-Gas–Powered Industrial Truck (Forklift Truck). (Courtesy of Engineered Controls International, Inc.)
Exhibit 11.14	Floor Maintenance Machine. (Courtesy of Amana Pioneer Eclipse Corp.)
Exhibit 13.1	An LP-Gas Marine Terminal. (Courtesy of SEA-3, Inc.)
Exhibit 13.2	Marine Terminal Handling Flammable Liquids. (Source: NFPA 30, 2003 edition)
Exhibit 13.3	Handheld LP-Gas Detector. (Courtesy of J and N Enterprises, Inc.)
Exhibit 15.1	Sketch of an LP-Gas Vapor Piping System.
C-Table 15.1	Approximate Gas Input for Typical Appliances
C-Table 15.2	Summary of Pipe Sizing Tables
C-Table 15.3	Pipe Size Table
C-Table 15.4	Pipe Sizing Between Second-Stage Regulator and Appliance: Nominal Pipe Size, Schedule 40 [Extracted from code Table 15.1(c)]

Supplement Exhibits

Number	Exhibit
Exhibit S2.1	System Consisting of 10 or More Homes Supplied by a Single LP-Gas Tank.
Exhibit S2.2	System Consisting of a Single LP-Gas Tank Supplying More Than One Customer Where the System is Located in a Public Place.
Exhibit S2.3	System Consisting of Two Manifolded LP-Gas Tanks Supplying a Restaurant Where a Portion of the System is Located in a Public Place.
Exhibit S2.4	Sample Checklist for a Major Emergency.
Exhibit S2.5	RSPA Form F 7100.1.
Exhibit S4.1	Propane Torches for Fire Exposure.
Exhibit S4.2	Vertical Cylinder Prior to Flame Impingement.
Exhibit S4.3	Horizontal Cylinder Prior to Flame Impingement.
Exhibit S4.4	Vertical Cylinder During Fire Test.
Exhibit S4.5	Schematic of Fire Test Room – Type 2 Tests.
Exhibit S4.6	Composite Cylinder After Fire Test, Shown Inside Heater (top) and Composite Cylinder After Fire Test (bottom).
Exhibit S4.7	Schematic of the Fire Test Room – Type 3 Tests.
Exhibit S4.8	Spare Cylinder After Fire Test.
Exhibit S5.1	Propane Container Moved by Hurricane Katrina.
Exhibit S5.2	Two Propane Container Foundations After the Containers Were Washed Away in Floodwaters Resulting from Hurricane Katrina.
Exhibit S5.3	Basic Wind Speed – Western Gulf of Mexico Hurricane and Coastline. (Courtesy of ASCE)

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

Preface

The eighth edition of the *LP-Gas Code Handbook* continues the tradition begun by Wilbur L. Walls, editor of the first edition in 1986. The handbook provides commentary that brings the legalistic language of the code to life. The code must be written using a technically clear, usable, and enforceable style. It cannot include the guidance and explanations that the Technical Committee on Liquefied Petroleum Gases would like to include.

The purpose of this handbook is to assist you, the enforcer or user of NFPA 58, *Liquefied Petroleum Gas Code*. The commentary and supplements provide guidance, recommendations, and common practices for the use of LP-Gas as a fuel.

The 2008 edition of the code contains several important changes, including the following:

1. Revised table of container appurtenance requirements
2. New section on patio heaters
3. New requirements for notification prior to transfer of liquid LP-Gas from rail cars to tank cars without intermediate storage
4. New requirements for operation of small LP-Gas pipeline vapor systems with 10 to 99 users (such as might be located at a mobile home park) that is consistent with U. S. Department of Transportation requirements

An NFPA code handbook is never complete. In order to stay current, it must change as technology and code requirements change. Users will find that problems they encounter may not be addressed fully in the handbook commentary, tables, illustrations, or photographs, or that the commentary appears incomplete when applied to real problems. Therefore, the editor invites suggestions, examples, new illustrations, and photographs from all readers for use in the next edition.

History of NFPA 58

NFPA standards concerned with gases date from 1900, only four years after the establishment of NFPA itself. The first standards were concerned with acetylene, which was actually used in those days as a household cooking, lighting, and heating fuel, and with manufactured, or "city," gas derived from coal and oil.

The NFPA Technical Committee on Gases developed the early standards. By 1924, the use of liquefied petroleum gas (LP-Gas), primarily as a cooking and heating fuel in rural areas, had become common, and the need for a national fire safety standard was recognized. The LP-Gas for these systems was stored in compressed gas cylinders. Because of their cylindrical shape, the LP-Gas they contained was widely referred to simply as "bottled gas," an identification rather lacking in specificity (acetylene was also a "bottled gas") but one still used today.

In 1927, the Committee on Gases secured NFPA approval of the first NFPA standard on LP-Gas, a four-page document with a title — *Regulations for the Installation and Operation of Compressed Gas Systems Other than Acetylene for Lighting and Heating* — that comprised a fair proportion of the text of the standard itself. The standard covered only systems in which

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

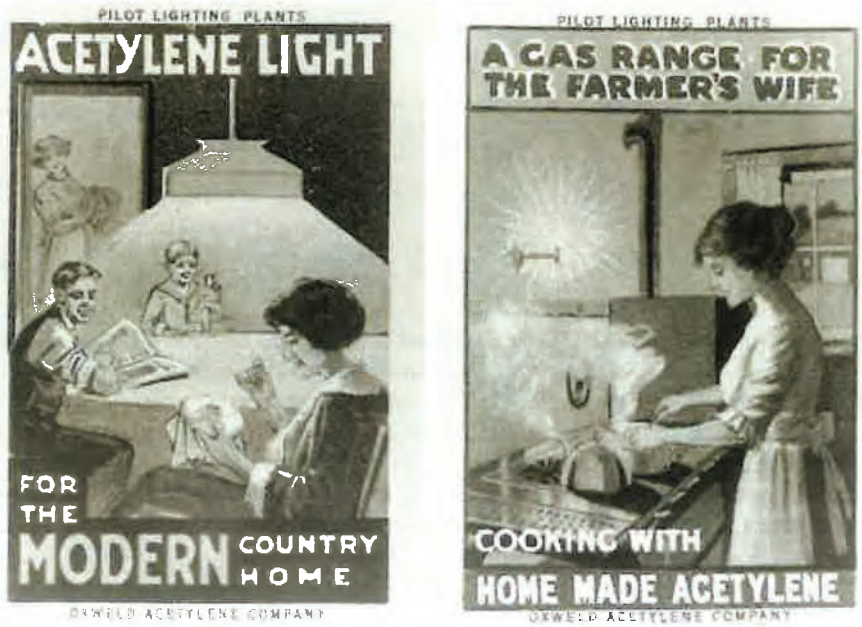


EXHIBIT P.1 *Early Magazine Advertisements for Acetylene Lighting and Cooking.*

the LP-Gas was stored in cylinders fabricated to regulations of the U.S. Interstate Commerce Commission (ICC), today known as the U.S. Department of Transportation (DOT).

In those days, NFPA published its standards only in the Proceedings of the Annual Meeting at which the standards were adopted. To make them more available to users, the National Board of Fire Underwriters (NBFU), now known as the American Insurance Association, obtained NFPA permission to publish many of them in pamphlet form. These were identified as standards of the NBFU "as recommended by the NFPA." In those days, NFPA did not identify many of its standards by number. However, the NBFU did, and the standard was thus designated NBFU 52. Amended editions of the standard were adopted in 1928, 1933, and 1937.

Because the LP-Gas "bottles" had to be refilled (in those days, only at a plant built for that purpose), which required the use of a much larger container for plant storage, new specifications had to be developed. In addition, major consumers found a container larger than an ICC cylinder to be advantageous. These larger containers required different design and siting criteria.

In 1931, NFPA tentatively adopted *Regulations for the Design, Installation and Construction of Containers and Pertinent Equipment for the Storage and Handling of Liquefied Petroleum Gases*, which was officially adopted at the next NFPA meeting in 1932. This standard covered the larger containers, which are the ASME containers of today. Also published by the NBFU, under the designation NBFU 58, this standard had 14 pages, 10 more than NBFU 52.

At the 1931 Annual Meeting, committee chairman Harry E. Newell of the NBFU noted in his report that the proposed standard had been prepared by a joint subcommittee of the Committee on Gases and the Committee on Flammable Liquids. He attributed this to the fact that "it was difficult to decide whether liquefied petroleum gases were flammable liquids or gases." Even today, confusion exists on this score. Some municipal ordinances, undoubtedly of considerable vintage, equate them, and many communities have failed to adopt LP-Gas regulations under the erroneous impression that their flammable liquid regulations apply to LP-Gas.

For many years, the Committee on Gases was composed of 11 to 20 members. In 1932, there were 15 members, representing the Associated Factory Mutual Fire Insurance Compa-

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

nies, American Gas Association, Board of Fire Underwriters of Allegheny County, Western Factory Insurance Association, Conference of Special Risk Underwriters, Manufacturing Chemists Association, Boston Board of Fire Underwriters, International Acetylene Association, Underwriters Laboratories Inc., Compressed Gas Manufacturers Association, American Petroleum Institute, Railway Fire Protection Association, and the U.S. National Bureau of Standards, as well as the NBFU. With 6 of the 15 members, including the chairman, representing the insurance industry, the standard could be presumed to be rather conservative and thus lacked the balance of interests that is required under today's NFPA procedures.

The extreme versatility of "gas in a bottle" soon led to more and more complex uses, and the Committee on Gases was hard-pressed to keep up. Amended editions of the 1931 standard were adopted in 1934, 1937, 1938, and 1939.

In 1935, a standard on LP-Gas cargo vehicles, whose use had become widespread in the early 1930s, was adopted and published by NBFU as NBFU 59. In 1937, a standard was adopted to regulate the use of LP-Gas as a fuel to power vehicles, a practice that had become prevalent by the mid-1930s. In 1938, however, this became a part of the ASME Code container standard (NBFU 58).

By now, it was apparent that the various standards contained considerable duplicate material and could be combined into a single standard. This was done in 1940. The resulting 47-page standard (in the NBFU 58 pamphlet version) combined the 1937 edition of NBFU 52 and the 1939 editions of NBFU 58 and 59. This single standard also replaced the *Liquefied Petroleum Gas Code*, which was adopted in 1937 in response to a request by regulatory and insurance interests to provide container siting and basic fabrication criteria that were not as detailed as those found in the existing standards. This code ultimately proved inadequate from the industry's point of view, and it was withdrawn when the combined standard was introduced. The 1943 edition of the standard was the first edition to be designated NFPA 58. The first pamphlet edition of NFPA 58 was published in 1950.

The dates of each edition of NFPA 58 are given in the "Origin and Development" section of each edition. To date, there have been 31 editions since the 1940 edition, an average of about one every two years. From 1950 to 1961, in fact, a new edition was adopted each year. This is a very high rate, and it placed an impossible burden upon its usefulness as a public safety regulatory instrument. Since 1961, new editions have been adopted about every three years, except for the 2008 edition, which took four years due to controversy, which resulted in a last-minute deletion of proposed coverage of cabinet heaters.

The Committee on Gases itself developed NFPA 58 until 1956. By that time, the number and variety of NFPA standards covering various gases had grown so large that the size of the committee was becoming difficult to manage. The solution was to establish a number of smaller committees, known as sectional committees, composed of experts on the different gas applications. The developmental and interpretative responsibilities for NFPA 58 were thus assigned to the Sectional Committee on Liquefied Petroleum Gases. However, the sectional committee could only recommend amendments, Formal Interpretations, or Tentative Interim Amendments (TIAs) for adoption by the Committee on Gases.

Because the sectional committee lacked authority, its membership essentially duplicated that of the Committee on Gases, and the purpose of the sectional committee was defeated. It was also becoming evident that the Committee on Gases seldom overturned a sectional committee recommendation.

In 1966, the sectional committees — there were four at the time — were organized into three full-fledged technical committees, and the Committee on Gases ceased to exist. NFPA 58 thus became the complete responsibility of the Technical Committee on Liquefied Petroleum Gas.

From 1940 to 1969, NFPA 58 consisted of a chapter entitled Basic Rules, followed by a number of chapters entitled Divisions and by appendixes. The Introduction and Basic Rules included all material common to all applications, such as scope statements, retroactivity, definitions, odorization, approval requirements, container fabrication, siting, design criteria for

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

piping, valves, hoses and fittings, filling levels, and ignition source controls. The eight divisions amplified and sometimes modified the basic provisions for specific applications, some on the basis of kinds of containers and others on the basis of the environment in which the system was used.

As a new application was developed, it was essentially treated as a package and added as a new division, which was easier to do and allowed for the timely inclusion in the standard of new applications. The problem with this approach was that similar hazards were being treated differently, and the basic rules were becoming less and less basic.

In the late 1960s, the Technology and Standards Committee of the National Propane Gas Association (NPGA) undertook the development of a format that would provide consistency in hazard evaluation, would reduce the extent to which particular interests would have to study the entire standard, and would make the format more like that used in other NFPA standards.

In the current format, Chapters 1 through 4 include only material truly relevant to all applications.

Chapters 5 and 6 address the fundamental breakdown of interest that experience has shown exists between manufacturers of equipment and those who assemble this equipment into systems and actually install them. Fire experience clearly reveals that incidents are nearly always due to failure to comply with one or more provisions and that many of these failures are the result of confusion between manufacturers and installers as to who should do what. To help reduce this confusion, Chapter 5 is aimed at the equipment manufacturer and Chapter 6 at the installer.

The same experience has also shown that the great majority of nonappliance-related accidents occur when LP-Gas liquid is being transferred from one container to another. An essential aspect of such operations is the presence and performance of a person or persons conducting the transfer operation: An accident generally involves human behavior, as well as equipment. Chapter 7 addresses LP-Gas liquid transfer.

Chapter 8, Storage of Cylinders Awaiting Use, Resale, or Exchange, and Chapter 9, Vehicular Transportation of LP-Gas, retain the old format of Divisions V and III.

Chapter 10 was essentially new in the 1972 edition. Earlier editions had not considered the role of the structural behavior of a room or building in an explosion.

Chapter 11 was created in the 1992 edition by relocating the coverage of engine fuel systems from Chapter 6 to this chapter.

Drawn largely from NFPA 59 and NFPA 59A, Chapter 12 was added in the 1989 edition to provide requirements for the new coverage of refrigerated storage containers.

Coverage of marine shipping and receiving was relocated from Chapter 4 to create Chapter 13 in the 1992 edition.

Chapter 14, Operations and Maintenance, was added in the 2001 edition. It contains only operations and maintenance requirements that were new in the 2001 edition. In the current edition, a new section was added, Small LP-Gas Systems, covering vapor systems of 10 to 99 users connected to a common supply system. These requirements essentially duplicate requirements in U. S. Federal Law applicable to these pipeline systems. The intent is to make them more easily available to operators of these relatively small systems, which may be located in mobile home parks, campgrounds, and housing developments.

Chapter 15 was added in the 1998 edition. It consists of tables used to size propane vapor piping. The tables were extracted from NFPA 54, *National Fuel Gas Code*. The chapter was added because some pipe sizing in buildings is now included in the scope of NFPA 58, because it was deleted from NFPA 54 in the 1996 edition.

While the 1972 edition went a long way toward bringing the format of NFPA 58 into line with other NFPA standards, it still did not properly segregate mandatory and nonmandatory provisions, and it used a different paragraph numbering system. These differences were corrected in the 1983 edition.

Experience with the format of the 1972 edition and with subsequent editions indicates that it has led to improved comprehension and application. However, it is more difficult to re-

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

view existing provisions to see if a new application is in fact already covered than it is to start from scratch. Furthermore, there is always pressure to include all provisions applicable to a new and "hot" application in one place. This temptation must be resisted lest the standard evolve into the conflicting and cumbersome document it once was.

The administration of the committees responsible for NFPA 58 has been remarkably stable over its history. Harry E. Newell of the NBFU was chairman from 1932 until 1956, when he retired from NBFU. As an indication of the respect the committee and NFPA had for him, the position of honorary chairman was created for him, the only time this position has existed. He served in this capacity until 1958.

Newell's dedication was even more remarkable in that he also performed the chores of committee secretary, albeit anonymously. It wasn't until 1954 that NFPA was able to assign a staff member, Clark F. Jones, as committee secretary. Jones served in this post until his untimely death in 1962. Wilbur L. Walls succeeded him in September 1962. Walls was the committee secretary until his retirement from NFPA in 1984. In May 1985, Theodore C. Lemoff became the NFPA staff secretary.

Franklin R. Fetherston succeeded Newell as chairman of the Committee on Gases in 1956. Initially representing the Liquefied Petroleum Gas Association (now the National Propane Gas Association), he later represented the Compressed Gas Association until he retired in 1966. During Fetherston's tenure, the Sectional Committee on Liquefied Petroleum Gases was chaired by Harold L. DeCamp of the Fire Insurance Rating Organization of New Jersey from 1956 to 1964, and by Myron Snell of the Hartford Accident and Indemnity Company from 1964 to 1966.

Hugh V. Keepers of the Fire Prevention and Engineering Bureau of Texas became the first chairman of the current committee in 1966 and served for 10 years until his retirement. He was followed by Connor Adams of the City of Miami, who served as chair from 1975 to 1996. The immediate past chairman, E. E. (Al) Linder, a safety consultant and former propane company employee, took over the reins in 1996 and served through the 2004 edition. He was replaced by Frank Mortimer of Federated Mutual Insurance Company.

Acknowledgments

A book that compiles the history, intent, and application of an NFPA standard, as the *LP-Gas Code Handbook* does, is the work of many contributors, many of whom are members of the Technical Committee on Liquefied Petroleum Gases, and all of whom work with LP-Gas daily. The foundation for this sixth edition was laid by the three authors who contributed to the first edition in 1986: Wilbur L. Walls, who represented, at the time, the expertise of NFPA on flammable gases; Walter H. Johnson, who possessed a broad knowledge of the LP-Gas industry from the industry association viewpoint; and H. Emerson Thomas, who offered his perspective as one of the founders of the propane industry in the United States.

The preparation of this eighth edition was enhanced by the contributions of Bruce Swiecicki, Senior Technical Advisor for the National Propane Gas Association. Bruce, as the contributing editor, provided draft commentary on the entire code and made many important contributions. He is a registered professional engineer in Illinois and has an M.S. in Mechanical Engineering from the University of Illinois. Bruce has been a member of the Technical Committee on Liquefied Petroleum Gases since 1994, and his efforts on this publication are appreciated.

Also deserving of special thanks for their work on this handbook are Sam McTier of McTier Supply Co. and Richard Fredenburg of the North Carolina Department of Agriculture, who provided insight into how enforcers use the code and handbook.

In addition, I wish to thank the many contributors of new artwork that makes this handbook more useful. These contributors include the following companies and individuals: Algas-SDI; Alternate Energy Installations; American Welding and Tank Company; AmeriGas; Amano Pioneer Eclipse Corporation; Anderson Greenwood; Blackmer, A Dover

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

Company; Brian Clayton; Cavagna North America, Inc.; Cenex, a brand name of CHS Inc.; ChefMaster, a division of MR. Bar-B-Q, Inc.; CleanFuel USA; Corken, Inc.; Cornerstone Propane; Eastern Propane Corp; Engineered Controls International, Inc. (Rego); Ely Energy; Elster Perfection Corp.; Ferrellgas; First Virginia Propane Company; Fisher Controls International, LLC; Flame Engineering; Foster-Miller, Inc.; Full Circle; Gas Equipment Co., Inc.; Gastite Division, Titeflex Corporation; H. Emerson Thomas; Heath Consultants Incorporated; H&H Gas; Hoffman & Feige; Illinois Propane Gas Association; IMPCO Technologies, Inc.; Independent Propane Co.; J&N Enterprises, Inc.; Lin's Propane Trucks; Liquid Controls; Lite Cylinder; Manchester Tank; Mississippi Tank Co.; National Board of Boiler and Pressure Vessel Inspectors; National Propane Gas Association; North Carolina Dept. of Agriculture; the Propane Education and Research Council (PERC); Pioneer Eclipse Corp.; Perfection Corporation; Permagas; Propane Technical Services; Ragasco; Ransome Manufacturing; Revere Gas & Appliance; Rochester Gauges, Inc; R.W. Lyall & Company, Inc.; Screen Graphics of Florida; SEA-3 Inc.; Sensidyne; Sherwood; Harsco Gas & Fluid Control Group; Smith Precision Products Co., Inc.; Superior Energy Systems; Texas Trailer Corp.; Trinity Containers, LLC; U.S. DOT; Wilbur Walls; Worthington Cylinder Corp.

Also deserving great thanks for their artwork contributions are Bill Young of Superior Energy Systems; Rob Nicholson III of Eastern Propane Corp.; Jim Griffin of Fisher Controls;; Angrest Harris of Meeder Equipment Co.; and Larry Horowitz, H&H Gas.

This handbook is built on the foundation laid by the Technical Committee on Liquefied Petroleum Gases, which writes NFPA 58. The editor appreciates the work the committee members do in carefully considering each proposal and comment and the discussions on other topics, which is the basis of the book.

I would also like to again thank Wilbur Walls, NFPA gases engineer emeritus, who, though retired, volunteered his time and energy to assist me when I joined NFPA and took over responsibility for the NFPA gases project. Bill continues to be a valuable resource for the historical questions that arise.

I also appreciate the efforts of the NFPA staff who made this book possible. Particular thanks go to Josiane Domenici, permissions editor, Marla Marek, copy editor, Irene Herlihy, developmental and project editor, and Debra Rose, product manager.

Theodore C. Lemoff, P.E.
Editor

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

About the Contributors

Ronald R. Czischke

Ronald R. Czischke is principal engineer, compressed and fuel gas equipment, at Underwriters Laboratories Inc. He has over 19 years of engineering experience and over 11 years of experience in laboratory quality management. He is a member of the American Society of Mechanical Engineers, the American Society for Quality, and the National Fire Protection Association, for which he serves on the LP-Gas Code Technical Committee, Vehicular Alternate Fuel System Technical Committee, and the Industrial and Medical Gas Technical Committee. Ronald has a bachelor's degree in mechanical engineering from Michigan Technological University and is a registered professional engineer in the state of Illinois.

Pravinray D. Gandhi

Pravinray D. Gandhi is global business development director for the fire and security division of Underwriters Laboratories Inc. During his tenure at UL, he has been involved in hazard and risk assessment; standards development; small-scale and large-scale fire testing; thermal, structural, and fire modeling; and data acquisition and instrumentation. He has also been involved with national standards (ASTM, NFPA) and international standards (ISO, IEC) development. He has been a member of the NFPA Technical Committees on Hazards and Contents and Fire Tests. Pravinray received his Ph.D. in mechanical engineering from the University of Notre Dame and is a registered professional engineer in the state of Illinois.

Eric Kuster

Eric Kuster is currently Loss Control Specialist for the Fairmont Specialty Group. He was a fire fighter/hazmat responder/crash injury medical tech for the Raritan Township Fire Co. for several years, where he served as first lieutenant. He has served on numerous committees for the Mid-Atlantic Propane Gas Association, National Propane Gas Association, and Propane Education & Research Council. He has presented to many organizations on emergency response and propane issues, including the 2005 EPA emergency preparedness/ prevention and HAZMAT spills conference and NPGA's pinnacle conference.

Rodney L. Osborne

Rod Osborne has been with Battelle for 20 years, performing and managing a wide range of energy-related projects. Rod's work has been in materials/structural mechanics, risk assessment, and integrity management of U.S. and international natural gas and propane pipelines; appliance energy, thermal, and failure analyses; and propane regulator and stationary and cargo tank testing and failure analyses. Rod has a Ph.D. in nuclear engineering from the Ohio State University and is a registered professional engineer.

John Roberts

John Roberts has a bachelor's degree in chemistry and mathematics from St. Olaf College and a Ph.D. in organic chemistry from the University of North Dakota. He worked at Phillips

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

Petroleum Company in Research and Development as a product development chemist in sulfur chemicals and also did new product development and technical support for gas odorization for Phillips 66 Chemical Company. He has worked for Engineering and Fire Investigations in Kingwood, Texas, and currently has his own firm, Materials & Chemicals Consulting, in Kingwood, Texas. He currently consults on gas odorization matters in natural gas and propane, natural gas and propane quality, and other chemical-related matters.

Bruce Swiecicki

Bruce Swiecicki has worked 14 years at the National Propane Gas Association as vice president of technical services and now as senior technical advisor. His work experience includes 10 years at Building Officials and Code Administrators, International, where he was senior staff engineer. He has been a member of the Technical Committee on Liquefied Petroleum Gases since 1994 and a member of several other NFPA committees as well as other codes and standards organizations. Bruce holds bachelor's and master's degrees in mechanical engineering from the University of Illinois and is a registered professional engineer in the state of Illinois.

Stuart Weidie

Stuart Weidie is President and CEO of Blossman Gas. He is a member of the Board of Directors of the National Propane Gas Association and Chairman of the PERC Research and Development Advisory Committee.

Kenneth Wood

Ken Wood has 38 years of experience in LP-Gas and pipeline gas. He worked 20 years at various positions for a gas utility with a propane business. He spent the last ten years as the company vice president and general manager before moving on to become Vermont PSD's gas safety program manager. He has been a member of the National Fire Protection Association, NARUC Gas Safety Subcommittee, National Association of Pipeline Safety Reps., New England Pipeline Safety Reps., Vermont LP Gas Education & Safety Committee, and an associate staff member of the Transportation Safety Institute as an LP-Gas trainer. Ken was a member of the committee that produced the *Training Guide for Operators of Small LP-Gas Systems*. He has helped investigate gas incidents resulting in fire and/or explosion and carbon monoxide poisonings. Ken is also one of the instructors at the New England Institute of Fire Science teaching the relationship of propane and other gases during fires, to aid in the investigation process. Ken is currently a co-owner of Education, Training and Safety Associates.

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

About the Editor

After graduating from the City College of New York with a Bachelor of Engineering (Chemical) degree, Theodore C. Lemoff was employed in the chemical and petrochemical industry by Proctor and Gamble Company, Sun Chemical Corporation, and Badger Engineers, Inc., in various engineering positions. He joined NFPA in 1985 and currently serves as NFPA's principal gases engineer. He serves as the NFPA staff liaison to the National Fuel Gas Code Committee, and he is also responsible for other NFPA standards on flammable gases.

In addition to being the editor of the *LP-Gas Code Handbook*, Lemoff is the editor of the *National Fuel Gas Code Handbook* and co-author of the *NFPA Pocket Guide to Fuel Gas Storage and Use.*

Lemoff represents NFPA on the ASME Code for Pressure Piping Committee (National Interest Review Group) (B31), the pipeline safety advisory committee of the U.S. Department of Transportation, and the IAPMO Mechanical and Plumbing Code Committees.

Lemoff is a registered professional engineer in the Commonwealth of Massachusetts and is a member of the American Institute of Chemical Engineers and Society of Fire Protection Engineers, the American Society of Plumbing Engineers, and the International Association of Plumbing and Mechanical Officials.

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

PART ONE

NFPA® 58, *Liquefied Petroleum Gas Code,* with Commentary

Part One of this handbook includes the complete text of the 2008 edition of NFPA 58, *Liquefied Petroleum Gas Code,* which is made up of 15 mandatory chapters and 12 nonmandatory annexes. Working within the framework of NFPA's consensus codes- and standards-making process, the Technical Committee on Liquefied Petroleum Gases prepared the mandatory provisions found in Chapters 1 through 15.

The Technical Committee on Liquefied Petroleum Gases also developed the material found in the annexes of the code. The annex material is designed to assist users in interpreting the mandatory code provisions. It is not considered part of the requirements of the code; it is advisory or informational in nature. An asterisk (*) following a code paragraph number indicates that advisory annex material pertaining to that paragraph appears in Annex A. For the reader's convenience, in this handbook Annex A material has been repositioned to appear immediately following its base paragraph in the body of the code text.

The explanatory commentary in this handbook was prepared by the handbook editor, with the assistance of those persons mentioned in the acknowledgments, and is intended to provide the reader with an understanding of the provisions of the code and to serve as a resource and reference for implementing the provisions of or enforcing the code. It is not a substitute for the actual wording of the code or the text of the many codes and standards that are incorporated by reference. The commentary immediately follows the code text it discusses and is set in blue type for easy identification.

This edition of the handbook includes a frequently asked questions feature. The marginal FAQs are based on the questions most commonly asked of the NFPA 58 staff. The handbook also features a tool designed to help users easily identify important new or revised elements in the code. New or revised material is identified with a "new" icon in the margin of the book next to that material.

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

Definitions

CHAPTER 3

Since the 2004 edition, all definitions that apply to subjects covered throughout the code have been located in Chapter 3.

The sections in Chapter 3 are outlined as follows:

- General (See Section 3.1.)
- NFPA Official Definitions, which apply to all NFPA codes and standards (See Section 3.2.)
- General Definitions, which apply to NFPA 58 only (See Section 3.3.)

3.1 General

The definitions contained in this chapter shall apply to the terms used in this code. Where terms are not defined in this chapter or within another chapter, they shall be defined using their ordinarily accepted meanings within the context in which they are used. *Merriam-Webster's Collegiate Dictionary,* 11th edition, shall be the source for the ordinarily accepted meaning.

Generally, if terms used in the code are not defined in Chapter 3, then *Merriam-Webster's Collegiate Dictionary* [1] is the source for common usage.

3.2 NFPA Official Definitions

Section 3.2 contains definitions that are used in other NFPA documents and are not specifically related to the propane industry. NFPA attempts to make all of its documents consistent with respect to terms used to describe the enforcement authority and approval process.

3.2.1* Approved. Acceptable to the authority having jurisdiction.

A.3.2.1 Approved. The National Fire Protection Association does not approve, inspect, or certify any installations, procedures, equipment, or materials; nor does it approve or evaluate testing laboratories. In determining the acceptability of installations, procedures, equipment, or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure, or use. The authority having jurisdiction may also refer to the listings or labeling practices of an organization that is concerned with product evaluations and is thus in a position to determine compliance with appropriate standards for the current production of listed items.

Equipment, materials, or services can be listed, approved, or both. *Listed*, defined in 3.2.5, means that the item has been reviewed by an independent testing organization that evaluates products and continues to evaluate their production. Listed products are included in "lists" maintained by the testing agency. *Approved*, as defined in 3.2.1, means that the equipment, material, or services have been accepted by the authority having jurisdiction. Listed products

◄ **FAQ**
What is the difference between the terms *listed* and *approved*?

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

must comply with standards, while approved products may or may not comply with standards.

3.2.2* Authority Having Jurisdiction (AHJ). An organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure.

A.3.2.2 Authority Having Jurisdiction (AHJ). The phrase "authority having jurisdiction," or its acronym AHJ, is used in NFPA documents in a broad manner, since jurisdictions and approval agencies vary, as do their responsibilities. Where public safety is primary, the authority having jurisdiction may be a federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the authority having jurisdiction. In many circumstances, the property owner or his or her designated agent assumes the role of the authority having jurisdiction; at government installations, the commanding officer or departmental official may be the authority having jurisdiction.

FAQ ▶
What is the meaning of "authority having jurisdiction" as used in NFPA 58?

An authority having jurisdiction is a governmental agency responsible for protecting the public welfare through its activities to enforce the codes and standards that have been enacted into law. The propane industry can be regulated through a number of governmental agencies, including the state or local fire marshal's office, the state or local building department, or the federal or state department of transportation. Notably, many enforcement agencies, including the U.S. Occupational Safety and Health Administration, promulgate rules that reference earlier editions of NFPA 58 than the 2008 edition. As noted in A.3.2.2, nongovernmental bodies can be the authority having jurisdiction by virtue of the conditions of a private contract (e.g., an insurance policy).

Each propane retail marketing business should become familiar with which authorities have jurisdiction over each operation of its business. The following are examples of authorities having jurisdiction for different parts of a propane business:

- Bulk plant — Fire marshal or fire chief
- Vehicles — State vehicle bureau or state police
- Residential installations — Building or gas official

3.2.3* Code. A standard that is an extensive compilation of provisions covering broad subject matter or that is suitable for adoption into law independently of other codes and standards.

A.3.2.3 Code. The decision to designate a standard as a "code" is based on such factors as the size and scope of the document, its intended use and form of adoption, and whether it contains substantial enforcement and administrative provisions.

3.2.4 Labeled. Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

FAQ ▶
What information should be on a label?

A product is labeled to indicate that a third-party, independent agency has either conducted testing or otherwise evaluated the performance or the design of a product or system. The label indicates the name of the evaluating organization (such as Underwriters Laboratories Inc. or CSA-America) as well as the manufacturer's name or trademark and the model number and/or serial number and should list the applicable standard under which the product or equipment was evaluated or tested.

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

3.2.5* Listed. Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states that either the equipment, material, or service meets appropriate designated standards or has been tested and found suitable for a specified purpose.

A.3.2.5 Listed. The means for identifying listed equipment may vary for each organization concerned with product evaluation; some organizations do not recognize equipment as listed unless it is also labeled. The authority having jurisdiction should utilize the system employed by the listing organization to identify a listed product.

The AHJs customarily accept or even require (depending on whether or not NFPA 58 requires) the use of listed equipment whenever it is available. In the United States and Canada, the major LP-Gas equipment listing agencies customarily recognized as such by the authorities having jurisdiction are Underwriters Laboratories Inc., Underwriters' Laboratories of Canada, FM Global, CSA-International, and others. Many other organizations perform such services, however, and equipment listed by them is acceptable provided that the organization is acceptable to the authority having jurisdiction.

A point of some confusion is that not all the above organizations use the term *listed*. For example, CSA-America uses the term *certified* and FM Global uses the term *approved*. The terms *certified* and *approved* are synonymous with the term *listed* in this definition.

3.3 General Definitions

3.3.1 Actuated Liquid Withdrawal Excess-Flow Valve. An excess-flow valve for liquid withdrawal applications that remains in a closed position until actuated by a pipe nipple or adapter, as recommended by the manufacturer, and that is used with a shutoff valve attached to the actuator.

The definition of *actuated liquid withdrawal excess-flow valve* was added in the 1995 edition. These valves are required in ASME containers of 125 gal to 2000 gal (0.5 m^3 to 7.6 m^3) water capacity manufactured after July 1, 1961. The valve is designed to eliminate the need to roll a container on its side to remove liquid from it. Since the early 1960s, at least three manufacturers have made valves that accomplish the requirements related to this definition under the names of Check-Lok® and Check-Mate®. Prior to the 1995 edition, this specific function valve had no name or definition. The term *actuated* is used to indicate that the valve remains closed until the insertion of the mating connection opens it.

3.3.2 Anodeless Riser. A transition assembly where polyethylene or polyamide pipe or tubing is permitted to be installed underground and is terminated above ground outside of a building.

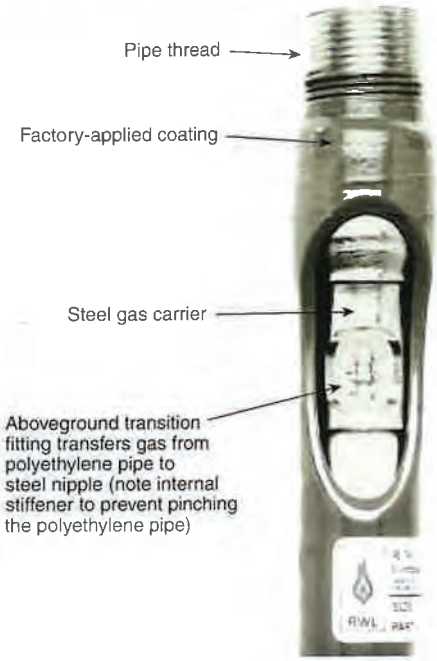
An anodeless riser is a piping component that connects to polyethylene (or polyamide) pipe under ground and terminates in a metal threaded connection above ground (see Exhibit 3.1). It is anodeless because it provides no metallic surface that contacts the soil, thereby protecting the riser against corrosion. Typically, anodeless risers are manufactured of steel-encased polyethylene liners. The steel is coated with an epoxy covering that protects the inner components. (See 6.9.4.3.)

3.3.3 ANSI. American National Standards Institute.

The American National Standards Institute (ANSI) is a private, nonprofit organization that administers and coordinates the U.S. voluntary standardization and conformity assessment

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

EXHIBIT 3.1 *Cutaway View of Riser Assembly. (Courtesy of R.W. Lyall & Company, Inc.)*



system. ANSI does not develop its own standards but sanctions those prepared by committees and organizations that are ANSI members and that use procedures approved by ANSI.

NFPA is recognized as a standards-developing organization under ANSI and issues codes and standards with the ANSI designation because its regulations are accepted by ANSI.

3.3.4 API. American Petroleum Institute.

The American Petroleum Institute (API) is a trade association composed largely of U.S. oil companies. Many oil companies produce and distribute LP-Gas because it is a byproduct of the refining of crude oil as well as the processing of natural gas. API also develops standards that can be useful for those involved in the LP-Gas industry.

3.3.5 API-ASME Container (or Tank). A container constructed in accordance with the pressure vessel code jointly developed by the American Petroleum Institute and the American Society of Mechanical Engineers.

Until 1961 a joint API-ASME code was used for designing propane tanks. A small number of these vessels are still in service, and they remain acceptable for service. After the joint code was discontinued, API addressed the refining industry's need for large storage vessels, while ASME addressed pressure vessels for all applications.

3.3.6 ASME. American Society of Mechanical Engineers.

The American Society of Mechanical Engineers (ASME) is a membership organization of mechanical engineers.

3.3.7 ASME Code. The American Society of Mechanical Engineers Boiler and Pressure Vessel Code.

3.3.8 ASME Container. A container constructed in accordance with the ASME Code.

3.3.9 ASTM. American Society for Testing and Materials.

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

The American Society for Testing and Materials (ASTM) promulgates the largest body of private-sector standards in the United States. As is evident in 2.3.5, many ASTM standards that address piping and castings are adopted by mandatory reference in NFPA 58.

3.3.10* Bulk Plant. A facility where the primary function is to store LP-Gas prior to further distribution. LP-Gas is received by cargo tank vehicle, railroad tank car, or pipeline, and then distributed by portable container (package) delivery, by cargo tank vehicle, or through gas piping.

A.3.3.10 Bulk Plant. Bulk plants receive gas through a variety of methods, such as railroad tank car, transport, cargo tank vehicle, gas piping, or watercraft. These plants are generally utilized for domestic, commercial, agricultural, institutional, and industrial applications, or for the storage of product awaiting delivery to the end user. A facility that transfers LP-Gas from railroad tank cars from a private track directly into cargo tank vehicles is also in this category. Such plants could have container-filling and truck loading/unloading facilities on the premises. Normally, no persons other than the plant management or plant employees have access to these facilities.

As defined in 3.3.10, bulk plants are facilities where LP-Gas is stored before it is delivered to the end-use customer. Frequent liquid transfer operations take place at bulk plants. These include cylinder filling, transport truck unloading, rail tank car unloading, and bobtail (retail bulk delivery truck) filling. See Exhibit 3.2 for an example of a typical bulk plant. Exhibit 3.3 shows a larger bulk plant with the capability to unload LP-Gas from rail cars. See also F.I. 58-04-3.

◀ **FAQ**
What is meant by the term *bulk plant?*

3.3.11 Cargo Tank. A container that is used to transport LP-Gas as liquid cargo and either is mounted on a conventional truck chassis or is an integral part of a cargo transporting vehicle.

Cargo tanks are typically installed on truck chassis (cargo tank motor vehicles), which are built to comply with DOT requirements (MC-330 and MC-331 specifications) [2,3]. Cargo tank vehicles include bobtails (see Exhibit 3.4) and transports (see Exhibit 3.5). Cargo tanks differ from DOT containers, which are "portable" and are transported on trucks.

3.3.12 CGA. The Compressed Gas Association.

In 1913, a nonprofit service organization was incorporated in New York as the Compressed Gas Manufacturers' Association to promote, develop, represent, and coordinate technical and standardization activities in the compressed gas industries in the interest of safety and effi-

EXHIBIT 3.2 *Aerial View of a Bulk Plant. (Courtesy of Revere Gas and Appliance)*

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

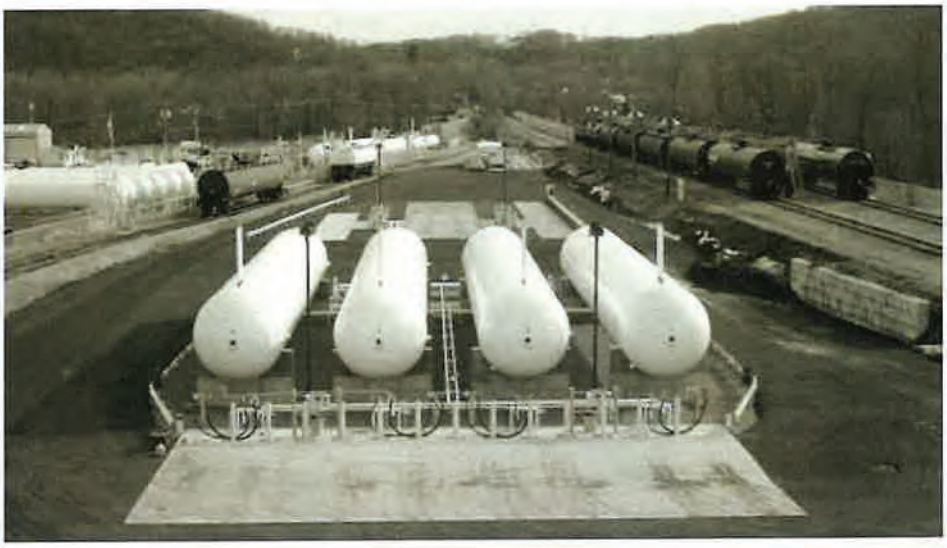


EXHIBIT 3.3 *Large Bulk Plant. (Courtesy of Eastern Propane Corp.)*

Formal Interpretation
NFPA 58
Liquefied Petroleum Gas Code
2008 Edition

Reference: 3.3.10

F.I. No.: 58-04-3

Question: Is it the intent of the Committee, based on the definition provided in 3.3.10 of NFPA 58, that a building, at a bulk plant, containing cylinders for distribution or buildings at bulk plants where LP-Gas cylinders are filled, is part of the bulk plant?

Answer: Yes

Issue Edition: 2004

Reference: 3.3.10

Issue Date: November 30, 2005

Effective Date: December 19, 2005

Copyright © 2007 All Rights Reserved
NATIONAL FIRE PROTECTION ASSOCIATION

ciency. Today, among the Compressed Gas Association's (CGA's) members are companies and individuals producing compressed, liquefied, and cryogenic gases and their containers (including cargo containers), container appurtenances, and other system components.

From its inception, a major activity of CGA has been the development of standards through the efforts of more than 40 technical committees. The 1932 edition of what is now NFPA 58 was based on a draft prepared by CGA's Test and Specification Committee in 1930 and 1931. (See "History of NFPA 58" in the Preface.) Much of this work has now passed on

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

EXHIBIT 3.4 *Bobtail. (Courtesy of CENEX, a brand name of CHS Inc.)*

EXHIBIT 3.5 *Transport Vehicle. (Courtesy of Mississippi Tank Co.)*

to the National Propane Gas Association (NPGA). CGA continues to provide valuable technical assistance to the NFPA Technical Committee on Liquefied Petroleum Gases.

3.3.13 Container. Any vessel, including cylinders, tanks, portable tanks, and cargo tanks, used for the transporting or storing of LP-Gases.

As noted in the definition of *container,* there are several different pressure containers used to store and transport LP-Gas, and each must comply with specific fabrication requirements. The word *container* is a generic description in NFPA 58 for pressure vessels that store LP-Gases and is used by itself in the code whenever it is not necessary to cite a specific type. A container may be either a DOT cylinder or an ASME tank.

3.3.14 Container Appurtenances. Devices installed in container openings for safety, control, or operating purposes.

3.3.15 Container Assembly. An assembly consisting of the container and fittings for all container openings such as shutoff valves, excess-flow valves, liquid level gauging devices, pressure relief devices, and protective housings.

3.3.16 Cylinder. A container designed, constructed, tested, and marked in accordance with U.S. Department of Transportation specifications, Title 49, Code of Federal Regulations, or in accordance with a valid DOT exemption.

The definition of *cylinder* was revised in the 2008 edition to include the stipulation that the cylinder be designed, tested, and marked to comply with DOT requirements, in addition to the previous requirement that the cylinder be constructed in accordance with DOT requirements. Therefore, a container is not a cylinder unless it complies with all DOT requirements.

3.3.17 Design Certification. The process by which a product is evaluated and tested by an independent laboratory to affirm that the product design complies with specific requirements.

3.3.18 Diameter. The length of a straight line passing through the center of a cycle, terminating at the periphery.

3.3.19 Direct Gas-Fired Tank Heater. A gas-fired device that applies hot gas from the heater combustion chamber directly to a portion of the container surface in contact with LP-Gas liquid.

3.3.20 Dispensing Station. Fixed equipment in which LP-Gas is stored and dispensed into portable containers.

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

The definition of *dispensing station* was extracted from NFPA 30A, *Code for Motor Fuel Dispensing Facilities and Repair Garages*, 2003 edition [4], and first appeared in the 1992 edition of NFPA 58.

The fundamental feature differentiating vehicle fuel dispensers and dispensing stations from bulk plants or industrial plants is that persons other than management or employees have access to the vehicle fuel dispensing facility. The distinct provisions for dispensing fuel into portable containers are included in Section 6.24.

Dispensing stations include cylinder refilling facilities, which are open to the public; cylinder refueling facilities at recreational vehicle parks; facilities at hardware, equipment rental, and sporting goods stores for filling gas grill cylinders; and facilities at marinas. Refueling of industrial truck cylinders could be at a bulk plant where exchange cylinders are refilled or at an industrial plant where either exchange cylinders or containers mounted on the industrial truck are refilled.

3.3.21 DOT. U.S. Department of Transportation.

3.3.22 Filling.

All LP-Gas containers have a maximum permitted filling limit to prevent the container from becoming "liquid full" if the temperature of the gas rises. If a container becomes "liquid full," gas can be released into the atmosphere, possibly resulting in a fire or explosion if a source of ignition is present. If liquid LP-Gas is released through a pressure relief valve, it will expand to 270 times its liquid volume. Two fundamental methods are allowed for filling LP-Gas containers — *volumetric* and *weight.*

3.3.22.1 ***Volumetric Method Filling.*** Filling a container to not more than the maximum permitted liquid volume.

The volumetric method filling limits the volume of liquid LP-Gas to 80 percent for cylinders and smaller ASME containers, or to a level determined by the density and temperature of the liquid LP-Gas for ASME containers over 1200 gal (4.5 m^3) (see 7.4.3). Volumetric filling is typically performed using a fixed maximum liquid level gauge, which comprises a dip tube protruding into the container and a knurled nut or slotted screw that opens the dip tube to the atmosphere. When the liquid LP-Gas level contacts the bottom of the dip tube, liquid is transported out of the cylinder and vaporizes outside the cylinder at the lower pressure of the atmosphere. The act of vaporization causes moisture in the surrounding air to condense and appear as a white fog. The appearance of this fog indicates that the container has been filled to its maximum limit.

3.3.22.2 ***Weight Method Filling.*** Filling containers to not more than the maximum permitted filling limit by weighing the LP-Gas in the container.

The weight method for filling cylinders is used for smaller size cylinders and limits the amount of liquid propane gas to 42 percent of the water capacity (in pounds) marked on the cylinder. Using the weight filling method for cylinders requires the use of a scale to measure the weight of the gas in the container.

3.3.23* Fire Protection. Fire protection for the purposes of this code shall be defined in the broad sense to include fire prevention, fire detection, and fire suppression.

A.3.3.23 Fire Protection. *Fire prevention* covers measures directed at avoiding the inception of fire or the escalation of an incident following the accidental or inadvertent release of LP-Gas. Such measures could include product control equipment and the insulation, mounding, or burial of containers.

Fire detection covers equipment that detects the presence of fire or heat either to initiate automated operation of the product control or other process equipment or to initiate local or remote alarms.

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

Fire suppression covers means of supplying water or other agents providing for fire control, exposure protection, or fire extinguishment.

The definition of *fire protection* was added to the code in 2004 to clarify the intent of the term as it relates to the provisions contained in Section 6.25, Fire Protection. Fire protection systems can include methods for fire prevention, fire detection, or fire suppression. Methods of fire prevention include requirements that are specified in the code, such as restricting the separation distance between propane containers and combustible materials or tanks containing flammable liquids. Fire detection methods may be traditional systems, such as smoke or heat detectors, but they may also be systems specifically required by the code, such as thermal activation links for internal valves and emergency shutoff valves. Fire suppression systems are traditionally recognized as being active systems, such as water spray or deluge systems. However, "passive" systems, such as insulating, burying, or mounding containers, also fall into this category.

3.3.24 Fixed Piping System. Piping, valves, and fittings permanently installed in a location to connect the source of the LP-Gas to the utilization equipment.

3.3.25 Flexible Connector. A short [not exceeding 60 in. (1.52 m) overall length] piping system component that is fabricated from a flexible material and equipped with connections at both ends.

The definition of *flexible connector* was revised in the 2008 edition, and new subdefinitions were added for related connectors to allow the user to discern between different materials used for flexible connectors.

The definition of *flexible connector* recognizes an increase in the permitted length up to 60 in. because flexible connectors are necessarily longer than 36 in. in order to achieve the necessary separation between the containers and the appliances they connect to. Previously, the 36 in. maximum was insufficient to maintain the 36 in. separation required by the code. Flexible connectors in permanent installations are restricted to flexible metallic connectors for durability.

3.3.25.1 Flexible Hose Connector. A component fabricated from LP-Gas hose that meets the requirements of UL 569, *Standard for Pigtails and Flexible Hose Connectors for LP-Gas,* or the following requirements of UL 21, *Standard for LP-Gas Hose*: (1) The tube or lining of a hose shall be made from a material compatible with LP-Gas. (2) The hose reinforcement shall be of cotton, synthetic fibers, or corrosion-resistant material such as stainless steel, or any combination thereof, evenly applied over the tube.

3.3.25.2 Flexible Metallic Connector. A component fabricated from flexible metal such as stainless steel wire braid or soft copper tubing.

Flexible hose connectors or flexible metallic connectors are allowed for portable and exchange cylinders. This construction is successfully used in many applications, including recreational vehicles. Flexible hose connectors up to 60 in. in length would only be used for portable exchange cylinders. Flexible hose connectors and flexible metallic connectors longer than 36 in. are successfully being used in areas subject to seismic forces for piping system flexibility. The additional length avoids overstressing the connector in order to maintain required separation distances between the appliance and the container.

The use of stainless steel wire braid hose is an accepted practice for motor fuel supply lines. The stainless steel reinforced tube provides extra protection for the tube assembly within the flexible hose connector.

3.3.26 Gallon. U.S. Standard. 1 U.S. gal = 0.833 Imperial gal = 231 $in.^3$ = 3.785 L.

3.3.27 Gas. Liquefied petroleum gas in either the liquid or vapor state. The more specific terms *liquid LP-Gas* or *vapor LP-Gas* are used for clarity.

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

3.3.28* Gas–Air Mixer. A device or a system of piping and controls that mixes LP-Gas vapor with air to produce a mixed gas of a lower heating value than the LP-Gas.

A.3.3.28 Gas–Air Mixer. A gas–air mixture normally is used in industrial or commercial facilities as a substitute for another fuel gas.

Gas–air mixers are used to provide substitute fuel gas in natural gas systems. They are commonly referred to as "peak shaving" installations where the economics of the system make the temporary or permanent use of diluted LP-Gas more economically attractive than using natural gas.

3.3.29 Gauge.

3.3.29.1 Fixed Liquid Level Gauge. A liquid level indicator that uses a positive shutoff vent valve to indicate that the liquid level in a container being filled has reached the point at which the indicator communicates with the liquid level in the container.

3.3.29.2 Fixed Maximum Liquid Level Gauge. A fixed liquid level gauge that indicates the liquid level at which the container is filled to its maximum permitted filling limit.

An *outage gauge* is a common term for a fixed maximum liquid level gauge. A *10 percent gauge* is a common term for a fixed maximum liquid level gauge located at the 90 percent fill level of a container (leaving 10 percent empty space). A *20 percent gauge* is a common term for a fixed maximum liquid level gauge located at the 80 percent fill level of a container (leaving 20 percent empty space). Exhibit 3.6 shows the components of a fixed maximum liquid level gauge.

EXHIBIT 3.6 *Fixed Maximum Liquid Level Gauge.*

3.3.29.3 Float Gauge. A gauge constructed with an element installed inside the container that floats on the liquid surface and transmits its position to a device outside the container to indicate the liquid level.

3.3.29.4 Magnetic Gauge. See 3.3.29.3, Float Gauge.

A magnetic gauge is a type of float gauge that relies on a magnetized coupling to display the liquid level in the container. With a magnetic gauge, there is no possible leakage of LP-Gas through a seal since there is no penetration of the container wall.

3.3.29.5 Rotary Gauge. A variable liquid level gauge consisting of a small positive shutoff vent valve located at the outside end of a tube that has a bent end inside the container and can be manually rotated to determine the liquid level in the container. It is equipped with a pointer and an outside dial to indicate the liquid level.

A rotary gauge is a manually operated gauge that is used in both stationary and mobile storage containers. It comprises a vent to the atmosphere (a small tube with a valve) that is normally closed and a tube within the container that is manually rotated from outside. The gauge is operated by locating the tube in its uppermost position and opening the valve. A small stream of LP-Gas vapor is released, which is not visible. The tube is rotated until the stream turns white, indicating that liquid is being released, and the position of the gauge is read from the scale. For a more accurate reading, the tube rotation is continued, and the point at which the stream turns clear again is noted. The two measurements are averaged, compensating for any bending of the tube in the container.

3.3.29.6* Slip Tube Gauge. A variable liquid level gauge in which a relatively small positive shutoff valve is located at the outside end of a straight tube, normally installed vertically, that communicates with the container interior.

A.3.3.29.6 Slip Tube Gauge. The installation fitting for the tube is designed so that the tube can be slipped in and out of the container and so that the liquid level at the inner end of the tube can be determined by observing when the shutoff valve vents liquid.

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

*3.3.29.7 **Variable Liquid Level Gauge.*** A device that indicates the liquid level in a container throughout a range of levels.

3.3.30 GPA. Gas Processors Association.

3.3.31 ICC. U.S. Interstate Commerce Commission.

3.3.32 Ignition Source. See 3.3.67, Sources of Ignition.

3.3.33 Industrial Occupancy. Includes factories that manufacture products of all kinds and properties devoted to operations such as processing, assembling, mixing, packaging, finishing or decorating, and repairing.

Industrial occupancies may sometimes have large LP-Gas storage on hand. In that respect, an industrial occupancy may be similar to a retail bulk plant. The primary difference between the two is that a retail bulk plant typically has many more liquid transfer operations.

This definition is taken from *NFPA 5000®*, *Building Construction and Safety Code®* [5], and is also used in NFPA *101®*, *Life Safety Code®* [6].

3.3.34 kPa. Absolute pressure in kilo-Pascals.

3.3.35 kPag. Gauge pressure in kilo-Pascals.

3.3.36 Liquefied Petroleum Gas (LP-Gas). Any material having a vapor pressure not exceeding that allowed for commercial propane that is composed predominantly of the following hydrocarbons, either by themselves or as mixtures: propane, propylene, butane (normal butane or isobutane), and butylenes.

◄ FAQ
Is propane the same as LP-Gas?

LP-Gas can comprise any of a number of different hydrocarbons, but within the scope of NFPA 58, it is limited to a material with a vapor pressure for commercial propane. ASTM D 1835, *Standard Specification for Liquefied Petroleum Gases* [7], defines the vapor pressure for commercial propane to be 208 psig at 100°F (1.43 MPa at 38°C). By the same standard, commercial propane must be "predominantly propane," while HD-5 propane grade must be at least 90 percent propane.

3.3.37* Low Emission Transfer. Establishes a maximum fugitive emissions standard for certain product transfer operations. Low emission transfer specifications might be employed to comply with environmental regulations or to determine certain minimum distance requirements.

A.3.3.37 Low Emission Transfer. Specifications for low emission transfer might be employed to comply with environmental regulations or to determine certain minimum distance requirements.

Low emission transfer is a method of transferring LP-Gas into containers with significantly reduced emission of hydrocarbon vapors. It is accomplished with specialized dispensing nozzles and corresponding transfer fittings that limit the amount of vapor released to the atmosphere to 4 cc (0.24 $in.^3$) of product (liquid equivalent).

3.3.38 LP-Gas System. An assembly consisting of one or more containers with a means for conveying LP-Gas from a container to dispensing or consuming devices that incorporates components that control the quantity, flow, pressure, and physical state (liquid or vapor) of the LP-Gas.

LP-Gas systems include LP-Gas transfer facilities such as bulk plants.

3.3.39 Maximum Allowable Working Pressure (MAWP). The maximum pressure at which a pressure vessel is to operate as described by the ASME *Boiler and Pressure Vessel Code*.

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

3.3.40 Minimum Design Metal Temperature (MDMT). As described by the ASME *Boiler and Pressure Vessel Code*.

3.3.41 Mobile Container. A container that is permanently mounted on a vehicle and connected for uses other than supplying engine fuel.

The term *mobile container* defines permanently mounted, non-engine fuel containers on vehicles, such as recreational and catering vehicles. Exhibit 3.7 shows a mobile container designed for use in recreational vehicles. The definition does not include cargo tank motor vehicles.

EXHIBIT 3.7 *Recreational Vehicle Propane Tank. (Courtesy of Manchester Tank)*

3.3.42 Mounded Container. An ASME container designed for underground service installed above the minimum depth required for underground service and covered with earth, sand, or other material, or an ASME container designed for aboveground service installed above grade and covered with earth, sand, or other material.

Mounded containers are aboveground or partially aboveground containers covered with earth, sand, or other material so that the container itself is not visible. Mounding provides protection from exterior flame impingement.

3.3.43* Movable Fuel Storage Tender. A container equipped with wheels (including a farm cart) not in excess of 1200 gal (4.5 m^3) water capacity that is moved from one location to another.

A farm cart is shown in Exhibit 9.12.

A.3.3.43 Movable Fuel Storage Tender. Movable fuel storage tenders or farm carts are basically non-highway vehicles but can occasionally be moved over public roads or highways for short distances to supply fuel for farm tractors, construction machinery, and similar equipment.

3.3.44 MPa. Absolute pressure in mega-Pascals.

3.3.45 MPag. Gauge pressure in mega-Pascals.

3.3.46 Multipurpose Passenger Vehicle. A motor vehicle with motive power, with the exception of a trailer, designed to carry 10 or fewer persons that is constructed on a truck chassis or with special features for occasional off-road operations.

The definition of *multipurpose passenger vehicle* is needed because the term, as used in Chapter 11, is not self-evident. A label affixed to the vehicle in accordance with U.S. federal regulations identifies a multipurpose passenger vehicle.

3.3.47 NFPA. National Fire Protection Association.

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

3.3.48 NPGA. National Propane Gas Association.

The National Propane Gas Association (NPGA), originally the National Bottled Gas Association and later the National LP-Gas Association, is the national association for the liquefied petroleum gas industry. NPGA members include producers of LP-Gas, wholesale and retail marketers, gas appliance and equipment manufacturers and distributors, tank and cylinder fabricators, transport firms, and others. NPGA has 3500 members throughout the United States and 228 other countries.

One of the primary reasons for the association's establishment in 1931 was to afford all interested segments of the industry full opportunity to aid in making the rules that safeguard it. The NPGA was first affiliated with the Compressed Gas Manufacturers' Association (now the Compressed Gas Association), the only technical association in existence that could manage the problems involving gases in cylinders, the primary method of handling LP-Gases at that time.

Today, the NPGA is a separate and distinct organization that carries on its own technical activities through its technical committees. One of these committees, the Technology and Standards Committee, has engineering and technical representation from all segments of the industry. In addition, there are advisory members representing other related industry associations, testing laboratories, regulatory officials, insurance organizations, and others that greatly assist the technical committee in its standards development work. The technical committee initiates many recommendations for new provisions and amendments of existing provisions in NFPA 58 as industry-sponsored recommendations. The NFPA Technical Committee on Liquefied Petroleum Gases, which reflects a broader interest, in turn considers these recommendations. Because the NPGA Technology and Standards Committee has at its disposal a large amount of technical talent, the NFPA Technical Committee on Liquefied Petroleum Gases has at times referred matters to this group for initial study and recommendations.

3.3.49 Overfilling Prevention Device (OPD). A safety device that is designed to provide an automatic means to prevent the filling of a container in excess of the maximum permitted filling limit.

The definition of *overfilling prevention device (OPD)* was added in the 1998 edition to describe a device that is required in cylinders with a propane capacity of 4 lb (2 kg) through 40 lb (18 kg) and in engine fuel containers fabricated after January 1, 1984. There are different designs in use, but all of them shut off flow into the container when the liquid within reaches a specific level. (See 5.7.3 and 11.4.1.13 for requirements for overfilling prevention devices.) Exhibit 3.8 shows an OPD.

3.3.50 Overpressure Shutoff Device. A device that shuts off the flow of LP-Gas vapor when the outlet pressure of the regulator reaches a predetermined maximum allowable pressure.

NFPA 58 requires protection against excessive vapor pressure in propane piping systems in buildings. This protection is in the form of an overpressure shutoff device, which is usually incorporated into pressure regulators used in vapor distribution systems. The outlet pressure of a first-stage pressure regulator is 10.0 psig (69 kPag), and a second-stage pressure is 11 in. water column (2.7 kPag). Regulators require a feature (which can be an overpressure shutoff device) to prevent the pressure at the discharge of the second-stage regulator from exceeding 2.0 psig (14 kPag). [See 5.8.1.2(1) and its related commentary.]

3.3.51 Permanent Installation. See 3.3.71, Stationary Installation.

3.3.52 Permitted. Allowed or acceptable, and not requiring a permit (a document granting permission) to be secured.

The definition of *permitted* is new to the 2008 code and is intended to clarify a misconception regarding the issuance of formal permits. The term, as used in NFPA 58, does not require or imply a need for a permit from a local or state official. It means that something is permissible according to NFPA 58.

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

EXHIBIT 3.8 *Overfilling Prevention Device. (Courtesy of Cavagna North America, Inc.)*

3.3.53 Piping Systems. Pipe, tubing, hose, and flexible rubber or metallic hose connectors with valves and fittings made into complete systems for conveying LP-Gas from one point to another in either the liquid or the vapor state at various pressures.

3.3.54 Point of Transfer. The location where connections and disconnections are made or where LP-Gas is vented to the atmosphere in the course of transfer operations.

Point of transfer is a term used to identify the location of the temporary connection between a liquid transfer supply tank, such as a bobtail or a dispenser tank, and the storage container that is being filled. (See Exhibit 3.9.) This connection establishes the point from which clearance must be maintained to sources of ignition and other equipment. It was introduced in the 1972 edition of NFPA 58.

3.3.55* Portable Container. A container designed to be moved readily, as opposed to a container designed for stationary installations.

A.3.3.55 Portable Container. Portable containers, designed for transportation, include *cylinders*, *cargo tanks*, and *portable tanks*, which are defined separately in this code. Containers that are designed to be readily moved from one location of use to another but that are substantially empty of product are *portable storage containers* and are also defined separately in this code.

3.3.56* Portable Storage Container. A container that is designed and constructed to be moved over a highway from one usage location to another.

A.3.3.56 Portable Storage Container. Portable storage containers have legs or other supports attached or are mounted on running gear (such as trailer or semitrailer chassis), with suitable supports that can be of the fold-down type. Such supports allow them to be placed on a reasonably firm and level surface. For large-volume, limited-duration product usage (such

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

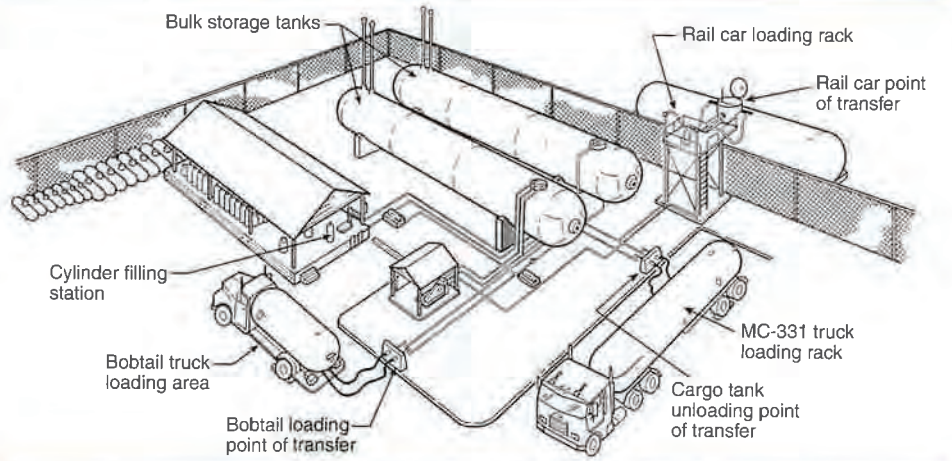


EXHIBIT 3.9 *Points of Transfer at a Propane Bulk Plant. (Courtesy of National Propane Gas Association)*

as at construction sites and normally for 12 months or less), portable storage containers serve as permanently installed stationary containers.

3.3.57 Portable Tank (or Skid Tank). A container of more than 1000 lb (454 kg) water capacity that is equipped with protected container appurtenances, is used to transport LP-Gas, and is designed and fabricated with permanently mounted skids or runners or is fabricated and installed within a full framework.

The definition of *portable tank* was revised in the 2008 edition to ensure that it is consistent with the terminology used by DOT in Title 49 of the Code of Federal Regulations. A portable tank differs from a portable storage container in that the portable tank complies with DOT requirements and can be shipped entirely filled with LP-Gas. However, a portable storage container is an ASME container but not an approved DOT shipping container and therefore must be transported with no more than 5 percent liquid within it.

◄ **FAQ**
What is the difference between a portable storage container and a portable tank?

3.3.58 Pressure Relief Device. A device designed to open to prevent a rise of internal pressure in excess of a specified value due to emergency or abnormal conditions.

All cylinders and ASME containers used for LP-Gas are equipped with pressure relief devices. These are designed to prevent failure of the container due to overpressurization. Overpressurization may occur when the container becomes "liquid full," due to the heating of the container by a fire or, in some cases, if the container has been overfilled. Although opening of the pressure relief device will prevent the container from failure due to overpressure, the released flammable LP-Gas may also present a hazard.

In addition to containers, pressure relief devices are used in segments of hose or piping where liquid can be trapped between shutoff valves.

◄ **FAQ**
When is a pressure relief device likely to activate?

3.3.59 psi. Pounds per square inch.

3.3.60 psia. Pounds per square inch, absolute.

3.3.61 psig. Pounds per square inch gauge.

Units of pressure measurement used in the code are pounds per square inch (psi) and Pascals (Pa). When metric units of measurement were added to the code in the 1980s, pressure measurements were converted into Pascals (and kilo-pascals and mega-pascals because the Pascal is a small unit). Pressure measurements are usually given in one of two forms, either gauge or absolute. *Absolute pressure* is the pressure of the gas in the container plus the atmospheric

◄ **FAQ**
What is the difference between gauge pressure and absolute pressure?

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

pressure. *Gauge pressure* is the absolute pressure of a gas minus the local atmospheric pressure, or the pressure one would read on an accurate gauge connected to a tank. A pressure gauge at sea level will read 0, even though a pressure of 14.7 psi is present. Traditionally, pressure in tanks and piping systems is expressed in gauge pressure.

3.3.62 Quick Connectors. Fittings used to connect hose assemblies to piping and valves without the use of tools.

Quick connectors are used to connect transfer hose to piping and valves for loading and unloading cargo tank vehicles or railroad tank cars. They can also be used as connectors on swivel-type transfer piping. Quick connectors are also used in other LP-Gas systems, such as those used for engine fuel refueling and cylinder filling, connecting cylinders to gas-fired barbecue grills, and connecting gas systems between two sections of mobile homes.

3.3.63 Refrigerated LP-Gas. LP-Gas that is maintained as a liquid at temperatures below ambient temperature to reduce the storage pressure including fully refrigerated LP-Gas at pressures near atmospheric pressure but not exceeding 15 psig (103 kPag) and semi-refrigerated LP-Gas at pressures above 15 psig (103 kPag).

Refrigerated LP-Gas is just what the term implies — LP-Gas that has been refrigerated or cooled. When the gas is propane, the liquid is typically at a temperature of about –40 °F (–40 °C). At that temperature propane is a liquid that exerts no pressure on its container, thus providing a way to store propane in a nonpressurized (and usually insulated) container, which is less expensive than a pressure vessel. The economics are such that refrigerated storage is normally used for very large containers (1,000,000 gal is not unusual), and refrigerated LP-Gas storage is normally found at pipeline and marine terminals and occasionally at larger storage facilities.

3.3.64 Regulator.

The various types of regulators defined in NFPA 58 are shown in Exhibits 3.10 to 3.13 and listed in Commentary Table 3.1.

3.3.64.1* Automatic Changeover Regulator. An integral two-stage regulator that combines two high-pressure regulators and a second-stage regulator into a single unit designed for use with multiple cylinder installations.

A.3.3.64.1 Automatic Changeover Regulator. An automatic changeover regulator incorporates two inlet connections and a service-reserve indicator. The system automatically changes the LP-Gas vapor withdrawal from the designated service cylinder(s) when depleted to the designated reserve cylinder(s) without interruption of service. The service reserve indicator gives a visual indication of the cylinder(s) that is supplying the system.

EXHIBIT 3.10 *Automatic Changeover Regulator. (Courtesy of Sherwood, Harsco Gas & Fluid Control Group.)*

EXHIBIT 3.11 *Cutaway of First-Stage Regulator. (Courtesy of Engineered Controls International, Inc.)*

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

***COMMENTARY TABLE 3.1** Regulators*

Type	Location	Description or Use
Automatic changeover (Exhibit 3.10)	Outdoor	Changes service cylinder to reserve cylinder automatically
First stage (Exhibit 3.11)	Outdoor	Reduces tank pressure to 10 psig or less
High pressure	Outdoor	Reduces tank pressure to lower pressure above 1 psig
Integral 2 psi service	Outdoor	Reduces tank pressure in two stages to 2 psig
Integral two-stage (Exhibit 3.12)	Outdoor	Reduces tank pressure in two stages to 11 in. w.c.
Line pressure	Indoor	Reduces 2 psig inlet pressure to 11 in. w.c.
Second-stage (Exhibit 3.13)	Outdoor/indoor*	Reduces first-stage pressure to 11 in. w.c.
Single-stage	Outdoor	Reduces tank pressure to 11 in. w.c.
2 psi service	Outdoor	Reduces first-stage pressure to 2 psig
2 psi system	Outdoor/indoor**	Reduces first-stage pressure to 2 psig

* Regulator vent is piped to outdoors.

** Only the line pressure regulator is installed indoors.

***EXHIBIT 3.12** Integral Two-Stage Regulator. (Courtesy of Engineered Controls International, Inc.)*

***EXHIBIT 3.13** Second-Stage Regulator. (Courtesy of Engineered Controls International, Inc.)*

3.3.64.2 First-Stage Regulator. A pressure regulator for LP-Gas vapor service designed to reduce pressure from the container to 10.0 psig (69 kPag) or less.

3.3.64.3 High-Pressure Regulator. A pressure regulator for LP-Gas liquid or vapor service designed to reduce pressure from the container to a lower pressure in excess of 1.0 psig (6.9 kPag).

3.3.64.4 Integral 2 psi Service Regulator. A pressure regulator for LP-Gas vapor service that combines a high-pressure regulator and a 2 psi service regulator into a single unit.

3.3.64.5 Integral Two-Stage Regulator. A pressure regulator for LP-Gas vapor service that combines a high-pressure regulator and a second-stage regulator into a single unit.

3.3.64.6 Line Pressure Regulator. A pressure regulator in accordance with the *Standard for Line Pressure Regulators*, ANSI Z-21.80/CSA 6.22, with no integral overpressure protection device for LP-Gas vapor service designed for installation inside a building to reduce a nominal 2 psig inlet pressure to 14 in. w.c. (4.0 kPa) or less.

3.3.64.7 Second-Stage Regulator. A pressure regulator for LP-Gas vapor service designed to reduce first-stage regulator outlet pressure to 14 in. w.c. (4.0 kPag) or less.

3.3.64.8 Single-Stage Regulator. A pressure regulator for LP-Gas vapor service designed to reduce pressure from the container to 1.0 psig (6.9 kPag) or less.

3.3.64.9 2 psi Regulator System. An LP-Gas vapor delivery system that combines a first-stage regulator, a 2 psi (14 kPag) service regulator, and a line pressure regulator(s).

3.3.64.10 2 psi Service Regulator. A pressure regulator for LP-Gas vapor service designed to reduce first-stage regulator outlet pressure to a nominal 2 psig (14 kPag).

3.3.64.11 Two-Stage Regulator System. An LP-Gas vapor delivery system that combines a first-stage regulator and a second-stage regulator(s), or utilizes a separate integral two-stage regulator.

3.3.65 Service Head Adapter. A transition fitting for use with polyethylene or polyamide pipe or tubing that is recommended by the manufacturer for field assembly and installation at the aboveground termination end of an anodeless riser.

A service head adapter is a fitting that connects plastic pipe or tubing inserted inside a non-pressure-containing steel jacket to steel piping.

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

3.3.66 Skid Tank. See 3.3.57, Portable Tank.

3.3.67 Sources of Ignition. Devices or equipment that, because of their modes of use or operation, are capable of providing sufficient thermal energy to ignite flammable LP-Gas vapor–air mixtures when introduced into such a mixture or when such a mixture comes into contact with them, and that will permit propagation of flame away from them.

Although the code has addressed the control of ignition sources since its inception, this definition for *sources of ignition* was added in the 1979 edition. The definition became necessary because of the existence of electrical devices and equipment that could ignite a flammable LP-Gas–air mixture under certain conditions. In addition, the definition clarifies that other devices might produce ignition but would not permit a flame to propagate away from them, in which case they are not a hazard. Examples of such devices include certain Class I, Division 1, Group D electrical equipment in which devices are installed in enclosures using gap flame-quenching principles and devices or enclosures equipped with flame arresters.

Some sources of ignition are as follows:

- Devices or equipment — such as gas- or oil-burning appliances, torches, matches, and lighters — producing, or capable of producing, flame
- Devices or equipment — such as motors, generators, switches, lights, and wiring and welding machines — producing, or capable of producing, electrical arcs or sparks of sufficient energy (Devices or equipment listed for Class I, Group D locations are not sources of ignition when properly used and maintained in the classified areas prescribed in this code.)
- Devices or equipment having, or capable of having, surfaces at temperatures exceeding 700°F (371°C)
- Devices or equipment — such as grinders, metal saws, chipping hammers, and flint lighters — producing, or capable of producing, mechanical (struck) sparks of sufficient energy (Unpowered hand tools used only by one individual at a time and for their intended purposes are not considered sources of ignition.)
- Cigarettes and other smoking materials
- Gravity or mechanical air intakes and exhaust terminals of ventilation systems for structures housing the ignition sources described, because they constitute a readily communicating pathway (These include air intakes and exhaust terminals for gas- or oil-burning appliances such as those for direct-vent appliances, and air intakes and exhaust terminals for air conditioners.)

Operating spark-ignition internal combustion engines do not appear, based on experience, to be an ignition source. However, they have been an ignition source during the act of being started. Operating diesel engines have been identified as the ignition source in fire reports, usually as the result of burning carbon being blown out of their exhausts. Such engines tend to speed up when LP-Gas is drawn into their intake manifolds.

3.3.68* Special Protection. A means of limiting the temperature of an LP-Gas container for purposes of minimizing the possibility of failure of the container as the result of fire exposure.

A.3.3.68 Special Protection. Where required in this code, special protection consists of one of the following:

(1) Applied insulating coating
(2) Mounding
(3) Burial
(4) Water spray fixed systems
(5) Fixed monitor nozzles that meet the criteria specified in this code
(6) Any means listed for this purpose

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

See Section 6.25 for more information on fire protection and special protection.

In the late 1960s and early 1970s, the propane industry in the United States experienced a number of BLEVEs (Boiling Liquid Expanding Vapor Explosions) of LP-Gas railroad tank cars (some following derailments). Most of these incidents were caused by container failure from overheating of the container metal (steel) through contact with flames from flammable or combustible materials released from other cars. These incidents were accompanied by fire fighter fatalities.

Although this hazard was beyond the scope of NFPA 58, these accidents resulted in widespread fear of all large LP-Gas containers among the fire service and the public. Notable in this respect was an increasing reluctance by fire fighters to approach an LP-Gas container exposed to fire in order to limit the container temperature by the application of water from hose streams. Because this procedure was, and is, a fundamental and universal BLEVE prevention tactic, the NFPA Technical Committee on Liquefied Petroleum Gases and the industry were concerned that a reduction in its use would increase the frequency and severity of BLEVEs.

A joint task force of the NFPA technical committee and the NPGA's Technology and Standards Committee (augmented by representatives of railroad and DOT groups studying the tank car problem) concluded that additional provisions were needed to reduce the chances for BLEVEs caused by fire exposure. As a result, the following two provisions were first included in the 1976 edition of NFPA 58.

1. The first provision was for the installation and use of emergency shutoff valves as described in Section 6.10. These valves were considered important enough to require retroactive installation in all of the larger facilities as prescribed in Section 6.10.
2. The second provision was for special protection as stipulated in 6.25.5. It is noted, however, that the need for this protection is predicated on the results of a required fire safety analysis.

The six modes of special protection cited in A.3.3.68 represent those currently recognized and for which standards exist. However, the definition is broad enough to recognize other means, provided those means are listed for the purpose.

3.3.69 Standard Cubic Foot (SCF). The volume of gas in cubic feet at the standard atmospheric conditions at 60°F (15.6°C) and 14.7 psia (101 kPa).

3.3.70 SCFM. Standard cubic feet per minute. [**1901,** 2003]

3.3.71 Stationary Installation (Permanent Installation). An installation of LP-Gas containers, piping, and equipment for indefinite use at a particular location; an installation not normally expected to change in status, condition, or location.

3.3.72 UL. Underwriters Laboratories Inc.

Founded in 1894, Underwriters Laboratories Inc. (UL) was chartered as a not-for-profit, independent organization performing testing for public safety. The organization maintains laboratories for the examination and testing of devices, systems, and materials to determine their relation to life, fire, casualty hazards, and crime prevention.

UL-listed materials within the scope of NFPA 58 are included in the following UL Product Directories: *Hazardous Location Equipment* [8]; *Marine Products* [9]; *Automotive, Burglary Protection, and Mechanical Equipment* [10]; and *Flammable and Combustible Liquids & Gases Equipment* [11].

Where NFPA 58 requires listing of a product, any listing agency acceptable to the authority having jurisdiction can be used.

◄ FAQ
Is UL the only agency that can test and list products, devices, and systems for use within the scope of NFPA 58?

3.3.73 Universal Cylinder. A cylinder that can be connected for service in either the vertical or the horizontal position, so that the fixed maximum liquid level gauge, pressure relief device, and withdrawal appurtenances function properly in either position.

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org

EXHIBIT 3.14 *Universal Cylinder. (Courtesy of Worthington Cylinder Corp.)*

A universal cylinder is shown in Exhibit 3.14.

3.3.74 Valve.

3.3.74.1 Emergency Shutoff Valve. A shutoff valve incorporating thermal and manual means of closing that also provides for remote means of closing.

3.3.74.2 Excess-Flow Valve (or Excess-Flow Check Valve). A valve designed to close when the liquid or vapor passing through it exceeds a prescribed flow rate.

3.3.74.3 Internal Excess-Flow Valve. An excess-flow valve constructed and installed so that damage to valve parts exterior to the container does not prevent closing of the valve.

3.3.74.4* Internal Valve. A container primary shutoff valve having the following features: (1) The seat and seat disc remain inside the container so that damage to parts exterior to the container or mating flange does not prevent effective sealing of the valve; (2) The valve is designed for the addition of a means for remote closure and is also designed for automatic shutoff when the flow through the valve exceeds its maximum rated flow capacity or when pump actuation differential pressure drops to a predetermined point.

A.3.3.74.4 Internal Valve. An internal valve has provision for the addition of a means of remote closure. An internal valve closes when flow through the valve exceeds its rated excess-flow capacity or when pump actuation differential pressure drops to a predetermined point.

An internal valve is a valve that is installed in ASME container openings. It is typically installed in the liquid inlet/outlet of propane containers of 4000 gal (15.1 m^3) and larger, but can also be used to protect openings used for vapor inlet and outlet. An internal valve allows flow to be stopped remotely in the event of failure in the piping system. Remote operation can be by a mechanical, pneumatic, or electrical means. Internal valves are required in all new installations of containers larger than 4000 gal (15.1 m^3) and must be installed on all existing containers larger than 4000 gal (15.1 m^3) by July 1, 2011 (see 5.7.4.2).

By halting the flow of gas, a fire or the potential fuel for a fire is eliminated. In addition, internal valves can be operated at their installed locations, and they have an excess flow valve incorporated into them to stop the flow should it exceed the rating of the valve. Exhibit 3.15 shows an internal valve.

3.3.74.5 Pressure Relief Valve. A type of pressure relief device designed to both open and close to maintain internal fluid pressure.

3.3.74.5.1* External Pressure Relief Valve. A pressure relief valve that is used on older domestic containers, on pressure relief valve manifolds, and for piping protection where all the working parts are located entirely outside the container or piping.

EXHIBIT 3.15 *Internal Valve. (Courtesy of Engineered Controls International, Inc.)*

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

A.3.3.74.5.1 ***External Pressure Relief Valve.*** See Figure A.3.3.74.5.1.

3.3.74.5.2* ***Flush-Type Full Internal Pressure Relief Valve.*** An internal pressure relief valve in which the wrenching section is also within the container connection, not including a small portion due to pipe thread tolerances on makeup.

A.3.3.74.5.2 ***Flush-Type Full Internal Pressure Relief Valve.*** See Figure A.3.3.74.5.2.

3.3.74.5.3* ***Full Internal Pressure Relief Valve.*** A pressure relief valve, for engine fuel and mobile container use, in which all working parts are recessed within the container connection, and the spring and guiding mechanism are not exposed to the atmosphere.

A.3.3.74.5.3 ***Full Internal Pressure Relief Valve.*** See Figure A.3.3.74.5.3.

3.3.74.5.4* ***Internal Spring-Type Pressure Relief Valve.*** A pressure relief valve, for use on ASME stationary containers, that has a low profile and is similar to a full internal relief valve except the wrenching pads and seating section are above the container connection. The adjusting spring and the stem are below the seat and are not exposed to the atmosphere.

A.3.3.74.5.4 ***Internal Spring-Type Pressure Relief Valve.*** See Figure A.3.3.74.5.4.

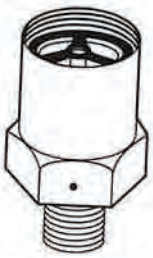


FIGURE A.3.3.74.5.1 *External Pressure Relief Valve.*

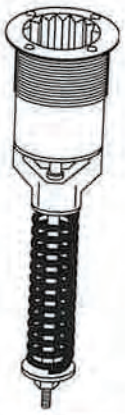


FIGURE A.3.3.74.5.2 *Flush-Type Full Internal Pressure Relief Valve.*

3.3.75 Vaporizer. A device, other than a container, that receives LP-Gas in liquid form and adds sufficient heat to convert the liquid to a gaseous state.

Vaporizers are heat exchangers that transfer heat to convert LP-Gas liquid to vapor, just as boilers convert water into steam. The heat provided to a vaporizer converts the liquid to a gaseous state in pipes, coils, or chambers within the vaporizer. There are several styles of listed vaporizers that perform this function. Section 5.21 provides detailed requirements for different vaporizer styles.

Exhibit 3.16 shows principal features and operating characteristics of a typical vaporizer installation. Liquid flows from the bottom of the tank into the direct-fired vaporizer (shown on the left). A float controls the liquid level in the vaporizer. Flames provide heat to the liquid through the shell. Vapor travels from the upper part of the vaporizer to a tee where it goes to the equipment. Excess pressure is returned to the tank through the optional vapor line. If the tank pressure is high enough, it will supply the load, and the vaporizer will no longer be required to operate.

3.3.75.1 Direct-Fired Vaporizer. A vaporizer in which heat furnished by a flame is directly applied to some form of heat exchange surface in contact with the liquid LP-Gas to be vaporized. This classification includes submerged-combustion vaporizers.

Direct-fired vaporizers convert liquid propane into propane vapor, just as boilers convert water into steam. In a direct-fired vaporizer the flame is directed on piping or a vessel containing liquid propane. This differs from an indirect vaporizer where the liquid propane is vaporized in a coil immersed in a heated fluid (see 3.3.75.3).

Submerged combustion vaporizers are vaporizers in which a flame is directed into a nonflammable fluid, usually water, which surrounds pipe coils containing liquid propane. This type of vaporizer is usually used for very large vaporizing loads. Although they do not meet the definition of direct-fired vaporizers in 3.3.75.1, for purposes of this code, submerged combustion vaporizers may be treated as direct-fired.

3.3.75.2 Electric Vaporizer. A vaporizer that uses electricity as a source of heat.

Because electric vaporizers can be designed so that they are not a source of ignition (unlike a vaporizer using fuel-fired burners), they can be installed differently and thus need to be defined separately. Electric vaporizers are separated into two types — direct immersion, described in 3.3.75.2.1, and indirect, described in 3.3.75.2.2.

FIGURE A.3.3.74.5.3 *Full Internal Pressure Relief Valve.*

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

FIGURE A.3.3.74.5.4 Internal Spring-Type Pressure Relief Valve.

3.3.75.2.1 Direct Immersion Electric Vaporizer. A vaporizer wherein an electric element is immersed directly in the LP-Gas liquid and vapor.

3.3.75.2.2 Indirect Electric Vaporizer. An immersion-type vaporizer wherein the electric element heats an interface solution in which the LP-Gas heat exchanger is immersed or heats an intermediate heat sink.

3.3.75.3 Indirect (or Indirect-Fired) Vaporizer. A vaporizer in which heat furnished by steam, hot water, the ground, surrounding air, or other heating medium is applied to a vaporizing chamber or to tubing, pipe coils, or other heat exchange surface containing the liquid LP-Gas to be vaporized; the heating of the medium used is at a point remote from the vaporizer.

3.3.75.4 Waterbath (or Immersion-Type) Vaporizer. A vaporizer in which a vaporizing chamber, tubing, pipe coils, or other heat exchange surface containing liquid LP-Gas to be vaporized is immersed in a temperature-controlled bath of water, water-glycol combination, or other noncombustible heat transfer medium that is heated by an immersion heater not in contact with the LP-Gas heat exchange surface.

A waterbath vaporizer is shown in Exhibit 3.17.

3.3.76 Vaporizing Burner (Self-Vaporizing Liquid Burner). A burner that also vaporizes liquid LP-Gas prior to burning it.

3.3.77 Vehicle Fuel Dispenser. A device or system designed to transfer and measure LP-Gas into engine fuel and mobile containers on vehicles.

3.3.78 Volumetric Loading. See 3.3.22.1, Volumetric Method Filling.

3.3.79 Water Capacity. The amount of water at 60°F (16°C) required to fill a container.

The water capacity of a container is the maximum amount of water the container can hold at 60°F (15.6°C). The water capacity (full of water) is expressed in pounds (kilograms) for cylinders and gallons (cubic meters) for ASME containers.

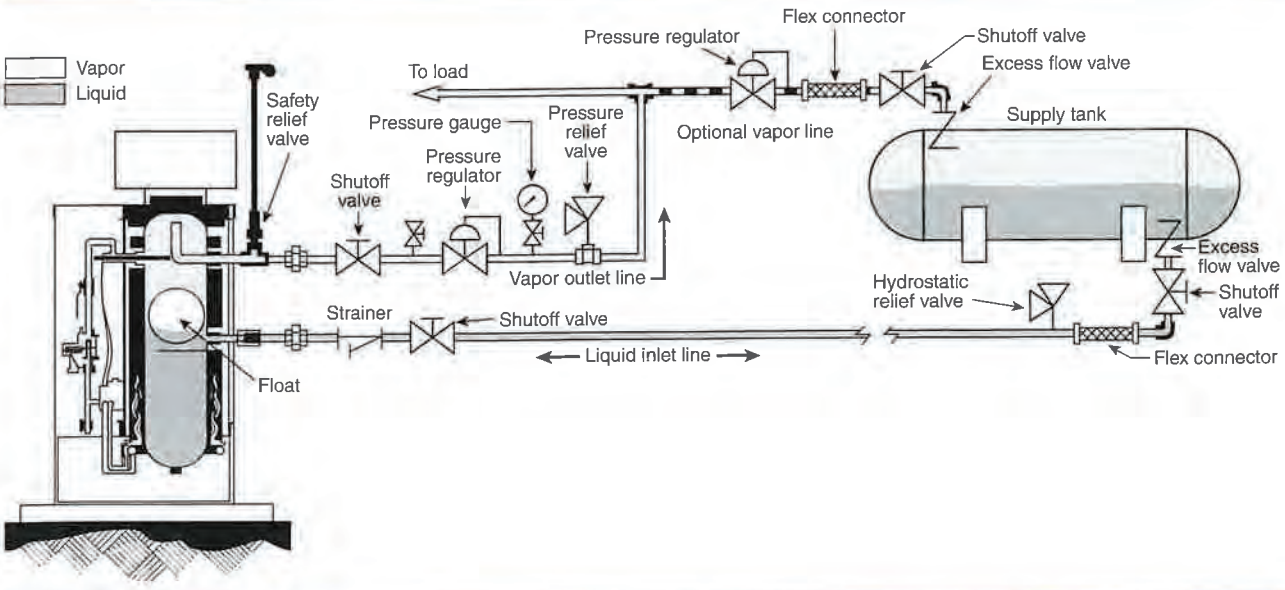


EXHIBIT 3.16 *Typical Vaporizer Installation. (Courtesy of Ransome Manufacturing)*

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

The water capacity is different from the propane capacity of a container. Water capacity is measured with the container 100 percent full, whereas the maximum permitted filling limit allowed for propane is typically set at 80 percent of the water capacity, although there are exceptions to this practice as described in Chapter 7. For example, the typical 1000 gal (3.8 m^3) water capacity ASME container is allowed to hold about 800 gal (3.0 m^3) of propane (80 percent). However, a 30,000 gal (114 m^3) container can be filled to 25,800 gal (86 percent at 40°F) of propane because its large size minimizes extreme swings in the temperature of the product (and therefore expansion and contraction are minimized) due to daytime solar heating and night cooling.

The maximum propane capacity of a cylinder is also based on its water capacity, but since the water capacity is given in pounds, the multiplying factor for propane is 42 percent because propane is about half the density of water. If the water capacity of a cylinder is marked as being 48 lb (36 kg), the propane capacity is 42 percent of 48 lb (36 kg), or about 20 lb (9 kg).

EXHIBIT 3.17 *Waterbath Vaporizer. (Courtesy of Ransome Manufacturing)*

REFERENCES CITED IN COMMENTARY

1. *Merriam-Webster's Collegiate Dictionary,* 11th edition, Merriam-Webster, Inc., Springfield, MA, 2003.
2. Title 49, Code of Federal Regulations, Part 178, U.S. Government Printing Office, Washington, DC.
3. Title 49, Code of Federal Regulations, Part 178.337, U.S. Government Printing Office, Washington, DC.
4. NFPA 30A, *Code for Motor Fuel Dispensing Facilities and Repair Garages,* 2008 edition, National Fire Protection Association, Quincy, MA.
5. *NFPA 5000®, Building Construction and Safety Code®,* 2006 edition, National Fire Protection Association, Quincy, MA.
6. NFPA *101®, Life Safety Code®,* 2006 edition, National Fire Protection Association, Quincy, MA.
7. ASTM D 1835 *Standard Specification for Liquefied Petroleum Gases,* 2005 edition, American Society for Testing and Materials, West Conshohocken, PA.
8. UL Product Directory, *Hazardous Location Equipment*, 2007 edition, Underwriters Laboratories Inc., Northbrook, IL.
9. UL Product Directory, *Marine Products*, 2006 edition, Underwriters Laboratories Inc., Northbrook, IL.
10. UL Product Directory, *Automotive, Burglary Protection, and Mechanical Equipment*, 2007 edition, Underwriters Laboratories Inc., Northbrook, IL.
11. UL Product Directory, *Flammable and Combustible Liquids & Gases Equipment*, 2006 edition, Underwriters Laboratories Inc., Northbrook, IL.

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

General Requirements

CHAPTER 4

Chapter 4 covers general requirements that apply to the entire code. In the 2001 and previous editions of the code, these requirements were included in Chapter 1. The sections in Chapter 4 cover the following:

- Acceptance of Equipment and Systems (See Section 4.1.)
- LP-Gas Odorization (See Section 4.2.)
- Notification of Installations (See Section 4.3.)
- Qualification of Personnel (See Section 4.4.)
- Ammonia Contamination (See Section 4.5.)
- Minimum Requirements (See Section 4.6.)

4.1 Acceptance of Equipment and Systems

4.1.1 Systems or components assembled to make up systems shall be approved as specified in Table 4.1.1.

Approval of systems using cylinders applies to the following:

- The cylinder itself, which must meet DOT specifications and have the dates of manufacture and retest (if done) stamped in the collar, as shown in Exhibit 5.13 (See Annex C for information on requalification of cylinders.)

TABLE 4.1.1 Containers

Containers Used	*Capacity, Water* gal	*Capacity, Water* m^3	*Approval Applies to . . .*
Cylinders	<120	0.445	Container valves and connectors Manifold valve assemblies Regulators and pressure relief devices
ASME containers	≤2000	≤7.6	Container system* including regulator, or container assembly* and regulator separately
ASME containers	>2000	>7.6	Container valves Container excess-flow valves, backflow check valves, or alternate means of providing this protection such as remotely controlled internal valves Container gauging devices Regulators and container pressure relief devices

*Where necessary to alter or repair such systems or assemblies in the field in order to provide for different operating pressures, change from vapor to liquid withdrawal, or the like, such changes shall be permitted to be made by the use of approved components.

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

- Cylinder valves, which must comply with DOT regulations, which reference CGA V-1, *Standard Compressed Gas Cylinder Valve Outlet and Inlet Connections* [1]
- Cylinder connectors, manifold valve assemblies, regulators, and pressure relief devices, which must be approved

The approval of systems using ASME containers of 2000 gal (7.6 m^3) or less includes one of the following:

- The container, which must be designed, fabricated, and marked in accordance with the ASME *Boiler and Pressure Vessel Code* [2], and its appurtenances, which may be approved as a unit
- The container, which may be approved separately, in which case the container appurtenances and pressure regulator must also be approved separately

The approval of systems using ASME containers of more than 2000 gal (7.6 m^3) includes the following:

- Container valves
- All other container appurtenances, as listed in Table 4.1.1, and the pressure regulator(s)

Larger systems using ASME containers with capacities greater than 2000 gal (7.6 m^3) capacity are not approved as a system. Instead, the individual parts are approved. The reason is that there are many variations on how a container may be used, and approval of the entire unit as a system would be very difficult, possibly requiring many different approvals to cover all possible applications.

4.1.2 Where necessary to alter or repair containers or container assemblies in the field, such changes shall be made using approved components.

4.1.3 Acceptance applies to the complete system or to the individual components of which it is comprised as specified in Table 4.1.1.

4.2 LP-Gas Odorization

4.2.1* All LP-Gases shall be odorized prior to delivery to a bulk plant by the addition of a warning agent of such character that the gases are detectable, by a distinct odor, to a concentration in air of not over one-fifth the lower limit of flammability.

A.4.2.1 It is recognized that no odorant will be completely effective as a warning agent in every circumstance.

It is recommended that odorants be qualified as to compliance with 4.2.1 by tests or experience. Where qualifying is by tests, such tests should be certified by an approved laboratory not associated with the odorant manufacturer. Experience has shown that ethyl mercaptan in the ratio of 1.0 lb (0.45 kg) per 10,000 gal (37.9 m^3) of liquid LP-Gas has been recognized as an effective odorant. Other odorants and quantities meeting the provisions of 4.2.1 can be used. Research on odorants has shown that thiophane (tetrahydrothiophene) in a ratio of at least 6.4 lb (2.9 kg) per 10,000 gal (37.9 m^3) of liquid LP-Gas might satisfy the requirements of 4.2.1.

NOTE: Odorant research includes *A New Look at Odorization Levels for Propane Gas*, BERC/RI-77/1, United States Energy Research and Development Administration, Technical Information Center, September 1977.

FAQ ►
Why is ethyl mercaptan a good choice for an odorant in propane?

The note to A.4.2.1 provides additional information on the important subject of odorization. It must be remembered that the code requires the gas to have an odor that serves as a "distinctive" warning agent, but it does not specify the type of odorant or the quantity of odorant. While specific recommendations for odorization levels are made in A.4.2.1, LP-Gas is re-

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

quired to be odorized prior to delivery to a bulk plant or other bulk storage where a bulk plant is bypassed in the chain of distribution. There are several odorants that have been tested through many research projects, but ethyl mercaptan remains as the odorant of choice for its distinctive smell and its chemical and physical properties, which match up well with those of propane. (See the commentary following A.4.2.3.)

4.2.2 Odorization shall not be required if it is harmful in the use or further processing of the LP-Gas or if such odorization will serve no useful purpose as a warning agent in such further use or processing.

LP-Gas used as a feedstock in the manufacture of petrochemicals and for use as an aerosol filling are two examples of situations in which the gas is not required to be odorized. Another potentially large application of propane in the future may be the fuel cell. Fuel cells convert hydrocarbon fuels to electricity through a chemical process. LP-Gas is being considered as a potential fuel for this application, but the sulfur added in the form of odorant to the gas may present a problem for the fuel cell stack and can possibly damage it. Therefore, it may be necessary to strip the odorant and sulfur from LP-Gas prior to introducing it to the fuel cell. This procedure, however, would most likely have to be done on site and as part of the fuel conversion process to remain in compliance with the code requirement for odorant to serve as a warning agent.

4.2.3* If odorization is required, the presence of the odorant shall be determined by sniff-testing or other means, and the results shall be documented as follows:

(1) When LP-Gas is delivered to a bulk plant
(2) When shipments of LP-Gas bypass the bulk plant

A.4.2.3 Another method of determining the presence of odorant is the stain tube test. This method involves using a small hand-held pump to draw a sample across a filled glass tube and reading the length of color change. For additional information, see GPA Standard 2188, *Tentative Method for the Determination of Ethyl Mercaptan in LP-Gas Using Length of Stain Tubes,* and CAN/CGSB-3.0 No. 18.5, *Test for Ethyl Mercaptan Odorant in Propane, Field Method.* At the time of the preparation of this code, additional analytical methods were under development.

LP-Gas is stored in pressure vessels, or containers, that contain both liquid LP-Gas and vapor. The pressure in the container depends on the temperature of the LP-Gas in the container, with higher pressure at higher temperature. (See Annex B for pressure-temperature charts.) When this pressure is reduced (e.g., by vapor being drawn out of the container to supply an appliance) the liquid in the container begins to boil, producing additional vapor to raise the pressure back to equilibrium. In the process of this boiling, the temperature of the liquid is reduced as it vaporizes, which in turn reduces the equilibrium vapor pressure. This temperature reduction is sometimes seen as ice forming on the outside of a container on a humid day.

◀ FAQ
How does the odorant in LP-Gas get into the vapor?

The odorant used with propane is ethyl mercaptan, which is a liquefied flammable gas that is mixed with the liquid propane and which, in turn, boils with the propane. The boiling point of ethyl mercaptan is higher than that of propane [95°F (35°C) for ethyl mercaptan versus –44°F (–42°C) for propane], which means that as propane is first withdrawn from a full cylinder with ethyl mercaptan more propane will boil than ethyl mercaptan. The result is that 15 to 25 percent of the amount of ethyl mercaptan in the liquid (depending on the temperature of the propane) is found in the vapor. More ethyl mercaptan than propane is left in the container, and the concentration of ethyl mercaptan in the vapor increases as more propane is vaporized and will exceed the concentration added to the liquid near the end of vapor withdrawal. The amount of ethyl mercaptan added to the propane takes this fact into account. A sufficient amount of odorant is in the gas phase, throughout the entire useful temperature range to meet code requirements.

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

Determining the presence of an odorant in LP-Gas is important and is required by the code to be done on each shipment to a bulk plant. Shipments that bypass a bulk plant and are delivered directly to the end user must also be tested. Sniff testing, in which a human with a normal sense of smell verifies the odor, is common practice. In some cases, however, an evaluation method with a quantifiable result may be desired.

The odorization of gas started as early as 1880 in Europe, where it was used to prevent injuries or fatalities resulting from escaping gas. The first reported odorant used was ethyl mercaptan, a prevalent compound still used to odorize LP-Gas. Ethyl mercaptan has a characteristic smell that has been described as garlic or rotten eggs. Regardless of dosage levels, it is impossible to warn 100 percent of the population of gas leaks by the use of odorant systems. Some individuals may simply not be able to discern the odor. Others may have their sense of smell temporarily impaired due to a cold, sickness, or other condition. Odorization is a valuable practice, because it does serve as a useful warning in the vast majority of cases. In a study conducted by inserting a "scratch and sniff" card in its magazine, *National Geographic* reported that gas was one of the most recognized odors [3].

Odorization for bottled propane and LP-Gases began in the late 1920s and early 1930s in the United States. Around this same time, the companies that sold LP-Gases into home-use markets began using odorants. The work of the Bureau of Mines [4], which was funded by the American Gas Association, and research conducted by those companies developing this new market showed that ethyl mercaptan was the best odorant for propane because of its volatility, odor properties, and chemical properties. The concentration of ethyl mercaptan required was also determined by research and calculation during this same period.

Ethyl mercaptan and later thiophane (tetrahydrothiophene or THT) were used at a rate of at least 1.0 lb per 10,000 gal (0.45 kg per 37.9 m^3) until the late 1970s, when an industry group funded a study at the Bartlesville Energy Research Center [5]. The main action resulting from this study was an increase in the amount of THT from 1.0 lb per 10,000 gal (0.45 kg per 37.9 m^3) to 6.4 lb per 10,000 gal (2.9 kg per 37.9 m^3) of propane (0.012 kg/m^3 to 7.7 kg/m^3). This study measured values for the distribution coefficients of ethyl mercaptan and THT from propane at a variety of temperatures. Because THT has a much higher boiling point than ethyl mercaptan, its odor is not as striking as that of ethyl mercaptan. For this reason and because of its cost, THT is not used in the U.S. propane market.

Further research funded by companies that were part of the propane industry — the Gas Processors Association (GPA), the Canadian Propane Gas Association (CPGA), and the National Propane Gas Association (NPGA) — and by the Consumer Product Safety Commission (CPSC) indicated that there was a potential problem with "odor fade" in the use of ethyl mercaptan in propane. The GPA, CPGA, and the NPGA funded another series of tests, which evaluated alternative odorants for use in propane. This study and the results of the summation of industry research were synthesized into a document issued by the Joint Industry Task Force on Propane Odorization [6]. This group verified that ethyl mercaptan was the best choice for propane odorization.

A result of an engineering study funded by the CPSC was the incorporation of 4.2.3 into NFPA 58 [7]. This requirement stipulates that the presence of odorant in LP-Gas should be determined and also documented. Although the code requires only that the presence of odorant be verified, there are laboratory methods and field test methods that may be used to determine the amount of odorant present in the gas. The note to A.4.2.3 contains information regarding "length-of-stain" tube tests, which were developed by the GPA and by the CPGA, as part of the activity of the Joint Industry Task Force on Propane Odorization. In the stain tube test, a sample of the propane is drawn through a glass tube (see Exhibit 4.1), which changes color in the presence of ethyl mercaptan or other mercaptan. The length of the changed color indicates the concentration of the odorant.

The odorant level can also be determined through the use of an instrument called an Odorator®, which is shown in Exhibit 4.2. The Odorator mixes odorized gas with air in vary-

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

EXHIBIT 4.1 Stain Tubes and Pump. (Courtesy of Sensidyne, Inc., www.Sensidyne.com)

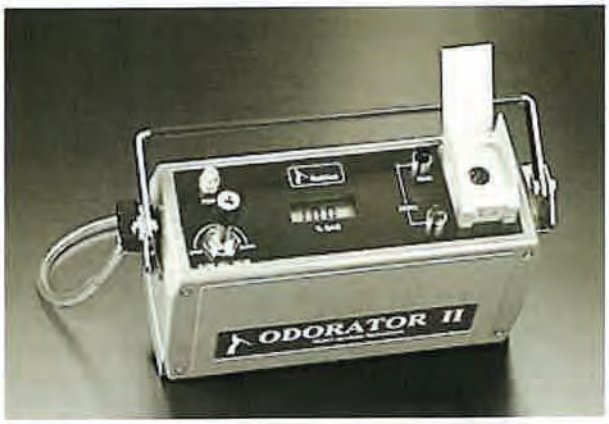


EXHIBIT 4.2 Odorator®. (Courtesy of Heath Consultants Incorporated)

ing amounts, as the operator sniffs the gas. When the odor is detected, the operator presses a button and reads the concentration of the odorant.

Another method used to verify the odorant concentration is by the gas chromatographic analysis of a liquid propane sample. This laboratory method takes more time and is complicated by sampling and shipping issues. A knowledgeable chemist, familiar with the properties of propane and odorants, should be consulted before taking samples of propane for gas chromatographic analysis.

Those interested in odorization are encouraged to review the latest available work in the field. (See "Additional Readings on Odorization," a list of published papers and magazine articles on the subject at the end of this chapter. The additional readings cover odorization of both natural gas and propane.)

4.3 Notification of Installations

4.3.1 Stationary Installations.

Plans for stationary installations utilizing storage containers of over 2000 gal (7.6 m^3) individual water capacity, or with aggregate water capacity exceeding 4000 gal (15.1 m^3), and all rooftop installations of ASME containers shall be submitted to the authority having jurisdiction by the person or company that either installs or contracts to have the containers installed before the installation is started. *[See also 6.19.11.1(F).]*

Plans should be submitted to the authority having jurisdiction (AHJ), which is usually a fire department. In the absence of specific requirements from the AHJ, plans should include a site plan showing key distances and references to the code, along with information regarding key equipment (i.e., container specifications, investigation of reused equipment, etc.). Subsection 6.25.3 also requires a written fire safety analysis to be submitted for installations that have an aggregate water capacity of more than 4000 gal (15.1 m^3) subject to exposure from a single fire in heavily populated or congested areas. (See Supplement 1, Guidelines for Fire Safety

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

Analysis, and the *Fire Safety Analysis Manual for LP-Gas Storage Facilities* [8] for more information.)

FAQ ▶
Why are plans only required to be submitted for installations of containers of over 2000 gal individual water capacity or 4000 gal aggregate water capacity?

Installations smaller than 2000 gal individual / 4000 gal aggregate do not require plans to be submitted because they are relatively simple and standard installation procedures are used. Smaller installations include most one- and two-family homes and typical smaller commercial services that use DOT cylinders and/or ASME 500 gal or 1000 gal capacity containers. Some authorities, however, do require approval of these small installations in heavily populated or congested areas. In such instances, the authorities will either amend 4.3.1 or adopt specific wording in the document that requires approval.

NEW

4.3.2 Temporary Installations.

The authority having jurisdiction shall be notified of temporary (not to exceed 12 months) installations of the container sizes covered in 4.3.1 before the installation is started.

Subsection 4.3.2 recognizes that some installations are of a temporary nature. These temporary installations of the sizes covered in 4.3.1 must be brought to the attention of the AHJ prior to installation so that the fire service can be made aware of them. Such notice is important for emergency response planning. Temporary installations are found at construction sites if temporary heating is needed. They are also found at fairs, where they are used for heating tents and cooking, and at other similar locations.

FAQ ▶
What happens after the 12-month period for a temporary installation has passed?

Twelve months is now the maximum period for temporary installations. This change in the 2008 edition resolves a conflict that existed in the 2004 edition, where temporary installations were defined as 6 months in one section and 12 months in another. Twelve months was chosen because many construction projects use propane for heating during the construction phase, which often takes longer than 6 months to complete. However, it is not unusual for a new permit application to be submitted after the 12-month period has expired, due to the fact that the job may be ongoing. Under such circumstances, the authority would conduct a review of the submittal as if it were a new temporary installation.

Specific requirements for containers in all temporary services are found in 5.2.7.2 and 6.6.5.

Installations that are removed and then reinstalled in the same specific location might not be considered temporary. For example, a 5-month installation at a cabin used only in the winter might not be considered temporary beyond the first year if the installation is removed after the heating season. However, many summertime fairs require propane for cooking, and these installations are made and removed after a few days in the same location year after year. These are temporary installations and must be approved by the AHJ every year. The AHJ is responsible for determining the nature of all such installations.

NEW

4.3.3 Notification of intent for transfer of LP-Gas directly from railcar to cargo tank shall be submitted to the authority having jurisdiction before the first transfer. The authority having jurisdiction shall have the authority to require inspection of the site or equipment for such transfer prior to the initial transfer.

Subsection 4.3.3 has been added to the 2008 edition. It requires anyone planning to transfer LP-Gas directly from a railcar to a cargo tank to notify the authority having jurisdiction of the installation. The authority having jurisdiction can require that the system be inspected before the first transfer. This requirement applies to both transfers from a railcar to a cargo tank vehicle at rail sidings and to such transfers at a bulk plant. The intent of this requirement is not to discourage such transfers, as long as all the required safety equipment is in place, but to ensure that the authorities having jurisdiction are aware of them.

While not specifically stated in the code, in an emergency situation where the transfer must be done promptly, such as a derailment, notification should be as soon as practical following the incident, which may be the following day or the following business day.

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

4.4* Qualification of Personnel

Persons who transfer liquid LP-Gas, who are employed to transport LP-Gas, or whose primary duties fall within the scope of this code shall be trained in proper handling procedures. Refresher training shall be provided at least every 3 years. The training shall be documented.

A.4.4 The term *refresher* indicates that the periodic training could be less intensive than the original training, whose primary purpose is to reinforce initial training rather than repeat it.

A requirement for training in proper handling and operation procedures has been included in NFPA 58 since the first edition in 1932. This requirement has been revised over the last decade, as shown in Commentary Table 4.1.

COMMENTARY TABLE 4.1 Changes in Qualification of Personnel Requirement

Edition Year	*Nature of Change*
1992	Each employee required to carry written certification of his or her job qualifications issued by the training agent or to carry a written document issued by the authority have jurisdiction identifying the functions each employee is authorized to perform
1995	Training required to be documented, but employee no longer required to carry proof of training
1998	Required training limited to those — Who transfer liquid LP-Gas — Who are employed to transport LP-Gas — Whose primary duties fall within the scope of NFPA 58
2001	Refresher training required every three years added

The evolution of the requirements of Section 4.4 shows how difficult it can be to convey the intent of any technical committee. The change in 1992 that required documentation of training was well received by all parties as a way to verify that training was being conducted. The requirement to carry proof of training, however, was not well received, except in areas that had state licensing requirements in place. Because it merely duplicated employee and company records, the requirement was removed in 1995.

◄ FAQ
Are all employees of a propane company required to be trained to handle LP-Gas?

Questions regarding who should be trained led to the 1998 revision, which excluded those who handle cylinders as an incidental part of their jobs from being trained in the hazards of LP-Gas. For example, drivers of propane-powered industrial trucks who exchange fuel cylinders and clerks at retail stores who exchange empty propane cylinders for full ones are exempt from the training requirements. By the same token, office workers in a propane plant are not required to be trained to fill cylinders if that operation is not associated with their job.

The 2001 requirement for refresher training every three years recognizes that ongoing reinforcement of training is needed, especially for tasks that are not normally part of the job function, but that the employee may be called on to do. For example, a bobtail driver may occasionally be called on to fill cylinders at a dispensing station at the propane company's plant. The driver clearly must have been trained on filling stationary tanks, but must also be trained to fill cylinders.

Complete retraining of all employees on a three-year cycle is not required. Refresher training should cover the normal job functions the employee is expected to perform, any new equipment and procedures introduced since the last training, and the operating procedures established by the company. Note that Chapter 14, Operations and Maintenance, requires each LP-Gas bulk plant and industrial plant to have an operating plan and a maintenance plan. Training should follow the procedures in these plans.

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

4.5* Ammonia Contamination

A.4.5 To test for the presence of ammonia, allow a moderate vapor stream of the product to be tested to escape from the container. A rotary, slip tube, or fixed level gauge is a convenient vapor source. Wet a piece of red litmus paper by pouring distilled water over it while holding it with clean tweezers. Hold the wet litmus paper in the vapor stream from the container for 30 seconds. The appearance of any blue color on the litmus paper indicates that ammonia is present in the product.

NOTE: Because the red litmus paper will turn blue when exposed to any basic (alkaline) solution, care is required in making the test and interpreting the results. Tap water, saliva, perspiration, or hands that have been in contact with water having a pH greater than 7, or with any alkaline solution, will give erroneous results.

NOTE: For additional information on the nature of this problem and conducting the test, see NPGA Safety Bulletin 122, *Recommendations for Prevention of Ammonia Contamination of LP-Gas*, published by the National Propane Gas Association.

Because anhydrous ammonia and LP-Gas are liquefied gases that have about the same vapor pressure characteristics at the same temperature, the same transportation and storage equipment can be used for either ammonia or LP-Gas. In warmer months, when the demand for LP-Gas for heating falls, LP-Gas tanks are commonly used for ammonia in agricultural areas where ammonia is used as a fertilizer. When switching from ammonia back to LP-Gas service, the tank must be cleaned properly. If not cleaned properly, serious consequences can result.

Specifically, brass fittings are commonly used on tanks in LP-Gas service, particularly on consumers' and dealers' containers. Ammonia can cause these brass fittings to fail while in service through a process known as stress corrosion cracking. If ammonia gets into an LP-Gas distribution system, the ammonia will spread through the system and may damage any brass fittings it contacts.

The maximum concentrations of ammonia that can be tolerated in LP-Gas have been determined through a research project, "A Study of Cleaning Methods for LP-Gas Transports," conducted by Battelle Memorial Institute of Columbus, Ohio [9]. This research indicates that the red litmus paper test for ammonia in LP-Gas, if performed properly, is a much better indicator than simply trying to detect the absence of ammonia odor, and it will ensure that tolerable limits are not exceeded. Litmus paper will detect ammonia to a concentration of 1 to 2 parts per million. This procedure is referenced only in A.4.5 because the test is not mandated for ammonia but rather is informative material for the user. Other test methods can be used, and it is the responsibility of the user to verify that any alternative method will be equally effective in identifying ammonia concentrations that will cause corrosion.

4.5.1 LP-Gas stored or used in systems within the scope of this code shall contain less ammonia than the quantity required to turn the color of red litmus paper to blue.

4.5.2 The initial fill of LP-Gas in a transportation or storage system that has been converted from ammonia to LP-Gas service shall be tested for ammonia contamination prior to being used or transferred from that system.

Testing for ammonia is not required to be performed prior to or after every transfer of LP-Gas from one container to another. Subsection 4.5.2 does require, however, that a test be performed on the LP-Gas transferred into a container that has just undergone a change in service from ammonia to LP-Gas.

4.6* Minimum Requirements

For any purpose or application addressed within the scope of this code, where the minimum requirements of the code are met, additional features or components of equipment not prohibited by the code shall be permitted to be used.

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org

A.4.6 The installation of safety-enhancing equipment that is not otherwise required by the code is permitted by the code. This includes any device that performs a safety-related function even though the device is designed or named to perform a required function. For example, an emergency shutoff valve (ESV) is installed in a location where it is not required to provide all the safety functions of an ESV. Even though the installer uses it to provide a specific feature that can be common to all ESVs, the code would still not require compliance with all of the ESV provisions — for example, the closing requirements described in 5.12.4.

Section 4.6 was added to the 2004 edition. It is intended to permit the installation and use of equipment that is not specifically required by the code, even if that particular piece of equipment, which may be commonly used within a specific system, is not installed with the other components of that system. For example, if an installation were made using an emergency shutoff valve where the code did not necessarily require one to be installed, the installation could be made without requiring a thermal element to be installed to operate the valve in the event of a fire.

REFERENCES CITED IN COMMENTARY

1. CGA V-1, *Standard Compressed Gas Cylinder Valve Outlet and Inlet Connections,* 2005 edition, Compressed Gas Association, Chantilly, VA.
2. ASME *Boiler and Pressure Vessel Code*, 2004 edition, American Society of Mechanical Engineers, New York, NY.
3. Gilbert, A. N., and C. J. Wysocki. "The Smell Survey Results." *National Geographic* 172, 4 (1987) 514–526.
4. Fieldner, A. C., et al. "Warning Agents for Fuel Gases." U.S. Bureau of Mines, Monograph 4 (1931).
5. Whisman, M. L., J. W. Goetzinger, et al. "A New Look at Odorization Levels for Propane Gas," BERC/RI-77/1 (September 1977) Bartlesville, OK.
6. *Proceedings of the Symposium on LP-Gas Odorization Technology,* Gas Processors Association, National Propane Gas Association, Propane Gas Association of Canada, April 18–19, 1989 and October 10–11, 1990.
7. "Status Report on LP-Gas Residential Heating Equipment" (1986), U.S. Consumer Product Safety Commission.
8. Raj, P. K., and T. C. Lemoff. *Fire Safety Analysis Manual for LP-Gas Storage Facilities* (2004). Available from www.nfpa.org.
9. "A Study of Cleaning Methods for LP-Gas Transports" (1969), Battelle Memorial Institute, Columbus, OH.

Additional Readings on Odorization

Andreen, B. H., and R. L. Kroencke. "Stability of Mercaptans Under Gas Distribution System Conditions." *Proceedings of the American Gas Association* 136 (1964). Covers oxidation, odor fade, natural gas, odorant, alkyl mercaptans, t-butyl mercaptan, ethyl mercaptan.

Andreen, B. H., and R. L. Kroencke. "Stability of Mercaptans Under Gas Distribution System Conditions." *American Gas J* 48 (May 1965). Covers natural gas odorant, mercaptan, oxidation, iron oxide, odor fade.

Arthur D. Little, Inc. "Development of New Gas Odorants." *Arthur D. Little Report to Gas Research Institute,* GRI Contract No. 5010-352-0047. Covers oxidation, odor fade, natural gas, mercaptans, iron oxides, amyl mercaptans, adsorption.

ASTM D 5305-92, *Standard Test for Determination of Ethyl Mercaptan in LP-Gas Vapor* (January 1992), American Society for Testing and Materials, West Conshohocken, PA. Covers stain tube, LP-Gas, propane, ethyl mercaptan, odorant, and analysis.

Bacha, John D. "Chevron/Gulf Studies Regarding LPG Odorants." *Proceedings of the Symposium on LP-Gas Odorization* 43 (1989). Covers ethyl mercaptan, alternate, TBM, t-butyl mercaptan, odor fade, IGT, odorants, oxidation.

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

Barclay, A. T., et al. "Rail Car Field Test Evaluating Ethyl Mercaptan Odorant in Propane." *Institute of Gas Technology Odorization Symposium* (1990). Covers LP-Gas, oxidation, odor fade, treatment, tank, propane, ethyl mercaptan, odorant.

Beltis, Kevin J., and Daniel J. Ehntholt. "Characterization of LP-Gas Odorant Fade." *Proceedings of the Symposium on LP-Gas Odorization* 43 (1989). Covers odor fade, ethyl mercaptan, oxidation, adsorption, surfaces, concrete, propane, LP-Gas.

Bergqvist, L. "LPG Odorization in Europe: No Apparent Cause for Concern." *Proceedings of the Symposium on LP-Gas Odorization* 88 (1989). Covers propane, odorant, ethyl mercaptan, odor fade, oxidation.

Bullerdiek, W. Alan. "LP-Gas Detection: Odorization and Electronic Methods." *Proceedings of the Symposium on LP-Gas Odorization* 94 (1990). Covers gas detectors, alarms, propane, LP-Gas, odorant, ethyl mercaptan, warnings.

Cain, William S., and Amos Turk. "Smell of Danger: An Analysis of LP-Gas Odorization." *American Industrial Hygiene Association* 46 (3), 115 (1985). Covers ethyl mercaptan, LP-Gas, propane, odorant, oxidation, odor intensity, odor fade.

Campbell, Ian D. "Factors Affecting Odorant Depletion in LPG." *Proceedings of the Symposium on LP-Gas Odorization* 28 (1989). Covers oxidation, barbeque cylinders, 5-gallon cylinders, 20-pound cylinders, ethyl mercaptan, odor fade, propane.

Campbell, Ian D. "Research Proposal: LPG Odorant Fade in Consumer Tanks." *Proposal of the Petroleum Gas Association of Canada.* Covers odor fade, ethyl mercaptan, oxidation, tanks, barbeque cylinder, 20-pound cylinders, 5-gallon cylinder.

Campbell, Ian D., et al. "The Chemical Oxidation of Ethyl Mercaptan in Steel Vessels." *Institute of Gas Technology Odorization Symposium* (1994). Covers odor fade, diethyl disulfide, DEDS, barbeque cylinders, 5-gallon cylinders, 20-pound cylinders.

Chowdiah, Prasan, and Amir Attari. "Stability of Gas Phase Odorant Compounds." *Proceedings of the Institute of Gas Technology Odorization Symposium* (1992). Covers adsorption, oxidation, aluminum, steel, stainless, odor fade.

Cooper, L. S., et al. "Some Aspects of the Reception and Transmission of North Sea Gas." 34th Autumn Meeting, Institution of Gas Engineers. Covers wet gas, natural gas, high BTU, odor fade hydrates, absorption, liquids.

Elf, Atochem. "Odor Fade." *Skunk Tips*, 1.2. Covers odorants, odor fade, oxidation, adsorption, absorption.

Gavrilov, L. E. "American Studies of the Stability of Odorants Added to Natural Gas." *Gazovoe Delo* 12, no. 20 (1971). Covers odorant, stability, oxidation, ethyl mercaptan, natural gas.

Goetzinger, J. W., and D. L. Ripley. "Effect of Ammonia on LP-Gas Odorant." *GPA Technical Publication TP-20* (May 1996). Covers ammonia, ethyl mercaptan, odorant, LP-Gas, propane.

Goetzinger, J. W., and D. L. Ripley. "A Study of Passivation Agents for Odorized Propane Containers." *GPA Research Report RR-143* (March 1994). Covers propane, LP-Gas, odorants, ethyl mercaptan, tanks, passivation, treatments, corrosion inhibitors.

Goetzinger, John W., et al. "Vapor-Liquid Equilibrium Data of Ethanethiol and Tetrahydrothiophene in Propane." *Chemical Engineering Data* 22, no. 396 (1977). Covers LP-Gas, propane, THT, thiophane, vapor liquid equilibrium, ethyl mercaptan, vaporization.

Henderson, E. L. "Odorization of Gas." *Operating Section Meeting, American Gas Association* (1952). Covers literature references, soil adsorption, natural gas, odorants, practices, odor fade, testing, leak complaints, equipment, new odorant research.

Hines, William J., and Carl G. Hefley. "Field Test Program of Measuring Odorant in Continuous Use Tank LP-Gas Tanks." *Proceedings of the Symposium on LP-Gas Odorization* 32 (1990). Covers analysis, length-of-stain tubes, propane, LP-Gas, odorant, ethyl mercaptan, continuous use, level, concentration.

Holmes, S. A., et al. "Laboratory and Field Experience with Ethyl Mercaptan Odorant in Propane." *Proceedings of the Symposium on LP-Gas Odorization* (1990). Covers

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

propane, LP-Gas, odorizing, odorization, odorant, ethyl mercaptan, odor fade, oxidation, railroad cars.

Jacobus, O. John, and David Swienton. "Odorant Vapor-Liquid Equilibria: A Generalized Treatment." *Proceedings of the Symposium on LP-Gas Odorization* 79 (1990). Covers vapor liquid equilibrium K-factor, propane, LP-Gas, ethyl mercaptan, THT, DMS, blends, alternates, thiophane, dimethyl sulfide, concentration.

Jacobus, O. John, and John Roberts. "What Constitutes Adequate Odorization of Fuel Gases?" *Institute of Gas Technology Odorization Symposium*, Chicago, IL (August 1995). Covers mostly natural gas, but discusses odor intensity and concentration issues.

Jacobus, O. John, and John Roberts. "Relationship Between Gas Composition and Odor Intensity." *Institute of Gas Technology Odorization Symposium*, Chicago, IL (July 1996). Covers mostly natural gas, but discusses odor intensity and concentration issues.

Jentoft, R. E., and S. A. Olund. "Solubilities of Odorants in Liquid Petroleum Gas." *Proceedings of the American Chemical Society Chicago Meeting*, Chicago, IL (August 30, 1964). Covers odorants, solubility, solubilities, LP-Gas, propane, butane, ethyl mercaptan, isopropyl, thiophane.

Johnson, James L. "1965 Report on Project PB-48, Stability of Odorant Compounds." *Proceedings of the American Gas Association Conference* (1966). Covers oxidation, kinetics, rust, hydrated, Fe_2O_3, ferric oxide, natural gas, mercaptan, disulfide, odor fade, ethyl, methyl, isopropyl, t-butyl, TBM, IPM.

Johnson, S. J. "Ethyl Mercaptan Odorant Stability in Stored Liquid Propane." *Proceedings of the Symposium on LP-Gas Odorization* (1989). Covers oxidation, new tank, steel, carbon, ethyl mercaptan, disulfide, diethyl, purge, purging, analysis, odor fade.

Kemp, Daniel W. "An Overview of Odorization Technology." *Proceedings of the Symposium on LP-Gas Odorization* 1 (1989). Covers odor fade, ethyl mercaptan, oxidation, alternates, blends, adsorption.

Kniebes, Duane V., and Robert C. Stubbs. "Odorant Concentration in Partially Full LPG Tanks." *Proceedings of the Symposium on LP-Gas Odorization* 54 (1989). Covers LP-Gas, propane, tanks, K-factor, Kd's, ethyl mercaptan, odorants, concentration, vapor liquid equilibria.

Kuhlman, Michael R. "LP-Gas Odorant Stability Under Simulated Residential Conditions." *Proceedings of the Symposium on LP-Gas Odorization* (1990). Covers odorant, odor fade, ethyl mercaptan, LP-Gas, propane, adsorption.

Maddox, R. N. "Odorization of Hydrocarbon Fuel Gases." *Proceedings of the LP-Gas Odorization Symposium*. Covers LP-Gas, propane, odorization, ethyl mercaptan, alternate blends, odorants.

Marshall, M. D., and C. A. Palladino. "Analysis of Long Term Degradation of LP-Gas Odorants." *Proceedings of the Symposium on LP-Gas Odorization* 69 (1989). Covers propane, LP-Gas, ethyl mercaptan, vapor, used, new, tanks, sampling, sample, analysis, odor fade, oxidation, adsorption.

Marshall, M. D., and C. A. Palladino. "Field Testing for Ethyl Mercaptan in LP-Gas Storage Tanks in Four Marketing Areas." *Proceedings of the Symposium on LP-Gas Odorization* 22 (1990). Covers odor fade, testing, LP-Gas, propane, ethyl mercaptan, odorant level.

Marshall, M. D., and C. A. Palladino. "Ethyl Mercaptan Stability After Refill of New and Air-Exposed Used LP-Gas Service." *Proceedings of the Symposium on LP-Gas Odorization* 54 (1990). Covers oxidation, odor fade, ethyl mercaptan, tanks, new, used.

Matson, A. F., and R. E. DuFour. "Persistency of Odor of Accidentally Released Pyrofax LPG." *Underwriters Laboratories Inc., Research Bulletin* 37 (1946). Covers LP-Gas, propane, odorant, ethyl mercaptan, stratification.

McCullough, J. P., et al. "Ethanethiol: Thermodynamic Properties in the Solid, Liquid and Vapor States." *American Chemical Society* 74 (1952):2801–2804. Covers ethanethiol properties, thermodynamic, physical, ethyl mercaptan.

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

McHenry, William B., and H. M. Faulconer. "Summary Report on Odorant Investigations." *Proceedings of the Symposium on LP-Gas Odorization* 1 (1990). Covers joint task force report, odorant, odorizing, propane, LP-Gas, ethyl mercaptan, alternates.

Moshfeghian, Mahmood, et al. "Prediction of Odorant Distribution in LP-Gas Tanks." *Proceedings of the Symposium on LP-Gas Odorization* 87 (1990). Covers vapor liquid equilibrium, equilibria, propane, LP-Gas, ethyl mercaptan, alternates, t-butyl, tertiary, THT, tetrahydrothiophene, thiophane.

MSA Research Corporation. "Test Ethyl Mercaptan Concentration." *Final Report to National Propane Gas Association.* Covers propane, ethyl mercaptan, odorant, odor fade, continuous service, out-of-service, LP-Gas, stain tube.

Nevers, Ashley D., and W. H. Oister. "Problems in the Critical Comparison of Odor Intensities." *Operating Section Proceedings of the American Gas Association* 65-P-126 (1965). Covers natural gas, odorants, thresholds, levels, intensity, concentration, olfactometer, ethyl mercaptan.

Osborn, Ann G., and Donald R. Douslin, Jr. "Vapor Pressure Relations of 36 Sulfur Compounds Present in Petroleum." *Chemical Engineering Data* 11, no. 502 (1966). Covers vapor pressure, measurement, mercaptans, ethyl mercaptan, isopropyl, t-Butyl, sec-butyl, sulfides, disulfides, thiophane.

Pickard, Andrew J. "Test Methods for Ethyl Mercaptan Odorant In Propane." *Proceedings of the Symposium on LP-Gas Odorization* (1989). Covers ethyl mercaptan, propane, LP-Gas, analysis, length of stain, stain tube.

Present, Paula A. "Consumer Survey of Households with Gas Appliances." *CPSC Report* (June 1986). Covers CPSC, odorant, lighting, out of gas, pilot lights, odor fade, LP-Gas, propane.

Ripley, D. L., et al. "Untrained Panel Determinations of Odorant Warning Levels." *Proceedings of the Symposium on LP-Gas Odorization* 12 (1990). Covers warning level, odorant, LP-Gas, propane, ethyl mercaptan, THT, thiophane, t-butyl, tertiary, isopropyl.

Ripley, Dennis L., and John W. Goetzinger. "LP-Gas Odorants." *Proceedings of the Institute of Gas Technology Odorization Symposium* (August 1992). Covers LP-Gas, propane, odorants, ethyl mercaptan, alternate.

Roberts, John S. "Propane Odorant Blends: Panacea or Mythology." Institute of Gas Technology First Annual Conference and Exhibition on Natural Gas Technologies (September 30–October 2, 2002).

Roberts, John S. "Thiols." In *Kirk-Othmer Encyclopedia of Chemical Technology*, 4th ed., 24, 19. New York: John Wiley and Sons, Inc. (1997). Covers mercaptans properties and chemistry (very general).

Roberts, John S. "Thiols." In *Kirk-Othmer The Concise Encyclopedia of Chemical Technology*, New York: John Wiley and Sons, Inc. (1998). Covers mercaptan properties and chemistry (very general).

Roberts, John S., and Daniel W. Kelly. "Selection and Handling of Natural Gas Odorants." *Odorization III, Proceedings of the Institute of Gas Technology* 29, Chicago, IL (1993). Covers toxicity of odorants, ethyl mercaptan included.

Roberts, John, and John Jacobus. "Case Study: The Effect of Propane Tanks on Odorants." *Institute of Gas Technology Odorization Symposium*, Chicago, IL (July 1997). Covers oxidation of propane odorants in new tanks.

Schumacher, John L., and John M. Freeman. "Confirmation of Odor Fade of Ethyl Mercaptan in New and Used LP Tanks." *Natural Gas & LP Odorization Case Study and Best Practices Workshop* (July 21–22, 2003).

Stubbs, Robert C. "Pitfalls in Odorization." *Odorization III*, ed. Wilson & Attari, *Proceedings of the Institute of Gas Technology* 7 (1993). Covers propane, LP-Gas, ethyl mercaptan, blends, alternates, oxidation, adsorption, absorption, soil, odor intensity, thiophane, t-butyl.

Suchomel, Frank H. "Odor Fading and Supplemental Odorization." *Proceedings of the Insti-*

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

tute of Gas Technology Symposium on Odorization (July 12, 1976). Covers odor fade, natural gas, supplemental odorization, methods, oxidation, adsorption, absorption, iron oxides.

Sullivan, Frederick, "Development of New Gas Odorants." *Arthur D. Little Report to GRI,* GRI Contract No. 5010-352-0047. Covers natural gas odorants, alternates, oxidation, odor fade, ferric oxide, ferrous oxide, Fe_2O_3, hydrated, FeO(OH), t-Amyl mercaptan.

Sullivan, Frederick. "New Gas Odorants." *Odorization II*, ed. Wilson & Attari, *Proceedings of the Institute of Gas Technology* 209 (1987). Covers amyl mercaptans, t-butyl, soil penetrability, adsorption, oxidation, odor fade.

Switzer, Donald W. "Engineering Hazard Analysis of Residential LP-Gas Use." *CPSC Report on Contract CPSC-C-85-1131,* Bullerdiek. Covers CPSC, odorant, LP-Gas, propane, odor fade, ethyl mercaptan, out of gas, relight, gas detector.

Switzer, Donald W. "CPSC Fuel Gas Study." *Proceedings of the Symposium on LP-Gas Odorization* (1989). Covers CPSC, propane, LP-Gas, odorants, ethyl mercaptan, odor fade.

"Tentative Method for the Determination of Ethyl Mercaptan in LP-Gas" (January 1988). *GPA 2188-88*. Covers analysis, LP-Gas, propane, odorant, stain tube, length of stain, ethyl mercaptan.

Thomas, E. R., et al. "VLE Data and Correlations for Odorants in Propane." *Proceedings of the Symposium on LP-Gas Odorization* 25 (1989). Covers propane, LP-Gas, odorants, vapor liquid equilibrium, K-factors, Kd's, TBM, MES, IPM, ethyl mercaptan, t-butyl, methyl ethyl sulfide, isopropyl, blends, dimethyl sulfide.

Thompson, C. J. "A New Look at Odorization — Revisited." *Proceedings of the Symposium on LP-Gas Odorization* 4 (1989). Covers BERC, 1977 Bartlesville, OK, study on ethyl mercaptan, thiophane, warning level, detection, directed, misdirected, threshold.

Whisman, M. L., et al. "A New Look at Odorization Levels for Propane Gas." *USERDA Document*, BERC/R1-77/1 (1977). Covers ethyl mercaptan, THT, thiophane, LP-Gas, propane, odorant level, detection, threshold, warning, odor fade, oxidation, absorption, adsorption.

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

LP-Gas Equipment and Appliances

CHAPTER 5

Chapter 5 provides the information necessary for the design, manufacture, marking, and performance requirements for individual LP-Gas components or complete systems, with the exception of cargo tank vehicles, which are covered in Chapter 9, and engine fuel systems, which are covered in Chapter 11.

The chapter is organized by numbering many of the sections to align with the sections in Chapter 6, Installation of LP-Gas Systems. This organization makes it easy to go from product to installation requirements, because they will carry similar numbering. For example, Section 5.9, Piping (Including Hose), Fittings, and Valves, contains the requirements for all piping materials, and Section 6.9, Piping Systems, contains requirements for the installation of piping systems. Because of the alignment of subject matter, a number of sections in Chapter 5 are reserved (not used).

Chapter 5 includes detailed information and requirements for the following topics:

- Containers — cylinders and ASME containers (See Section 5.2.)
- Container appurtenances, such as pressure relief devices, regulators, pressure regulators, overfilling prevention devices, container connections, and various gauges (See Section 5.7.)
- Pressure regulators and regulator vents (See Section 5.8.)
- Piping (including hose), fittings, and valves (See Section 5.9.)
- Valves other than container valves (See Section 5.12.)
- Hydrostatic relief valves (See Section 5.13.)
- Equipment, such as pumps, compressors, meters, engines, and sight flow indicators (See Section 5.17.)
- Appliances (See Section 5.20.)
- Vaporizers, tank heaters, vaporizing burners, and gas–air mixers (See Section 5.21.)

5.1* Scope

NEW

This chapter applies to individual components and components shop-fabricated into subassemblies, container assemblies, and complete container systems.

A.5.1 The field assembly of components, subassemblies, container assemblies, or complete container systems into complete LP-Gas systems is addressed in Chapter 6. *(See 3.3.38, LP-Gas System.)*

NEW

5.2 Containers

5.2.1 General.

5.2.1.1* Containers shall be designed, fabricated, tested, and marked (or stamped) in accordance with the regulations of the U.S. Department of Transportation (DOT); the ASME *Boiler and Pressure Vessel Code*, Section VIII, "Rules for the Construction of Unfired Pressure

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

Vessels"; or the API-ASME *Code for Unfired Pressure Vessels for Petroleum Liquids and Gases*, except for UG-125 through UG-136.

DOT has approved a new type of cylinder for use in the United States — a composite cylinder fabricated from reinforced fiberglass. Only composite cylinders fabricated under a DOT special permit can be used. They have a 15-year service life and must be requalified every 5 years. These cylinders can be used for all applications not prohibited by NFPA 58, such as outdoor gas grills, industrial trucks, and other applications not located in buildings.

(A) Adherence to applicable ASME Code case interpretations and addenda that have been adopted and published by ASME 180 calendar days prior to the effective date of this code shall be considered as compliant with the ASME Code.

The text of 5.2.1.1(A) was revised in the 2001 edition of NFPA 58 to ensure that the NFPA Technical Committee on Liquefied Petroleum Gases had an opportunity to review any "code case" amendments to the ASME *Boiler and Pressure Vessel Code* [1] before being accepted in NFPA 58. According to ASME procedures, a code case (similar to a Tentative Interim Amendment) is effective when issued by the ASME committee.

(B) Containers fabricated to earlier editions of regulations, rules, or codes listed in 5.2.1.1 and of the Interstate Commerce Commission (ICC) *Rules for Construction of Unfired Pressure Vessels*, prior to April 1, 1967, shall be permitted to be continued to be used in accordance with Section 1.4.

The intent and application of 5.2.1.1(B) are often misinterpreted with regard to containers that were built to the API-ASME Code (specification U-200 and U-201) and pre-1949 editions of the ASME Code (specification U-68 and U-69). Because these ASME containers have a very long service life when properly maintained, many remain in use and are sometimes relocated and reinstalled. However, not all containers built to these older editions of the ASME Code can be continued in use and reinstalled, regardless of their condition. Before it is filled, a container must be found suitable for continued use, as required in 7.2.2, which states:

> **7.2.2 Filling and Evacuating of Containers.**
>
> **7.2.2.1** Transfer of LP-Gas to and from a container shall be accomplished only by qualified individuals trained in proper handling and operating procedures meeting the requirements of Section 4.4 and in emergency response procedures.
>
> **7.2.2.2** When noncompliance with Section 5.2 and Section 5.7 is found, the container owner and user shall be notified in writing.
>
> **7.2.2.3** Injection of compressed air, oxygen, or any oxidizing gas into containers to transfer LP-Gas liquid shall be prohibited.
>
> **7.2.2.4** When evacuating a container owned by others, the qualified person(s) performing the transfer shall not inject any material other than LP-Gas into the container.
>
> **7.2.2.5*** Valve outlets on cylinders of 108 lb (49 kg) water capacity [nominal 45 lb (20 kg) propane capacity] or less shall be equipped with a redundant pressure-tight seal or a listed quick-connect coupling. Where seals are used, they shall be in place whenever the cylinder is not connected for use.
>
> **7.2.2.6** Nonrefillable (disposable) and new unused cylinders shall not be required to be equipped with valve outlet seals.
>
> **7.2.2.7** Containers shall be filled only after determination that they comply with the design, fabrication, inspection, marking, and requalification provisions of this code.
>
> **7.2.2.8** "Single trip," "nonrefillable," or "disposable" cylinders shall not be refilled with LP-Gas.
>
> **7.2.2.9** Containers shall comply with the following with regard to service or design pressure requirements:
>
> (1) The service pressure marked on the cylinder shall be not less than 80 percent of the vapor pressure of the LP-Gas for which the cylinder is designed at 130°F (54.4°C).

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

(2) The maximum allowable working pressure for ASME containers shall be in accordance with Table 5.2.4.2.

7.2.2.10 Transfer of refrigerated product shall be made only into systems that are designed to accept refrigerated product.

7.2.2.11 A container shall not be filled if the container assembly does not meet the requirements for continued service.

7.2.2.12 Transfer hoses larger than $^1/_2$ in. (12 mm) internal diameter shall not be used for making connections to individual cylinders being filled indoors.

A.5.2.1.1 Prior to April 1, 1967, regulations of the U.S. Department of Transportation were promulgated by the Interstate Commerce Commission. In Canada, the regulations of the Canadian Transport Commission apply and are available from the Canadian Transport Commission, Union Station, Ottawa, Canada.

Construction of containers to the API-ASME *Code for Unfired Pressure Vessels for Petroleum Liquids and Gases*, has not been authorized after July 1, 1961.

The requirements for the construction of pressure vessels used to store LP-Gases are referenced in 5.2.1.1. (Requirements for nonpressurized refrigerated containers are located in Chapter 12, Refrigerated Containers.) The referenced codes provide a level of safety such that the NFPA Technical Committee on Liquefied Petroleum Gases has not needed to develop its own requirements for pressure vessels for LP-Gas. In referencing the ASME *Boiler and Pressure Vessel Code* [1], the committee has made an exception to sections UG-125 through UG-136, which cover pressure relief devices. The requirements for pressure relief devices in the ASME *Boiler and Pressure Vessel Code* are more conservative than those in UL 132, *Standard on Safety Relief Valves for Anhydrous Ammonia and LP-Gas* [2], which requires larger pressure relief valves.

Pressurized LP-Gas containers in the United States, Canada, and other countries served by marketers based in the United States and Canada comply with 5.2.1.1. Many other countries that use NFPA 58 have their own container requirements. In the event that a container constructed to a different standard, such as one used in a foreign country, is to be filled in a jurisdiction that enforces NFPA 58, approval to fill that container must be obtained from the authority having jurisdiction. For cylinders, the authority having jurisdiction is the U. S. Department of Transportation (DOT), and approval to fill is not likely to be given. Given the relatively low cost of cylinders, it is easier to purchase a new cylinder than to petition DOT for a variance. Small foreign vessels and campers that travel internationally provide a source of cylinders built to specifications of other countries. Cylinders manufactured to other than DOT specifications can be used in the United States, but cannot be refilled.

◄ FAQ

Is it permissible to use containers that have been fabricated and marked in accordance with regulations in foreign countries?

If the container is a pressure vessel, the authority having jurisdiction is the state in which the container is installed. Because most states adopt and enforce the ASME *Boiler and Pressure Vessel Code* [1], the state boiler agency must be contacted. For example, when packaged propane equipment is imported with propane tanks, the authority having jurisdiction should be contacted to determine how to proceed. The following paragraphs provide more detailed information on the specific types of containers used in the LP-Gas industry.

U.S. Department of Transportation (DOT) Cylinders. DOT cylinders first used for LP-Gas were built to specifications of the Interstate Commerce Commission (ICC). DOT restricts cylinders to 1000 lb (454 kg) water capacity or less. Prior to 1967, ICC specifications were used, but they have not been used for many years. The current basic cylinders for reusable service are DOT 4BA-240 (steel construction) and DOT 4E (aluminum construction) cylinders, specifications for which are found in 49 CFR 178.50 [3] and 49 CFR 178.68 [4], respectively. Disposable cylinders, such as hand torch cylinders, have different DOT specifications.

The regulations for DOT cylinders [and similar cylinders built to Transport Canada (TC) specifications] are concerned with transportation, whereas much of NFPA 58 is concerned

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

with container usage and storage. Several DOT/TC cylinders are shown in Exhibits 5.1 and 5.2. Nevertheless, there are compelling reasons why NFPA 58 must recognize these cylinders as storage containers. Because DOT specifications are developed for transportation applications only, the NFPA technical committee continuously monitors DOT and TC standards to ensure that the standards are adequate for the applications covered by NFPA 58. For example, the committee did not permit the use of 4E (aluminum) cylinder for several years, until the cylinder's use and storage safety were demonstrated by tests and experience.

All DOT/TC cylinders are portable and designed to be transported when filled with product. Cylinders hold from 1 lb to 420 lb (0.5 kg to 191 kg) of propane. (See Exhibit 5.3.) Cylinders can be moved with reasonable ease by an individual or by vehicles that are equipped with lifting devices that can transport the larger portable cylinders.

Cylinders are filled at the location where they are installed or used. It is common to see 100 lb (45 kg) cylinders "permanently" installed at residential and commercial locations being filled on site. When the cylinder is permanently installed, the standard cylinder valve is replaced with a multipurpose valve so that the cylinder can be refilled without disconnecting the piping.

Commentary Table 5.1 lists types of popular cylinders, their applications, water and propane capacities, and specification numbers. The information listed in Commentary Table 5.1 is especially useful because the capacity of cylinders is rated by weight, in pounds (kilograms), and their spacing is determined by the volumetric capacity, in gallons (cubic meters), by Table 6.3.1. Commentary Table 5.1 allows conversions from pounds to gallons so that the proper spacing distances can be easily determined.

A DOT cylinder must be marked with certain information, usually on the cylinder itself or on its collar, as shown in Exhibit 5.4. This information is especially vital in determining the suitability of the cylinder for continued service, as indicated by the requalification date.

EXHIBIT 5.1 *DOT/TC Cylinders. Top: Typical Industrial Truck Motor (Engines) Fuel Cylinders; Bottom: Typical Stationary and Portable Cylinders for Residential and Commercial Uses. (Courtesy of Manchester Tank)*

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

EXHIBIT 5.2 *DOT/TC Cylinders. (Courtesy of Manchester Tank)*

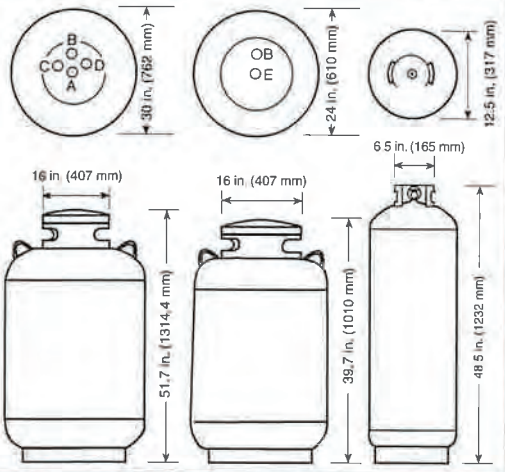
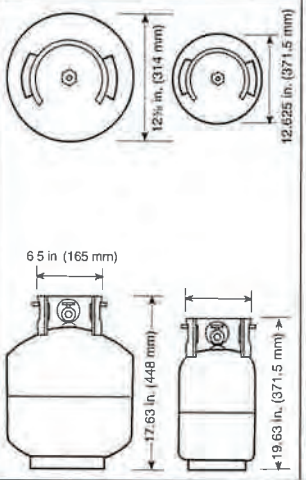
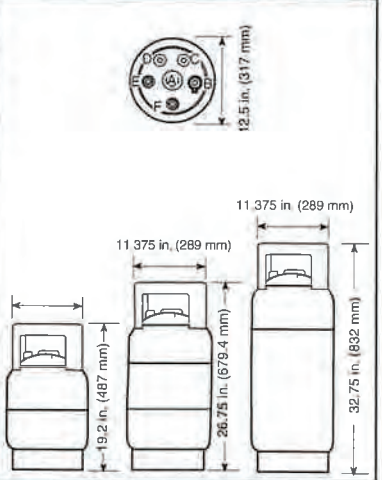
Industrial/Commercial			Consumer		Industrial Truck/Fork Lift		
Description/Size Openings A. Safety relief valve 1 in. D. Vapor service valve .75 in B. NPT float gauge 1 in. E. Multi-valve .75 in. C. Fill valve .75 in.					**Description** A. Universal float gauge D. Fixed liquid level B. Liquid service valve E. Vapor service (plugged) C. Safety relief valve F. Liquid fill port (plugged)		
						
	420 lb	**200 lb**	**100 lb**	**20 lb**	**6 lb**	**20 lb**	**33-1/2 lb**	**43-1/2 lb**
LP-Gas cap.	100 gal	47 gal	23 gal	5 gal	1.5 gal	5 gal	8 gal	10 gal
Tare wt.	289 lb/131 kg	150 lb/71 kg	72 lb/32.6 kg	18 lb/8.2 kg	9.2 lb/4.1 kg	26.5 lb/12 kg	34.5 lb/15.5 kg	40 lb/18 kg
Water cap.	1000 lb/454 kg	474 lb/215 kg	240 lb/108 kg	47.7 lb/21.6 kg	15.5 lb/7 kg	47.7 lb/21.6 kg	80 lb/36.3 kg	103.6 lb/47 kg
	DOT-4BW240	DOT-4BW240	DOT-4BW240	DOT-4BA240	DOT-4BA260	DOT-4BA240	DOT-4BW240	DOT-4BW240

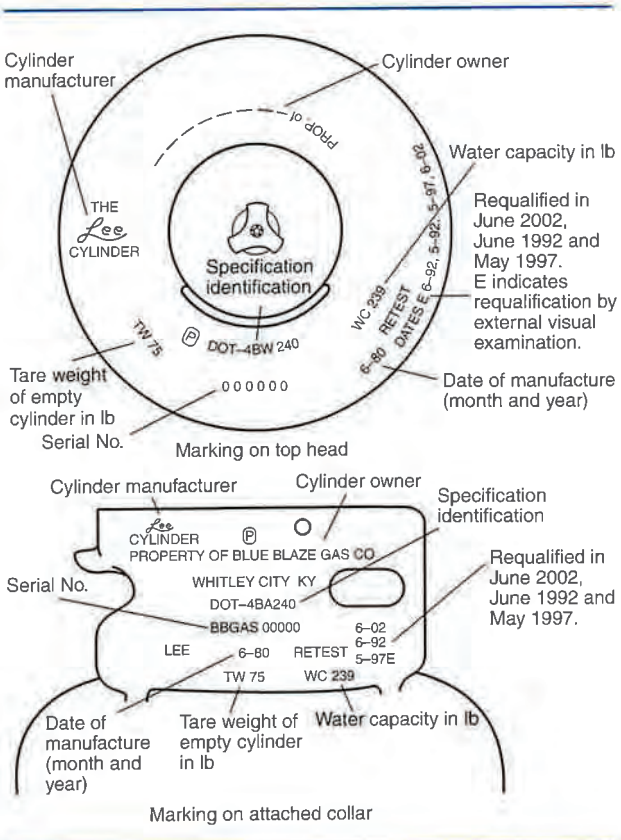
EXHIBIT 5.3 *Dimensions and Capacities of Typical DOT Cylinders. (Courtesy of Worthington Cylinder Corp.)*

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org

COMMENTARY TABLE 5.1 DOT/TC Cylinder Applications

Type of Service	Typical Use	Propane Capacity			Water Capacity			Common DOT Mfg. Code
		Pounds	Kilograms	Gallons	Pounds	Kilograms	Gallons	
Stationary	Homes, business	420	191	99	1000	454	119	4B, 4BA, 4BW
Stationary	Homes, business	300	136	71	715	324	86	4B, 4BA, 4BW
Stationary	Homes, business	200	91	47	477	216	57	4B, 4BA, 4BW
Stationary	Homes, business	150	68	35	357	162	43	4B
Exchange	Homes, business	100	45	24	239	108	29	4B, 4BA, 4BW
Exchange	Homes, business	60	27	14	144	65	17	4B, 4BA, 4BW
Engine fuel	Forklift	43.5	19.7	10	104	47	12	4B, 4BA, 4BW, 4E
Engine fuel	Forklift	33.5	15.2	8	80	36	9.6	4B, 4BA, 4BW, 4E
Engine fuel	Forklift	20	9	4.7	48	22	5.7	4B, 4BA, 4BW, 4E
Engine fuel	Forklift	14	6.4	3.3	34	15.4	4.1	4B, 4BA, 4BW, 4E
Portable	Rec. vehicles	40	18	9.5	95	43	11	4B, 4BA, 4BW, 4E
Portable	Rec. vehicles	30	13.6	7.1	72	32.7	8.6	4B, 4BA, 4BW, 4E
Portable	Rec. vehicles	25	11.3	5.9	59.5	27	7.1	4B, 4BA, 4BW
Portable	Rec. vehicles, grills	20	9	4.7	48	22	5.7	4B, 4BA, 4BW, 4E
Portable	Rec. vehicles, and small appliances	10	4.5	2.4	23.8	10.8	2.8	4B, 4BA, 4BW, 4E
Portable	Indoors, trailers	5	2.3	1.2	12	5.4	1.4	4B, 4BA, 4BW, 4E
Portable	Torches, RV	0.93	0.42	0.2	2.2	1	0.3	39 (disposable), 4B240 (refillable)

EXHIBIT 5.4 *Typical DOT Cylinder Marking. (Courtesy of National Propane Gas Association)*



Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

ASME Containers. ASME containers, often referred to as bulk containers, are unfired pressure vessels built to the ASME Code, Section VIII, Division 1 or 2. Division 1 is a "prescriptive" approach to container design that lays out the requirements in "cookbook" fashion. Division 2 is a "performance" approach that allows the designer more latitude in the choice of materials, but requires a more extensive analysis to demonstrate compliance. ASME Code containers are usually found in stationary installations but can also be mounted on trucks for use as a cargo tank motor vehicle. (See Exhibit 5.5.)

EXHIBIT 5.5 *Small ASME Container Commonly Used in Residential and Commercial Applications. (Courtesy of Trinity Containers)*

Prior to World War I, the first LP-Gas bulk containers in use were riveted, but keeping these containers leak-free around the rivets and the seams was difficult. Forge-welded containers came into use after World War I as the technology became available in the United States. In the 1930s, the current-style fusion-welded pressure vessels were used. At that time, the ASME Code specifications were U-68 and U-69. These specifications had a design margin (safety factor) of 5 to 1 — the ratio of the theoretical burst pressure to the design operating pressure. The normal working pressure of U-68 and U-69 containers was 200 psig (1.4 MPag). At that time, NFPA 58 allowed the pressure relief valve setting to be 125 percent of the working pressure, or 250 psig (1.7 MPag). Pressure relief valves prevent the excessive buildup of pressure in the containers in case of overfilling, or excessive heating of the propane due to fire impingement on the container.

ASME specifications U-200 and U-201, which were developed in conjunction with the American Petroleum Institute (API), were also applied prior to 1949. ASME specifications U-200 and U-201 were known as the API-ASME Code. These API-ASME Code specifications applied to containers that were restricted in use to installations such as refineries, gas processing plants, and tank farms.

In 1949, ASME adopted the current ASME Code precept with a design margin (safety factor) of 4 to 1. At that time, the requirement for the pressure relief valve setting was changed to the working pressure of a container, 250 psig minimum (1.7 MPag minimum) for propane. In effect, the 4 to 1 safety factor and the previous 5 to 1 safety factor are comparable, with the same ultimate burst pressure, as 250×4 and 200×5 both equal 1000. Many pre-1949, 200 psig (1.4 MPag) ASME tanks are still in service.

In the mid-1990s, the ASME Code design margin (safety factor) was further reduced from 4 to 1 to 3.5 to 1. The ASME Boiler and Pressure Vessel Code Committee took this action because of the improvement in both material quality control and welding technology since the 1950s. The design margin in pressure vessel design anticipates minor defects in materials (thickness variation, imperfections, and inclusions in the metal) as well as less than perfect welding. Because both materials and welding have improved since the 1950s, it was determined that the design margin was excessive and was reduced. This reduction does not

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

decrease safety in pressure vessels designed to the ASME Code. [See Annexes C and D for further descriptions of DOT (ICC) and ASME containers.]

Commentary Table 5.2 shows popular ASME container sizes, their applications, and their water and propane capacities. The table also lists the capacities, in pounds, of smaller size containers for easy comparison to cylinder capacities. It is important to note that the ranges given for LP-Gas capacity in the table are not all at the same reference temperature. For example, the LP-Gas capacity for a bulk plant tank of 12,000 gal (45.4 m^3) is shown to be 10,800 gal (41 m^3), which is 90 percent of the container water capacity. However, 7.4.3.2(B), and referenced Table 7.4.2.3(b), only permit volumetric filling to 90 percent when the propane is at a temperature of 70°F (21°C). Therefore, it is important to realize that the capacities shown in Commentary Table 5.2 are those at assumed propane temperatures.

Intermodal Containers. Intermodal containers, as shown in Exhibit 5.6, are shipping containers larger than cylinders that are mounted within a frame for shipment on railroads, trucks, and ships. The containers are similar to dry shipping containers. The United Nations accepts intermodal containers for international shipping. These containers must meet DOT specifications and ASME Code requirements. LP-Gas is shipped via intermodal containers to islands and inland areas that are accessible only by rivers or other bodies of water.

Container Ownership. Usually, the LP-Gas marketer leases residential and commercial LP-Gas containers to the customer. However, NFPA 58 does not prevent consumers from purchasing their own containers. Industrial and other large users are more likely to own their containers. When residential consumers and industrial LP-Gas users own their containers, they are responsible for complying with the code requirements concerning container maintenance. The propane supplier is responsible for taking reasonable steps to verify that a container is fit for service before filling it and should not fill a container that is unfit for service. This applies equally to a 20 lb (9.1 kg) gas grill cylinder, a 500 gal (1.9 m^3) ASME container at a residence, and a 30,000 gal (14 m^3) ASME container at an industrial facility.

5.2.1.2 Containers that have been involved in a fire and show no distortion shall be requalified for continued service before being used or reinstalled.

COMMENTARY TABLE 5.2 Typical Stationary ASME Container Applications

	Water Capacity		LP-Gas Capacity		
Service	Gallons	Liters or Cubic Meters	Gallons*	Liters or Cubic Meters	Pounds
Domestic	100	379 L	80	301 L	338
Domestic	125	473 L	100	379 L	423
Domestic	150	568 L	120	454 L	508
Domestic	250	946 L	200	757 L	848
Domestic	325	1230 L	260	984 L	
Domestic	500	1893 L	400	1514 L	
Domestic	1,000	3.8 m^3	800	3 m^3	
Industrial/agricultural/commercial	1,000–5,000	3.8–19 m^3	800–4,500	3–17 m^3	
Service stations	1,000–6,500	3.8–24.6 m^3	800–5,850	3–22 m^3	
Bulk plant or standby storage	12,000–18,000	45.4–68 m^3	10,800–16,200	41–61 m^3	
Bulk plant or standby storage	20,000–30,000	76–114 m^3	18,000–27,000	45.4–102 m^3	
Bulk plant or standby storage	30,000–60,000	114–227 m^3	27,000–54,000	102–204 m^3	
Bulk plant or standby storage	60,000–120,000	227–454 m^3	48,000–96,000	182–364 m^3	

*Based on propane specific gravity of 0.508 at 70°F (21°C). Actual filling level depends on the specific gravity and temperature of the propane.

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

EXHIBIT 5.6 *Intermodal Container. (Courtesy of Permagas)*

(A) Cylinders shall be requalified by a manufacturer of that type of cylinder or by a repair facility approved by DOT.

(B) ASME or API-ASME containers shall be retested using the hydrostatic test procedure applicable at the time of the original fabrication.

Older containers can continue to be used when evidence of design or construction flaws, or dents, pits, and corrosion, is not evident. When these containers were built, they incorporated the latest technology in design, metallurgy, and fabrication techniques. Although technology has improved significantly over the years, there is no evidence that older containers are less safe now than when they were built, as long as they have been properly maintained.

Other nondestructive test methods may be considered as alternatives to the hydrostatic test required in 5.2.1.2(B). The following methods are listed in the ASME *Boiler and Pressure Vessel Code* [1] and may be useful for finding flaws in the container that would prevent it from being placed back into service after a fire:

- Radiography
- Ultrasonics
- Magnetic particle
- Liquid penetrants
- Visual inspection
- Leak testing
- Electromagnetic testing
- Acoustic emission

It is important to remember that the ASME Code is a construction code, and not a maintenance or an inspection code, and other codes (e.g., DOT, NFPA 58) may allow or require hydrostatic pressure testing as a nondestructive test when needed. While a hydrostatic pressure test is considered nondestructive, it can result in damage to the pressure vessel if a significant flaw is detected. The person performing such tests must be familiar both with the code requirements used to construct the container and with the test methods used to test the container.

(C) All container appurtenances shall be replaced.

(D) DOT 4E specification (aluminum) cylinders and composite cylinders involved in a fire shall be permanently removed from service.

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

If a cylinder has been subjected to fire, the metal shell, which is usually steel or aluminum, can be weakened, and the cylinder must be requalified by a properly qualified repair facility authorized by DOT (in the United States) or TC (in Canada). When an ASME container has been subjected to fire, it must be retested using the hydrostatic test procedure applicable at the time the container was originally made. The testing is required because the fire heat can alter the properties of the steel, reducing its ability to contain pressure. Container appurtenances must also be replaced after a container has been exposed to fire.

Paragraph 5.2.1.2(D) was not located here in the 2004 edition, where it was paragraph 5.2.3.2. It was moved to this more appropriate location in the 2008 edition. DOT 4E aluminum cylinders may not be returned to service after a fire because even exposure to moderately high temperatures can affect the structural properties of aluminum and severely decrease its tensile strength.

Exhibit 5.7 shows a container that has been exposed to fire.

EXHIBIT 5.7 *ASME Container Damaged by Fire. (Courtesy of Independent Propane Co., Pine, CO)*

5.2.1.3 ASME paragraph U-68 or U-69 containers shall be permitted to be continued in use, installed, reinstalled, or placed back into service. Installation of containers shall be in accordance with all provisions listed in this code. *(See Section 5.2, Table 5.2.4.2 and Table 5.7.2.4(A), and Annex D.)*

FAQ ►
Can ASME containers constructed to U-68 and U-69 requirements be installed into a new service?

The requirement in 5.2.1.3 clearly and specifically states ASME paragraph U-68 or U-69 containers may be continued in service and reinstalled. This addition to the 1995 edition of NFPA 58 was intended to clarify the NFPA technical committee's opposition to one state's interpretation of the code that would not permit ASME containers built under ASME U-68 and U-69 to be reinstalled. [See the commentary following 5.2.1.1(B) for more information on ASME U-68 and U-69.]

5.2.1.4 Containers that show excessive denting, bulging, gouging, or corrosion shall be removed from service.

All containers that show excessive dents, bulges, gouges, or corrosion must be removed from service because these defects can reduce the pressure capability of the container. Once removed from service, the container should be scrapped, or repaired using methods that are in accordance with the code of manufacture.

5.2.1.5 Repairs or alteration of a container shall comply with the regulations, rules, or code under which the container was fabricated. Repairs or alteration to ASME containers shall be in accordance with the *National Board Inspection Code*.

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

5.2.1.6 Field welding shall be permitted only on saddle plates, lugs, pads, or brackets that are attached to the container by the container manufacturer.

The heat of welding directly to the container can affect the strength of the material and change its characteristics so that it may no longer meet the requirements of the ASME *Boiler and Pressure Vessel Code* [1]. Such heating can set up localized stresses that can reduce the material's strength. Repairs to pressure vessels must meet the requirements of the *National Board Inspection Code* (NBIC) [5], and must be performed by a repair organization accredited by the National Board and authorized to utilize the "R" code symbol stamp. Following a repair and final inspection by a National Board Commissioned Inspector, the repair organization will affix a "Repair" nameplate to the pressure vessel that is similar to the ASME nameplate. The requirements in the NBIC were developed to maintain the integrity of the pressure vessel after it has been placed in service. (See Exhibit 5.8.)

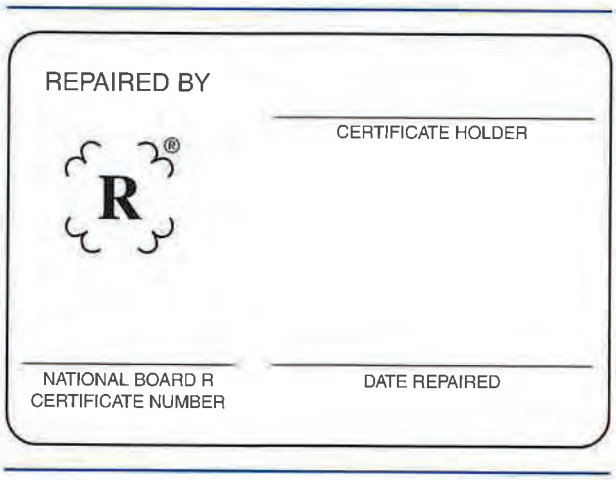


EXHIBIT 5.8 *National Board "R" Stamp. (This material is taken from the National Board Inspection Code and is reprinted with permission of the National Board of Boiler and Pressure Vessel Inspectors.)*

5.2.1.7 Containers for general use shall not have individual water capacities greater than 120,000 gal (454 m^3).

Containers installed for general use and in dispensing stations are limited in size per 5.2.1.7. However, the number of containers in general use is not limited. The term *general use*, which is not defined in the code, refers to installations where LP-Gas is being stored for an end use application, such as for use as a fuel. Thus an LP-Gas bulk plant, where most employees can be expected to be aware of the proper procedures for handling LP-Gas, is not general use, whereas a container used as an alternate fuel supply at a manufacturing plant, whose product is not related to LP-Gas, would be considered to be general use.

5.2.1.8 Containers in dispensing stations not located in LP-Gas bulk plants, industrial plants, or industrial applications shall have an aggregate water capacity not greater than 30,000 gal (114 m^3).

The 30,000 gal (114 m^3) water capacity limit on total storage in dispensing stations provides a limit on storage capacity at locations where only cylinders are filled or LP-Gas is dispensed.

5.2.1.9 Heating or cooling coils shall not be installed inside storage containers.

Internal container components, such as heating and cooling coils, can be inspected only when the container is emptied, purged, and declared safe for entry. It is possible that a container's components may not be inspected during the container's normal life of service. If not inspected, corrosion or other container component failure will not be observed. If heating or cooling coils installed inside the storage container leak, the gas could enter the piping of the

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

heating or cooling system, because the LP-Gas pressure is normally higher than the pressure in the internal coil. Leakage into the system could result in a pressure that could rupture or create leaks in the heating or cooling system. Even if a break does not occur, a flammable product will be present in the heating or cooling system that could escape near an ignition source.

5.2.2 Cylinders.

5.2.2.1* Cylinders shall be continued in service and transported in accordance with DOT regulations.

A.5.2.2.1 See CGA Publication C-6, *Standard for Visual Inspection of Steel Compressed Gas Cylinders*, or C-6.3, *Guidelines for Visual Inspection and Requalification of Low Pressure Aluminum Compressed Gas Cylinders*, for further information regarding cylinder inspection.

5.2.2.2 A cylinder with an expired requalification date shall not be refilled until it is requalified by the methods prescribed in DOT regulations.

An important safety provision of NFPA 58 is that all LP-Gas containers be safe before they are filled. Cylinders that are built to DOT requirements can be filled for 12 years from the date of manufacture and subsequently must be recertified periodically. Until the 2004 edition, the question of recertification of cylinders that were used outside of the scope of DOT (not in transportation) was not completely clear. This issue has been resolved by 5.2.2.2 and 5.2.3, which address cylinders that are filled on site and not subject to DOT regulation.

There are three different methods by which to requalify a cylinder:

Requalification Method	*Time Before Next Recertification*
Water-jacket hydrostatic test method	12 years
Modified hydrostatic	7 years
Visual	5 years

Refer to Annex C for a detailed description of these methods.

Requalification of cylinders under DOT regulations using the visual method could have been done by anyone up until August 8, 2002, when DOT issued Final Rule HM-220D, which requires registration of requalifiers using the visual method. The rule requires facilities or individuals that requalify cylinders to register with DOT in order to obtain a requalifier identification number (RIN). Registration of a business facility covers individual employees at the facility. The following also applies to cylinder requalification using the visual method:

- Beginning May 31, 2004, only facilities that held an RIN were permitted to requalify cylinders by external visual inspection.
- Inspections must have been be performed in accordance with CGA C-6, *Standard for Visual Inspection of Steel Compressed Gas Cylinders* [6], and/or C-6.3, *Guidelines for Visual Inspection and Requalification of Low Pressure Aluminum Compressed Gas Cylinders* [7].
- Cylinders passing requalification by external visual inspection must be marked as described below
- Cylinder markings must be made by stamping, engraving, scribing, or any other method that produces a legible, durable mark. Interpretations obtained from DOT allow the mark to be on a "durable pressure adhesive label."
- Each facility that requalifies cylinders must maintain records at the facility where the requalification is performed.

The requirement for an RIN applies only to those who requalify cylinders for use "in transportation" and does not apply to those who visually inspect stationary cylinders per the procedures in 5.2.3.

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

The following is reprinted from 49 CFR Part 180.213 [8]:

◄ **FAQ**
How must the requalifier identification number be applied to a cylinder?

49 CFR Part 180 — CONTINUING QUALIFICATION AND MAINTENANCE OF PACKAGINGS

Subpart C — Qualification, Maintenance and Use of Cylinders
180.213 Requalification markings.

(a) *General.* Each cylinder or UN pressure receptacle requalified in accordance with this subpart with acceptable results must be marked as specified in this section. Required specification markings may not be altered or removed.

(b) *Placement of markings.* Each cylinder must be plainly and permanently marked on the metal of the cylinder as permitted by the applicable specification. Unless authorized by the cylinder specification, marking on the cylinder sidewall is prohibited.

(1) Requalification and required specification markings must be legible so as to be readily visible at all times. Illegible specification markings may be remarked on the cylinder as provided by the original specification. Requalification markings may be placed on any portion of the upper end of the cylinder excluding the sidewall, as provided in this section. Requalification and required specification markings that are illegible may be reproduced on a metal plate and attached as provided by the original specification.

(2) Previous requalification markings may not be obliterated, except that, when the space originally provided for requalification dates becomes filled, additional dates may be added as follows:

(i) All preceding requalification dates may be removed by peening provided that—

(A) Permission is obtained from the cylinder owner;

(B) The minimum wall thickness is maintained in accordance with manufacturing specifications for the cylinder; and

(C) he original manufacturing test date is not removed.

(ii) When the cylinder is fitted with a footring, additional dates may be marked on the external surface of the footring.

(c) *Requalification marking method.* The depth of requalification markings may not be greater than specified in the applicable specification. The markings must be made by stamping, engraving, scribing or other method that produces a legible, durable mark.

> [NOTE: Although DOT has not published a rulemaking to this effect, it has stated in letters to the propane industry that a "durable pressure adhesive label is acceptable" to be used to mark the cylinder]

(1) and (2) [not applicable to propane cylinders]

(3) For a composite cylinder, the requalification markings must be applied on a pressure sensitive label, securely affixed in a manner prescribed by the cylinder manufacturer, near the original manufacturer's label. Stamping of the composite surface is not authorized.

(d) *Requalification markings.* Each cylinder successfully passing requalification must be marked with the RIN set in a square pattern, between the month and year of the requalification date. The first character of the RIN must appear in the upper left corner of the square pattern; the second in the upper right; the third in the lower right, and the fourth in the lower left.

Example: A cylinder requalified in September 2006, and approved by a person who has been issued RIN "A123", would be marked plainly and permanently into the metal of the cylinder in accordance with location requirements of the cylinder specification or on a metal plate permanently secured to the cylinder in accordance with paragraph (b) of this section. An example of the markings prescribed in this paragraph (d) is as follows:

A1

9 06 X

32

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

Where:
"9" is the month of requalification,
"A123" is the RIN,
"06" is the year of requalification, and
"X" represents the symbols described in paragraphs (f)(2) through (f)(9) of this section.

(1) Upon a written request, variation from the marking requirement may be approved by the Associate Administrator.

(2) *Exception.* A cylinder subject to the requirements of §173.301(l) of this subchapter may not be marked with a RIN.

(e) *Size of markings.* The size of the markings must be at least 6.35 mm (1/4 in.) high, except RIN characters must be at least 3.18 mm (1/8 in.) high.

(f) *Marking illustrations.* Examples of required requalification markings for DOT specification and special permit cylinders are illustrated as follows:

(1) For designation of the 5-year volumetric expansion test, 10-year volumetric expansion test for UN cylinders and cylinders conforming to §180.209(f) and (h), or 12-year volumetric expansion test for fire extinguishers conforming to §173.309(b) of this subchapter and cylinders conforming to §180.209(e) and 180.209(g), the marking is as illustrated in paragraph (d) of this section.

(2) and (3) [not applicable to propane cylinders]

(4) For designation of the proof pressure test, the marking is as illustrated in paragraph (d) of this section, except that the "'X" is replaced with the letter "S".

(5) For designation of the 5-year external visual inspection for cylinders conforming to Sec. 180.209(g), the marking is as illustrated in paragraph (d) of this section, except that the "X" is replaced with the letter "E".

(5) through (9) [not applicable to visual requalification of propane cylinders]

DOT initially underestimated the number of companies that would be registering as cylinder requalifiers and ran out of four-digit numbers to assign. A seven-digit numbering system was started. Facilities using the seven-digit number must display it, along with the date of inspection, using one of the following formats:

V100001 0907 V100001 0907
0907 V100001

5.2.3 Cylinders Filled on Site.

DOT cylinders in stationary service that are filled on site and therefore are not under the jurisdiction of DOT either shall be requalified in accordance with DOT requirements or shall be visually inspected within 12 years of the date of manufacture and within every 5 years thereafter, in accordance with 5.2.3.1 through 5.2.3.3.

FAQ ►
Are all cylinders, whether or not they are under DOT jurisdiction, required to be requalified in accordance with DOT procedures?

Subsection 5.2.3 was added to the 2004 edition of the code. It addresses the need to inspect stationary cylinders and provides a method to recertify cylinders filled on site. Cylinders not "in transportation" are not subject to DOT regulations for recertification; however, they are required to be recertified by NFPA 58. Cylinders "in transportation" include cylinders transported by common carriers (trucking companies); by someone in the LP-Gas business; or by those who use them as a material of trade, such as a caterer or a roofer using propane fuel.

The need for this requirement, which differs from DOT regulations, stems from the difficulty involved in recertifying cylinders filled on site without disconnecting piping, emptying the cylinder, and inspecting and weighing the cylinder, as required by DOT regulations. Weighing is deleted here, because the committee was advised that CGA C-6, *Standard for Visual Inspection of Steel Compressed Gas Cylinders* [6] (which is referenced by DOT), was being revised to drop the re-weighing requirement, and the committee saw

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

potential safety disadvantages to the additional gas transfers that emptying the cylinder would require.

The need for the new requirement was recognized prior to the processing of the 2004 edition with TIA (01-1), which was issued in 2002 on the 2001 edition. The TIA delayed the implementation of the requalifications until July 1, 2004, for cylinders of 100 lb and larger that are filled on site. The delay resulted from the recognition of the burden to propane marketers and their customers, because all cylinders that needed recertification would have been required to be pulled from the field immediately for requalification.

5.2.3.1 Any cylinder that fails one or more of the criteria in 5.2.3.3 shall not be refilled or continued in service until the condition is corrected.

5.2.3.2 Personnel shall be trained and qualified to perform inspections. Training shall be documented in accordance with Section 4.4.

Per 5.2.3.2, training received by persons visually inspecting stationary cylinders filled on site must be documented. As with any documentation required by the code, training documentation should be placed in the employee's file so that it can be located if needed.

5.2.3.3 Visual inspection shall be performed in accordance with the following:

(1) The cylinder is checked for exposure to fire, dents, cuts, digs, gouges, and corrosion according to CGA C-6, *Standard for Visual Inspection of Steel Compressed Gas Cylinders*, except that paragraph 4.2.1.1(1) of that standard (which requires tare weight verification) shall not be part of the required inspection criteria.
(2) The cylinder protective collar (where utilized) and the foot ring are intact and are firmly attached.
(3) The cylinder is painted or coated to minimize corrosion.
(4) The cylinder pressure relief valve indicates no visible damage, corrosion of operating components, or obstructions.
(5) There is no leakage from the cylinder or its appurtenances that is detectable without the use of instruments.
(6) The cylinder is installed on a firm foundation and is not in contact with the soil.
(7) A cylinder that passes the visual examination shall be marked with the month and year of the examination followed by the letter "E" (example: 10-01E, indicating requalification in October 2001 by the external inspection method).
(8) The results of the visual inspection shall be documented, and a record of the inspection shall be retained for a 5-year period.

The procedures for visual inspection listed in 5.2.3.3 are simple and will identify cylinder defects and conditions that require correction. Several are taken from CGA C-6 [6], the standard for visually inspecting steel cylinders.

In 5.2.3.3(3), the phrase "retard corrosion" was revised to read "minimize corrosion." The technical committee intends that the painting or coating prevent excessive corrosion from occurring.

Paragraph 5.2.3.3(5) states that using an electronic or other gas detection device is not required.

Paragraph 5.2.3.3(6) addresses an important installation requirement, namely, that the cylinder be installed on a firm foundation, not in contact with the soil. "Firm" is not defined but in the context of the usage, it is intended to require the foundation to remain substantially intact and level while it supports the cylinder.

The marking requirements of 5.2.3.3(7) are similar to those used for cylinders that are requalified. An important difference is that a requalifyer identification number is not required to be marked on the cylinder.

Paragraph 5.2.3.3(8) provides a definite five-year term for retaining the records of all inspected cylinders.

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

5.2.4 Container Service Pressure.

5.2.4.1 The service pressure of cylinders shall be in accordance with the appropriate regulations published under 49 CFR, "Transportation."

See Annex C, Design, Construction, and Requalification of DOT (ICC) Cylinders, for information on the DOT requirements for cylinder design and fabrication.

5.2.4.2 The maximum allowable working pressure (MAWP) for ASME containers shall be in accordance with Table 5.2.4.2.

FAQ ►
Can a container having a maximum allowable working pressure of 200 psi be used in propane service?

Table 5.2.4.2 provides minimum MAWP for ASME containers in LP-Gas service. Most containers require a MAWP of 250 psig (1.7 MPag). The higher pressure of 312 psig (2.2 MPag) [125 percent of 250 psig (1.7 MPag)] is now required for all engine fuel container installations, including automobiles, industrial trucks, buses, recreational vehicles, school buses, and multipurpose passenger vehicles.

Note that containers constructed to the ASME *Boiler and Pressure Vessel Code* [1] up to the 1946 edition, and paragraphs U-68 and U-69 in the 1949 edition, are permitted to be used even though the MAWP is 200 psi. The reason for this allowance is due to the design margin (safety factor) of 5 that was used to design those containers. The recognized benefits of modern technologies and material science have resulted in a reduced design margin for the current ASME *Boiler and Pressure Vessel Code.*

5.2.4.3 In addition to the applicable provisions for horizontal ASME containers, vertical ASME containers over 125 gal (0.5 m^3) water capacity shall comply with 5.2.4.3(A) through 5.2.4.3(E).

(A) Containers shall be designed to be self-supporting without the use of guy wires and shall be designed to withstand the wind, seismic (earthquake) forces, and hydrostatic test loads anticipated at the site.

(B) Maximum allowable working pressure *(see Table 5.2.4.2)* shall be the pressure at the top head with allowance made for increased pressure on lower shell sections and bottom head due to the static pressure of the product.

TABLE 5.2.4.2 Maximum Vapor Pressures and MAWP

Maximum Vapor Pressure in psig (MPag)		MAWP Pressure in psig (MPag)					
				Earlier Codes			
		Current ASME Code[a]		API-ASME		ASME[b]	
At 100°F	At 37.8°C	psig	MPag	psig	MPag	psig	MPag
80	0.6	100	0.7	100	0.7	80	0.6
100	0.7	125	0.9	125	0.9	100	0.7
125	0.9	156	1.1	156	1.1	125	0.9
150	1.0	187	1.3	187	1.3	150	1.0
175	1.2	219	1.5	219	1.5	175	1.2
215	1.5	250	1.7[c]	250	1.7[c]	200	1.4
215	1.5	312	2.2[c]	312	2.2[c]	—	—

Note: See Annex D for information on earlier ASME or API-ASME codes.

[a]ASME Code, 1949 edition, paragraphs U-200 and U-201 and all later editions *(see D.2.1.5).*

[b]All ASME codes up to the 1946 edition and paragraphs U-68 and U-69 of the 1949 edition *(see D.2.1.5).*

[c]See 6.23.3.1(A), 6.23.3.1(C), and 6.23.3.1(D) for required maximum allowable working pressure (MAWP) for ASME engine fuel and mobile containers.

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

(C) Wind loading on containers shall be based on wind pressures on the projected area at various height zones above ground in accordance with ASCE 7, *Minimum Design Loads for Buildings and Other Structures*. Wind speeds shall be based on a mean occurrence interval of 100 years.

(D) Seismic loading on containers shall be in accordance with ASCE 7, *Minimum Design Loads for Buildings and Other Structures*. A seismic analysis of the proposed installation shall be made that meets the approval of the authority having jurisdiction.

(E) Shop-fabricated containers shall be fabricated with lifting lugs or other means to lift the container.

Where a container is installed in a vertical rather than a horizontal position, the loading dynamics of the container differ. The methods of support for the vertical container must be designed to account for the increased possibility of toppling the taller container in high wind and seismic conditions. These methods of support are addressed further in 5.2.7.1.

Paragraph 5.2.4.3(B) was changed editorially to employ terms that are commonly used in the ASME *Boiler and Pressure Vessel Code* [1]. The intent remains the same — that is, to require a container to be designed with a maximum allowable working pressure sufficient to encompass all of the pressures present at the bottom of the container.

Paragraph 5.2.4.3(E) requires lifting lugs, but does not require the lugs to carry a specific weight. It must be assumed that the lifting lugs are not adequate to carry the entire weight of the container when filled with LP-Gas or water, so additional support, such as a strapping system, must be used to lift ASME tanks that contain product.

5.2.4.4* ASME engine fuel and mobile containers shall have a MAWP of 312 psig (2.2 MPag) or higher.

A.5.2.4.4 ASME mobile fuel containers constructed prior to April 1, 2001, were required to have a maximum allowable working pressure (MAWP) of 250 psig (1.7 MPag).

The maximum allowable working pressure (MAWP) for engine fuel and mobile containers was changed from 250 psig (1.7 Mpag) to 312 psig (2.2 MPag) or higher in the 2004 edition in order to resolve a conflict with NFPA 1192, *Standard on Recreational Vehicles* [9], which required the higher design pressure. The following two safety benefits resulted from this change:

1. The higher design pressure provides a stronger container, which could be important in a vehicle accident.
2. The higher design pressure reduces the remote possibility of pressure relief valve opening in the event of high internal vehicle temperature.

5.2.4.5 Cylinders shall be designed and constructed for at least a 240 psig (1.6 MPag) service pressure.

5.2.5 ASME Container Openings.

5.2.5.1 ASME containers shall be equipped with openings for the service for which the container is to be used.

NFPA 58 does not limit the number of container openings because a properly installed plug, cap, or blind flange will provide an effective seal to maintain the integrity of the container.

5.2.5.2 The openings required by 5.2.5.1 shall be located either in the shell, in the heads, or in a manhole cover.

5.2.5.3* ASME containers of more than 30 gal (0.1 m^3) through 2000 gal (7.6 m^3) water capacity that are designed to be filled volumetrically shall be equipped for filling into the vapor space.

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

A.5.2.5.3 Prior to December 1, 1963, ASME containers greater than 30 gal (0.11 m^3) water capacity, up to and including 2000 gal (76 m^3) water capacity, were not required to be equipped for filling into the vapor space of the container.

FAQ ▶
Why is it desirable to fill into the vapor space of the container rather than the liquid space?

Filling only into the vapor space, but not into the liquid space, more rapidly achieves equilibrium between the vapor and the liquid in the container. Lower container pressure results when filling into the vapor space, compared to filling into the liquid space. Filling only into the vapor space allows containers to be filled more rapidly, because the pump does not have to overcome a greater pressure in the container.

5.2.5.4* ASME containers of 125 gal (0.5 m^3) through 2000 gal (7.6 m^3) water capacity shall be provided with an opening for an actuated liquid withdrawal excess-flow valve with a connection not smaller than 3/4 in. national pipe thread.

NEW

A.5.2.5.4 Containers fabricated on or before July 1, 1961, are exempt from this requirement.

An actuated liquid withdrawal excess-flow valve is defined in Chapter 3 as follows:

> **3.3.1 Actuated Liquid Withdrawal Excess-Flow Valve.** An excess-flow valve for liquid withdrawal applications that remains in a closed position until actuated by a pipe nipple or adapter, as recommended by the manufacturer, and that is used with a shutoff valve attached to the actuator.

This valve (see Exhibit 5.9), which is required by 5.2.5.4, is needed to remove liquid from ASME containers before they are transported to another location. The DOT regulations require that such tanks can only be transported when the liquid volume is 5 percent or less of the water capacity of the tank. However, a special permit was issued by DOT in 2006 (see Special Permit No. 13341) that allows the transportation of ASME containers with more than 5 percent liquid volume in the container, subject to several limitations. The special permit may be obtained at the following website: http://hazmat.dot.gov/sp_app/special_permits/spec_perm_index.htm

The actuated liquid withdrawal excess-flow valve is more commonly known by the trade names Chek-Lok®, Checkmate®, and SafEvac®, as well as by liquid withdrawal valve with excess flow. An actuated liquid withdrawal valve is operated by removing the valve cap and threading a pipe nipple or adapter (available from the manufacturer) into the valve. As the nipple or adapter turns, the valve opens, liquid flows through the valve until the flow exceeds the excess flow, and the valve closes. (See Exhibit 5.10.) A manual valve is then installed to the pipe nipple or adapter, and the valve is closed. A small bypass allows a small amount of vapor to bypass the excess-flow valve, and pressure increases on the outlet side of the adapter. When pressure on both sides of the excess flow disc is about equal, the excess flow valve opens with an audible "click." The liquid can then be removed.

EXHIBIT 5.9 *Actuated Liquid Withdrawal Excess-Flow Valve; Old Style (Left) and Current Style (Center and Right). (Courtesy of Engineered Controls International, Inc.)*

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

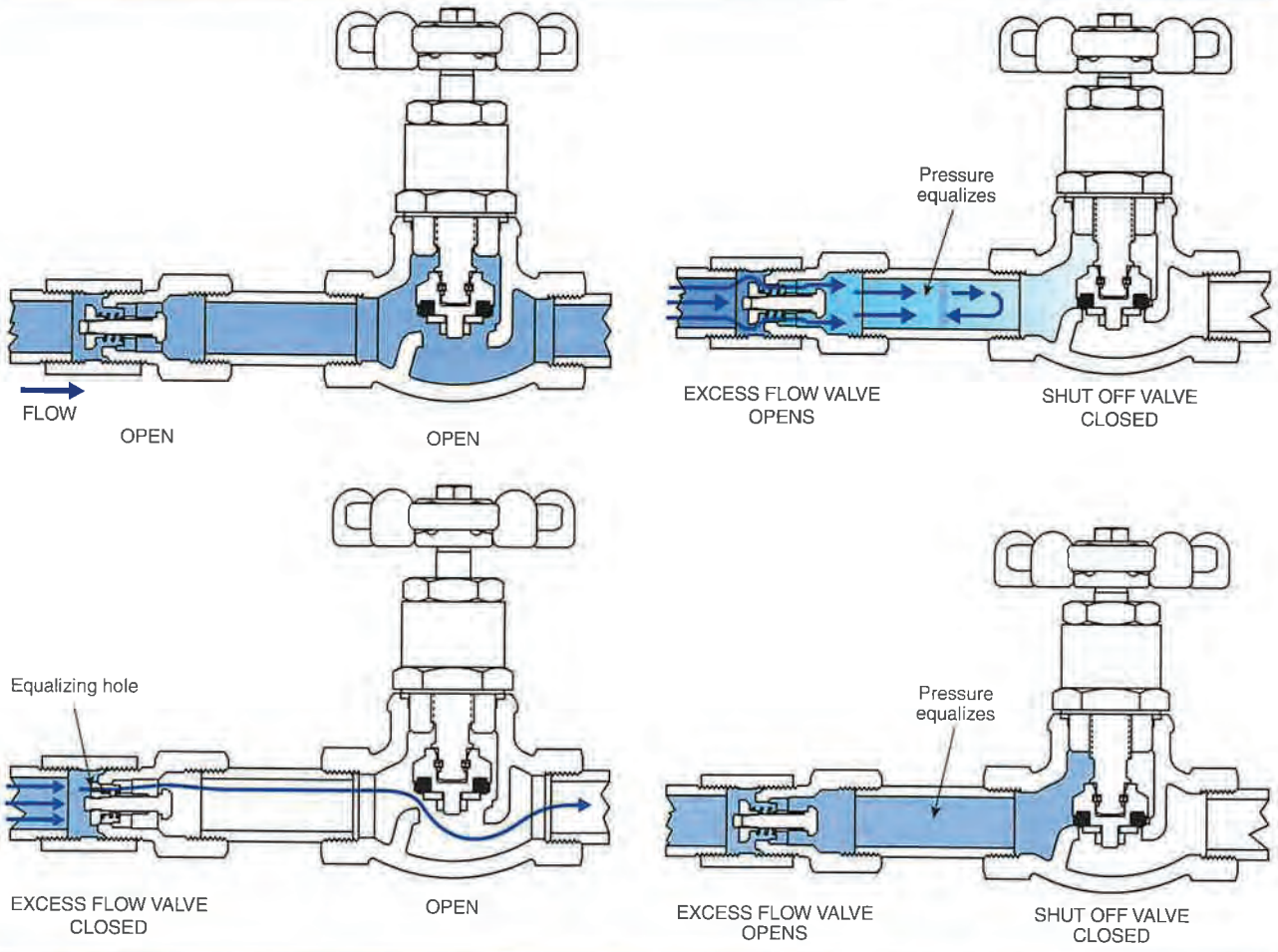


EXHIBIT 5.10 *Operation of an Actuated Liquid Withdrawal Excess-Flow Valve. (Courtesy of Fisher Controls Intl, LLC)*

Section A of Exhibit 5.10 shows an excess-flow valve in the open position, with a manually operated shutoff valve connected also in the open position. The flow through the excess-flow valve is less than the rate that will close the valve. Section B shows an excess-flow valve in the closed position, because the flow has exceeded the rate that will close the excess-flow valve. Note that a small amount of propane, shown as a blue line, continues to flow through the closed excess-flow valve through a designed bypass, such as a small hole drilled in the valve. The manually operated valve remains in the open position. Section C shows the shutoff valve closed, which has allowed the bypass flow to begin to pressurize the space between the shutoff valve and the excess-flow valve. The spring tension retains the excess-flow valve in the closed position. Section D shows the shutoff valve closed, which has allowed the bypass flow to fully to pressurize the space between the shutoff valve and the excess flow valve. With equal pressure (force) on both sides of the excess flow valve, the spring tension opens the excess flow valve. The shutoff valve can now be opened (slowly) to restart the flow.

In 5.7.4.1(B) and 5.7.4.1(D), the code recognizes that the valves are usually intended for only occasional use and that the valve manufacturer may or may not recommend them for continuous use.

Can an actuated liquid withdrawal excess-flow valve be used on a permanent basis to convert a container to liquid withdrawal service?
◀ **FAQ**

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

5.7.4.1(B) Containers of 125 gal through 4000 gal (0.5 m^3 through 15.2 m^3) water capacity shall be provided with an actuated liquid withdrawal excess-flow valve with a connection not smaller than 3/4-in. national pipe thread.
5.7.4.1(D) The actuated liquid withdrawal excess flow valve shall not be connected for continuous use unless the valve is recommended by the manufacturer for such service.

To the editor's knowledge, the major valve manufacturers recommend that the old-style actuated liquid withdrawal excess-flow valves shown in Exhibit 5.9 (left) should not be used for continuous liquid withdrawal operations. The new-style valves, shown in Exhibit 5.9 (center and right), are more robust, and according to the editor's information, the manufacturers do recommend these new, listed valves for continuous service. To be sure, check with the valve manufacturer.

There is a difference between 5.2.5.4 and 5.7.4.1(B). The latter paragraph was changed in the 2001 edition to recognize that residential customers' tanks sometimes exceed 2000 gal (7.6 m^3), and therefore the assumed upper limit for vapor service residential customers was increased to 4000 gal (15 m^3). Tanks larger than 4000 gal (15 m^3) were treated as a bulk plant or dispenser tank, for the purposes of establishing the requirements for appurtenances in 5.7.4.1. This difference is minor, as there are relatively few containers in the size range greater than 2000 gal (7.6 m^3) up to 4000 gal (15 m^3).

5.2.5.5* ASME containers of more than 2000 gal (7.6 m^3) water capacity shall have an opening for a pressure gauge.

NEW **A.5.2.5.5** See 5.7.8.6 for the pressure gauge requirement.

Knowledge of the pressure in larger containers is useful, especially during liquid transfer operations. When installing a pressure gauge, reference should be made to 5.7.6.2, which reminds the user of an important safety feature requiring either a maximum opening of a No. 54 drill size between the container and the pressure gauge or installation of an excess-flow check valve. This safety feature prevents discharge of significant amounts of LP-Gas in case the pressure gauge is broken off. In the 2008 edition, Annex A text was added that refers to the requirement for pressure gauges in 5.7.8.6.

5.2.5.6 ASME containers in storage or use shall have pressure relief valve connections that have direct communication with the vapor space of the container.

(A) If the pressure relief valve is located in a well inside the ASME container with piping to the vapor space, the design of the well and piping shall have a flow capacity equal to or greater than that of the pressure relief valve.

(B) If the pressure relief valve is located in a protecting enclosure, the enclosure shall be designed to minimize corrosion and to allow inspection.

(C) If the pressure relief valve is located in any position other than the uppermost point of the ASME container, the connection shall be internally piped to the uppermost point practical in the vapor space of the container.

FAQ ►
Why is it important that the relief valve be in communication with the vapor space of a container?

By discharging vapor through the relief valve, the total quantity of LP-Gas escaping to the atmosphere is reduced, compared to discharging liquid, and the pressure within the container is reduced more quickly. Because of the high liquid-to-vapor expansion ratio of LP-Gas (270 to 1 for propane), a liquid discharge through the relief valve represents a much greater quantity of gas discharging into the atmosphere. If vapor is discharged, the pressure is reduced inside the container and the remaining liquid boils, cooling the liquid and thus reducing the pressure in the container. If liquid is discharged, the following results:

- Vaporization occurs outside the container.
- There is no cooling effect from vaporization inside the container.
- Container pressure is higher.

These factors are significant if the valve is discharging as a result of fire exposure.

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

The relief valve must either be located at the uppermost point of the container or be internally piped to the uppermost point practical in the vapor space of the container. This provision recognizes that some containers used for engine fuel and recreational vehicle applications have been manufactured with the relief valve located just above the 80 percent liquid level. The provision that the relief valve be piped to the uppermost point practical in the container recognizes that, in some containers — for example, portable lift truck cylinders that are stored vertically and used horizontally — the relief valve inlet cannot be located at the uppermost point for use in both positions.

5.2.5.7* ASME containers to be filled on a volumetric basis shall be fabricated so that they can be equipped with a fixed maximum liquid level gauge(s) that is capable of indicating the maximum permitted filling level(s) in accordance with 7.4.2.3.

A.5.2.5.7 Containers fabricated on or before December 31, 1965, are exempt from this requirement.

Variable liquid level gauges indicate liquid level over most of the container's capacity range but are not completely reliable. The float may develop a leak, the float arm may sag over time, the mechanism may bind, or the gauge may otherwise indicate an inaccurate reading. Therefore, a fixed maximum liquid level gauge is required by 5.2.5.7 to be used to accurately fill the container.

5.2.6 Portable Container Appurtenance Physical Damage Protection.

5.2.6.1 Cylinders of 1000 lb (454 kg) water capacity [nominal 420 lb (191 kg) propane capacity] or less shall incorporate protection against physical damage to cylinder appurtenances and immediate connections to such appurtenances when not in use by either of the following means:

(1) A ventilated cap
(2) A ventilated collar

The cap or collar described in 5.2.6.1 and shown in Exhibit 5.11 is required to provide physical protection for the valves and any other appurtenances connected to the cylinder.

EXHIBIT 5.11 *Cylinder Collars. (Courtesy of Manchester Tank)*

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

Cylinders are portable and normally are transported from their normal use point to a filling point; there are inevitable occurrences where the cylinder is involved in a transportation incident, falls over, or is dropped. If a removable cap is used, it must be in place prior to moving the cylinder. The cap also provides a lifting point for the cylinder. The valve must never be used for lifting a cylinder. Ventilation openings are required to permit discharge from the pressure relief valve to dissipate.

5.2.6.2 Protection of appurtenances of portable containers, skid tanks, and tanks for use as cargo tanks of more than 1000 lb (454 kg) water capacity [nominal 420 lb (191 kg) propane capacity] shall comply with 5.2.6.2(A) through 5.2.6.2(C).

(A) Appurtenance protection from physical damage shall be provided by recessing, by protective housings, or by location on the vehicle.

(B) Appurtenance protection shall comply with the provisions under which the containers are fabricated.

NEW **(C)** Appurtenance protection shall be secured to the container in accordance with the ASME code under which the container was designed and built.

Paragraph 5.2.6.2(C) was revised in the 2008 edition with regard to the design of appurtenance protection to refer to the code under which the container was built, instead of specifying the safety factors to be used. As the appurtenance protection is usually installed by the container manufacturer or assembler of a portable tank unit, it is reasonable to assume that the fabricator has access to the container construction code.

5.2.7 Containers with Attached Supports.

5.2.7.1 Vertical ASME containers of over 125 gal (0.5 m^3) water capacity for use in permanent installations in stationary service shall be designed with steel supports that allow the container to be mounted on and fastened to concrete foundations or supports.

(A) Steel supports shall be designed to make the container self-supporting without guy wires and to withstand the wind and seismic (earthquake) forces anticipated at the site.

(B) Steel supports shall be protected against fire exposure with a material having a fire resistance rating of at least 2 hours.

(C) Continuous steel skirts having only one opening of 18 in. (460 mm) or less in diameter shall have 2-hour fire protection applied to the outside of the skirt.

Vertical containers, as shown in Exhibit 5.12, are used where space is not available for horizontal containers. Because the failure of a vertical tank's structural supports can result in severe damage to the container when it falls, there are special fire protection requirements for the supports. The two-hour fire resistance rating is obtained by using a protective material that has been tested to the requirements of ASTM E-119, *Standard Test Methods for Fire Tests of Building Construction and Materials* [10], a standard used to determine the fire resistance rating of structural elements. Vertical tanks are most often located at propane vehicle refueling stations where space is usually at a premium. Larger vertical tanks have also been installed where land cost is very high, such as near New York City.

Paragraph 5.2.7.1(C) addresses vertical tanks equipped with continuous steel skirts, which are not normally found at propane dispensing locations, but are more common in refineries. Their use is permitted where the skirt is protected with fire resistance-rated insulation on its exterior.

5.2.7.2 ASME containers to be used as portable storage containers, including movable fuel storage tenders and farm carts for temporary stationary service (normally not more than 12 months duration at any location), shall comply with 5.2.7.2(A) through 5.2.7.2(D).

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

EXHIBIT 5.12 *Vertical Container.*

Notification of temporary installations is required by 4.3.2, and notification is required for all installations of 12 months or less. (See the commentary following 4.3.2 for additional information.)

(A) The legs or supports, or the lugs for the attachment of legs or supports, shall be secured to the container in accordance with the ASME code under which the container was designed and built.

(B) The attachment of a container to either a trailer or semi-trailer running gear, or the attachments to the container to make it a vehicle, so that the unit can be moved by a conventional over-the-road tractor, shall comply with the DOT requirements for cargo tank service.

(C) The unit shall be approved for stationary use.

(D) Movable fuel storage tenders, including farm carts, shall be secured to the trailer support structure for the service involved.

Paragraph 5.2.7.2 was revised in the 2008 edition to reference the ASME *Boiler and Pressure Vessel Code* [1], rather than to extract selected parts. Significant changes are as follows:

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org

1. Former subparagraphs 5.2.7.2(A) and (B) are combined into (A), as they both covered the attachment of legs or supports, and reference to the specific safety factor of 4 is deleted and replaced with a reference to the ASME *Boiler and Pressure Vessel Code*.
2. Subparagraph 5.2.7.2(B), formerly (C), was revised by deletion of the last sentence, which had provided a design basis for a stress calculation. This topic is covered in the DOT regulations, and the technical committee believes that DOT is in a better position to regulate design of container attachments.
3. Subparagraph 5.2.7.2(D) is not new, but was relocated from 5.2.7.4 as it deals with the subject of securing a container to its supports.

See Exhibit 9.12 in Chapter 9 for a photo of a farm cart.

NEW

5.2.7.3 Portable tank design and construction of a full framework, skids, or lugs for the attachment of skids, and protection of fittings shall be in accordance with DOT portable tank specifications. The bottom of the skids shall be not less than 2 in. (50 mm) or more than 12 in. (300 mm) below the outside bottom of the tank shell.

Section 5.2.7.3 was revised to insert the words "full framework" into the text. This change makes the code consistent with Title 49 of the Code of Federal Regulations.

5.2.8 Container Marking.

5.2.8.1 Cylinders shall be marked as provided in the regulations, rules, or code under which they are fabricated.

(A) Where LP-Gas and one or more other compressed gases are to be stored or used in the same area, the cylinders shall be marked "Flammable" and either "LP-GAS," "Propane," or "Butane," or shall be marked in accordance with the requirements of 49 CFR, "Transportation."

(B) When being transported, cylinders shall be marked and labeled in accordance with 49 CFR, "Transportation."

By referencing the code of fabrication for marking requirements, NFPA 58 defers to the requirements of other codes. ASME containers require a nameplate with all required markings, while DOT cylinders require stamping in the head and other markings

The requirements of DOT regulations can be difficult to understand. Markings and labeling of cylinders have specific meanings within the context of the DOT, as the following two paragraphs explain.

Labels. Hazardous materials labels are normally printed on or affixed to cylinders containing hazardous materials. They are color- and symbol-coded to afford easy and immediate recognition of the existing hazards. Cylinders containing propane require the label to appear as a diamond with a red background and at least 3.9 in.^{2}, unless the neck ring listed in CGA-Pamphlet 7 shown in Exhibit 5.13 is used. The "2" represents the hazard class, which is "compressed gas." Sometimes the number "2.1" will appear instead of "2." The "2.1" represents the hazard class division and denotes "flammable gas."

EXHIBIT 5.13 *DOT Flammable Gas Label (Red).*

Markings. Markings are printed on or affixed to packages of hazardous materials such as propane cylinders to convey additional information about the hazardous material being transported. Cylinders that contain hazardous materials must be marked with the proper name of the material (either "Liquefied Petroleum Gas" or "Propane" and the shipping identification number, usually "1075" but may also be "1978").

5.2.8.2* Cylinders shall be marked with the following information:

(1) The water capacity of the cylinder in pounds
(2) The tare weight of the cylinder in pounds, fitted for service

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

A.5.2.8.2 The tare weight is the cylinder weight plus the weight of all permanently attached valves and other fittings but does not include the weight of protecting devices that are removed in order to load the cylinder.

Exhibit 5.14 illustrates a typical DOT cylinder marking. Note that the cylinder manufacturer's name, serial number, DT specification number, tare weight, and water capacity are shown. The date of manufacture and the retest date are of special importance. NFPA 58 prohibits the refilling of a cylinder if the requalification or inspection date of the cylinder has passed.

EXHIBIT 5.14 *DOT Cylinder Marking. (Tank courtesy of Worthington Cylinder Corp.)*

5.2.8.3* The markings specified for ASME containers shall be on a stainless steel metal nameplate attached to the container, located to remain visible after the container is installed.

(A) The nameplate shall be attached in such a way as to minimize corrosion of the nameplate or its fastening means and not contribute to corrosion of the container.

(B) Where the container is buried, mounded, insulated, or otherwise covered so the nameplate is obscured, the information contained on the nameplate shall be duplicated and installed on adjacent piping or on a structure in a clearly visible location.

(C) ASME containers shall be marked with the following information:

(1) Service for which the container is designed (for example, underground, aboveground, or both)
(2) Name and address of container supplier or trade name of container
(3) Water capacity of container in pounds or U.S. gallons
(4) MAWP in pounds per square inch
(5) The wording "This container shall not contain a product that has a vapor pressure in excess of ___ psig at 100°F" *(See Table 5.2.4.2.)*
(6) Outside surface area in square feet
(7) Year of manufacture
(8) Shell thickness and head thickness
(9) OL (overall length), OD (outside diameter), HD (head design)
(10) Manufacturer's serial number
(11) ASME Code symbol

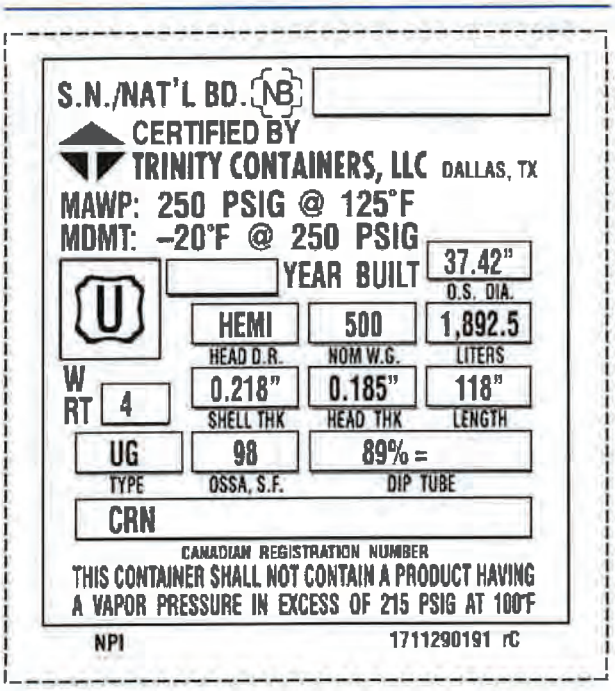
Copyright 2014 National Fire Protection Association (NFPA) Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA For inquires or to report unauthorized use, contact licensing@nfpa.org

(12) Minimum design metal temperature ___°F at MAWP ____ psi
(13) Type of construction "W"
(14) Degree of radiography "RT-___"

A.5.2.8.3 Head design refers to the shape of the head. Shapes include hemispherical, semi-ellipsoidal, and others. *(Refer to the API-ASME Code for Unfired Pressure Vessels for Petroleum Liquids and Gases for more information.)*

The container nameplate, as shown in Exhibit 5.15, must be stainless steel and must be attached to the container in order to eliminate the possibility of corrosion to the nameplate, fasteners, or the container. Container corrosion can occur if water is trapped between the nameplate and the container. The nameplate is usually attached to the container using a continuous stainless steel weld around the nameplate. Because the ASME Code requires the nameplate to be attached to a container (otherwise the container does not meet the ASME Code), the need for this provision is consistent with the long service life of propane containers. This requirement exceeds the ASME Code requirements, which do not specify how the nameplate is attached. This provision is not in conflict with the ASME Code, but it is important to be aware of the provision if ordering a propane container from a fabricator that does not normally fabricate propane containers.

EXHIBIT 5.15 *Optional Container Listing on Container Nameplate. (Courtesy of Trinity Containers, LLC)*



FAQ ▶
Can a container without a nameplate be used in LP-Gas service?

Nameplates provide the operating parameters used in the design of the container and information on the materials used. If the nameplate is missing, the container cannot be used as a pressure vessel. It may be possible to obtain a replacement nameplate, if the manufacturer is still in business, and records of the container construction are available.

The provisions for buried or mounded tanks in 5.2.8.3(B) require that duplicate nameplate information be provided in a visible location if the original nameplate is obscured. This additional marking permits verification of the container nameplate information without digging up an underground container, which could damage the container; the protective coating; or a cathodic protection system, if one is used.

Copyright 2014 National Fire Protection Association (NFPA) Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND No other reproduction or transmission in any form permitted without written permission of NFPA For inquires or to report unauthorized use, contact licensing@nfpa.org.

The information required by 5.2.8.3(C)(12) through 5.2.8.3(C)(14) was revised in the 2004 edition and was inserted to make the requirements of NFPA 58 consistent with the manufacturers' requirements in the ASME *Boiler and Pressure Vessel Code* [1]. Containers manufactured prior to this edition of NFPA 58 are not required to display this new information on the nameplate.

5.2.8.4 Warning labels shall meet the following requirements:

(1) Warning labels shall be applied to all cylinders of 100 lb (45.4 kg) propane capacity or less that are not filled on site.
(2) Warning labels shall include information on the potential hazards of LP-Gas.

The requirements in 5.2.8.4 recognize the need to provide warning to users who are not familiar with the properties and potential hazards of propane. A variety of labels address various container sizes and uses. Exhibits 5.16 and 5.17 show examples of different types of warning labels. This requirement was clarified in the 2008 edition by deleting "LP-Gas capacity" and substituting "propane capacity" as propane and butane, which are both LP-Gases, have different densities and therefore different weights for a full cylinder of the same volume. The term *filled on site* means filled at the usage site and typically applies to cylinders permanently installed at buildings that are filled by a propane delivery truck (bobtail). Cylinders that are filled on site do not require a warning label because the consumer does not handle or install the cylinder.

◄ FAQ
What kind of warning label is needed on a propane tank?

Warning labels are only required on portable cylinders of 100 lb propane capacity (45.4 kg water capacity) and less, because these are the containers that are most likely to be used by consumers of gas who may not be familiar with the hazards associated with LP-Gas. Larger cylinders are assumed to be handled only by propane companies, although there are probably a few exceptions.

The code does not specify the text of a label. The label must include information on the potential hazards of LP-Gas as well as other information. Many labels include a warning that the cylinder must not be brought into buildings. This is true for most cylinders, but not all. In accordance with Section 6.19 certain cylinders can be brought into buildings. A warning stating that the cylinder may not be brought into buildings should not be placed on such

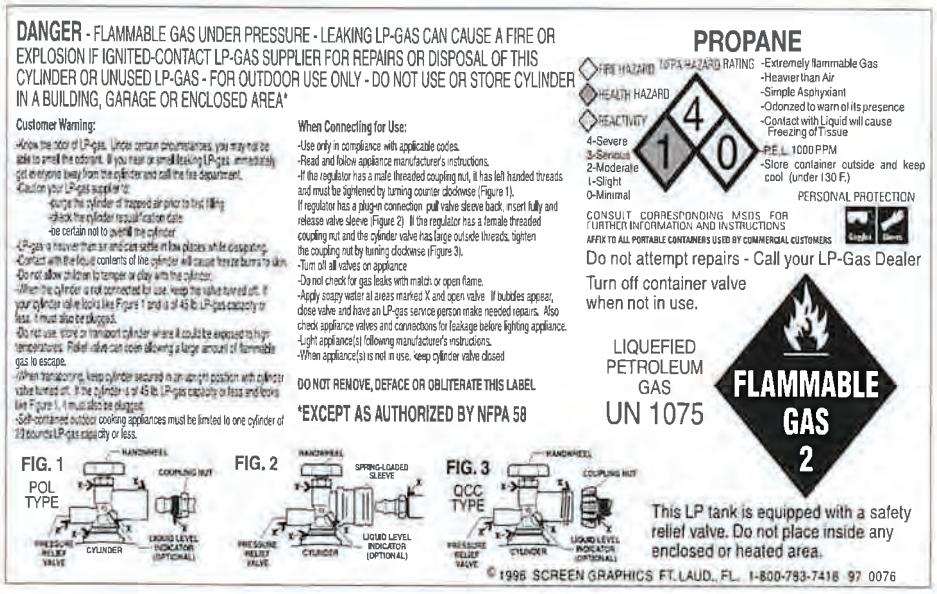


EXHIBIT 5.16 *Sample Warning Label Intended for Gas Grill Cylinders. (Courtesy of Screen Graphics of Florida)*

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

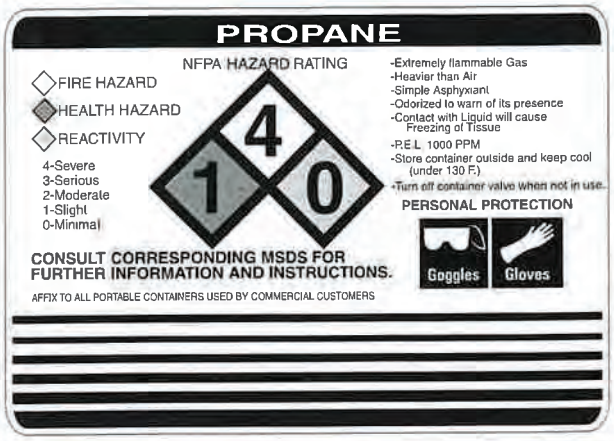


EXHIBIT 5.17 *Sample Warning Label Intended for Use on Cylinders in Commercial or Industrial Service. (Courtesy of Screen Graphics of Florida)*

cylinders. Although this may seem obvious, problems have arisen when inspectors have found cylinders that are permitted by Section 6.19 to be used in buildings that have labels stating that they must not be used in buildings. This situation occurs because the most common size of propane cylinders is 20 lb, and their most common use is with gas grills. Cylinder manufacturers usually provide a warning label that anticipates use of the cylinder with gas grills, unless otherwise specified.

FAQ ►
Can the warning label required for cylinders of 100 lb or less be applied on an enclosure holding the cylinder or on another cylinder cover?

The code does not specify the form of the label, only that it be applied to the cylinder. Applied means "to put on." Therefore, the label can be glued to the container or be attached by a mechanical means such as a plastic strip. If the label is not on the cylinder, but on an enclosure holding the cylinder, or on a cylinder cover or other container, it has not been applied to the cylinder and does not meet the requirement of 5.2.8.4. Therefore, if a decorative cover or plastic sleeve is used to cover a cylinder, the required label must be on the cylinder, and can also be on the cover or sleeve.

NEW

5.2.8.5 All containers that contain unodorized LP-Gas products shall be marked NOT ODORIZED. The marking shall have a contrasting background surrounded by a rectangular border in red letters and red border in the sizes shown in Table 5.2.8.5. The markings shall be on both ends or on both sides of a container or on both sides and the rear of cargo tanks.

TABLE 5.2.8.5 NOT ODORIZED Label Size

Water Capacity		*Letter Height*		*Border Width*	
gal	*L*	*in.*	*cm*	*in.*	*cm*
499 and over	1881 and over	4.0	10.0	1/2	1.3
49 to 498	184 to 1880	1.5	3.7	5/16	0.8
2.6 to 48	10 to 183	3/4	1.8	1/4	0.6
1 to 2.5	4 to 9	3/8	1.0	1/16	0.2

FAQ ►
Are any special precautions needed when storing LP-Gas that has not been odorized?

The marking NOT ODORIZED on ASME containers of unodorized propane provides important information to emergency responders. (See Exhibit 5.18.) The lack of odorant in a storage container adds to the potential hazard that both users and emergency responders face. By providing a visible marking, everyone working around stationary containers holding unodorized LP-Gas is made aware of the absence of odorant. If leakage is suspected, alternate sensing devices can be used to locate the leak.

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

EXHIBIT 5.18 *ASME Containers Marked NOT ODORIZED.*

Paragraph 5.2.8.5 was revised in the 2008 edition of the code to expand its applicability to not only ASME containers, but cylinders as well. Table 5.2.8.5 was added in recognition that 2 in. letters would not fit on smaller containers.

Unodorized propane is also likely to be found at refineries, import terminals, pipeline terminals, and other similar locations. Odorant is normally added to bulk shipments of propane leaving these facilities.

Odorized LP-Gas cannot be used in a few applications; for example, where propane is used as a chemical feedstock and the odorant could poison a catalyst; where butane is used as a foaming gas in the manufacture of styrene trays used to package meats for retail display; or where butane is used as a propellant in filling aerosol cans.

5.3 Reserved

5.4 Reserved

5.5 Reserved

5.6 Reserved

5.7 Container Appurtenances and Regulators

NEW

In the early days of distribution of bulk quantities of LP-Gas to an ASME container located on the consumer's premises, each container assembly of 1200 gal (4.5 m^3) [and subsequently 2000 gal (7.6 m^3)] water capacity or less had to be tested and listed, or inspected and approved, by the authority having jurisdiction. Each appurtenance and regulator on larger containers also had to be listed. Many LP-Gas distributing companies and container fabricators had their own systems listed by Underwriters Laboratories Inc. (UL). Today, the individual appurtenances are tested and listed and either shop-installed by container fabricators or field-installed. Section 5.7 addresses criteria for such appurtenances, which are used as a basis for testing laboratories, manufacturers, and installers.

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

5.7.1 Materials.

NEW **5.7.1.1** Container appurtenances and regulators shall be fabricated of materials that are compatible with LP-Gas and shall be resistant to the action of LP-Gas under service conditions. The following materials shall not be used:

(1) Gray cast iron
(2) Nonmetallic materials, for bonnets or bodies of valves or regulators

FAQ ▶ Can cast iron be used as a material to construct an appurtenance for an ASME container?

Gray cast iron is prohibited because cast iron can be subject to cracking and failing from mechanical shock and from severe thermal shock under fire conditions. The requirement for using metallic materials for the bodies of valves and regulators ensures that exposure of the device to the elements, a fire, or mechanical abuse will result in a reasonable expectation that the device will continue to function without creating a safety hazard. Although there have been considerable improvements in the temperature and pressure capabilities of plastic materials, these materials still do not approach the melting or softening point of metals.

5.7.1.2* Pressure-containing metal parts of appurtenances shall have a minimum melting point of 1500°F (816°C), except for the following:

(1) Fusible elements
(2) Approved or listed variable liquid level gauges used in containers of 3500 gal (13.2 m^3) water capacity or less

A.5.7.1.2 Materials with melting points exceeding 1500°F (816°C) include steel, ductile (nodular) iron, malleable iron, or brass, as follows:

(1) Ductile iron should meet the requirements of ASTM A 395, *Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures,* or equivalent and malleable iron should meet the requirements of ASTM A 47, *Standard Specification for Ferritic Malleable Iron Castings,* or equivalent.
(2) Approved or listed variable liquid level gauges used in containers of 3500 gal (13.2 m^3) water capacity or less are exempt from the minimum melting point requirement.
(3) Cast-iron should not be used.
(4) Nonmetallic materials should not be used for bonnets or bodies of valves or regulators.

The melting-point criteria for metal parts of appurtenances in 5.7.1.2 are intended to provide a degree of structural integrity in the event of exposure to fire and the application of water for fire control. However, appurtenance configuration, mass, and location on the container affect the degree of hazard to the appurtenance. Paragraph 5.7.1.2(2) for liquid level gauges on smaller containers reflects this consideration.

Note that metal used for pressure-containing parts is required to have a melting point of at least 1500°F (816°C). Most metals and alloys become structurally unusable at temperatures approaching one-third to one-half their Fahrenheit melting points, making materials with melting points below 1500°F (816°C) a potential safety concern should the appurtenance be exposed to fire.

NEW **5.7.1.3** Container appurtenances shall have a service pressure of at least 250 psig (1.7 MPag).

5.7.1.4 Gaskets used to retain LP-Gas in containers shall be resistant to the action of LP-Gas.

(A) Gaskets shall be made of metal or other material confined in metal having a melting point over 1500°F (816°C) or shall be protected against fire exposure.

(B) When a flange is opened, the gasket shall be replaced.

(C) Aluminum O-rings and spiral wound metal gaskets shall be permitted.

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

(D) Gaskets for use with approved or listed liquid level gauges for installation on a container of 3500 gal (13.2 m^3) water capacity or less shall be exempt from the minimum melting point requirement.

LP-Gas systems must be able to maintain their integrity when subjected to fire. Therefore, the requirements in 5.7.1.4 that gaskets maintain their integrity when subjected to a temperature of 1500°F (816°C) limits their use to those materials that have the best chance of maintaining their integrity in a fire. Other gasket materials, such as Teflon® and rubber, are permitted only when the flange containing the gasket is protected against fire exposure. This protection, although not specified, must safeguard the gasket from temperatures that would degrade it in a reasonably expected fire condition. A thermal insulating material that would not be degraded in a fire situation can be used.

When a flange is opened, the gasket can be damaged, and the damage may not be visible to the person opening the flange. Therefore, gasket replacement is required.

Aluminum O-rings and spiral-wound metal gaskets are permitted because of long and successful experience with this equipment, which has been listed for many years.

5.7.2 Pressure Relief Devices.

(See Section 5.13 for hydrostatic relief valves.)

Subsection 5.7.2 applies to pressure relief devices that relieve vapor only. Hydrostatic relief valves, which release liquid, are not addressed here, but are addressed in Section 5.13.

5.7.2.1 ASME containers shall be equipped with one or more pressure relief valves that are designed to relieve vapor.

The requirement in 5.7.2.1 restates a key safety requirement, namely, that one or more pressure relief valves are required on all ASME containers. The number of valves is not important, as long as adequate relief capacity (flow) is provided. Pressure relief valves open when the pressure in the container reaches the rated pressure of the relief valve. The valves are required to be in communication with the vapor space of the container so that they release vapor, not liquid LP-Gas.

5.7.2.2 Cylinders shall be equipped with pressure relief valves as required by DOT regulations.

In the 2004 edition of the code, a requirement that appeared in previous editions stating that the start-to-discharge pressure for spring-loaded pressure relief valves used to protect cylinders must be between 75 percent and 100 percent of the minimum required test pressure for the cylinder was deleted. Although no longer included in the code, this provision is still a requirement because the DOT regulations specify the relief valve setting through a reference to CGA S-1.1 *Pressure Relief Device Standards, Part I — Cylinders for Compressed Gases* [11]. The NFPA Technical Committee on Liquefied Petroleum Gases simply felt that it was inappropriate to re-state this requirement. Because cylinder pressure relief valves are provided with cylinders, the requirement is for the cylinder manufacturer, rather than the propane user, and is not needed in NFPA 58.

Most propane cylinders have a service pressure of 240 psig (1.6 MPag). Therefore, DOT requires the test pressure for these cylinders to be at least 480 psig (3.3 MPag). Based on the requirement in CGA S-1.1, the start-to-discharge setting for pressure relief valves in these cylinders would be between 360 psig (2.5 MPag) and 480 psig (3.3 MPag). In actual practice, many of these relief valves are set at 375 psig (2.6 MPag).

5.7.2.3 DOT nonrefillable metal containers shall be equipped with a pressure relief device(s) or system(s) that prevents propulsion of the container when the container is exposed to fire.

DOT regulations in 49 CFR 173.301(f) require that cylinders in butane and propane service be equipped with one or more pressure relief devices selected and tested in accordance with

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

CGA S-1.1, *Pressure Relief Device Standards* [11]. A pressure relief valve (see Exhibit 5.19) is always required, and a fusible plug can be installed in addition to the pressure relief valve. The pressure relief device system must be capable of preventing rupture of the normally charged cylinder when the cylinder is subjected to a bonfire fire test conducted in accordance with CGA C-14, *Methods for Hydrostatic Testing of Compressed Gas Cylinders* [12].

DOT-specification 2P and 2Q nonrefillable metal containers are used primarily for aerosol products. The 2P and 2Q containers have also been used with LP-Gas, specifically butane, for portable butane-fired appliances and for refilling butane cigarette lighters.

In 5.7.2.2, all cylinders are required to have relief devices. In accordance with 49 CFR 173.304(d)(3)(ii) [13], DOT 2P and 2Q nonrefillable metal containers are authorized for LP-Gas. However, depending on the pressure and the quantity of gas, cylinders may not be required to be equipped with a relief device. The LP-Gas committee believes, however, that any container for LP-Gas must contain a relief device or system to help prevent failure or propulsion of the container. Small LP-Gas cylinders can be very dangerous in warehouse fires because they have been known to "rocket" and spread the fire laterally. Sprinkler systems are not always able to contain warehouse fires that involve aerosol containers, resulting in the loss of the structure. Requiring cylinders to have relief devices prevents such incidents involving butane containers. There are at least two ways to prevent "rocketing" of cylinders exposed to fire, as follows:

- A designed point of weakness in the cylinder that forces the failure mode by overpressure and causes the partial separation of the bottom or top of the cylinder (This method results in the gas being released quickly over a large area with little propelling force. Some butane 2P and 2Q containers being sold for use with portable cooking stoves contain a weakness point at one seam that provides pressure relief without rocketing. See Exhibit 5.20, in

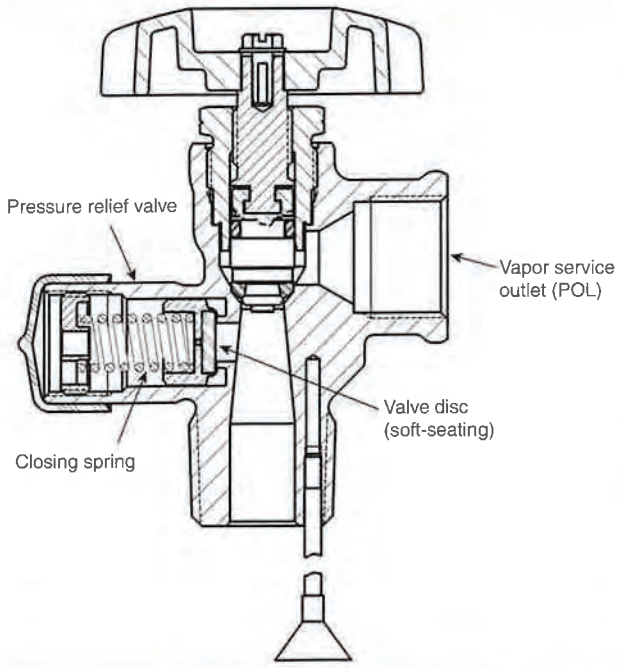


EXHIBIT 5.19 *Pressure Relief Valve on DOT/TC Cylinder. On these cylinders, the relief valve is part of a fitting that includes the manual shutoff valve. (Courtesy of Engineered Controls International, Inc.)*

EXHIBIT 5.20 *Indentations on the Upper Rim Seal of a Listed Butane Cylinder.*

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA For inquires or to report unauthorized use, contact licensing@nfpa.org.

which small dents at the top seam of a butane cylinder can be seen. These weakness points provide the pressure relief.

- An inert, porous fill in the cylinder that slows the release of gas in the event of cylinder failure

5.7.2.4 ASME containers for LP-Gas shall be equipped with direct spring-loaded pressure relief valves conforming with applicable requirements of UL 132, *Standard on Safety Relief Valves for Anhydrous Ammonia and LP-Gas*, or other equivalent pressure relief valve standards.

(A) The start-to-leak setting of such pressure relief valves, in relation to the pressure rating of the container, shall be in accordance with Table 5.7.2.4(A).

The provision in 5.7.2.4 specifically states that spring-loaded pressure relief valves must comply with UL 132, *Standard on Safety Relief Valves for Anhydrous Ammonia and LP-Gas* [2], or its equivalent. UL 132 is essentially an exception to the mandatory reference to the ASME Code in 5.2.1.1, which states in part:

> Containers shall be designed, fabricated, tested, and marked (or stamped) in accordance with the regulations of the . . . *ASME Boiler and Pressure Vessel Code*, Section VIII, "Rules for the Construction of Unfired Pressure Vessels," . . . except for UG-125 through UG-136.

This exception recognizes differences between the ASME Code and UL 132. The difference between the pressure relief valve requirement of the ASME *Boiler and Pressure Vessel Code* [1] and UL 132 is that ASME requires a larger pressure relief valve because of its more conservative testing method, which requires larger pressure relief valves than those required by UL 132.

Exhibit 5.21 shows a pressure relief valve that is used with a relief valve manifold for a large ASME container and Exhibit 5.21 shows an external pressure relief valve for an older, small ASME container. The manifold allows the pressure relief valves to be removed individually for testing or replacement without emptying the container of propane.

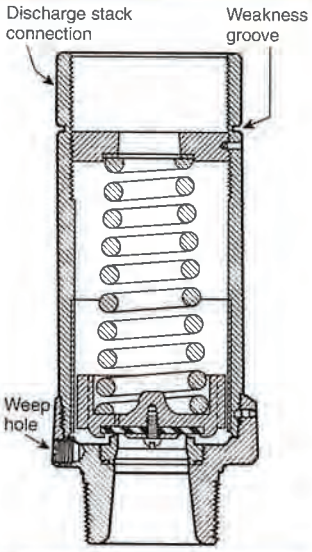


EXHIBIT 5.21 *External-Type Pressure Relief Valve for Large Stationary ASME Container for Use with a Relief Valve Manifold. (Courtesy of Engineered Controls International, Inc.)*

EXHIBIT 5.22 *External-Type Pressure Relief Valve for Older, Small ASME Container. (Courtesy of Engineered Controls International, Inc.)*

A difference still exists between the ASME Code and other standards — the official capacity of the valves. The ASME Code requires 10 percent derating of the average test capacities of three samples to determine the official capacity of the valve. NFPA 58 and UL 132 do not require such derating.

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org

Reference is made to "direct spring-loaded pressure relief valves" to describe accurately the type of relief valve desired on ASME containers used in installations covered by NFPA 58. Various types of direct spring-loaded pressure relief valves exist, such as flush-type internal pressure relief valves used on cargo containers and full internal-type pressure relief valves for engine fuel containers. (See Exhibit 5.23 and 11.4.1.7.) More complex types, such as pilot-operated pressure relief valves, are not needed, are unlikely to receive adequate maintenance, and could result in undesirable frequent premature operation in facilities covered by NFPA 58. Pilot-operated pressure relief valves can only be used on containers larger than 40,000 gal because of their excellent history of use on these larger containers. Simpler devices also exist; for example, burst discs that fail catastrophically at the relief set pressure and cannot reclose. Burst discs are not permitted because the entire contents of the container would be released if the disc opens.

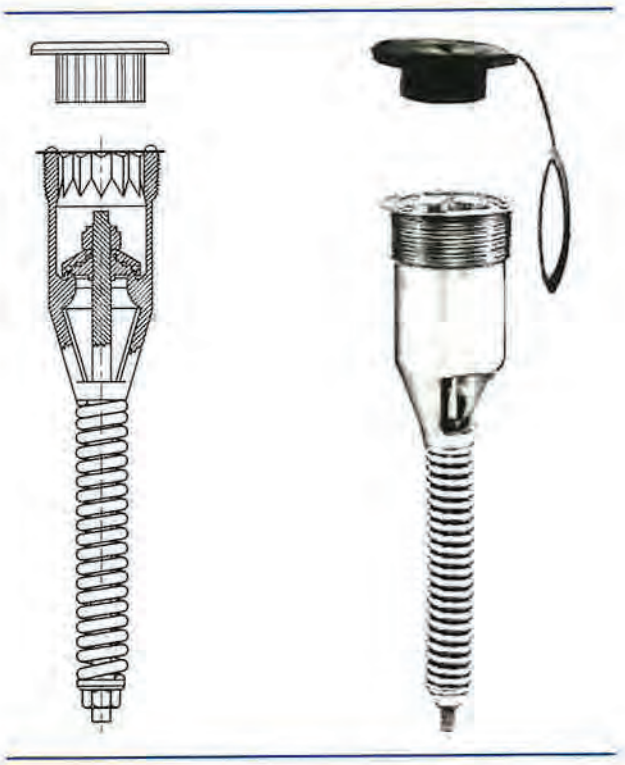


EXHIBIT 5.23 *Flush-Type Internal Pressure Relief Valve Used on Cargo Containers. All working parts are within the container or below the container shell. Stacks are not used. (Courtesy of Fisher Controls Intl, LLC)*

(B) Containers of 40,000 gal (151 m^3) or more water capacity shall be equipped with either a spring-loaded pressure relief valve or a pilot-operated pressure relief valve, as follows:

(1) The pilot-operated relief valve shall be combined with and controlled by a self-actuated, direct, spring-loaded pilot valve that complies with Table 5.7.2.4(A).
(2) The use of a pilot-operated pressure relief valve shall be approved.
(3) Pilot-operated pressure relief valves shall be inspected and maintained by persons with training and experience and shall be tested for operation at intervals not exceeding 5 years.

The requirement in 5.7.2.4(B) recognizes that direct spring-loaded pressure relief valves may not be available in the larger sizes required by larger containers. Large installations that use 40,000 gal (151 m^3) storage containers are more likely to comply with the testing and training conditions specified in 5.7.2.4(B)(3).

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

TABLE 5.7.2.4(A) Start-to-Leak Pressure Settings of Pressure Relief Valves in Relation to Container Pressure Rating

Containers	Minimum	Maximum
All ASME codes prior to the 1949 edition, and the 1949 edition, paragraphs U-68 and U-69	110%	125%*
ASME Code, 1949 edition, paragraphs U-200 and U-201, and all ASME codes later than 1949	100%	100%*

* Manufacturers of pressure relief valves are allowed a plus tolerance not exceeding 10 percent of the set pressure marked on the valve.

Exhibit 5.24 shows a pilot-operated relief valve typically used on very large containers. Exhibits 5.25 and 5.26 show a pilot-operated relief valve in the closed and open (relieving) position, respectively. In the closed position, pressure from the pressure relief valve inlet at the bottom of the valve is transmitted through the tube to the pilot at the right. The pressure is below the set pressure and is transmitted to the top of the pressure relief valve piston. Because the area of the piston at the top is larger than the area of the piston at the bottom, the force is down, holding the valve closed.

In Exhibit 5.26, the pressure has exceeded the set pressure, and the pilot piston moves up, releasing the pressure through the pilot discharge (shown at the left of the pilot). This reduces the pressure to the top of the piston, and it moves up very quickly.

◀ **FAQ**
What is a "pilot-operated" pressure relief valve?

5.7.2.5 The minimum rate of discharge of pressure relief valves installed in ASME containers shall be in accordance with Table 5.7.2.5 or shall be calculated using the following formula:

$$F = 53.632 \times A^{0.82}$$

where:

A = total outside surface area of container in ft^2

F = flow rate in SCFM air

EXHIBIT 5.24 *Pilot-Operated Relief Valve. (Courtesy of Anderson Greenwood)*

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

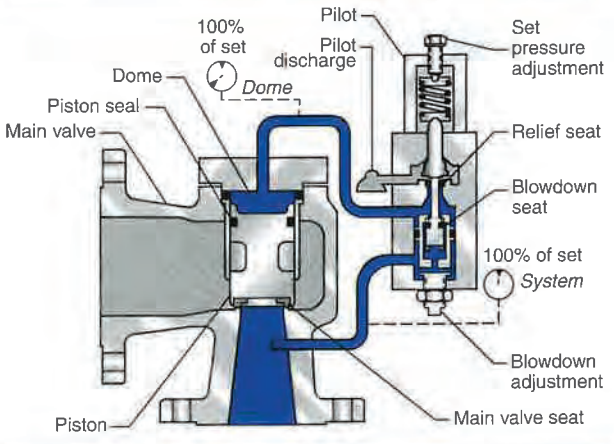


EXHIBIT 5.25 *Pilot-Operated Relief Valve in the Closed Position. (Courtesy of Anderson Greenwood)*

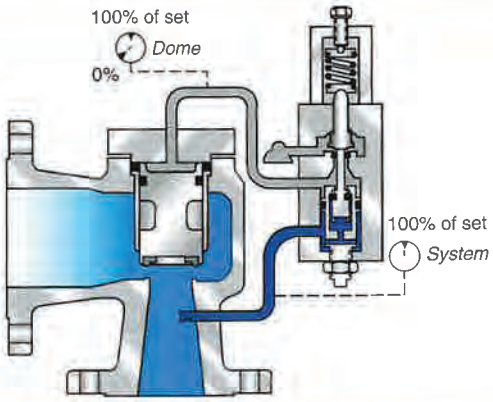


EXHIBIT 5.26 *Pilot-Operated Relief Valve in the Open Position. (Courtesy of Anderson Greenwood)*

TABLE 5.7.2.5 *Pressure Relief Valve Flow Capacity as a Function of Container Surface Area*

Surface Area (ft^2)	Flow Rate (SCFM)	Surface Area (ft^2)	Flow Rate (SCFM)	Surface Area (ft^2)	Flow Rate (SCFM)
≤20	626	170	3620	600	10,170
25	751	175	3700	650	10,860
30	872	180	3790	700	11,550
35	990	185	3880	750	12,220
40	1100	190	3960	800	12,880
45	1220	195	4050	850	13,540
50	1330	200	4130	900	14,190
55	1430	210	4300	950	14,830
60	1540	220	4470	1000	15,470
65	1640	230	4630	1050	16,100
70	1750	240	4800	1100	16,720
75	1850	250	4960	1150	17,350
80	1950	260	5130	1200	17,960
85	2050	270	5290	1250	18,570
90	2150	280	5450	1300	19,180
95	2240	290	5610	1350	19,780
100	2340	300	5760	1400	20,380
105	2440	310	5920	1450	20,980
110	2530	320	6080	1500	21,570
115	2630	330	6230	1550	22,160
120	2720	340	6390	1600	22,740
125	2810	350	6540	1650	23,320
130	2900	360	6690	1700	23,900
135	2990	370	6840	1750	24,470
140	3080	380	7000	1800	25,050
145	3170	390	7150	1850	25,620
150	3260	400	7300	1900	26,180
155	3350	450	8040	1950	26,750
160	3440	500	8760	2000	27,310
165	3530	550	9470	—	—

For SI units, 1 SCFM = 0.0283 m^3/min.

Note: Flow rate in SCFM air.

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

Although a pressure relief valve can function for other reasons (hydrostatic pressure buildup due to overfilling, for example), the minimum relieving capacity required is based on fire exposure. In the fire exposure scenario, the calculation of relief valve capacity assumes that the container is exposed to fire on the entire surface area and the vaporization rate is calculated from the heat transfer from the fire into the container over the entire surface area of the container. CGA publications describe the factors involved.

The equation in 5.7.2.5 is used to calculate the required relief valve rating based on the flow of air through the relief valve. The flow of air is used rather than the flow of propane for two reasons. First, it is simple and less expensive for valve manufacturers to test their products using air rather than propane. Using air eliminates the need to introduce a flammable gas into manufacturing facilities that otherwise do not need propane as a test gas, and helps keep the cost of producing valves down. Furthermore, using air prevents propane release into the atmosphere. Second, the valves can be used for other services such as ammonia and other gases. Conversions are available for the flow of air to the flow of propane, ammonia, and other gases. Table 5.7.2.5 provides the minimum airflow rate required for pressure relief valves based on the surface area of ASME containers. Although there is no advantage to testing relief valves with propane, testing with propane is not prohibited.

Exhibit 5.27 shows ASME container relief valve manifolds. The container shown requires three relief valves. The manifold contains four. By operating the hand wheel or lever, an internal valve is rotated to isolate any one of the four relief valves so that it can be removed for testing, maintenance, or replacement.

5.7.2.6 Relief valves for aboveground ASME containers shall relieve at not less than the flow rate specified in 5.7.2.5 before the pressure exceeds 120 percent of the minimum permitted start-to-leak pressure setting of the device. This does not include the 10 percent tolerance in Table 5.7.2.4(A).

◄ FAQ
Why does Table 5.7.2.4(A) permit a tolerance on the pressure settings of relief valves?

Pressure relief valves for ASME containers that are fabricated to current codes must begin to open at no less than 100 percent of the container design pressure, which is usually 250 psig (1.7 MPag). A tolerance of 10 percent is allowed per Table 5.7.2.4(A); therefore, the valve can begin to open between 250 psig and 275 psig (1.7 MPag and 1.9 MPag). Making pressure relief valves that begin to open at exactly 250 psig (1.7 MPag) would be very expensive, even if it could be done in mass production. The tolerance is allowed to exceed the design pressure

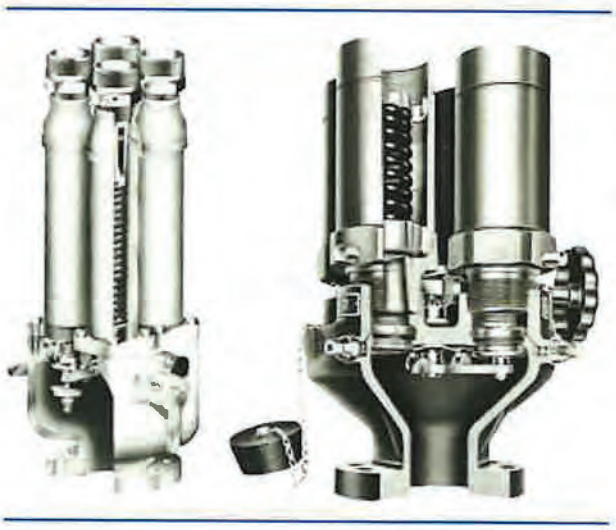


EXHIBIT 5.27 *ASME Container Relief Valve Manifolds. [Courtesy of Fisher Controls Intl, LLC (left) and Engineered Controls International, Inc. (right)]*

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

of the ASME container to prevent unneeded release of propane into the atmosphere. Allowing the ASME container to reach a pressure of 10 percent above its design pressure is recognized by the ASME *Boiler and Pressure Vessel Code*, and is not a threat to safety. Remember that the ASME containers are now built with a design margin (formerly called safety factor) of 3.5 to 1, so the container should maintain its integrity to a pressure of 875 psig (6.0 MPag), assuming no excessive corrosion, dents, pits, or other imperfections are present.

5.7.2.7 The flow capacity of pressure relief valves installed on underground or mounded containers shall be permitted to be reduced to 30 percent of the flow specified in Table 5.7.2.5.

Because underground containers cannot be exposed to fire in the same manner as an aboveground container, their required pressure relief valve capacities are 30 percent of those specified in Table 5.7.2.5.

If a container designed for underground installation is installed aboveground, the relief valve must be properly sized for aboveground service. The editor is aware of a case in which local laws were revised to relocate all underground fuel tanks (including propane) aboveground, based on concerns about potential gasoline and other liquid fuel contamination of groundwater. This law resulted in the relocation of propane containers above ground. (Note that propane is exempt from the EPA requirements for leaking underground storage tanks because it is not a toxic substance.) Propane containers for underground service are usually painted with black paint as part of their protective coating. Since black is a highly absorptive color when exposed to sunlight or another radiative source, installing these tanks above ground may result in occasional relief valve operation. Therefore, if an underground propane container is relocated above ground, the pressure relief valve must be resized in accordance with the requirements for aboveground containers.

5.7.2.8 Each pressure relief valve shall be plainly and permanently marked with the following:

(1) The pressure in psig at which the valve is set to start-to-leak
(2) Rated relieving capacity in SCFM air

The definition of *SCFM* has been added to the code and can be found in 3.3.70. Also see 3.3.69 for the definition of *standard cubic foot.*

(3) The manufacturer's name and catalog number

5.7.2.9 Shutoff valves shall not be installed between pressure relief devices and the container unless a listed pressure relief valve manifold meeting the requirements of 6.7.2.9 is used.

5.7.2.10 Pressure relief valves shall be designed to minimize the possibility of tampering.

Most pressure relief valves used on propane containers have nonadjustable internal springs that prevent tampering. Some older containers may have pressure relief valves that do not have tamper-proof adjustable springs. If the pressure setting on these valves is in doubt, the valves should be tested.

5.7.2.11 Externally set or adjusted valves shall be provided with an approved means of sealing the adjustment.

5.7.2.12 Where used on aboveground ASME containers of 1200 gal (4.5 m^3) or less water capacity in addition to spring-loaded pressure relief valves, fusible plugs shall be in accordance with the following:

(1) Have a yield point between 208°F and 220°F (98°C and 104°C)
(2) Have a total discharge area not exceeding 0.25 $in.^2$ (1.6 cm^2)
(3) Communicate directly with the vapor space of the container

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

Note that fusible plugs are allowed to be used in some instances for additional pressure relief capacity for smaller tanks, but they cannot replace spring-loaded pressure relief valves. (See the commentary following 5.7.2.3.)

5.7.2.13 All cylinders used in industrial truck service (including forklift truck cylinders) shall have the cylinder's pressure relief valve replaced by a new or unused valve within 12 years of the date of manufacture of the cylinders and every 10 years thereafter.

◄ FAQ
Why are relief valves on cylinders used in industrial truck service required to be changed periodically, although other relief valves are not?

Pressure relief valves on cylinders used in industrial truck service are exposed to the truck's operating environment in industrial facilities where foreign material may enter the relief valve. This condition could prevent normal operation of the pressure relief valve. Industrial truck maintenance procedures should include a periodic visual inspection so that any accumulated foreign material can be removed, and to ensure that a relief valve protective cover has been installed over the relief valve outlet.

Paragraph 5.7.2.13 requires that the pressure relief valve be replaced within 12 years of the date of manufacture of the cylinder and every 10 years thereafter. The first replacement coincides with the first required requalification of the cylinder, which is also 12 years after the date of manufacture. Thereafter, the containers are normally recertified by a visual inspection every 5 years, and the relief valve is replaced on each second requalification. This replacement should be marked on the cylinder. Markings are not permitted on the body of the cylinder, but can be made on the cylinder's collar, which is not a pressure-containing part.

5.7.3 Overfilling Prevention Devices.

Overfilling of cylinders can result in the release of liquid propane through the relief valve. An overfilled propane cylinder that is heated can lead to expansion of the liquid propane in the cylinder. If the liquid expands to the point where it fills the cylinder, the pressure is relieved through the cylinder's pressure relief valve, a very dangerous situation.

The vast majority of propane cylinders in use today are small cylinders in the range of 4 lb through 40 lb (1.8 kg through 18 kg) propane capacity. These cylinders are used with propane barbecue grills (i.e., gas grills) and other outdoor appliances (e.g., camping equipment, patio heaters, and mosquito traps) and for providing energy for space heating, water heating, and cooking in recreational vehicles.

In response to the problem of overfilled cylinders, the 1998 edition of NFPA 58 first required new small portable cylinders to be equipped with an overfilling prevention device (OPD) (see Exhibit 3.8). There are some exceptions to this requirement that are detailed in 5.7.3.5. In addition to new cylinders, all existing cylinders were required to be retrofitted in accordance with 5.7.3.2 by April 1, 2001. It is important to note that the OPD is not the primary means by which the proper cylinder fill level is to be determined. The OPD is intended to serve as a secondary safety measure to the primary means of filling a cylinder by weight or by volume, as described in Chapter 7.

At the time of writing this edition of the handbook, OPDs have been required for 8 years for new cylinders and 4 years for all cylinders. While the retrofitting of OPDs has not been adopted by all states, a significant number of cylinders have OPDs. Data analyzed by the NFPA Fire Analysis Department issued in April 2006, shown in Exhibit 5.28, show that the number of home structure fires involving gas grills has been cut in half since the new requirement took effect in 1998. According to NFPA, the number of gas grill home structure fires decreased from 1200 in 1997 to 600 in 2002. By contrast, the number of home structure fires involving charcoal grills remained steady during that same period (see Exhibit 5.28).

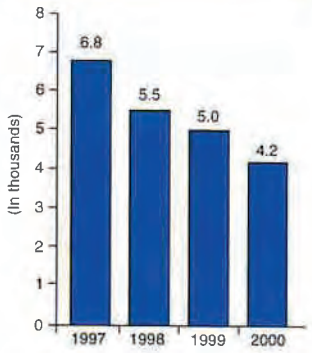


EXHIBIT 5.28 *U.S. Structure Fires Involving Gas Grills, 1997–2003 (Source: NFPA Fire Analysis Department).*

5.7.3.1 Cylinders with 4 lb (1.8 kg) through 40 lb (18 kg) propane capacity for vapor service shall be equipped or fitted with a listed overfilling prevention device that complies with UL 2227, *Overfilling Prevention Devices*, and a fixed maximum liquid level gauge. These devices shall be permitted to be a part of the container valve assembly.

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

Portable cylinders in the 4 lb to 40 lb (1.8 kg to 18 kg) propane capacity range are those that are most likely to be overfilled. The fixed maximum liquid level gauge has been used for many years to determine that the cylinder is properly filled by the volumetric method. In Exhibit 5.29, note the plastic dip tube to the right of the lower part of the valve. When the screw seen on the valve body is turned, it opens a valve from the bottom of the dip tube through the valve body to the atmosphere. The OPD, which is the lower part of the valve assembly, is a secondary safety device that prevents overfilling. Note that the OPD is required only for cylinders used in vapor service, not those used in liquid service.

EXHIBIT 5.29 *Cylinder Valve with Overfilling Prevention Device. Note the triangle-shaped hand wheel, which identifies the OPD valve. In addition to the unique hand wheel, the valve is also stamped "OPD." (Courtesy of Sherwood, Harsco Gas & Fluid Control Group)*

In the 2008 edition, the code now requires all OPD valves to be listed to UL 2227 [14]. Prior to this edition, OPD valves were still required to be listed, but there was no reference to a standard.

5.7.3.2* Cylinders requalified after September 30, 1998, shall be equipped with a listed overfilling prevention device and a fixed maximum liquid level gauge, sized in accordance with 7.4.3.2(A) or Table 5.7.3.2, prior to being filled.

Paragraph 5.7.3.2 is one of the few retrofit provisions that are contained in NFPA 58. The matter of requiring overfilling protection on cylinders is so significant that the industry decided to require even existing cylinders to be retrofitted with OPD valves when they were due for requalification. Refer to the commentary on 5.7.3 for information on the reduction in home fires since the introduction of OPDs.

A.5.7.3.2 Example: When the dip tube length marked on the cylinder is 3.8 in. (97 mm) use a 4.0 in. (102 mm) dip tube for the retrofit.

If the dip tube length is not marked on the cylinder, contact the manufacturer for the recommended dip tube length.

5.7.3.3 No cylinder shall be filled unless it is equipped with an overfilling prevention device and a fixed maximum liquid level gauge. The length of the fixed maximum liquid level gauge dip tube shall be in accordance with 7.4.3.2(A) or Table 5.7.3.2.

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

TABLE 5.7.3.2 Recommended Dip Tube Lengths for Various Cylinders

Propane Cylinder Size (lb)	*Material*	*Cylinder I.D. (in.)*	*Cylinder Water Capacity (lb)*	*Dip Tube Lengths for Various Cylinders (in.)*
4.25	Steel	8.9	10.2	2.2
5	Steel	7.8	11.9	3.0
6	Steel	7.5	15.5	3.2
10	Steel	8.9	26.1	3.6
11	Steel	8.9	26.2	3.6
11	Steel	12.0	26.2	3.0
11.5	Steel	12.0	27.3	3.2
20	Steel	12.0	47.6	4.0
25	Steel	12.0	59.7	4.8
30	Steel	12.0	71.5	4.8
40	Steel	12.0	95.3	6.5
6	Aluminum	6.0	15.0	4.8
10	Aluminum	10.0	23.6	4.0
20	Aluminum	12.0	47.6	4.8
30	Aluminum	12.0	71.5	6.0
40	Aluminum	12.0	95.2	7.0

For SI units, 1 lb = 0.454 kg; 1 in. = 25 mm.

Note: This table indicates the approximate fixed maximum liquid level gauge dip tube lengths to be used for retrofitting cylinders with valves incorporating an overfilling prevention device. This table does not cover every cylinder design or configuration. If the dip tube length that is marked on the cylinder does not appear in Table 5.7.3.2, use the next longer dip tube shown in the table.

5.7.3.4 Cylinders required to have an overfilling prevention device installed shall be equipped with either a CGA connection number 791 or a CGA connection number 810 as described in CGA V-1, *Standard Compressed Gas Cylinder Valve Outlet and Inlet Connections*.

◄ FAQ
Why can only certain types of cylinder connections be used with cylinders having OPD valves?

Paragraph 5.7.3.4 restricts the type of cylinder valve that can be used with an overfilling prevention device. (See CGA V-1, *Standard Compressed Gas Cylinder Valve Outlet and Inlet Connections*. [15]) The CGA designation numbers refer to two specific connection designs, both of which were developed for use with outdoor cooking gas appliances such as grills [see Exhibit 5.29, which shows a CGA 791 connection (Type I) with matching nut]. The performance requirements for each CGA designation require the cylinder connection device to provide three important safety attributes:

1. A "positive seal," which will not permit gas to flow from the cylinder to the appliance unless the connection is properly made
2. An excess flow feature, which will stop the flow of gas should a hose separation occur downstream of the cylinder connection
3. A thermal link that will shut gas flow from the cylinder if the temperature of the link reaches 300°–400°F (150°–205°C), which would occur if there was a fire in close proximity to the connection

5.7.3.5 The following types of cylinders shall be exempt from the requirements of 5.7.3.1 through 5.7.3.4 for installing a listed overfilling prevention device:

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

(1) Cylinders used in industrial truck service and cylinders identified and used for industrial welding and cutting gases

FAQ ▶

Are cylinders used for floor buffer machines required to be fitted with an OPD before they are filled?

Industrial truck cylinders used in liquid service are exempt from the OPD requirement per 5.7.3.5(1), and now so are industrial truck cylinders in vapor service. It is important to note that cylinders used in engine fuel service on vehicles, including floor buffer machines, are also exempt from the OPD requirements, per 5.7.4.1(E). This exception to the OPD requirement for cylinders used in industrial truck service and industrial welding and cutting recognizes the different characteristics of these cylinders, which have a higher level of quality control during the filling process and are therefore not subject to the same threats of overfilling that has occurred in grill cylinders.

- Cylinders used in industrial truck service are universal cylinders that can be filled or used in either the horizontal or the vertical position. They are exempt from the OPD requirements because an OPD is not available for universal cylinders [see 5.7.4.1(E)].
- Cylinders used with floor maintenance machines are usually equipped for vapor withdrawal and are exempt from the OPD requirement because of the higher flow required, which cannot be met with some OPD valves.
- Cylinders used in industrial and welding cutting gas service are exempt from the OPD requirement due to the higher gas flow required in cutting and welding, which cannot be met with some OPD valves.

(2) Cylinders manufactured prior to October 1, 1998, and designed for use in the horizontal position and where an overfilling prevention device is not available

Horizontal cylinders manufactured prior to October 1, 1998, are exempt from the OPD requirement because the connections for these cylinders are located on the head, which is on the side when the cylinder is in use. Horizontal cylinders manufactured after October 1, 1998, incorporated an OPD valve. The design of an OPD for a horizontal cylinder is different and more complicated than an OPD for a vertical cylinder, because each horizontal cylinder requires an opening in the head to accommodate the OPD. It would be prohibitively costly to empty, purge, and weld a new connection to a horizontal cylinder manufactured before the OPD was required. In addition, several styles of horizontal cylinders are no longer made, and replacement cylinders may not fit in the compartments of boats, recreational vehicles, and trailers that accommodate them. Because fewer horizontal cylinders are made, they are more expensive than gas grill cylinders — as much as 10 times more in some cases. This combination of hardships created by the unavailability of replacement cylinders in usable sizes, the high cost of such cylinders, and the relatively small number of horizontal cylinders in use led to their exemption from the OPD requirement.

5.7.3.6 Exempted horizontal cylinders shall be marked with a label to indicate that they are not equipped with an overfilling prevention device.

Note that horizontal cylinders not equipped with an OPD are required be marked so that the filler is aware that the cylinder is not equipped with an OPD and that extra care must be taken not to overfill the cylinder. The code does not state who is responsible for adding the label to cylinders not equipped with an OPD. Anyone — the cylinder owner, the filler, or any other party — can add this label, after determining that an OPD is not required for the cylinder (see 5.7.3.5).

NEW

5.7.4 Container Valves and Other Appurtenances.

NEW

5.7.4.1 Containers of 2000 gal (7.6 m^3) water capacity or less shall be fitted with valves and other appurtenances in accordance with Table 5.7.4.1. Shutoff, filler, check, and excess-flow valves shall comply with ANSI/UL 125, *Standard for Valves for Anhydrous Ammonia and LP-*

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org

TABLE 5.7.4.1 Container Connection and Appurtenance Requirements for Containers Used in Other Than Bulk Plants and Industrial Plants

		1	*2*	*3*
Part	***Appurtenance***	***Cylinders 2 Through 420 lb Propane Capacity***	***Stationary ASME Containers ≤ 4000 gal Water Capacity[3]***	***DOT and ASME Engine Fuel and Mobile Containers***
A	Vapor shutoff valve[1]	R (CGA 555 outlet prohibited)	R	R with internal excess-flow valve
B	Liquid shutoff valve[1]	R with CGA 555 outlet and internal excess flow shutoff	R with internal excess flow shutoff	R with internal excess-flow valve
D	Pressure relief valve	R (see 5.7.2.2)	R[2] [see 5.7.4.1(A)]	R (full internal or flush-type full internal pressure relief valve)
E	Fixed maximum liquid level gauge	R (filled by volume) R (filled by weight, ≤ 40 lb and > 100 lb) [see 5.7.4.1(H)]	R	R
F	Overfilling prevention device	R (4 thru 40 lb) (see 5.7.3)	NR	R (ASME only) (see 5.7.4.1(E))
G	Actuated liquid withdrawal excess flow valve	NR	R (≥ 125 gal) [see 5.7.4.1(B) through 5.7.4.1(D)]	NR
H	Float gauge	NR	R (> 124 gal only)	NR
I	Double backflow check filler valve	R (≥ 100 lb filled on site)	R	R (ASME only)

R: Required. NR: Not required.

[1]Where installed.

[2]Aboveground ASME containers, internal spring-type pressure relief valves only.

[3]All ASME container capacities are water capacity.

Gas (Other than Safety Relief), except that shutoff valves used on DOT cylinders shall comply with UL 1769, *Cylinder Valves*. Containers of 2001 gal through 4000 gal (7.6 m^3 through 15.1 m^3) water capacity in bulk plant and industrial plant service shall be fitted with valves and other appurtenances in accordance with Table 5.7.4.2. Containers of 2001 gal through 4000 gal (7.6 m^3 through 15.1 m^3) water capacity in other than bulk plant and industrial plant service shall be in accordance with Table 5.7.4.1.

Paragraph 5.7.4.1 draws distinctions between the size of containers and the type of service for which they are used. The code assumes that containers 2000 gal (7.6 m^3) and under are not used in bulk plant operations. In addition, a distinction is made between containers 4000 gal (15.2 m^3) or less used in bulk plant service and those that are not. This distinction is due to

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

the fact that bulk plant equipment is subject to many more liquid transfer operations than a typical residential or commercial customer facility. For that reason, the product control and appurtenance requirements in Table 5.7.4.2 (covering containers installed in bulk plants and industrial plants) are more rigorous than those appearing in Table 5.7.4.1. Industrial plants have historically been grouped with bulk plants, and Table 5.7.4.2 continues that tradition because the quantities of LP-Gas stored are similar.

Paragraph 5.7.4.1 was revised in the 2008 edition of the code to require the specific valves listed to comply with ANSI/UL 125, *Standard for Valves for Anhydrous Ammonia and LP-Gas (Other than Safety Relief)* [16], and to require cylinder valves to comply with UL 1769, *Cylinder Valves* [17]. These standards had not been referenced in the code prior to this edition.

Table 5.7.4.1 was completely revised in the 2008 edition to provide performance requirements only and not to attempt to cover all possible combinations, which makes it easier to use. The table now has columns for cylinders, 2 through 240 lb, ASME containers through 4000 gal, and engine fuel/mobile containers, compared to six types of containers previously. It also has nine appurtenances (rows), compared to fourteen previously. The former table had blank cells, which sometimes led to confusion as to the meaning of a blank cell. In this edition, all cells clearly state "R" for "required" or "NR" for "not required." Of course, anything that is not required can be used if desired.

(A) The requirement for internal spring-type pressure relief valves that are shown in Table 5.7.4.1 for stationary ASME containers up to and including 4000 gal (15.2 m^3) water capacity shall not apply to underground containers where external pressure relief valves are permitted or to containers that were originally equipped with external pressure relief valves.

Internal pressure relief valves are designed so that the entire valve mechanism is inside the container. In the event of a vehicle impacting a container, the pressure relief valve cannot be broken off, thus preventing the release of the container contents. Underground containers have used external pressure relief valves, because the valve is in the container dome, which is below ground level, and is therefore protected from being broken by vehicle impact.

(B) Containers of 125 gal through 4000 gal (0.5 m^3 through 15.2 m^3) water capacity shall be provided with an actuated liquid withdrawal excess-flow valve with a connection not smaller than 3/4 in. national pipe thread.

(C) An actuated liquid withdrawal excess-flow valve shall not be required on container connections equipped for liquid withdrawal with a positive shutoff valve that is located as close to the container as practical in combination with an excess-flow valve installed in the container connection.

A positive shutoff valve and an excess-flow valve in the container provide the same function as an actuated liquid withdrawal excess-flow valve. The term *positive shutoff valve* means a valve where the operation of the handle, wheel, or lever directly opens or closes the flow path.

(D) The actuated liquid withdrawal excess-flow valve shall not be connected for continuous use unless the valve is recommended by the manufacturer for such service.

Refer to the commentary following 5.2.5.4 for information on continuous service of actuated liquid withdrawal excess-flow valves.

(E) An overfilling prevention device shall not be required for engine fuel cylinders used on industrial (and forklift) trucks powered by LP-Gas or for engine fuel cylinders used on vehicles (including floor maintenance machines) having LP-Gas–powered engines mounted on them.

Refer to the commentary following 5.7.3.5(1) for an explanation of why overfilling prevention devices are not required for these vehicle applications.

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

(F) Excess-flow protection shall not be required for manual shutoff valves for vapor service where an approved regulator is directly attached or attached with a flexible connector to the outlet of the manual shutoff valve for vapor service and the controlling orifice between the container contents and the shutoff valve outlet does not exceed 5/16 in. (8 mm) in diameter.

◄ **FAQ**
Why is an excess-flow valve not required when a regulator with 5/16 in. flow orifice is connected to a container?

Paragraph 5.7.4.1(F) requires that unless an excess-flow valve is installed downstream of the container shutoff valve, a pressure regulator (either high pressure, first-stage, or integral two-stage) must be attached to the service valve or to a flexible connector emanating from the service valve. The 5/16 in. controlling orifice must be located within the shutoff valve itself. This paragraph serves as an alternative to the requirement for an excess-flow valve because it provides a "passive" restriction to the flow of gas should the line become severed downstream of the regulator, due to the restrictive orifice and pressure regulator.

(G) Overfilling prevention devices shall be required on cylinders having 4 lb through 40 lb (1.8 kg through 18 kg) propane capacity for vapor service. *(See 5.7.3.)*

See the commentary following 5.7.3 for an explanation of why overfilling prevention devices are only required on cylinders in the 4 lb to 40 lb range.

(H) Cylinders greater than 40 lb through 100 lb (18 kg through 45 kg) propane capacity filled by volume shall have a fixed maximum liquid level gauge.

NEW

The text was revised in the 2008 edition to make the fixed maximum liquid level gauge mandatory only for cylinders with capacities greater than 100 lb that are filled by volume. The technical committee was made aware that it is common practice of many companies where cylinders are exchanged, to fill all cylinders by the weight method, making the fixed maximum liquid level gauge unneeded. The requirement also recognizes that in the fuel gas distribution business, it is common to fill cylinders with capacities of greater than 40 lb through 100 lb by volume, especially at sites where the cylinder remains at the point of use.

5.7.4.2 ASME containers over 4000 gal (15.2 m^3) water capacity shall be equipped in accordance with 5.7.4.2(A) through 5.7.4.2(G) and Table 5.7.4.2.

◄ **FAQ**
Are there any differences between the requirements in 5.7.4.2 and those in Table 5.7.4.2?

The provisions in 5.7.4.2(A) through (G) are identical to the requirements shown in Table 5.7.4.2. The technical committee duplicated this information in the table because many users find it an easier format to understand.

Paragraph 5.7.4.2 was intended to address containers used in bulk plant and industrial installations. It recognizes that the internal valve incorporates all of the safety features that are available, including providing protection for the container opening in the event the valve is sheared off; thermal protection that would automatically close the valve if it is subjected to fire; and excess-flow protection and remote shutoff capability.

However, the code also recognizes that many existing installations provide similar protection and, therefore, does permit certain alternatives to be used instead of an internal valve. Those alternatives are described in 5.7.4.2(A) through (I).

Internal valves are categorized according to the means by which they are operated. See Exhibits 5.30, 5.31, 5.32, and 5.33 for examples of the different types of internal valves.

(A) Vapor withdrawal openings shall be equipped with either of the following:

(1) A positive shutoff valve located as close to the container as practical in combination with an excess-flow valve installed in the container
(2) An internal valve

The requirements for container appurtenance protection reflect the hazard presented by failure downstream of the connection. Vapor withdrawal lines carry much less propane than liquid withdrawal lines of the same size. Internal valves are not required but are allowed. An excess-flow valve will close in the event the piping system is compromised and the flow exceeds the design flow of the excess-flow valve. It is important to remember that excess-flow

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

TABLE 5.7.4.2 Connection and Appurtenance Requirements for New and Existing Container Installations in Bulk Plants and Industrial Plants

			Requirements for Containers of Greater Than 4000 gal W.C. With and Without Internal Valves[b]	
Service	*2001 gal Through 4000 gal W.C.*[a]	*Greater Than 4000 gal W.C.*[a]	*Without Existing Internal Valves (by 7/1/11)*	*With Existing Internal Valves*
Vapor inlet	Option A or Option B or Option C Option C	Option A or Option B or Option C	See Note	See Note
Vapor outlet	Option B or Option C	Option B or Option C	See Note	See Note
Liquid inlet	Option A or Option B or Option C	Option D or Option E	Option D or Option E or Option F or Option G	RT
Liquid outlet	Option B or Option C	Option E	Option E or Option H	RT

Option A: Positive shutoff valve installed as close as practical to a backflow check valve installed in the container.

Option B: Positive shutoff valve installed as close as practical to an excess-flow valve installed in the container and sized in accordance with 5.7.8.1(H).

Option C: Internal valve installed in the container or an excess-flow valve in accordance with 5.7.4.2(I).

Option D: Positive shutoff valve installed as close as practical to a backflow check valve designed for the intended application and installed in the container.

Option E: Internal valve installed in the container equipped for remote closure and automatic shutoff using thermal (fire) activation within 5 ft (1.5 m) of valve or an excess-flow valve in accordance with 5.7.4.2(I).

Option F: Emergency shutoff valve equipped for remote closure and automatic shutoff using thermal (fire) activation installed in the line upstream as close as practical to an existing positive shutoff valve/excess-flow valve combination.

Option G: Backflow check valve designed for the intended application and installed in the line upstream as close as practical to the existing positive shutoff valve/excess-flow valve combination.

Option H: Emergency shutoff valve equipped for remote closure and automatic shutoff using thermal (fire) activation, installed in the line downstream as close as practical to an existing positive shutoff valve/excess-flow valve combination.

RT: Equipping an existing internal valve for remote closure and automatic shutoff using thermal (fire) actuation within 5 ft (1.5 m) of the internal valve.

Note: Vapor connections on containers installed prior to the effective date of the 2001 edition of NFPA 58 are not required to be modified.

[a]Applicable to installations constructed on or after the effective date of this code.

[b]Applicable to installations constructed prior to the effective date of this code.

valves can not provide complete safety, as the flow from a container is a function of the pressure in the container, which is temperature dependent. On colder days, container pressure may not be sufficient to develop a flow that will close the excess-flow valve. Excess-flow valves may also not close if the pipe area is reduced by breakage that restricts flow.

(B) Liquid withdrawal openings in new installations shall be equipped with an internal valve that is fitted for remote closure and automatic shutoff using thermal (fire) actuation where the thermal element is located within 5 ft (1.5 m) of the internal valve.

Liquid withdrawal lines present a greater potential hazard than vapor withdrawal lines, and the requirement for the container appurtenance is more stringent. An internal valve is required.

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

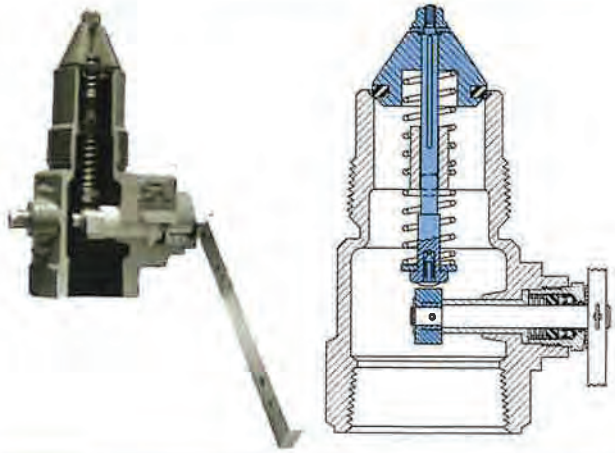


EXHIBIT 5.30 *Lever Operated Internal Valve for Threaded Installation. (Courtesy of Engineered Controls International, Inc.)*

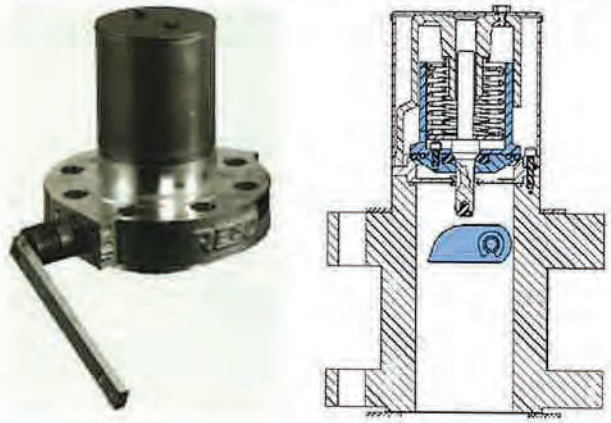


EXHIBIT 5.31 *Lever Operated Internal Valve for Flanged Installation. (Courtesy of Engineered Controls International, Inc.)*

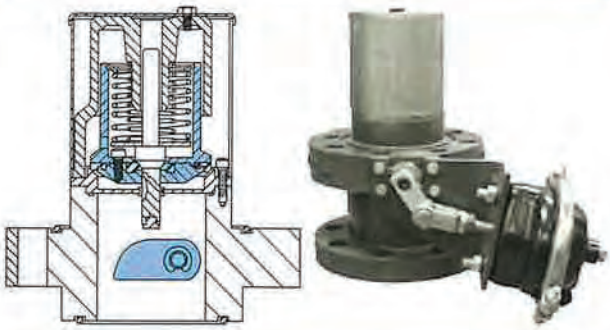


EXHIBIT 5.32 *Pneumatically Operated Internal Valve. (Courtesy of Engineered Controls International, Inc.)*

(C) Liquid withdrawal openings in existing installations where the container is equipped with an internal valve that is not fitted for remote closure and automatic shutoff using thermal (fire) actuation shall be equipped for remote and thermal closure by July 1, 2003.

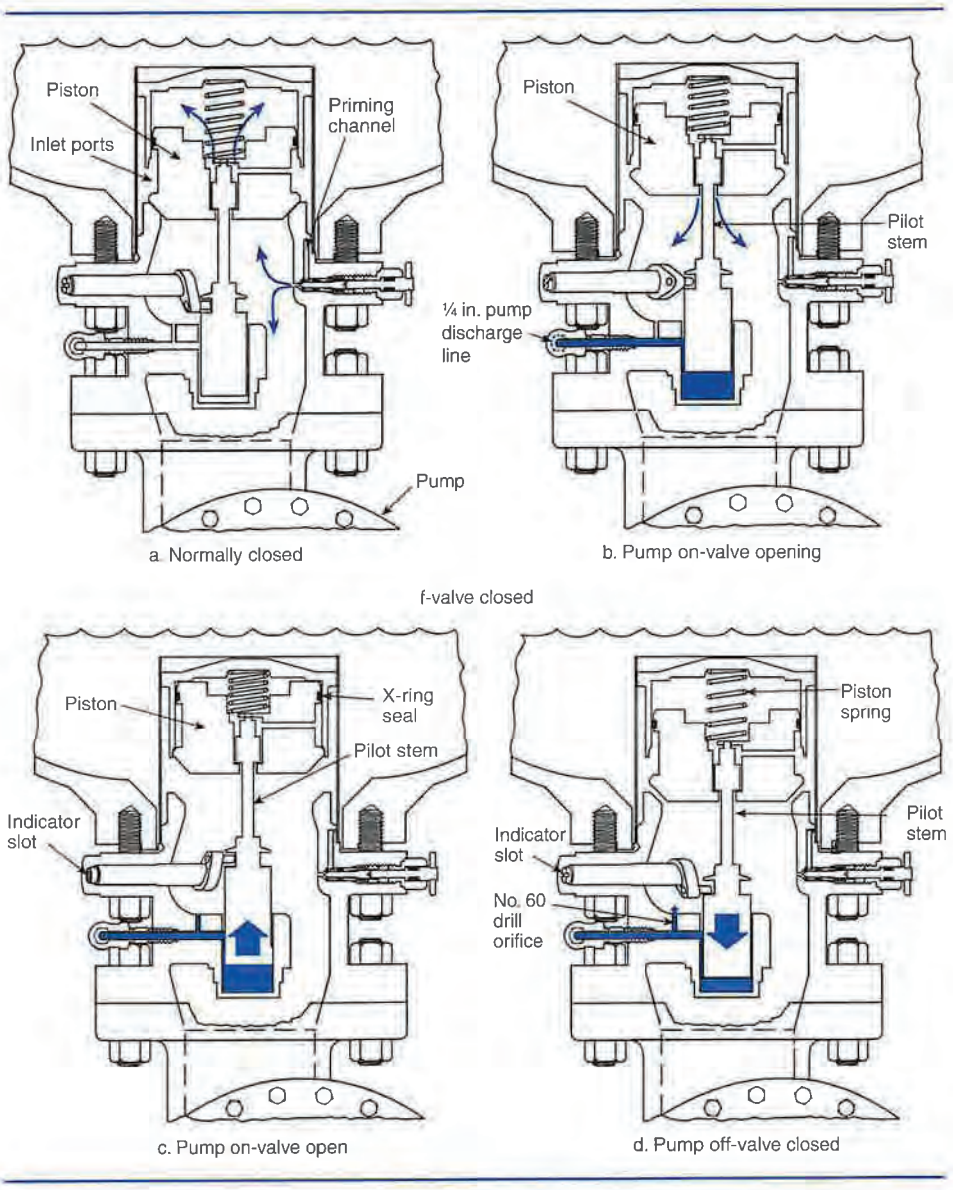
Although the July 1, 2003, date has passed, it is kept in the code to provide guidance to jurisdictions that may not yet have adopted the 2004 edition. This date is also prior to the retrofit date that appears in 5.7.4.2(D) because of the relative ease by which compliance with this paragraph can be achieved. Since the internal valve is already present in the tank, only the remote closure and thermal activation features need be installed.

(D) Liquid withdrawal openings in existing installations shall be equipped with either of the following by July 1, 2011:

(1) An internal valve that is fitted for remote closure and automatic shutoff using thermal (fire) actuation where the thermal element is located within 5 ft (1.5 m) of the internal valve
(2) An emergency shutoff valve that is installed in the line downstream as close as practical to a positive shutoff valve in combination with an excess-flow valve installed in the container

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org

EXHIBIT 5.33 *Operation of a Pump Pressure-Operated Internal Valve. (Courtesy of Engineered Controls International, Inc.)*



A substantial amount of time for compliance is given for this retrofit provision for existing installations. To add an internal valve, the container must be emptied of all product to remove the existing valve from the container. Seals and gaskets may be made of materials having low melting points that could potentially be affected when exposed to heat. The maximum 5 ft distance for the location of the thermal element is intended to keep the activation element close to the valve itself, to avoid heat affecting the ability of the valve to retain product while in the "open" position.

(E) Vapor inlet openings shall be equipped with either of the following:

(1) A positive shutoff valve that is located as close to the container as practical in combination with either a backflow check valve or excess-flow valve installed in the container

(2) An internal valve

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

The container appurtenance requirement for vapor withdrawal openings is the same as vapor inlet openings, because the potential consequences are the same.

(F) Liquid inlet openings in new installations shall be equipped with either of the following:

(1) An internal valve that is fitted for remote closure and automatic shutoff using thermal (fire) actuation where the thermal element is located within 5 ft (1.5 m) of the internal valve
(2) A positive shutoff valve that is located as close to the container as practical in combination with a backflow check valve that is designed for the intended application and is installed in the container

The container appurtenance requirements for liquid inlet openings in new installations allow either an internal valve or a positive shutoff valve and a check valve in the container. A check valve will allow flow only in one direction and will allow propane to enter the container, but not to leave. Check valves are not perfect, but experience with them has been better than with excess-flow valves, as their operation will occur over a much wider flow range than an excess-flow valve. Note that 6.12.9 requires that check valves used as container appurtenances be checked for proper operation annually

See 5.7.4.2(H) for requirements effective in 2011 for container appurtenances for all containers.

(G) Liquid inlet openings in existing installations where the container is equipped with an internal valve that is not fitted for remote closure and automatic shutoff using thermal (fire) actuation shall be equipped for remote and thermal closure by July 1, 2003.

Internal valves are required by NFPA 58 to provide a higher level of safety than provided by excess-flow valves, but they do so only when someone is present to operate the internal valve. The remote operating point must be installed properly. Installation distances are provided in 6.11.4. The requirement for installation by July 1, 2003, was added in the 2001 edition to require that remote operating stations be installed for all internal valves.

(H) Liquid inlet openings in existing installations shall be equipped with any of the following by July 1, 2011:

(1) An internal valve that is fitted for remote closure and automatic shutoff using thermal (fire) actuation where the thermal element is located within 5 ft (1.5 m) of the internal valve
(2) An emergency shutoff valve that is installed in the line upstream as close as practical to a positive shutoff valve in combination with an excess-flow valve installed in the container
(3) A positive shutoff valve that is located as close to the container as practical in combination with a backflow check valve that is designed for the intended application and is installed in the container
(4) A backflow check valve that is designed for the intended application and is installed in the line upstream as close as practical to a positive shutoff valve in combination with an excess-flow valve installed in the container

Note that these requirements are retroactive to all existing containers on July 1, 2011. This date was selected when the requirement was added in the 2001 edition to allow a 10-year period to modify all existing containers.

The options for liquid inlet openings are as follows:

- An internal valve
- An internal check valve with a positive shutoff valve
- An internal check valve with a positive shutoff valve and an external excess-flow valve
- An internal excess-flow valve with a positive shutoff valve and an external check valve.

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

These requirements are similar to those for liquid withdrawal openings, with the addition of another option, a check valve. Check valves can be used only on inlet openings because they will not allow liquid both into and out of a container.

(I) Container openings that are not compatible with internal valves shall be permitted to utilize both an excess-flow valve installed in the container and a valve complying with API 607, *Fire Test for Soft-Seated Quarter Turn Ball Valves*, with the following features:

(1) The valve shall be activated either hydraulically or pneumatically and shall fail in the closed position.
(2) The valve shall be equipped for remote closure and thermal actuation with a thermal element located within 5 ft (1.5 m) of the valve.

This provision was introduced in the 2004 edition of the code because the Technical Committee on Liquefied Petroleum Gases recognized that internal valves are not available in larger sizes to fit 3 in. or larger container openings. These larger sizes would be found typically on high-volume commercial or industrial installations and propane terminals. The option of an internal excess-flow valve with an external valve meeting API 607, *Fire Test for Soft-Seated Quarter Turn Ball Valves* [18], provides a similar level of safety. See Exhibit 5.34 for an API 607 valve.

EXHIBIT 5.34 *Tank Valve Complying with API 607. (Courtesy of Superior Energy Systems)*

5.7.4.3 Appurtenances used on inlet and outlet connections of containers larger than 2000 gal through 4000 gal (7.6 m^3 through 15.1 m^3) water capacity shall be in accordance with Table 5.7.4.1. Appurtenance requirements for inlet and outlet connections of containers in bulk plant and industrial plant service shall be in accordance with Table 5.7.4.2.

FAQ ►
Why are containers between 2000 and 4000 gal water capacity required to comply with different provisions, depending on whether they are used in residential/commercial service or bulk plant/industrial service?

Containers falling within the size range of greater than 2000 through 4000 gal water capacity are required to comply with either Table 5.7.4.1 or Table 5.7.4.2, depending on how they are being used. Because of more frequent liquid transfers to and from containers in bulk plant service, these containers must comply with Table 5.7.4.2 for the installation of internal valves or specified alternatives, rather than the less stringent requirements in Table 5.7.4.1.

5.7.4.4 ASME containers over 4000 gal (15.2 m^3) water capacity shall also be equipped with the following appurtenances:

(1) An internal spring-type, flush-type full internal, or external pressure relief valve *(see Annex E)*
(2) A fixed maximum liquid level gauge
(3) A float gauge, rotary gauge, slip tube gauge, or a combination of these gauges

Copyright 2014 National Fire Protection Association (NFPA) Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa org.

(4) A pressure gauge
(5) A temperature gauge

Since containers used in bulk plant and industrial service are not within the scope of Table 5.7.4.1, the requirements listed in 5.7.4.4 specify the types of appurtenances that must be installed on containers greater than 4000 gal water capacity.

5.7.4.5 The appurtenances specified in Table 5.7.4.1 and 5.7.4.3 shall comply with the following:

(1) Manual shutoff valves shall be designed to provide positive closure under service conditions.

The term *positive closure* means the valve should be leak-free across its seat, throughout its entire working pressure range.

(2) Excess-flow check valves shall be designed to close automatically at the rated flows of vapor or liquid specified by the manufacturer.
(3) Excess-flow valves shall be designed with a bypass that shall not exceed a No. 60 drill size opening to allow equalization of pressure.
(4) Excess-flow valves of less than 1/2 in. (1.3 cm) NPT shall have a bypass that limits propane vapor flow to 10 scf/hr at 100 psig (690 kPag).

An excess-flow check valve remains in the open position until the flow of liquid or vapor passing through the valve exceeds its designed closing flow rate. The small bypass is a hole or "nick" in the valve seat disc that allows a very small amount of LP-Gas to "leak." This feature is not required for all excess-flow valves, but is required for excess-flow valves in LP-Gas service. This leak is the means by which the valve is reopened, because excess-flow valves do not have a manual means of opening (no valve handle). To reopen a closed excess-flow valve, a valve downstream of the excess-flow valve is closed, and the leakage accumulates between the excess-flow valve and the closed manual valve, increasing the pressure downstream of the excess-flow valve. When the pressure on the downstream side is about equal to the pressure on the upstream side, the valve is no longer held closed and opens with an audible "click." (See Exhibits 5.35, 5.36, and 5.37.)

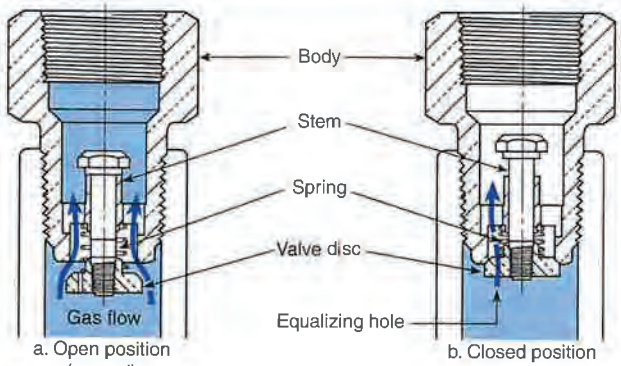


EXHIBIT 5.35 *Operation of Excess-Flow Check Valve. After the spring-loaded excess-flow valve has closed due to excessive flow above the manufacturer's flow rating, the closing of the downstream valve will allow pressure on both sides of the excess-flow check mechanism to equalize through the equalizing hole and the spring loading will cause the excess-flow check to reopen. (Courtesy of Fisher Controls Intl, LLC)*

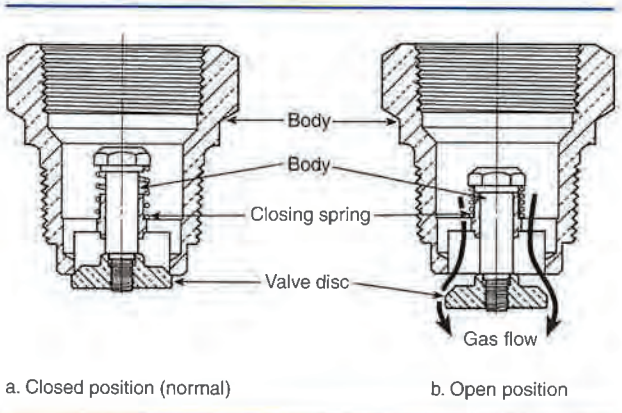


EXHIBIT 5.36 *Operation of Backflow Check Valve. (Courtesy of Fisher Controls Intl, LLC)*

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

EXHIBIT 5.37 *Various Excess-Flow Check Valves. (Courtesy of Fisher Controls Intl, LLC)*

Some other characteristics that apply to all excess-flow valves include the following:

- Excess-flow valves are designed to close automatically at the rated flow of vapor or liquid specified by the manufacturer. If there is only a partially broken hose or piping system and it does not allow the specified rated flow for closure, the excess-flow valve will not close.
- If the temperature of the liquid is extremely low, there may not be enough pressure in the container to reach the required differential pressure to close the valve even if there is complete breakage of the hose or piping system.

(5) Backflow check valves shall be of the spring-loaded or weight-loaded type with in-line or swing operation and shall close when the flow is either stopped or reversed.
(6) Internal valves *(see 3.3.74.4, Internal Valve)*, either manually or remotely operated and designed to remain closed except during operating periods, shall be considered positive shutoff valves.

The code specifically states that an internal valve is considered to be a "positive shutoff valve." When it is closed, no flow is passing through the valve. If an internal valve is left open and no flow occurs, it is not a positive shutoff valve, and the installation of another valve may be needed.

Installers should be aware that an internal valve does provide positive shutoff in both flow directions. Consider an internal valve installed in the liquid outlet of a container. When closed, the internal valve will not allow flow out of the container, but can allow flow into the container where more than one container is connected to a common manifold, especially in a container that has been taken out of service and depressurized. In such installations, a gate or globe valve should be installed with the internal valve.

5.7.5 Liquid Level Gauging Devices.

5.7.5.1 Liquid level gauging devices shall be installed on all containers filled by volume.

5.7.5.2 The gauging devices shall be either fixed maximum liquid level gauges or variable gauges of the slip tube, rotary, or float type (or combinations of such gauges).

5.7.5.3* Every container designed to be filled on a volumetric basis shall be equipped with a fixed maximum liquid level gauge(s) to indicate the maximum filling level(s) for the service(s) in which the container is to be filled or used *(see 7.4.3.3)*.

A.5.7.5.3 Containers fabricated on or before December 1, 1965, were exempt from this requirement.

5.7.5.4 ASME containers shall have permanently attached to the container adjacent to the fixed maximum liquid level gauge, or on the container nameplate, markings showing the percentage of capacity that is indicated by that gauge.

5.7.5.5 Cylinders shall have the letters DT stamped on them followed by the vertical distance (to the nearest tenth of an inch) measured from the top of the boss or coupling into which the gauge, or the cylinder valve of which it is a part, is installed to the end of the dip tube.

5.7.5.6 Cylinders equipped with a fixed maximum liquid level gauge where the dip tube is not welded to the inside of the cylinder shall be permanently marked adjacent to the gauge.

(A) Cylinders designed to be filled in one position shall be marked as follows:

(1) The marking shall be the letters DT followed by the dip tube length to the nearest tenth of an inch.
(2) The dip tube length shall be measured from the top center of the cylinder boss or coupling where the gauge is installed to the maximum permitted filling level.

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

(B) Universal-type cylinders, where the dip tube is not welded to the inside of the cylinder and that are permitted to be filled in either the vertical or horizontal position, shall be marked as follows:

(1) Vertical filling: With the letters VDT followed by the vertical distance (to the nearest tenth of an inch) measured from the top center of the coupling where the gauge is installed to the maximum permitted filling level
(2) Horizontal filling: With the letters HDT followed by the vertical distance (to the nearest tenth of an inch) measured from the centerline of the coupling opening into which the gauge is installed, that is located at the maximum filling level in the horizontal position, to the inside top of the cylinder

Universal cylinders are commonly used in the recreational vehicle industry and also in the forklift truck industry, because they allow filling to take place while the cylinder is still in its installed position. When filled in the horizontal position, a universal cylinder must be oriented correctly around its circumference in order to properly fill the cylinder.

5.7.5.7 Cargo tanks and ASME containers utilizing multiple fixed liquid level gauges shall have the loading percentage (to the nearest 2/10 percent) stamped adjacent to each gauge.

Liquid level gauges are needed on all containers that are filled volumetrically to enable proper filling. The two types of liquid level gauges are

- Fixed, which measure only one level in the container
- Variable, which measure and indicate all liquid levels in the container

Two types of variable gauges commonly used in LP-Gas service are the rotary type and the float type, as shown in Exhibits 5.38 and 5.39. Because variable gauges can be inaccurate, it is necessary to have a fixed maximum liquid level gauge installed in all containers for calibration purposes. The fixed maximum liquid level gauge is used to determine maximum filling levels if the variable gauge is inoperative and to calibrate the variable gauges to prevent inadvertent overfilling.

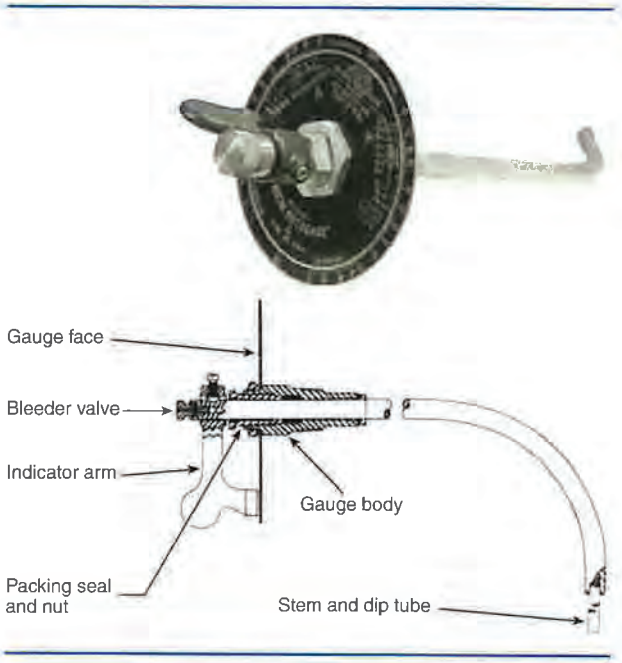


EXHIBIT 5.38 *Rotary Type of Variable Liquid Level Gauge. (Courtesy of Engineered Controls International, Inc.)*

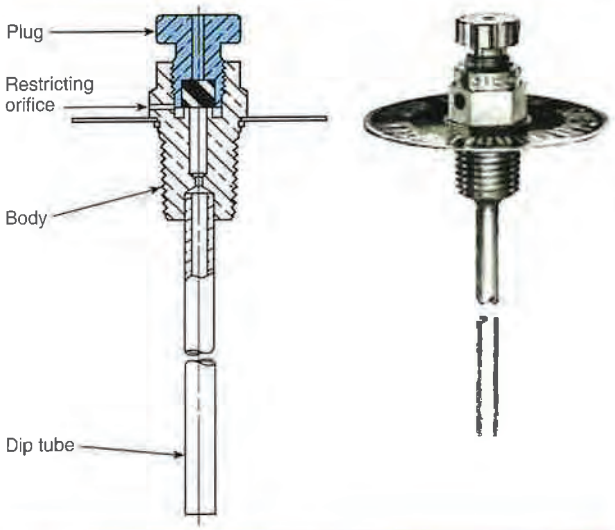
EXHIBIT 5.39 *Float Type of Variable Liquid Level Gauge (Top) and Dial Faces (Bottom). (Courtesy of Gas Equipment Co., Inc. and Rochester Gauges, Inc.)*

Copyright 2014 National Fire Protection Association (NFPA).rLicensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org

EXHIBIT 5.41 *Multiple Valve for 100 lb to 200 lb (45 kg to 91 kg) Cylinder with Fixed Maximum Liquid Level Gauge (Dip Tube) and Separate Inlet and Outlet Connections. (Courtesy of Sherwood, Harsco Gas & Fluid Control Group)*

Fixed maximum liquid level gauges incorporate dip tubes at the 80 percent liquid level of the container. Exhibit 5.40 shows a schematic drawing and a photograph of a fixed maximum liquid level gauge. The marking on the disk in the photograph reads, "STOP FILLING WHEN LIQUID APPEARS." Exhibit 5.43 shows a multiple function container valve assembly that incorporates a fixed maximum liquid level gauge. The dip tube is connected to a valve that allows a small amount of vapor or liquid to be discharged to the atmosphere when opened. The gauge discharge is invisible if vapor is emitted, but a white fog of condensed water vapor is created in the air by the refrigeration effect caused by the vaporizing liquid when it is discharged into the atmosphere.

EXHIBIT 5.40 *Fixed Maximum Liquid Level Gauge. [Courtesy of Fisher Controls Intl, LLC (left) and Engineered Controls International, Inc. (right)]*



The location of fixed maximum liquid level gauges in different containers is shown in Exhibit 5.42. Paragraphs 5.7.5.4 through 5.7.5.7 provide marking requirements for containers equipped with fixed maximum liquid level gauges to readily indicate the length of the dip tube or the percentage fill indicated by the fixed level gauge.

5.7.5.8 Variable liquid level gauges shall comply with the following:

(1) Variable liquid level gauges installed on containers over 2000 gal (7.6 m^3) water capacity shall be marked with the maximum liquid level, in inches, metric units, or percent of capacity of the container where they are to be installed.
(2) Markings shall indicate the maximum liquid level at liquid temperatures from 20°F to 130°F (–6.7°C to 54.4°C) and in increments not greater than 20°F (11°C) for propane, for 50/50 butane–propane mixtures, and for butane.
(3) Markings indicating the various liquid levels from empty to full shall be shown on the system nameplate, on the gauging device, or on both.
(4) Dials of magnetic float gauges or rotary gauges shall indicate whether they are for cylindrical or spherical containers and whether they are for aboveground or underground service.
(5) The dials of gauges for use only on aboveground containers of over 1200 gal (4.5 m^3) water capacity shall be so marked.

Variable liquid level gauges are normally found on larger containers with capacities over 2000 gal (7.6 m^3) (see Exhibit 5.43), and must be marked so that they can be easily read. Markings are required for propane, butane, and 50 percent propane/50 percent butane mix as these are

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

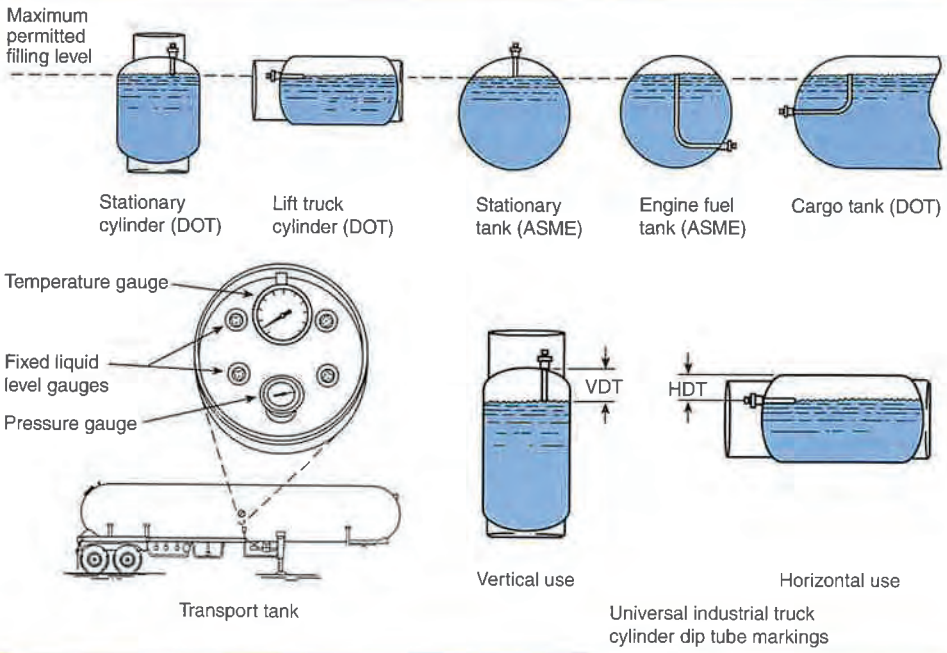


EXHIBIT 5.42 *Locations of Fixed Liquid Level Gauges. (Courtesy of Mississippi Tank Company)*

EXHIBIT 5.43 *Variable Liquid Level Gauge. (Courtesy of Eastern Propane Corp.)*

used. The gauge scale must also provide for the variation in density from 20°F to 130°F (–7°C to 54°C), in increments no larger than 20°F (11°C) so that the container can be properly filled at any temperature within this range. Because the shape of the container (cylindrical or spherical) affects the gauge reading, the type of container for which the gauge is calibrated must be indicated.

5.7.5.9 Variable liquid level gauges shall comply with the provisions of 7.4.3.2(B) if they are used for filling containers.

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

5.7.5.10 Gauging devices requiring bleeding of product to the atmosphere, such as fixed liquid level, rotary tube, and slip tube gauges, shall be designed so that the bleed valve maximum opening to the atmosphere is not larger than a No. 54 drill size.

A No. 54 drill size allows a very small amount of vapor or liquid flow and should not create a hazardous condition if the gauge is opened briefly.

5.7.6 Pressure Gauges.

5.7.6.1 Pressure gauges shall be attached directly to the container opening or to a valve or fitting that is directly attached to the container opening.

5.7.6.2 If the cross-sectional area of the opening into the container described in 5.7.6.1 is greater than that of a No. 54 drill size, an excess-flow check valve shall be provided for the container connection.

Pressure gauges are connected to container openings and because they extend outward, they can be easily broken off. Pressure gauges must be protected to minimize leakage in the event of accidental breakage. If a break should occur, the leakage is minimized by restricting the opening to the size of a No. 54 drill (see the commentary following 5.7.5.10) or by installing an excess-flow valve, which will close automatically if excessive flow passes through it.

5.7.7 Other Container Connections.

NEW **5.7.7.1** Other container openings shall be equipped with any of the following:

(1) A positive shutoff valve in combination with either an excess-flow check valve or a backflow check valve
(2) An internal valve
(3) A backflow check valve
(4) An actuated liquid withdrawal excess-flow valve, normally closed and plugged, with provision to allow for external actuation
(5) A plug, blind flange, or plugged companion flange

NEW **5.7.7.2** Any of the valves listed in 5.7.7.1(1), (2), or (3) that are not connected for service shall be plugged or capped.

5.7.8 Container Appurtenance Installation.

5.7.8.1 All container openings except those used for pressure relief devices, liquid level gauging devices, pressure gauges, double check filler valves, combination backflow check and excess-flow vapor return valves, actuated liquid withdrawal excess-flow valves, and plugged openings shall be equipped with internal valves or with positive shutoff valves and either excess-flow or backflow check valves.

(A) Valves in ASME containers, where excess-flow or backflow check valves are installed between the LP-Gas in the container and the shutoff valves, shall be installed either inside the container or at a point immediately outside where the line enters or leaves the container.

An excess-flow valve is used where flow is in either direction through a given connection. A backflow check valve can be used where flow is intended only into a container and where outflow must be prevented. It is preferable (and required in most cases) to have an excess-flow valve or backflow check valve installed inside the container so that if the piping outside of the container breaks, the safety device will not be adversely affected.

(B) If excess-flow and backflow check valves are installed outside the container, installation shall be made so that any strain beyond the excess-flow or backflow check valves will not cause breakage between the container and the valve.

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

(C) All connections that are listed in the ASME Manufacturers' Data Report for the container shall be considered part of the container.

(D) If an excess-flow valve is required for cylinders other than for mobile or engine fuel service, it shall be permitted to be located at the outlet of the cylinder shutoff valve.

◄ FAQ
Why are excess-flow valves installed in cylinders used in mobile and engine fuel service not permitted to be installed at the outlet of the cylinder shutoff valve?

Cylinders in mobile and engine fuel service are more prone to damage by the very nature of the service they are in. To reduce the possibility of an excess-flow valve being sheared or otherwise disabled on these cylinders, the code requires them to be installed within the container or immediately outside the container in accordance with 5.7.8.1(A) and (B).

(E) Shutoff valves shall be located as close to the container as practical.

(F) Shutoff valves shall be readily accessible for operation and maintenance under normal and emergency conditions.

(G) Shutoff valves either shall be located in a readily accessible position less than 6 ft (1.8 m) above ground level, or shall have extension handles, stairs, ladders, or platforms for access, or shall be equipped for remote operation.

(H) The connection or line that leads to or from any individual opening shall have a flow capacity greater than the rated flow of the excess-flow valve protecting the opening.

An excess-flow valve will shut off the flow of product only if the flow rate is in excess of the valve's flow rating. The sizing of excess-flow valves is critical to their performance. The valves must be sized above the normal design flow rating of the system, but also below the maximum flow capacity of the piping system. The flow of gas in a system can exceed the normal flow, especially during startup when there is no pressure in the system. This condition can cause the excess-flow valve to close when container valves are opened. One solution to this problem is to specify an excess-flow valve with a higher flow rating, but the flow selected must never exceed the maximum design flow capacity of the system. Finding an excess-flow valve with a higher capacity and lower than the maximum system capacity can be difficult, because excess-flow valves are only available with a limited number of flow ratings. The best solution to the problem may be to partially open the valve to avoid pressure spikes until the system reaches operating pressure.

Excess-flow valves are especially effective to control product after hose or piping systems have totally separated. If a partial break in a line occurs that will not allow a flow up to the rated capacity, the excess-flow valve will not close. Many designers and operators believe that an excess-flow valve provides 100 percent protection in case of a pipe break, but this is true only if the break will permit enough flow to operate the excess-flow valve. Because container pressure is a function of temperature, pressure in and flow from a container will be lower at lower temperatures. For this reason, it is well known that excess-flow valves cannot provide 100 percent assurance of stopping product flow. This problem became evident after an incident involving the unintended release of liquid during unloading of a transport truck. Other means of stopping flow in the event of this unintended discharge are now required by DOT for cargo tank vehicles, and by NFPA 58 (internal valves) for larger container installations. Bobtails must have a remote means of closure of the container liquid withdrawal valve within 20 seconds of unintended release of the liquid. This closure is most commonly accomplished with the use of a radio remote shutoff button carried by the operator. Transports require a "passive" shutdown device, which is one that operates without human intervention. Additional information on this subject can be obtained from DOT.

It is also important to size the piping downstream of the excess-flow valve so that it does not restrict the flow of product and thereby prevent the excess-flow valve from closing. If the pipe size is reduced in a branch pipe, the excess-flow valve in the main line will probably not close if the branch pipe is broken, because the flow will probably be less than the closing flow of the excess-flow valve in the main line. Branch lines that are reduced in size from the main

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

line must be equipped with a separate excess-flow valve that is sized for the smaller flows in the branch line.

5.7.8.2 Valves, regulators, gauges, and other container appurtenances shall be protected against physical damage.

Paragraph 5.7.8.2 does not intend that appurtenances must be provided with covers or other protection for all installations. The requirement is intended to apply to those installations where extraordinary circumstances may present the threat of physical damage to appurtenances. For example, an installation where material handling is routinely performed above or immediately adjacent to the container may present the need for additional protection.

5.7.8.3 Valves and other appurtenances that are part of the assembly of portable multicylinder systems shall be arranged so that replacement of cylinders can be made without shutting off the flow of gas in the system.

Paragraph 5.7.8.3 recognizes that where practical, locating the components in a system so that the system need not be shut off to replace cylinders will avoid the necessity of performing a leak check as required by the NFPA 54, *National Fuel Gas Code* [19], after an interruption of service has occurred.

5.7.8.4 Connections to ASME containers installed underground shall be located within a substantial dome, housing, or manhole and shall have a cover.

(A) Underground containers shall be installed so that all connections for hose and any opening through which there can be a flow from pressure relief devices or pressure regulator vents are located above the normal maximum water table.

(B) Such manholes or housings shall be ventilated.

(C) The area of ventilation openings shall equal or exceed the combined discharge areas of the pressure relief devices and other vent lines that discharge into the manhole or housing.

The housing around appurtenances on underground containers is subject to the accumulation of water and debris. Provisions must be in place to permit the proper operation of safety systems for the installation.

5.7.8.5 Container inlet and outlet connections on ASME containers of more than 2000 gal (7.6 m^3) water capacity shall be labeled to designate whether they communicate with the vapor or liquid space.

(A) Labels shall be permitted to be on valves.

(B) Connections for pressure relief devices, liquid level gauging devices, and pressure gauges shall not be required to be labeled.

Note that Exhibit 5.44 shows a typical method of identifying liquid and vapor lines at a bulk plant. Not only is the piping system identified by a label, but the liquid and vapor pipes are color-coded as well. The requirements of 5.7.8.5 can help avoid an incident due to the misidentification of a pipe or valve.

5.7.8.6 Every ASME storage container of more than 2000 gal (7.6 m^3) water capacity shall be provided with a pressure gauge.

5.8 Regulators and Regulator Vents

5.8.1 Regulators.

An LP-Gas pressure regulator, commonly referred to simply as a regulator, is designed to control propane vapor pressure. Propane appliances in buildings typically operate at 11 in. w.c.

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

EXHIBIT 5.44 *ASME Container with Labeled and Color-Coded Connections. (Courtesy of Propane Education and Research Council)*

(2.7 kPa) (about 1/2 psi), so the vapor pressure of the propane in the container must be reduced to a much lower pressure for the appliance to operate safely. Regulators also incorporate devices designed to prevent excessive pressure from reaching appliances installed in buildings. Regulators are the key to the safe use of propane in buildings. Exhibit 3.11 shows a first-stage regulator for vapor service. Exhibit 3.13 shows a second-stage regulator. Although these regulators look very similar, they operate at different pressures. Exhibits 5.45 and 5.46 illustrate how regulators work. The regulator also incorporates a pressure relief function, which is illustrated in Exhibit 5.46.

Since the 1995 edition, two-stage pressure regulation systems have been required for most fixed propane installations in buildings. The regulators used in two-stage regulator systems are designed to reduce propane container pressure to an intermediate pressure of 10 psig (69 kPag), and then further reduce pressure to 11 in. w.c. (2.7 kPag). This is accomplished with the use of two separate regulators (first- and second-stage), or with one single unit, an integral two-stage regulator.

See Exhibit 5.47, where the second stage is the large regulator and the first stage is bolted on at the right. The second-stage bonnet with the vent pointing to the left can be seen above the two pressure taps, which are used for reading first-stage and second-stage regulator outlet pressures. The first-stage regulator is at the threaded inlet with the vent pointing down.

5.8.1.1 Single-stage regulators shall have a maximum outlet pressure setting of 1.0 psig (7 kPag) and shall be equipped with one of the following *(see 6.8.1.5 for required protection from the elements)*:

(1) An integral pressure relief valve on the outlet pressure side having a start-to-discharge pressure setting within the limits specified in UL 144, *Standard for LP-Gas Regulators*.
(2) An integral overpressure shutoff device that shuts off the flow of LP-Gas vapor when the outlet pressure of the regulator reaches the overpressure limits specified in UL 144, *Standard for LP-Gas Regulators*. Such a device shall not open to permit flow of gas until it has been manually reset.

Single-stage regulators are permitted in limited applications. (See 6.8.1.9 for applications in which single-stage regulation is permitted.) The design requirements required by 5.8.1.1(2) are intended for the regulator manufacturer and not for the user.

5.8.1.2 Second-stage regulators and integral two-stage regulators shall have a maximum outlet pressure setting of 14 in. w.c. (4.0 kPag) and shall be equipped with one of the following *(see 6.8.1.5 for required protection from the elements)*:

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

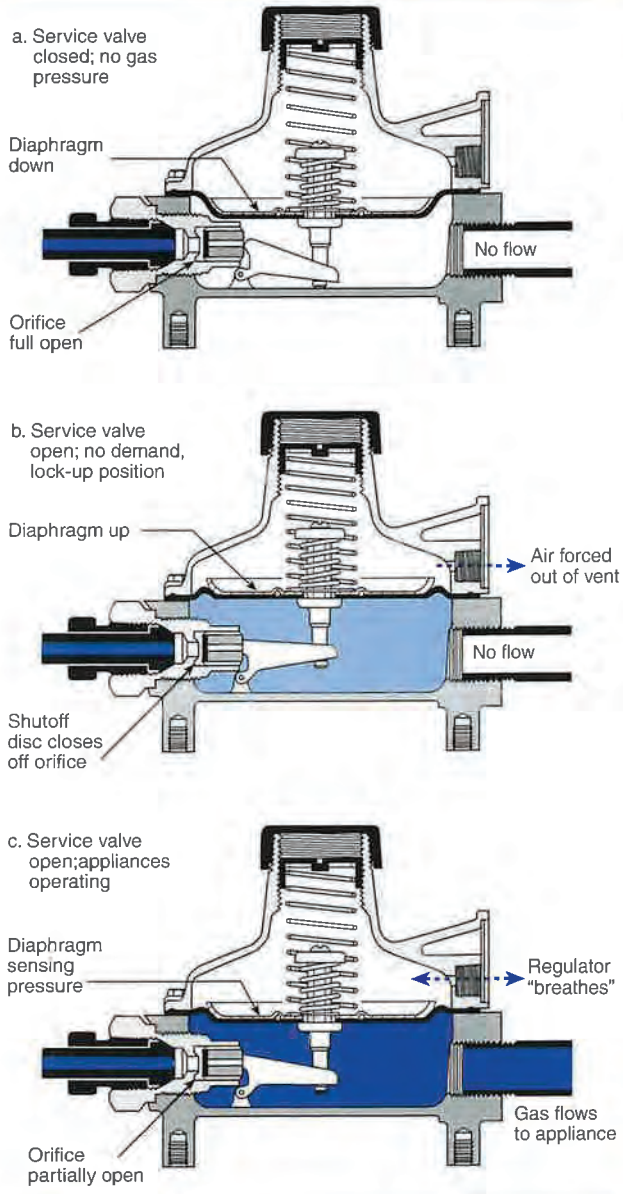


EXHIBIT 5.45 *Regulator Operation. (Courtesy of National Propane Gas Association)*

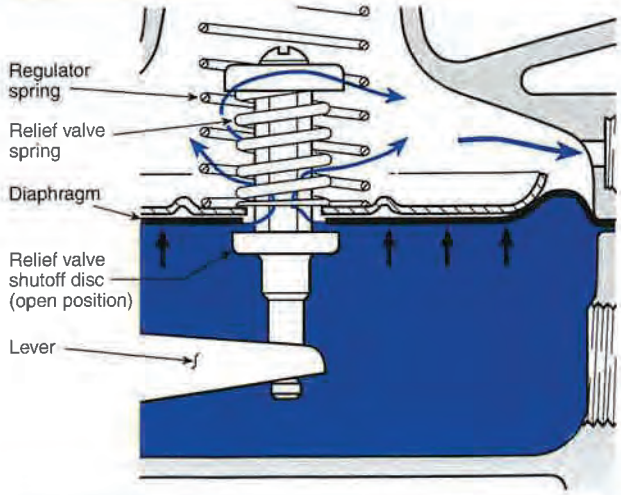


EXHIBIT 5.46 *Operation of Regulator Relief Valve. (Courtesy of National Propane Gas Association)*

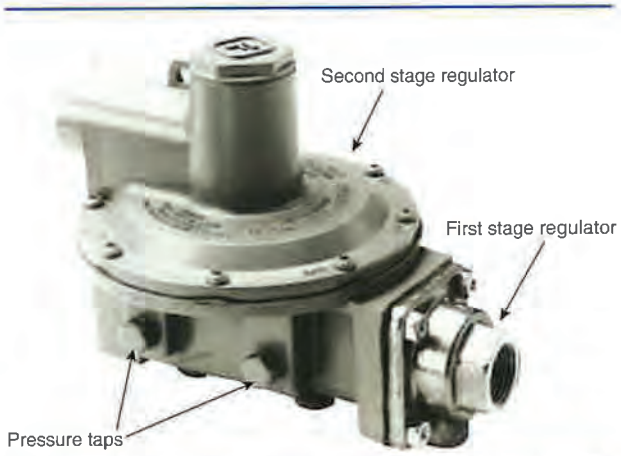


EXHIBIT 5.47 *Integral Two-Stage Regulator. (Courtesy of Fisher Controls Intl, LLC)*

(1) An integral pressure relief valve on the outlet pressure side having a start-to-discharge pressure setting within the limits specified in UL 144, *Standard for LP-Gas Regulators*. This relief device shall limit the outlet pressure of the second-stage regulator to 2.0 psig (14 kPag) when the regulator seat disc is removed and the inlet pressure to the regulator is 10.0 psig (69 kPag) or less, as specified in UL 144.

(2) An integral overpressure shutoff device that shuts off the flow of LP-Gas vapor when the outlet pressure of the regulator reaches the overpressure limits specified in UL 144, *Standard for LP-Gas Regulators*. Such a device shall not open to permit flow of gas until it has been manually reset.

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

The requirements in 5.8.1.1(1) and 5.8.1.1(2) and 5.8.1.2(1) and 5.8.1.2(2) are intended to prevent overpressure in building piping systems. Overpressure can force flames to protrude beyond an appliance and ignite nearby combustibles or otherwise give unsafe, inefficient combustion performance. Prevention of overpressure in the system begins by mandating two-stage regulation in most applications in buildings and by mandating the first-stage outlet pressure to be set at 10 psig (15 kPag) or less. Second-stage regulators must be designed to limit pressure in the building piping to 2 psig. This is accomplished by making the second-stage regulator relief capacity large enough to prevent pressure from exceeding 2 psig in the event of failure to control the flow of gas. The 2 psig limit is also in UL 144, *Standard for LP-Gas Regulators* [20], for second-stage pressure regulators. The seat is the resilient sealing component in the regulator. This 2 psig overpressure criterion was chosen because it should not cause appliance controls to fail. Appliance control standards require that they not leak when exposed to 2 psig.

Overpressure in piping systems can result from the failure of a regulator component or, in some cases, from blockage of the regulator vent in the regulator housing. Components that can fail include all the components of the regulator: seats, diaphragms, linkages, and other mechanical elements. Although a failure of one of these components may occur, it is not likely to happen. Insect nests built in the screen or opening, or freezing water may cause blockage of a regulator vent. Outdoor installation of regulators must comply with 6.8.1.5, which states in part that they be "designed, installed, or protected so their operation will not be affected by the elements." Regulators constructed and tested in accordance with UL 144 0have a test for vent blockage caused by freezing rain and require a vent screen to prevent insect blockage to protect the regulators. Unusual weather conditions can cause ice buildup of such thickness that it is beyond the testing mandated by UL 144. For example, one highly unusual storm in Cape May, New Jersey, in March 1984, reportedly resulted in ice thickness of about one inch.

The maximum discharge pressure from a second-stage regulator is limited to a 14 in. (4.0 kPag) water column. To the editor's knowledge, no regulators are available in the United States with an integral overpressure shutoff device for use in LP-Gas systems. The drawback of overpressure shutoff devices, in addition to their higher manufacturing cost, is that once the gas flow is shut off, it must be manually reset. The system thus experiences an "interruption of service," which then requires a leak check to be performed (per NFPA 54). Currently, all regulators use an integral full-capacity relief valve that prevents the outlet pressure from exceeding 2 psig (3 kPag), even with total regulator seat failure.

(3) Regulators with a rated capacity of more than 500,000 Btu/hr (147 kW/hr) shall be permitted to have a separate overpressure protection device complying with 5.9.2 of NFPA 54, *National Fuel Gas Code* (ANSI Z223.1). The overpressure protection device shall limit the outlet pressure of the regulator to 2.0 psig (14 kPag) when the regulator seat disc is removed and the inlet pressure to the regulator is 10 psig (69 kPag) or less.

Regulators with capacities over 500,000 Btu/hr (147 kW/hr) are exempt from the required integral overpressure protection provisions because, with an engineered system, one can use a special separate overprotection device that is addressed in NFPA 54. Information on sizing independent pressure relief valves is located in Supplement 3, Paragraphs 5.9.2 through 5.9.8 of NFPA 54, *National Fuel Gas Code*, state the following:

5.9.2 Devices.

5.9.2.1 Pressure relieving or pressure limiting devices shall be one of the following:

(1) Spring-loaded relief device
(2) Pilot-loaded back pressure regulator used as a relief valve so designed that failure of the pilot system or external control piping will cause the regulator relief valve to open
(3) A monitoring regulator installed in series with the service or line pressure regulator

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

(4) A series regulator installed upstream from the service or line regulator and set to continuously limit the pressure on the inlet of the service or line regulator to the maximum working pressure of the downstream piping system
(5) An automatic shutoff device installed in series with the service or line pressure regulator and set to shut off when the pressure on the downstream piping system reaches the maximum working pressure or some other predetermined pressure less than the maximum working pressure This device shall be designed so that it will remain closed until manually reset.
(6) A liquid seal relief device that can be set to open accurately and consistently at the desired pressure

5.9.2.2 The devices in 5.9.2.1 shall be installed either as an integral part of the service or line pressure regulator or as separate units. Where separate pressure relieving or pressure limiting devices are installed, they shall comply with 5.9.3 through 5.9.8.

5.9.3 Construction and Installation. All pressure relieving or pressure limiting devices shall meet the following requirements:

(1) Be constructed of materials so that the operation of the device will not be impaired by corrosion of external parts by the atmosphere or of internal parts by the gas.
(2) Be designed and installed so they can be operated to determine whether the valve is free. The devices shall also be designed and installed so they can be tested to determine the pressure at which they will operate and be examined for leakage when in the closed position.

5.9.4 External Control Piping. External control piping shall be protected from falling objects, excavations, or other causes of damage and shall be designed and installed so that damage to any control piping shall not render both the regulator and the overpressure protective device inoperative.

5.9.5 Setting. Each pressure limiting or pressure relieving device shall be set so that the pressure shall not exceed a safe level beyond the maximum allowable working pressure for the piping and appliances connected.

5.9.6 Unauthorized Operation. Precautions shall be taken to prevent unauthorized operation of any shutoff valve that will make a pressure relieving valve or pressure limiting device inoperative. The following are acceptable methods for complying with this provision:

(1) Lock the valve in the open position. Instruct authorized personnel in the importance of leaving the shutoff valve open and of being present while the shutoff valve is closed so that it can be locked in the open position before leaving the premises.
(2) Install duplicate relief valves, each having adequate capacity to protect the system, and arrange the isolating valves or three-way valve so that only one safety device can be rendered inoperative at a time.

5.9.7 Vents.

5.9.7.1 The discharge stacks, vents, or outlet parts of all pressure relieving and pressure limiting devices shall be located so that gas is safely discharged to the outdoors. Discharge stacks or vents shall be designed to prevent the entry of water, insects, or other foreign material that could cause blockage.

5.9.7.2 The discharge stack or vent line shall be at least the same size as the outlet of the pressure relieving device.

5.9.8 Size of Fittings, Pipe, and Openings. The fittings, pipe, and openings located between the system to be protected and the pressure relieving device shall be sized to prevent hammering of the valve and to prevent impairment of relief capacity. [**NFPA 54,** 2006]

5.8.1.3 Integral two-stage regulators shall be provided with a means to determine the outlet pressure of the high-pressure regulator portion of the integral two-stage regulator.

Integral two-stage regulators, as shown in Exhibit 3.12 — sometimes called "piggyback" regulators — consist of first-stage and second-stage regulators in the same body. They are sold and installed as one unit. To determine outlet pressure of the first-stage regulator portion, a plugged opening with a restrictive orifice for a pressure gauge or a permanently installed pressure-indicating device is included with the integral two-stage regulator.

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

5.8.1.4 Automatic changeover regulators shall be exempt from the requirement in 5.8.1.3.

5.8.1.5 Integral two-stage regulators shall not incorporate an integral pressure relief valve in the high-pressure regulator portion of the unit.

5.8.1.6 First-stage regulators shall incorporate an integral pressure relief valve having a start-to-discharge setting within the limits specified in UL 144, *Standard for LP-Gas Regulators*.

5.8.1.7 First-stage regulators with a rated capacity of more than 500,000 Btu/hr (147 kW/hr) shall be permitted to have a separate pressure relief valve.

5.8.1.8 High-pressure regulators with a rated capacity of more than 500,000 Btu/hr (147 kW/hr) where permitted to be used in two-stage systems shall incorporate an integral pressure relief valve or shall have a separate relief valve.

Regulators larger than 500,000 Btu/hr (147 kW/hr) can have a separate pressure relief valve or a separate overpressure shutoff device. Information on sizing independent pressure relief valves is located in Supplement 3.

5.8.1.9 First-stage regulators shall have an outlet pressure setting up to 10.0 psig (69 kPag) in accordance with UL 144, *Standard for LP-Gas Regulators*.

5.8.1.10 Regulators shall be designed so as to drain all condensate from the regulator spring case when the vent is directed down vertically.

5.8.1.11 Two-psi service regulators shall be equipped with one of the following:

(1) An integral pressure relief valve on the outlet pressure side having a start-to-discharge pressure setting within the limits specified in UL 144, *Standard for LP-Gas Regulators*. This relief device shall limit the outlet pressure of the 2 psi (14 kPa) service regulator to 5.0 psi (34.5 kPa) when the regulator seat disc is removed and inlet pressure to the regulator is 10.0 psi (69 kPa) or as specified in UL 144.
(2) An integral overpressure shutoff device that shuts off the flow of LP-Gas vapor when the outlet pressure of the regulator reaches the overpressure limits specified in UL 144, *Standard for LP-Gas Regulators*. Such a device shall not open to permit flow of gas until it has been manually reset.

The requirement in 5.8.1.11 preserves the overpressure protection limits to interior piping and appliances that have already been established in the code where 2 psi systems are used. Two psi (14 kPa) systems have the advantage over 11 in. w. c. systems in larger piping systems because smaller piping can be used. This difference can result in lower material costs. In addition, corrugated stainless steel tubing commonly is used with 2 psi (14 kPa) systems. This material is not rigid, so it offers the advantages of design flexibility, fewer fittings and joints, and a substantial decrease in installation time.

Two psi (14 kPa) systems are three-stage regulator systems comprised of a 10 psi (69 kPa) regulator at the container, a 2 psi (14 kPa) regulator at the outside of the building, and a line pressure regulator located in the building and near the appliance. NFPA 58 covers the first- and second-stage regulators. NFPA 54, *National Fuel Gas Code* [19], covers the line pressure regulator.

5.8.2 Pressure Regulators. (Reserved)

5.8.3* Pipe for Regulator Venting.

A.5.8.3 UL 651, *Schedule 40 or 80 Rigid PVC Conduit*, listed rigid PVC electrical conduit has been designed, manufactured, and tested for use in a wide variety of operating conditions, including low temperatures and exposure to sunlight and outdoor weather. UL 651 conduit is widely available and can be purchased in hardware and electrical supply stores, where it is usually sold as electrical conduit.

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

5.8.3.1 Pipe or tubing used to vent regulators shall be one of the following:

(1) Metal pipe and tubing in accordance with 5.9.3
(2) PVC meeting the requirements of UL 651, *Schedule 40 or 80 Rigid PVC Conduit*

FAQ ▶
Can plastic pipe or tubing be used to vent regulators? If so, what type of plastic pipe or tubing is permitted?

Permitting the use of PVC in the requirements for regulator venting was added in the 2001 edition to provide an alternative to the pressure piping materials listed in the code for regulator relief valve vent piping. It is noted that PVC complying with UL 651, *Schedule 40 and 80 Rigid PVC Conduit* [21], is tested and listed for outdoor use. The PVC electrical conduit is also ultraviolet-resistant and does not crack at subzero temperatures. These properties provide advantages over steel pipe, which will probably corrode over time if installed outdoors.

5.8.3.2 Other PVC piping materials and polyethylene and polyamide pipe and tubing shall not be permitted to be used to vent regulators.

5.9 Piping (Including Hose), Fittings, and Valves

The term *piping*, as used in NFPA 58, includes pipe, tubing, hose, and fittings used in the piping system. Minimum requirements for this equipment are given in Section 5.9 for use by manufacturers in producing piping system components. Guidelines, both for testing laboratories to list equipment for possible acceptance by authorities having jurisdiction and for users to select proper materials when making a piping installation, are also included. The requirements for valves used in a piping system are located in Section 5.12.

5.9.1 General.

5.9.1.1 Material specifications for pipe, tubing, pipe and tubing fittings, valves (including hydrostatic relief valves), hose, hose connections, and flexible connectors shall be in accordance with Section 5.9.

5.9.1.2 Piping, pipe and tubing fittings, and valves used to supply utilization equipment within the scope of NFPA 54, *National Fuel Gas Code*, shall comply with that code.

Most LP-Gas building piping systems downstream of the second-stage regulator are subject to the provisions of NFPA 54. Therefore, reference should be made to NFPA 54 to determine whether the particular installation (primarily a permanent building piping system) is subject to that code.

Where an LP-Gas system serves a building, piping between the container and the second-stage regulator is within the scope of NFPA 58 and piping downstream of the second-stage regulator is within the scope of NFPA 54. However, LP-Gas piping in buildings for agricultural applications — for example, brooders, dehydrators, dryers, and irrigation equipment — falls under NFPA 58 even when those buildings are served by fixed piping because NFPA 54 excludes piping serving farm equipment. [See 1.1.1.2(2) in NFPA 54.] Coverage by NFPA 58 is necessary because natural gas mains rarely serve farms, and NFPA 54 has specifically excluded farm equipment. Other piping systems beyond the second-stage regulator in applications not usually served by natural gas mains are covered under NFPA 58. These systems include piping systems serving railroad switch heaters and heaters that keep microwave antennae free of ice.

5.9.1.3 Pipe and tubing shall comply with one of the following requirements:

(1) Pipe and tubing shall comply with 5.9.3.
(2) Pipe and tubing shall be recommended for that service by the manufacturer and shall be approved.

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

5.9.1.4 Piping that can contain liquid LP-Gas and that can be isolated by valving and that requires hydrostatic relief valves, as specified under Section 6.13, shall have an operating pressure of 350 psig (2.4 MPag) or a pressure that is equivalent to the maximum discharge pressure of any pump or other source feeding the piping system if it is greater than 350 psig (2.4 MPag).

Liquid piping that can be isolated by valves can experience high pressures if the liquid is heated. Although Section 6.11 requires a hydrostatic pressure relief valve to prevent pipe failure, a higher pipe design pressure of 350 psig (2.4 MPag) is specified. There is no potential threat to the integrity of a piping designed to 350 psig (2.4 MPag) with a pressure relief valve setting up to 400 psig (2.8 MPag).

5.9.2 Reserved.

5.9.3 Pipe and Tubing.

5.9.3.1 Pipe shall be wrought iron or steel (black or galvanized), brass, copper, polyamide, or polyethylene and shall comply with the following:

(1) Wrought iron: ASME B36.10M, *Welded and Seamless Wrought Steel Pipe*
(2) Steel pipe: ASTM A 53, *Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless*
(3) Steel pipe: ASTM A 106, *Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service*
(4) Brass pipe: ASTM B 43, *Standard Specification for Seamless Red Brass Pipe, Standard Sizes*
(5) Copper pipe: ASTM B 42, *Standard Specification for Seamless Copper Pipe, Standard Sizes*
(6) Polyamide and polyethylene pipe: ASTM D 2513, *Standard Specification for Thermoplastic Gas Pressure Pipe, Tubing and Fittings*, and shall be recommended by the manufacturer for use with LP-Gas

5.9.3.2 Tubing shall be steel, stainless steel, brass, copper, polyamide, or polyethylene *(see 6.9.4)* and shall comply with the following:

(1) Steel tubing: ASTM A 539, *Standard Specification for Electric-Resistance-Welded Coiled Steel Tubing for Gas Fuel Oil Lines*
(2) Brass tubing: ASTM B 135, *Standard Specification for Seamless Brass Tube*
(3) Copper tubing:
    (a) Type K or L: ASTM B 88, *Standard Specification for Seamless Copper Water Tube*
    (b) ASTM B 280, *Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service*
(4) Polyamide and polyethylene tubing: ASTM D 2513, *Standard Specification for Thermoplastic Gas Pressure Pipe, Tubing and Fittings*, and shall be recommended by the manufacturer for use with LP-Gas
(5) Corrugated stainless steel tubing: ANSI/CSA 6.26 (LC1), *Interior Fuel Gas Piping Systems Using Corrugated Stainless Steel Tubing*

Provisions for plastic pipe and tubing were first incorporated in the 1979 edition of the code. Pipe and tubing were limited to polyethylene (PE) meeting certain ASTM standards and recommended for propane service by the manufacturer. Since the 2004 edition, the code now permits the use of polyamide (PA, or nylon) pipe and tubing as well. The technical committee reviewed data on the performance of PA with respect to temperature and pressure ratings and resistance to LP-Gas, and determined that PA is suitable to be used for LP-Gas applications.

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

In practice, it is not anticipated that nylon tubing will be widely used, because it is more costly than PE.

5.9.4 Fittings for Metallic Pipe and Tubing.

Fittings shall be steel, brass, copper, malleable iron, or ductile (nodular) iron.

Subsection 5.9.4 provides the material requirements for pipe and tubing fittings. The pressure limitations for piping materials were reorganized into table format in the 2001 edition, making the requirements easier to locate (see Table 5.9.4.1). No changes were made to the requirements themselves.

5.9.4.1 Pipe fittings shall have a minimum pressure rating as specified in Table 5.9.4.1 and shall comply with the following:

(1) Cast-iron pipe fittings shall not be used.
(2) Brazing filler material shall have a melting point that exceeds 1000°F (538°C).

TABLE 5.9.4.1 Service Pressure Rating of Pipe, Tubing Fittings, and Valves

Service	*Minimum Pressure*
Higher than container pressure	350 psig (2.4 MPag), or the MAWP, whichever is higher, or 400 psig (2.8 MPag) WOG rating
LP-Gas liquid, or vapor at operating pressure over 125 psig and at or below container pressure	250 psig (1.7 MPag)
LP-Gas vapor at operating pressure of 125 psig (0.9 MPag) or less	125 psig (0.9 MPag)

Brazing is an acceptable method of joining fittings to pipe and, more commonly, to tubing when the filler alloy has a melting point in excess of 1000°F (538°C). Nearly all brazes meet this requirement, because a braze is defined as a metal alloy with a melting point above 850°F (454°C). Any filler metal with a lower melting point is defined as solder. The lower melting point prohibits soldering as a method of joining LP-Gas fittings to pipe and tubing. The 1000°F (538°C) minimum temperature is intended to ensure the integrity of a gas piping system when exposed to fire.

Although brazing alloys are not specified in this code, NFPA 54 states that brazing alloys must not contain more than 0.05 percent phosphorus because this can lead to a deterioration of the joint. The editor is advised that all brazing materials available at the time of publication meet this phosphorus level requirement.

5.9.4.2 Metal tube fittings shall have a minimum pressure rating as specified in Table 5.9.4.1.

Paragraph 5.9.4.2 is silent on the fabrication and use of flared fittings. Flared fittings are fabricated when installed in the field and do not require approval.

5.9.5* Fittings for Polyethylene and Polyamide Pipe and Tubing.

Joints in polyamide and polyethylene pipe and polyethylene tubing shall be made by heat fusion, by compression-type mechanical fittings, or by factory-assembled transition fittings.

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

A.5.9.5 Persons joining PE pipe should be trained under the applicable joining procedure established by the manufacturer, including the following:

(1) Appropriate training in the use of joining procedures
(2) Making a specimen joint from pipe sections joined according to the procedures
(3) Visually examining these joints during and after assembly

PE joints in PE and PA pipe and tubing can be made by heat fusion and by compression-type mechanical fittings meeting ASTM D 2513, *Standard Specification for Thermoplastic Gas Pressure Pipe, Tubing, and Fittings* [22]. Factory-assembled transition fittings may also be used. The use of PE pipe and tubing is limited to vapor (no liquid) and must not exceed 30 psig (208 kPag). The system can only be installed outside and underground.

Fusion joints are made by inserting the ends of either PE or PA tubing sections into a fitting, and then heating the fitting using a special electrically heated tool or by butting the tubing ends in a heating tool and forcing the hot ends together. These methods are used widely for PE tubing in natural gas service, where the vast majority of this piping material is used. An installer using this equipment must be trained, certified, and experienced in its use in order to make leak-free joints.

Fittings that do not require special heating tools include the following:

- Fittings made of nonmetallic thermoplastic materials, other than PE, that comply with ASTM D 2513 [22] for selection of materials
- PE or PA compression-type mechanical fittings to join PE piping materials
- Risers that provide the transition from PE or PA pipe under ground to metallic pipe above ground. [See 5.9.5(E) for information on risers.]

(A) Polyethylene pipe shall not be joined by a threaded or miter joint.

(B) Polyamide and polyethylene fusion fittings shall be recommended by the manufacturer for use with LP-Gas and shall conform to one of the following:

(1) ASTM D 2683, *Standard Specification for Socket-Type Polyethylene (PE) Fittings for Outside Diameter Controlled Polyethylene Pipe*
(2) ASTM D 3261, *Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing*
(3) ASTM F 1055, *Standard Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene Pipe and Tubing*
(4) ASTM F 1733, *Standard Specification for Butt Heat Fusion Polyamide (PA) Plastic Fitting for Polyamide (PA) Plastic Pipe and Tubing*

(C) Installation instructions specific to the type and grade of polyethylene being joined shall be provided with heat fusion fittings.

(D)* Mechanical fittings shall comply with Category 1 of ASTM D 2513, *Standard Specification for Thermoplastic Gas Pressure Pipe, Tubing and Fittings,* and the following:

(1) Mechanical joints shall be tested and recommended by the manufacturer for use with polyethylene pipe and tubing.

An example of a mechanical fitting is shown in Exhibit 5.48.

(2) Compression-type mechanical fittings shall include a rigid internal tubular stiffener, other than a split tubular stiffener, to support the pipe.
(3) Gasket material in the fitting shall be resistant to the action of LP-Gas and shall be compatible with the polyamide or polyethylene pipe material.

Prior to the 1992 edition of NFPA 58, the use of PE and PA piping in LP-Gas service was not allowed except by approval from the authority having jurisdiction. The use of PE piping was

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

EXHIBIT 5.48 *Mechanical Fitting for PE Tubing. (Courtesy of Elster Perfection)*

restricted because compression-type mechanical fittings were prohibited until the publication of the 1992 edition of NFPA 58. Thus, there was no legal way to transition from PE pipe to steel pipe, because transition fittings were considered to be compression-type fittings. Since 1992, with the allowed use of compression-type mechanical fittings, the underground use of PE tubing in LP-Gas piping systems has grown at a very rapid rate. In the 2004 edition, the use of PA in addition to PE pipe and tubing was added.

The use of compression-type mechanical fittings provides a more practical joining method for propane system installers, because only a few inexpensive special tools are required and training and certification of the installers are easily accomplished. Compression-type mechanical fittings must comply with Category 1 of ASTM D 2513 [22], be tested and recommended for use with LP-Gas by the fitting manufacturer, and be installed in accordance with the fitting manufacturer's instructions. All installers must be trained appropriately, and the training must be documented. These qualifications are consistent with Section 4.4, Qualification of Personnel. (See Formal Interpretation 92-1.)

An important change made in the 2004 edition was recognition of the use of compression-type mechanical fittings on PE piping above 2 in. pipe size. This change was made because it was recognized that larger-size PE and PA pipe have been successfully joined with compression fittings in the natural gas industry.

A.5.9.5(D) 49 CFR 192.281(e) states the following:

Mechanical joints — Each compression-type mechanical joint on plastic pipe must comply with the following:

(1) The gasket material in the coupling must be compatible with the plastic.
(2) A rigid internal tubing stiffener, other than a split tubular stiffener, must be used in conjunction with the coupling.

49 CFR 192.283(b) states the following:

Mechanical joints — Before any written procedure established under 192.273(b) is used for plastic making mechanical plastic pipe joints that are designed to withstand tensile forces, the procedure must be qualified by subjecting five specimen joints made according to the procedure to the following tensile test:

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

Formal Interpretation
NFPA 58
Liquefied Petroleum Gas Code
2008 Edition

Reference: 5.9.5

FI 92-1

Question: Was it the intention of the Technical Committee on Liquefied Petroleum Gases, when they adopted 5.8.5 in the 1992 edition of NFPA 58, to restrict the choice of any, or all, of the materials that might be utilized in the several components that comprise the total assembly of mechanical joints to those specifically "listed" or mentioned in the ASTM Standard D2513-90.

Answer: No.

It was not the intent of the committee in 5.8.5 to specify materials of construction. Materials of construction of mechanical fittings are covered in 5.8.4 where it was the committee's intent to limit fittings to be constructed of materials listed in ASTM D2513, except for gasket materials, which are covered in 5.8.5.

In 1-2.4, Alternate Materials and Provisions, the committee provides a method of use of alternate materials when supported by sufficient evidence acceptable to the authority having jurisdiction.

Issue Edition: 1992
Reference: 2-4.4(c)(2)
Issue Date: January 15, 1993
Effective Date: February 3, 1993

Copyright © 2007 All Rights Reserved
NATIONAL FIRE PROTECTION ASSOCIATION

(1) Use an apparatus for the test as specified in ASTM D 638, *Standard Test Method for Tensile Properties of Plastics* (except for conditioning).
(2) The specimen must be of such length that the distance between the grips of the apparatus and the end of the stiffener does not affect the joint strength.
(3) The speed of testing is 5.0 mm (0.2 in.) per minute, plus or minus 25 percent.
(4) Pipe specimens less than 102 mm (4 in.) in diameter are qualified if the pipe yields to an elongation less than 25 percent or failure initiates outside the joint area.
(5) Pipe specimens 102 mm (4 in.) and larger in diameter shall be pulled until the pipe is subjected to a tensile stress equal to or greater than the maximum thermal stress that would be produced by a temperature change of 55°C (100°F) or until the pipe is pulled from the fitting. If the pipe pulls from the fitting, the lowest value of the five test results or the manufacturer's rating, whichever is lower, must be used in the design calculations for stress.
(6) Each specimen that fails at the grips must be retested using new pipe.
(7) Results obtained pertain only to the outside diameter and material of the pipe tested, except where testing of a heavier wall pipe is used to qualify pipe of the same material but with a lesser wall thickness.

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

EXHIBIT 5.49 *Factory-Assembled Risers. (Courtesy of R. W. Lyall & Company, Inc.)*

(E) Anodeless risers shall comply with the following:

(1) The metal-gas carrying portion of the anodeless riser after the transition shall have a wall thickness equal to Schedule 40 pipe.
(2) Factory-assembled anodeless risers shall be recommended for LP-Gas use and shall be leak tested by the manufacturer in accordance with written procedures.
(3) Field-assembled anodeless risers with service head adapters shall be equipped with moisture seals and shall be recommended for LP-Gas use by the manufacturer and shall be design certified to meet the requirements of Category 1 of ASTM D 2513, *Standard Specification for Thermoplastic Gas Pressure Pipe, Tubing and Fittings*; U.S. Department of Transportation, 49 CFR 192.281(e), "Transportation"; and 6.9.4.3 and 6.9.4.4.
(4) The manufacturer shall provide the user qualified installation instructions as prescribed by U.S. Department of Transportation, 49 CFR 192.283(b).

In the 1995 edition, the provision was added to permit the use of assembled anodeless risers, which are piping system components used to transition between underground PE and PA piping systems and aboveground metallic piping systems. Risers have been in use in the natural gas service for many years.

The term *anodeless*, used in conjunction with riser, indicates that the riser is designed to retard corrosion without the use of a sacrificial anode. Sacrificial anodes are used with underground propane containers. Risers are protected from corroding by a factory-applied, epoxy-based painted coating.

The two types of risers permitted are described as follows:

- A factory-assembled riser that requires only connection to the PE or PA pipe or tubing under ground and to metallic piping above ground. (See Exhibit 5.49.)
- A field-assembled riser with a flexible metallic or metallic casing incorporating the transition from the PE or PA pipe or tubing to the metal piping above ground. This transition is to be made in the field. The riser consists of a transition fitting (see Exhibit 5.49) and a prefabricated, pre-bent steel riser casing or a flexible metal riser casing. The PE or PA pipe or tubing is inserted up through the casing until it exits the upper end. The transition fitting is installed on the top of the casing, completing the connection from belowground PE or PA to aboveground steel pipe. The transition fitting must be located above ground to minimize corrosion to the steel pipe threads. A metallic or flexible metallic casing protects the PE pipe or tubing, and a moisture seal is installed at the lower end of the casing to prevent water from entering the riser. This type riser is an exception to the rule that PE or PA be used only below ground, but safety is not compromised because the PE or PA is encased with flexible metal or steel pipe and thus protected from mechanical and environmental damage.

5.9.6 Hose, Quick Connectors, Hose Connections, and Flexible Connectors.

5.9.6.1 Hose, hose connections, and flexible connectors *(see 3.3.25, Flexible Connector)* shall be fabricated of materials that are resistant to the action of LP-Gas both as liquid and vapor.

This new requirement in 5.9.6.1 recognizes that the hose used to transfer propane to and from containers and propane trucks includes materials that can be dissolved by propane. Each time propane is moved through a hose, a small amount of these soluble hose materials can be added to the propane. This requirement is intended to reduce the potential for hose products to contaminate LP-Gas.

NEW **5.9.6.2** When wire braid is used for reinforcement, it shall be of corrosion-resistant material such as stainless steel.

Carbon steel is not permitted to be used for wire braid reinforcement for hose. This prohibition is based on experience with hose that weakened as the carbon steel wire braid corroded.

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

5.9.6.3 Hose and quick connectors shall be approved.

5.9.6.4 Hose, hose connections, and flexible connectors used for conveying LP-Gas liquid or vapor at pressures in excess of 5 psig (34 kPag), and as provided in Section 6.19 regardless of the pressure, shall comply with 5.9.6.4(A) through 5.9.6.4(D).

(A) Hose shall be designed for a working pressure of 350 psig (2.4 MPag) with a safety factor of 5 to 1 and shall be continuously marked with LP-GAS, PROPANE, 350 PSI WORKING PRESSURE, and with the manufacturer's name or trademark.

The provisions of 5.9.6.4(A) for hose, hose connections, and flexible connectors apply only to those involved with pressures in excess of 5 psig (34 kPag). Requiring continuous marking permits identification of short pieces of hose used as connectors. In the 2008 edition, the word *propane* was substituted for *LP-Gas* to carry out the intent for international industry identification.

(B) Hose assemblies, after the application of couplings, shall have a design capability of not less than 700 psig (4.8 MPag).

The words *design capability* have been carefully chosen to convey the committee's intent that hose assemblies be capable of withstanding the anticipated pressure and that testing is an option. If testing is done, such assemblies must be pressure-tested at 120 percent of the maximum working pressure of the hose, which is required to be at least 350 psig (2.4 MPag).

(C) If a pressure test is performed, such assemblies shall be pressure tested at 120 percent of the maximum working pressure [350 psig (2.4 MPag) minimum] of the hose.

Note that pressure testing of hose is not required. Because the maximum hose working pressure is 350 psig (2.4 MPag), this optional testing is done at 420 psig (2.9 MPag).

(D) Hose assemblies shall be leak tested at the time of installation at not less than the operating pressure of the system in which they are installed.

5.9.6.5 Hoses at a pressure of 5 psig (34 kPag) or less in agricultural buildings not normally occupied by the public shall be designed for the working pressure of the system and shall be constructed of material resistant to the action of LP-Gas.

Paragraph 5.9.6.5 is an exception to the requirements of 5.9.6.4 for hose used in agricultural applications operating at a maximum pressure of 5 psig.

5.9.6.6 Hoses or flexible connectors used to supply LP-Gas to utilization equipment or appliances shall be installed in accordance with the provisions of 6.9.6 and 6.20.3.

5.10 Reserved

5.11 Internal Valves. (Reserved)

5.12 Valves Other Than Container Valves

5.12.1 Pressure-containing metal parts of valves shall be of steel, ductile (nodular) iron, malleable iron, or brass.

(A) Ductile iron shall meet the requirements of ASTM A 395, *Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures,* or equivalent.

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

(B) Malleable iron shall meet the requirements of ASTM A 47, *Standard Specification for Ferritic Malleable Iron Castings,* or equivalent.

(C) All materials used, including valve seat discs, packing, seals, and diaphragms, shall be resistant to the action of LP-Gas under service conditions.

FAQ ▶
What is meant by "resistant to the action of LP-Gas" in 5.12.1(C)?

The requirement in 5.12.1(C) uses language that is found in other areas of the code (e.g., 5.7.1.1, 5.7.1.4, and 5.9.6.1) to establish performance criteria for materials. The material must be resistant to LP-Gas such that it will not degrade, decompose, warp, or otherwise deteriorate to the point that it can no longer serve its intended function safely. Although this "criterion" is certainly subjective, the code relies upon product and material standards to establish more quantifiable performance criteria. For example, ANSI/UL125, *Standard for Valves for Anhydrous Ammonia and LP-Gas (Other than Safety Relief)* [16], provides testing criteria to establish the resistance of materials used in valves to the action of LP-Gas. Product standards of this type include tests intended for newly produced products and not to verify that products in use are suitable for continued use. Good judgment should be used in the selection of tests.

5.12.2 Valves shall have a service pressure rating as specified in Table 5.9.4.1.

5.12.3 Manual shutoff valves, emergency shutoff valves, excess-flow check valves, and backflow check valves used in piping systems shall comply with the provisions for container valves.

5.12.4 Emergency shutoff valves shall be approved and shall incorporate all of the following means of closing:

(1) Automatic shutoff through thermal (fire) actuation
(2) Manual shutoff from a remote location
(3) Manual shutoff at the installed location

The emergency shutoff valve (ESV) is a key valve in the protection of liquid transfer operations at bulk plants and industrial plants. An ESV is shown in Exhibit 5.50. The installation requirements for these emergency shutoff valves are located in Section 6.12. The actuating means for remote shutoff is not specified. Electrical, mechanical, and pneumatic systems are all used. Many systems use a pneumatic valve with a plastic gas tubing system in which the tubing itself acts as a fusible element. When the tubing melts due to high temperatures (from a fire), it releases the pressure holding the valve open, and the flow of fuel is stopped. Regardless of whether continuous tubing or a discrete fusible element is used, thermal activation must be located within 5 ft of the point established in 6.12.6. If the ESV is closed remotely by a cable attachment, it is recommended that the remote closing feature of the ESV be operated occasionally to verify proper operation, especially in winter. Cables can become disabled if they lie in water that freezes. Also, the entire system must be tested at least annually. (See 6.12.9.)

See Formal Interpretation 58-01-3 for more information.

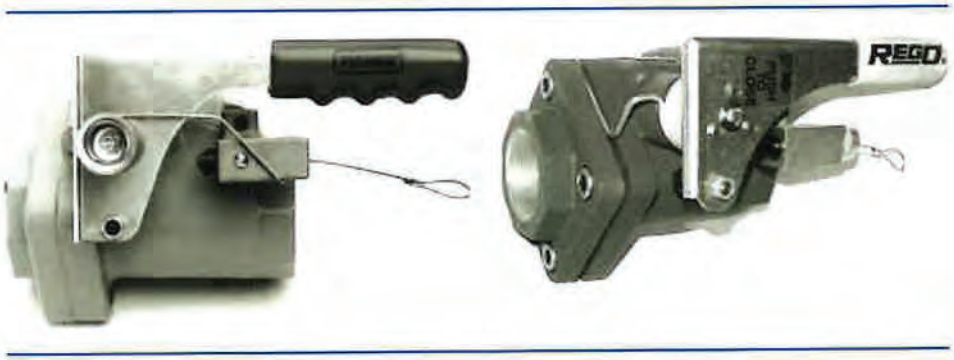


EXHIBIT 5.50 *Two Emergency Cutoff Valves. [Courtesy of Fisher Controls Intl, LLC (left) and Engineered Controls International, Inc. (right)]*

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

Formal Interpretation
NFPA 58
Liquefied Petroleum Gas Code
2008 Edition

Reference: 5.12.4
F.I. No.: 58-01-3

Question No. 1: Is it the intent of NFPA 58 to prohibit the installation and use of valves or other hardware not specifically required or described in the Code?

Answer: No.

Question No. 2: If a valve marketed as an "emergency shutoff valve" is installed in a location where it is not required to be, is the valve required to comply with all of the closing requirements described in Section 5.10.4?

Answer: No.

Question No. 3: Is it the intent of NFPA 58 for an emergency shutoff valve to be used as a container appurtenance?

Answer: No.

Issue Edition: 2001
Reference: 2.3.3.2 & 3.3.3.6
Issue Date: November 7, 2001
Effective Date: November 27, 2001

Copyright © 2007 All Rights Reserved
NATIONAL FIRE PROTECTION ASSOCIATION

5.12.5 Where fusible elements are used, they shall have a melting point not exceeding 250°F (121°C).

5.12.6 Valves in polyethylene piping systems shall be manufactured from thermoplastic materials listed in ASTM D 2513, *Standard Specification for Thermoplastic Gas Pressure Pipe, Tubing and Fittings,* that have been shown to be resistant to the action of LP-Gas and comply with ASTM D 2513. Valves in polyamide piping systems shall be manufactured from polyamide material as defined in ASTM D 2513. Metallic valves in polyethylene and polyamide piping systems shall be protected to minimize corrosion in accordance with Section 6.16.

5.12.7 Valves shall be recommended for LP-Gas service by the manufacturer.

5.13 Hydrostatic Relief Valves

5.13.1 Hydrostatic relief valves designed to relieve the hydrostatic pressure that can develop in sections of liquid piping between closed shutoff valves shall have pressure settings not less than 400 psig (2.8 MPag) or more than 500 psig (3.5 MPag) unless installed in systems designed to operate above 350 psig (2.4 MPag).

A hydrostatic pressure relief valve is shown in Exhibit 5.51. It is usually a small valve, because there is no capacity requirement for a hydrostatic relief valve, and it is usually equipped with a 1/4 in. male National Pipe Thread (MNPT) inlet connection. Hydrostatic pressure

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

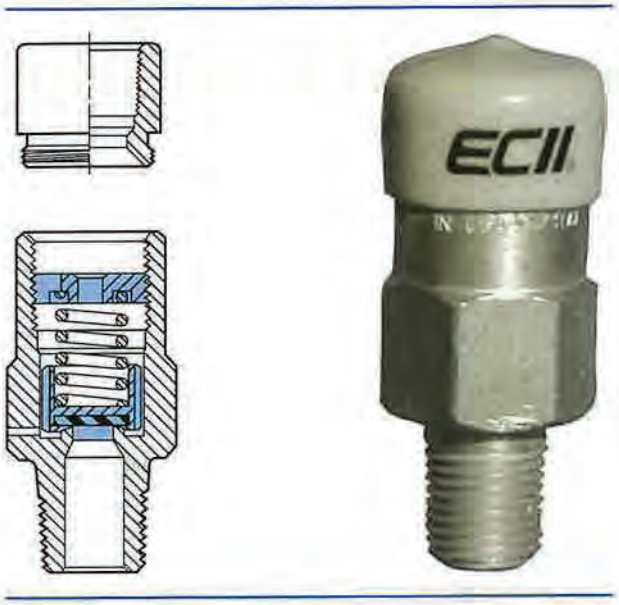


EXHIBIT 5.51 *Hydrostatic Relief Valve. (Courtesy of Engineered Controls International, Inc.)*

relief valves are required by Section 6.13 to be installed in sections of piping that can be isolated between positive shutoff valves or other devices that stop liquid flow.

FAQ ►
Why are hydrostatic relief valves required to be set at a higher activation pressure than pressure relief valves?

Hydrostatic pressure relief devices have a set point between 400 psig and 500 psig (2.8 MPag and 3.5 MPag) for piping systems with a design pressure of 350 psig (2.4 MPag). This pressure difference (400 psig vs. 350 psig) does not pose a problem for the piping because 350 psig (2.4 MPag) represents the maximum operating pressure at the maximum operating temperature of the piping. Because the actual operating temperature of LP-Gas systems is much less than the maximum temperature, the system is capable of withstanding much higher pressures.

It is significant to note that piping systems are designed for an operating pressure of 350 psig, whereas ASME containers are usually designed for a maximum working pressure of 250 psig. This lower value is why pressure relief valves for ASME containers are rated at 250 psig.

5.13.2 Hydrostatic relief valves for use in systems designed to operate above 350 psig (2.4 MPag) shall have settings not less than 110 percent or more than 125 percent of the system design pressure.

If the design pressure of the piping system exceeds 350 psig (2.4 MPag), hydrostatic relief valves must be set to operate between 110 percent and 125 percent of the system design pressure, because it is not practical to specify the hydrostatic pressure relief valve to operate exactly at the system design pressure of the piping. The hydrostatic pressure relief valve minimum is set to operate above the piping system pressure to minimize unnecessary operation, and the maximum is well below piping system burst pressure. The design pressure of propane piping systems can be higher than 350 psig if a positive displacement pump with a discharge pressure in excess of 350 psig is used. Such pumps are not normally used in the United States and Canada, but are used in other parts of the world.

5.14 Reserved

5.15 Reserved

5.16 Reserved

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

5.17 Equipment

Section 5.17 provides requirements for propane equipment, such as pumps, compressors, vaporizers, regulators, and other devices used to regulate, transfer, or vaporize propane.

5.17.1 General.

5.17.1.1 This section shall apply to pressure-containing metal parts of LP-Gas equipment.

5.17.1.2 The service pressure rating of equipment shall be in accordance with Table 5.17.1.2.

TABLE 5.17.1.2 Service Pressure Rating

Fluid	*Pressure*	*Equipment Design Pressure*
LP-Gas vapor	≤20 psig (≤138 kPag)	Maximum anticipated pressure
	20–125 psig (138 kPag–0.9 MPag)	125 psig (0.9 MPag)
	> 125 psig (>0.9 MPag)	250 psig (1.7 MPag) or the anticipated pressure, whichever is higher
LP-Gas liquid	≤250 psig (≤1.7 MPag)	250 psig (1.7 MPag)
	> 250 psig (>1.7 MPag)	350 psig (2.4 MPag) or the anticipated pressure, whichever is higher

5.17.1.3 Equipment shall be fabricated of materials that are compatible with LP-Gas under service conditions and shall be in accordance with Table 5.17.1.3.

(A) Pressure-containing metal parts shall be made from the following materials:

(1) Steel
(2) Ductile (nodular) iron (ASTM A 395, *Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures,* or ASTM A 536, *Standard Specification for Ductile Iron Castings,* Grade 60-40-18 or 65-45-12)
(3) Malleable iron (ASTM A 47, *Standard Specification for Ferritic Malleable Iron Castings*)
(4) Higher strength gray iron (ASTM A 48, *Standard Specification for Gray Iron Castings,* Class 40B)
(5) Brass
(6) Materials equivalent to 5.17.1.3(A)(1) through 5.17.1.3(A)(5) in melting point, corrosion resistance, toughness, and strength

(B) Cast-iron shall not be used as a material of construction for strainers or flow indicators.

(C) Aluminum shall be used only for cylinders, gaskets, regulators, approved meters, and indirect electric vaporizers.

An expanded list of components and equipment that are permitted to be fabricated of aluminum is new in the 2008 edition. The technical committee acknowledges the widespread use and performance history of aluminum in these listed and unlisted products.

(D) Zinc shall be used for approved regulators only, complying with ASTM B 86, *Standard Specification for Zinc-Alloy Die Casting.*

(E) Nonmetallic materials shall not be used for upper or lower casings of regulators.

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

TABLE 5.17.1.3 Materials for Equipment Used in LP-Gas Service

Equipment Material	*Service Condition*
Steel Ductile (nodular) iron (ASTM A 395, *Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures,* or ASTM A 536, *Standard Specification for Ductile Iron Castings,* Grade 60–40–18 or 65–45–12) Malleable iron (ASTM A 47, *Standard Specification for Ferritic Malleable Iron Castings*) Higher strength gray iron (ASTM A 48, *Standard Specification for Gray Iron Castings,* Class 40B) Brass Materials equivalent to 5.17.1.3(A)(1) through 5.17.1.3(A)(5) in melting point, corrosion resistance, toughness, and strength	Pressure containing metal parts
Cast iron	Not to be used as a material of construction for strainers or flow indicators
Aluminum	For approved meters, approved regulators, and indirect vaporizers
Zinc (ASTM B 86, *Standard Specification for Zinc-Alloy Die Casting*)	For approved regulators
Nonmetallic materials	Not to be used for upper or lower casings of regulators.

Materials used in equipment components must be suitable for use with LP-Gas. Equipment should not be purchased until the manufacturer has verified its suitability.

Restrictions on the use of cast iron in 5.17.1.3(B) reflect its tendency to crack under low temperature conditions and under fire control conditions when heated and suddenly cooled (for example, by water). The use of metals, such as aluminum and zinc, which melt at less than 1000°F (538.8°C), is restricted to situations in which their failure will not constitute an undue hazard. The prohibition of plastic for use in regulator casings reflects a concern for the material melting during fire conditions, allowing gas to flow freely and feed the fire.

The 2008 edition was revised to restrict the use of zinc to be used only in pressure regulators. Previously, the use of zinc in regulators was required to comply with ASTM B 86, *Standard Specification for Zinc-Alloy Die Casting* [23], but other uses were not specifically prohibited. The restriction was imposed because of the low melting point of zinc, which is 787°F (by comparison, the melting point of copper is 1984° F). The use of zinc in regulators is allowed because of a long history of safe use.

5.17.2 Pumps.

Pumps shall be designed for LP-Gas service.

It is important that pumps be designed and built for use with LP-Gas. There are many types of pumps, and some of these may not work satisfactorily in propane service. If necessary, the pump manufacturer can be contacted to determine if the pump is recommended for propane

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

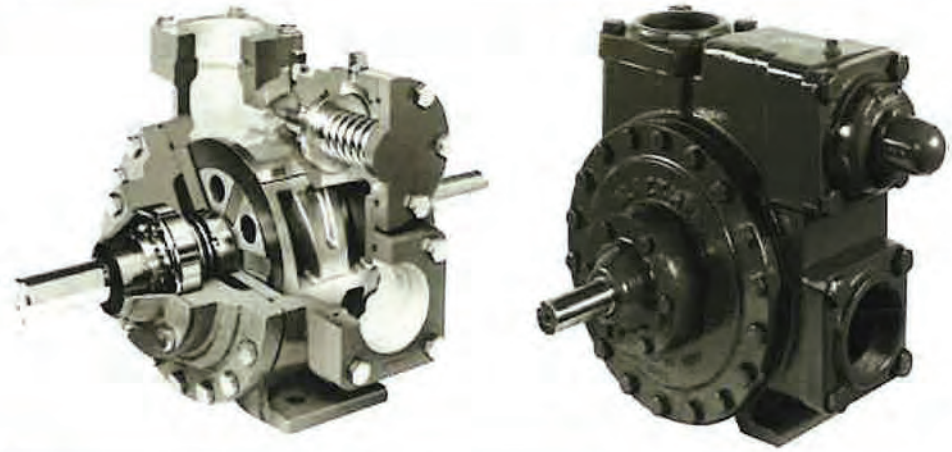


EXHIBIT 5.52 *Sliding Vane Positive Displacement Pump. The cutaway is shown at left. (Courtesy of Blackmer, A Dover Company)*

service and if it is capable of a discharge pressure higher than 350 psig (2.4 MPag). If the latter is the case, provisions must be made either to limit the pressure to 350 psig (2.4 MPag) or to design the system for the higher pressure.

Because pumps deliver a liquefied gas that will vaporize if the pressure drops even slightly, LP-Gas pumps are either positive displacement pumps or special types of centrifugal pumps, such as regenerative turbine pumps. (See Exhibits 5.52 through 5.55.) Standard centrifugal pumps may "vapor lock" easily and thus are ineffective. There are other types of pumps that can be used effectively for LP-Gas service, but they are not currently used in the United States. If required, such a pump can be used by referring to the Equivalency section (Section 1.5), and providing documentation to the authority having jurisdiction that the pump provides equivalent safety to those designed for LP-Gas service.

Prior to the 1998 edition, the discharge pressure of propane pumps was limited to 350 psig (2.4 MPag). This limitation was based on practice in the U.S. propane industry, in which the pumps used did not exceed this pressure. A proposal was made to delete the restriction based both on the use of pumps with higher discharge pressures in Mexico and other countries, and on the fact that this restriction was not based on safety, but reflected practice. Pumps

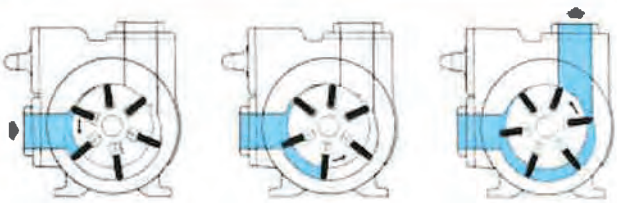


EXHIBIT 5.53 *Operation of Sliding Vane Pump. (Courtesy of Blackmer, A Dover Company)*

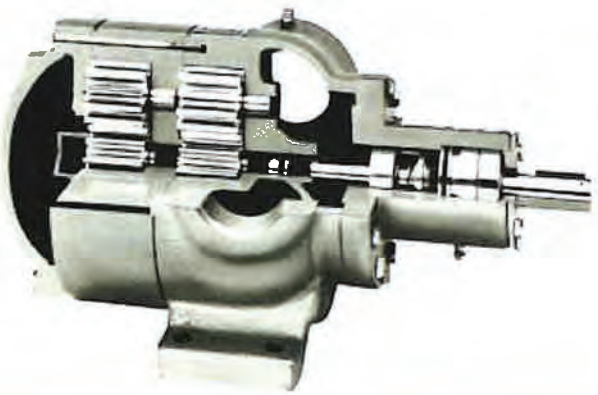


EXHIBIT 5.54 *Gear Pump. (Courtesy of Smith Precision Products Company, Inc.)*

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

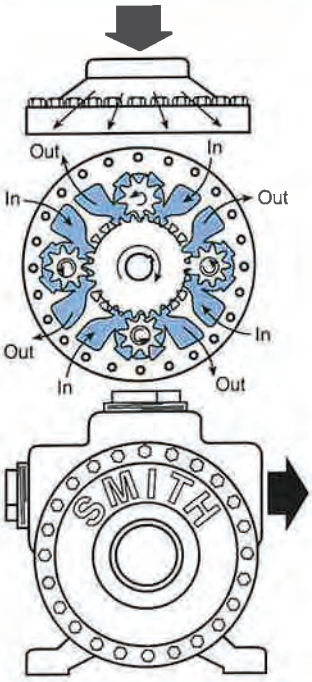


EXHIBIT 5.55 *Operation of Gear Pump. (Courtesy of Smith Precision Products Company, Inc.)*

and piping systems can be safely designed and operated at pressures above 350 psig (2.4 MPag).

5.17.3 Compressors.

5.17.3.1 Compressors shall be designed for LP-Gas service.

Care should be taken in selecting compressors designed for LP-Gas service. Compressors designed for noncombustible gases may not provide the required leak protection for flammable LP-Gases.

Compressors are used to transfer liquid by pumping vapor from the receiving storage containers into the supply transport truck or railcar that is supplying the LP-Gas. Increasing pressure in the vapor space of the supply container while at the same time lowering the pressure in the receiving container forces liquid from the supply tank to the receiving container. This type of loading or unloading operation is preferred when it is impractical or impossible to use liquid pumps, such as when unloading railroad tank cars. Tank cars have all fittings installed at the top in the protective tank car dome. The use of pumps is impractical because of the extended length of piping to the bottom of the tank car plus the additional hose and piping to the pump suction, which results in pump cavitation and reduced capacity. When compressors are used to unload railroad tank cars, it is common practice to reverse the vapor flow from the compressor with a three-way valve after all liquid is removed from the tank car and recover a large amount of the remaining vapor in the tank car. Normally, this vapor recovery continues until the pressure in the tank car is about 30 psig (207 kPag). Refer to Exhibit 7.7 for an illustration of liquid transfer using a compressor.

5.17.3.2 Compressors shall be constructed or shall be equipped with auxiliary devices to limit the suction pressure to the maximum for which the compressor is designed.

Exhibit 5.56 shows a compressor complete with motor and all accessories.

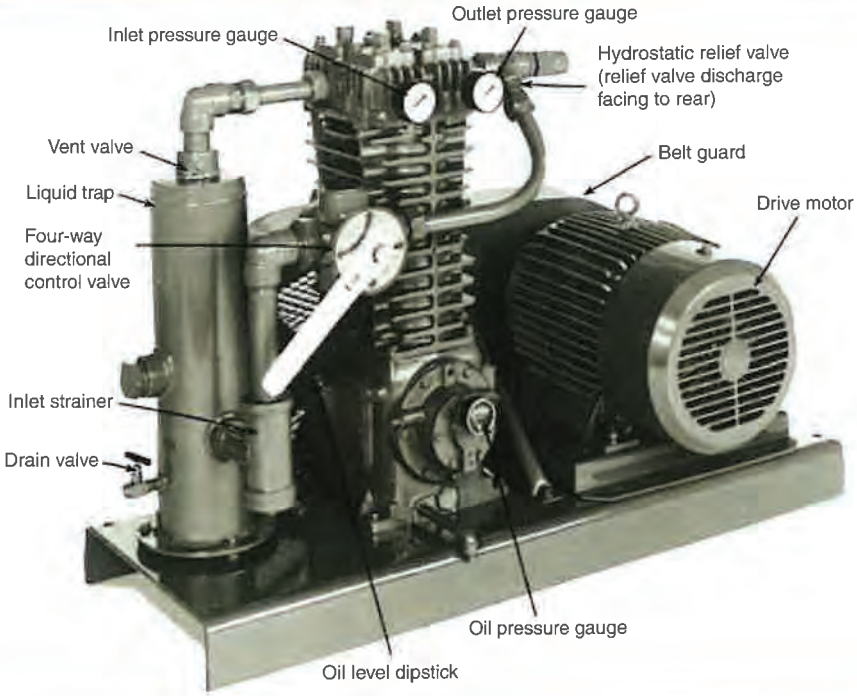


EXHIBIT 5.56 *Compressor with Protection Devices. (Courtesy of Blackmer, A Dover Company)*

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

5.17.3.3 Compressors shall be constructed or shall be equipped with auxiliary devices to prevent the entrance of LP-Gas liquid into the compressor suction.

Because all liquids, including liquid LP-Gas, are noncompressible, liquid must not be allowed to enter an operating compressor. If it does, the compressor will probably be damaged and may fail. A number of compressors manufactured for LP-Gas service include relief devices built into the cylinder head to prevent destruction of the compressor in case small amounts of liquid are allowed to enter. Continuously operating relief devices, however, eventually will damage the compressor.

Several float-operated devices, as shown in Exhibit 5.57, are designed to prevent liquid from entering the compressor. The liquid trap shown on the left is a standard trap with a mechanical float assembly and drain valve. The trap in the center shows an automatic liquid trap with one NEMA 7 liquid-level switch for compressor shutdown and drain valve. The trap on the right is an ASME Code-stamped automatic liquid trap with two NEMA 7 liquid-level switches for compressor shutdown and alarm. The trap shown on the right is equipped with a relief valve, pressure gauge, demister pad, and drain valve. Some manufacturers use these types of liquid traps, others simply use a large receiver as a liquid trap on the suction side of the compressor.

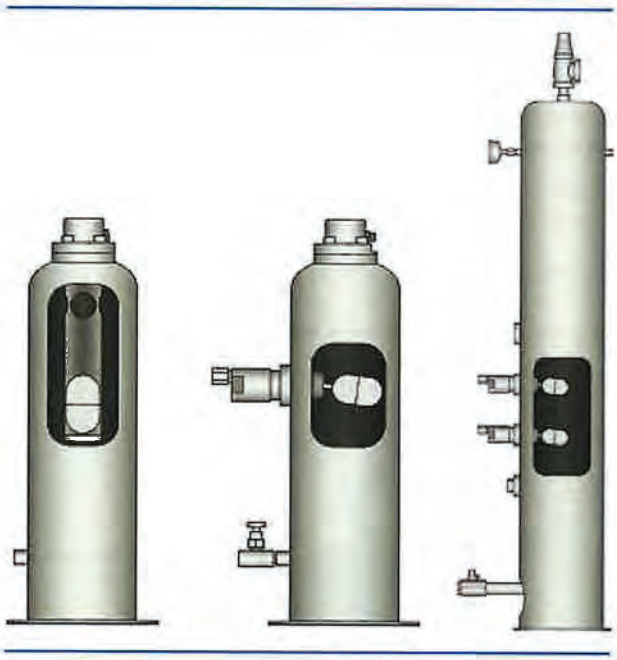


EXHIBIT 5.57 *Compressor Liquid Traps. (Courtesy of Corken, Inc.)*

5.17.3.4 Portable compressors used with temporary connections shall not require means to prevent liquid entrance into the compressor suction.

Portable compressors are exempt from the requirement to prevent liquid LP-Gas from entering a compressor, because the temporary connections used are empty at the time they are connected and thus usually prevent liquid from entering the compressor. Also, portable units are operated under continuous surveillance by an operator.

5.17.4 Reserved.

5.17.5 Meters.

5.17.5.1 Vapor meters of the tin or brass case type of soldered construction shall not be used at pressures in excess of 1 psig (7 kPag).

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

Meters are designed for either vapor or liquid service. Vapor meters are commonly used where one propane container serves more than one customer in vapor service (e.g., in an apartment house or mobile home park, or where vapor service to an industry or farm is provided from a tank where a propane company loads bobtails). Liquid meters are commonly used on bobtails, at bulk plants, at dispensing stations, and on transports that deliver to large accounts.

There are several meter technologies in propane use, including positive displacement meters, turbine meters, mass meters, and ultrasonic meters.

- Positive displacement meters are intended for liquid service. They operate by forcing the liquid to travel through metering chambers that have a precise, known volume. The number of times the chambers are filled and emptied is counted, resulting in a direct volume measurement.
- Turbine meters can be designed for either (but not both) vapor or liquid service. The flowing product rotates blades within the known volume turbine meter body. The number of times the blades rotate is counted, resulting in a direct volume measurement.
- Mass meters can be designed for either (but not both) vapor or liquid service. As the flowing product passes through vibrating tubes, the phase of the vibration changes in direct proportion to the mass of the flowing product. This permits a direct mass measurement utilizing the coriolis effect principle.
- Ultrasonic meters can be designed for either (but not both) vapor or liquid service. Ultrasonic pulses are transmitted through the flow, and the difference in propagation between various transmission paths is used to calculate the average flow velocity across a known volume section of pipe or meter. This permits a direct volume measurement.

About three-quarters of the states require that meters and registers used to deliver product to paying customers (other than contract sales) be controlled under the states' weights and measures programs. Specifically, this requires

1. "Type approval" to National Institute of Standards and Technology (NIST) Handbook 44 [24] by the National Type Evaluation Program (NTEP), operated by the National Conference on Weights and Measures (NCWM)
2. Field calibration in the final installation by a person or agency approved by the state.

Several positive displacement meters and a few mass flow meters are type-approved for LP-Gas delivery. A master meter is often used for field calibration. Some states require the use of a prover, a precisely calibrated container, to calibrate the meter. Meters tested for type approval and on the initial field testing must have errors within ±0.6 percent. Subsequent meter errors must be within ±1.0 percent. Under NTEP rules, vehicle-mounted metering systems must be equipped with a delivery ticket printer and all meters must have a provision for sealing such that an adjustment to the measuring element cannot be made without breaking the security seal.

The meter shown in Exhibit 5.58 is a positive displacement liquid meter. Note the differential backpressure valve located at the right (downstream), which is required by 6.24.3.5. The item to the left (upstream) is the vapor eliminator, which, working with the differential backpressure valve, prevents anything but liquid from being measured and delivered. The measuring chamber is between these units and has a register, or display of the quantity delivered, mounted above it.

5.17.5.2 Vapor meters of the die cast or iron case type shall be permitted to be used at any pressure equal to or less than the working pressure for which they are designed and marked.

NEW **5.17.5.3** Liquid meters shall be installed so that the meter housing is not subject to excessive strains from the connecting piping. If not provided in the piping design, flexible connectors that do not exceed 36 in. (1 m) in overall length shall be permitted to be used.

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

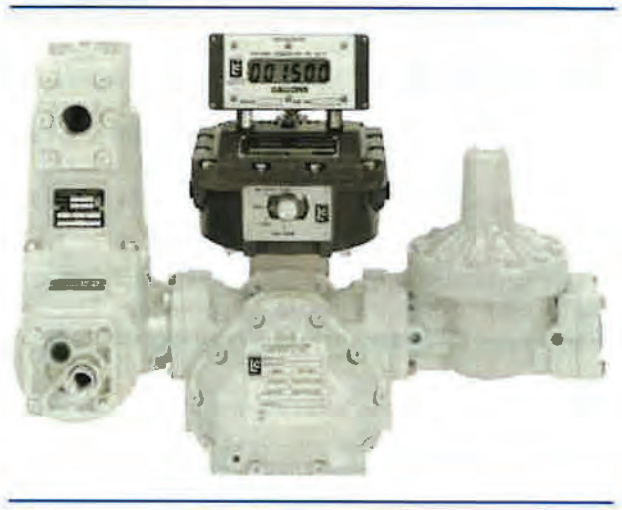


EXHIBIT 5.58 *Positive Displacement Liquid Meter. (Courtesy of Liquid Controls LLC)*

Paragraph 5.17.5.3 was added in the 2008 edition to provide requirements for liquid meters. The design of a liquid meter installation must take into account the vibration typically experienced on cargo tank motor vehicles to avoid potential failure of the meter housing or liquid piping. Where vibration is anticipated, flexible connectors can be used. A definition of *flexible connector* was added to the 2008 edition:

> **3.3.25 Flexible Connector.** A short [not exceeding 60 in. (1.52 m) overall length] piping system component that is fabricated from a flexible material and equipped with connections at both ends.

Note that flexible connectors are limited in length to 5 ft (1.52 m). This prohibits the use of hose to make connections any longer than 5 ft.

5.17.6 Engines.

Engines used to drive portable pumps and compressors shall be equipped with exhaust system spark arresters and shielded ignition systems.

◀ **FAQ**
Are internal combustion engines acceptable to drive portable compressors?

Internal combustion engines have been used safely to drive portable pumps, as shown in Exhibit 5.59, as well as portable compressors. This requirement is included in the code to provide specific guidance for the selection of portable engines for these uses.

The use of portable internal combustion engines has resulted in a disproportionate number of interpretation requests. These sometimes follow a local prohibition by enforcement officials on the use of internal combustion engines, because of the belief that "explosion-proof" motors or engines must be used. This confusion is understandable because Table 6.22.2.2, Electrical Area Classification, Part F, requires that the area within 15 ft (4.6 m) of an outdoor pump or vapor compressor be a Class I, Division 2 area. The following information is relevant in applying Table 6.22.2.2:

- Table 6.22.2.2 applies only to fixed electrical equipment and wiring and not to portable equipment.
- Internal combustion engines that are in good working order and are equipped with the required accessories are not a source of ignition. LP-Gas releases have occurred without causing ignition where cars have driven into, stalled, and coasted out of vapor clouds of LP-Gas that have been accidentally released [25].

The fact that these devices are portable indicates that, in many cases, they will be operated by an internal combustion engine. Subsection 5.17.6 requires the same level of protection for internal combustion engines driving portable pumps as for operating compressors.

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

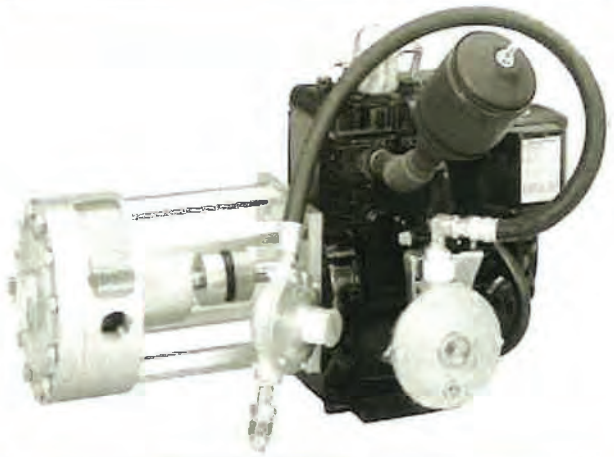


EXHIBIT 5.59 *Portable LP-Gas–Fueled Engine-Driven Pump. (Courtesy of Smith Precision Products Company, Inc.)*

EXHIBIT 5.60 *Sight Flow Indicator with Backflow Check Valve. (Courtesy of Engineered Controls International, Inc.)*

5.17.7 Sight Flow Indicators.

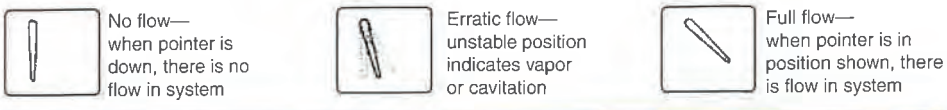
Where installed, sight flow indicators shall either be the simple observation type or be combined with a backflow check valve.

Sight flow indicators are used when it is necessary to visually verify the flow of liquid LP-Gas through a piping system. (See Exhibits 5.60 and 5.61.) These indicators are found at cargo tank vehicle and railroad tank car loading and unloading facilities.

5.18 Reserved

5.19 Reserved

EXHIBIT 5.61 *Flow Indicator with Backflow Check Valve. (Courtesy of Fisher Controls Intl, LLC)*



Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

5.20 Appliances

In the United States, Canada, and other economically developed countries, there are standards for LP-Gas and natural gas appliances. In many instances, private or governmental listing agencies have achieved an increasing level of safety for these appliances by evaluating them against these standards or through the exercise of their judgment. Because of these requirements, it has been unnecessary to provide detailed technical coverage in NFPA 58. Such coverage could create correlation problems. Therefore, NFPA 58 coverage has been limited to the following situations:

- Equipment not addressed in separate standards. The coverage may be due either to a small number or limited use of appliances or to the use of appliances in an environment under the control of specialists. Neither situation warrants the level of activity necessary to develop a separate standard.
- Coverage needed as an interim measure. It takes a considerable period of time to develop a separate standard, and frequently such a standard cannot be promulgated unless the use of the appliance is at least permitted by NFPA 58.

In such instances, although NFPA 58 serves a useful function, the technical committee must be careful to amend the code as necessary when a separate, specific code or standard is developed. Such amendment could include deletion of provisions in NFPA 58. In general, a specific appliance standard should govern in recognition of its more complete and intensive coverage, provided the code has suitable status. Many of the appliances addressed in Section 5.20 are actually installed under circumstances that place them under the scope of NFPA 54, rather than NFPA 58, in accordance with 1.3.2(6) of NFPA 58.

5.20.1 New residential, commercial, and industrial LP-Gas consuming appliances shall be approved.

The manufacturing of most residential and commercial LP-Gas appliances is covered by specific codes and standards. The largest of these documents are the ANSI Z21/83 series of standards promulgated by the ANSI Z21/83 Committee on Performance and Installation of Gas-Burning Appliances and Related Accessories [26]. (A partial list of current ANSI Z21/83 standards is included at the end of this chapter.) Underwriters Laboratories Inc. (UL) also develops some product standards. Most authorities having jurisdiction accept appliances listed to these standards, as well as to UL requirements. UL requirements are found in published UL standards and outlines of investigations. Outlines of investigations contain requirements used by UL to investigate products prior to their publication in a UL standard.

The requirement for approval does not include listing. The decision is that of the authority having jurisdiction, and many authorities usually prefer, or even require, listed appliances and equipment whenever they are available. Refer to 3.2.1 for the definition of *approved* and to 3.2.5 for the definition of *listed*.

Some appliance manufacturers have their appliances listed by organizations acceptable to most authorities having jurisdiction. One of these organizations is CSA America Inc. In addition, many LP-Gas appliances and equipment are listed by UL and other organizations. In the industrial area, FM Global listings are frequently found for industrial heat-processing equipment.

5.20.2 Any appliance originally manufactured for operation with a gaseous fuel other than LP-Gas shall not be used with LP-Gas unless it is converted to use LP-Gas and is tested for performance with LP-Gas before being placed into use.

◄ FAQ
Can a natural gas appliance be used with LP-Gas?

Most appliances are produced to operate on one fuel gas only, but can be converted to operate on another fuel gas. The conversion of a natural gas appliance to LP-Gas, for example, is not a complex operation, but it must be done safely by a qualified, trained individual. When

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

in doubt about such cases, check with the manufacturer or the listing laboratory. The appliance manufacturer may offer conversion parts for the appliance to use another fuel gas.

Some appliances are designed to operate on more than one fuel. These appliances are easily converted by turning a knob or lever. One example of such an appliance is a water heater designed for installation in manufactured housing. Other appliances must be converted in accordance with the appliance manufacturer's instructions to operate safely on LP-Gas.

5.20.3 Unattended heaters used inside buildings for animal or poultry production or care shall be equipped with approved automatic devices to shut off the flow of gas to the main burners and to pilots, if used, in the event of flame extinguishment or combustion failure.

5.20.4 Approved automatic devices to shut off the flow of gas to the main burners and pilots shall not be required in structures without enclosing walls with the approval of the authority having jurisdiction.

The provisions in 5.20.3 and 5.20.4 are examples of the use of NFPA 58 to fill a gap created by the absence of a specific code. (See the commentary following 5.20.1.) The use of unattended heaters inside a building used for animal or poultry production can be a hazard if the flame is extinguished and a flame safety device is not part of the appliance, because the released gas can be ignited. Because buildings used for animals in warmer climates may not have enclosing walls, NFPA 58 does not mandate the safety device with portable heaters used in these buildings, although the code requires local officials to approve such installations.

5.20.5 Appliances using vaporizing burners shall comply with 5.21.5.

5.20.6* Appliances used in mobile homes and recreational vehicles shall be approved for such service.

A.5.20.6 See NFPA 1192, *Standard on Recreational Vehicles*, for additional requirements where used on recreational vehicles.

At present, recreational vehicles are covered by NFPA 1192, *Standard on Recreational Vehicles* [9], and this requirement is consistent with the requirements of NFPA 501, *Standard on Manufactured Housing* [27]. New manufactured homes sold in the United States are covered under federal regulations issued by the Department of Housing and Urban Development (HUD). The HUD regulations apply only to the manufacture of such homes. This provision applies to appliances installed in manufactured homes after the original manufacture and sale.

5.20.7* LP-Gas appliances used on commercial vehicles shall be approved for the service.

(A) Gas-fired heating appliances and water heaters shall be equipped with automatic devices designed to shut off the flow of gas to the main burner and the pilot in the event the pilot flame is extinguished.

(B) Catalytic heating appliances shall be equipped with an approved automatic device to shut off the flow of gas in the event of combustion failure.

(C) Gas-fired heating appliances and water heaters to be used in vehicles intended for human occupancy shall be designed for complete separation of the combustion system and the living space.

(D) If the separation between the combustion system and the living space is not integral with the appliance, it shall be provided in accordance with installation requirements in 6.23.7.5.

A.5.20.7 Combustion air inlets and flue gas outlets should be included in the listing of the appliance.

The requirements of 5.20.7(A) and (B) are basic gas safety requirements.

Where gas appliances are used in vehicles intended for people, there are concerns about proper removal of the products of combustion and the possibility of carbon monoxide pro-

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

duction. The requirements of 5.20.7(C) and (D) are intended to ensure proper appliance operation, to remove the products of combustion from vehicles, and to prevent production of carbon monoxide. Carbon monoxide alarms are not required by NFPA 58, but they are required by NFPA 1192 for recreational vehicles with gas appliances.

5.21 Vaporizers, Tank Heaters, Vaporizing Burners, and Gas–Air Mixers

◀ **FAQ**
What is the difference between a vaporizer and a tank heater?

This section addresses equipment that is used for providing an external heat source to assist in the vaporization of LP-Gas. LP-Gas cannot be burned by an appliance while it is a liquid. It must be converted to a vapor in order to be utilized. Any liquid will vaporize at its boiling point if heat is added to it. The amount of heat required per unit of propane is known as the *latent heat of vaporization*. From Table B.1.2(a), propane requires about 773 Btu of energy to vaporize one gallon of liquid.

In a typical propane fuel distribution system, the latent heat of vaporization is provided by the surroundings of the tank: for aboveground tanks, it is the surrounding air; for belowground tanks, the surrounding soil. As soon as vapor is removed from the tank, the pressure inside the container drops and the liquid begins to boil to try to achieve equilibrium between the vapor pressure of the liquid at its temperature and the vapor pressure in the container. In order to vaporize, however, the liquid must be provided with heat energy. In those locations where the surrounding air or soil is too cold to provide sufficient heat to the liquid through the walls of the container, an external source of heat, such as a vaporizer, tank heater, or vaporizing burner, can be used.

A vaporizer is a piece of equipment that is really a heat exchanger. It transfers heat from an external source, such as a flame or electric resistance heating element to liquid LP-Gas as it passes through the vaporizer. Liquid enters the vaporizer at one point, and vapor leaves it at another point. A tank heater, on the other hand, never contacts liquid LP-Gas. A tank heater provides a source of heat energy to the walls of an LP-Gas container, which in turn transfer the heat into the liquid within the container. The source of heat can be an electric resistance heating element or a gas fired burner. See 3.3.75 for definitions of various types of vaporizers.

5.21.1 Reserved.

5.21.2 Indirect Vaporizers.

5.21.2.1 Indirect vaporizers shall be constructed in accordance with the applicable provision of the ASME Code for a MAWP of 250 psig (1.7 MPag) and shall be permanently and legibly marked with the following:

(1) The marking required by the ASME Code
(2) The maximum allowable working pressure and temperature for which designed
(3) The name of the manufacturer

Indirect vaporizers are heat exchangers that transfer heat from a "working" fluid heated outside the vaporizer to the liquid LP-Gas. The working fluid can be air, water or other fluid, steam, or other heated liquid. Indirect vaporizers must be built in accordance with the ASME *Boiler and Pressure Vessel Code* [1] to a MAWP of 250 psig (1.7 MPag). This pressure is the same as that required by the ASME Code for most propane containers. If the vaporizer is designed to be fed by a pump, the MAWP must be equal to or greater than the maximum pump discharge pressure.

5.21.2.2 Indirect vaporizers that have an inside diameter of 6 in. (152 mm) or less are exempt from the ASME Code and shall not be required to be marked. They shall be constructed for a MAWP of 250 psig (1.7 MPag).

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

Small indirect vaporizers that have an inside diameter of 6 in. (152 mm) or less must also be designed for an operating pressure of 250 psig (1.7 MPag), but need not be inspected by an ASME-approved inspector or marked with the code marking. This requirement is consistent with the ASME *Boiler and Pressure Vessel Code*, which is not applicable to pressure vessels with an inside diameter of 6 in. (152 mm).

5.21.2.3 Indirect vaporizers shall be provided with an automatic means to prevent the passage of liquid through the vaporizer to the vapor discharge piping.

Liquid cannot be allowed to leave a vaporizer through the vapor discharge piping at any time during normal operation or a malfunction of the vaporizer. If the vaporizer is sized and functioning properly, liquid will not be present in the vapor outlet. The requirement is intended to protect against a vaporizer malfunction in which the heat source of the vaporizer fails or the unit becomes overloaded. The hazard of liquid being present in the vapor piping is that none of the vapor control equipment, such as regulators, control valves, and burners, is designed to handle liquid. Liquid passing through vapor regulators will flash to vapor and can result in significantly increased flame size that can present a fire hazard. In addition, if liquid water is present anywhere downstream of the vaporizer, it can be frozen to form ice by the vaporizing liquid, which can then plug a regulator.

5.21.2.4 Indirect vaporizers, including atmospheric-type vaporizers using heat from the surrounding air or the ground and of more than 1 qt (0.9 L) capacity shall be equipped with a spring-loaded pressure relief valve providing a relieving capacity in accordance with 5.21.9. Fusible plug devices shall not be used.

EXHIBIT 5.62 *Direct-Fired Vaporizer. (Courtesy of Ransome Manufacturing)*

The prohibition of fusible plugs (instead of spring-loaded pressure relief valves) is included because fusible plugs (and rupture discs) cannot re-close and will allow the entire contents of the system to be discharged into the atmosphere in case of overpressure. Spring-loaded pressure relief valves can minimize the quantity of vapor discharged because they close after the pressure returns to a normal level.

5.21.2.5 Indirect atmospheric-type vaporizers of less than 1 qt (0.9 L) capacity shall not be required to be equipped with pressure relief valves but shall be installed in accordance with 6.21.2.11.

Vaporizers with an internal capacity less than 1 qt (0.9 L) are not required to be provided with a relief valve, but must be installed in accordance with 6.21.2.11 and Table 6.21.3.6 (which is referenced in 6.21.2.11). The table provides minimum separation distances between direct-fired vaporizers and specific exposures that may present a source of ignition.

5.21.3 Direct-Fired Vaporizers.

5.21.3.1 Design and construction of direct-fired vaporizers shall be in accordance with the applicable requirements of the ASME Code for the working conditions to which the vaporizer will be subjected, and the vaporizer shall be permanently and legibly marked with the following:

(1) The markings required by the ASME Code
(2) The maximum vaporizing capacity in gallons per hour
(3) The rated heat input in British thermal units per hour (Btu/hr)
(4) The name or symbol of the manufacturer

All direct-fired vaporizers must be constructed in accordance with the ASME Code, which includes inspection and marking. (See Exhibits 5.62 and 5.63.) The term *markings* required by the code refers directly to the markings required by the ASME Code. The term *outside surface* used in the marking requirements of the ASME Code does not refer to the surface of the outside of the cabinet or enclosure. The outside surface is that surface that can be in contact

Copyright 2014 National Fire Protection Association (NFPA) Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND No other reproduction or transmission in any form permitted without written permission of NFPA For inquires or to report unauthorized use, contact licensing@nfpa.org.

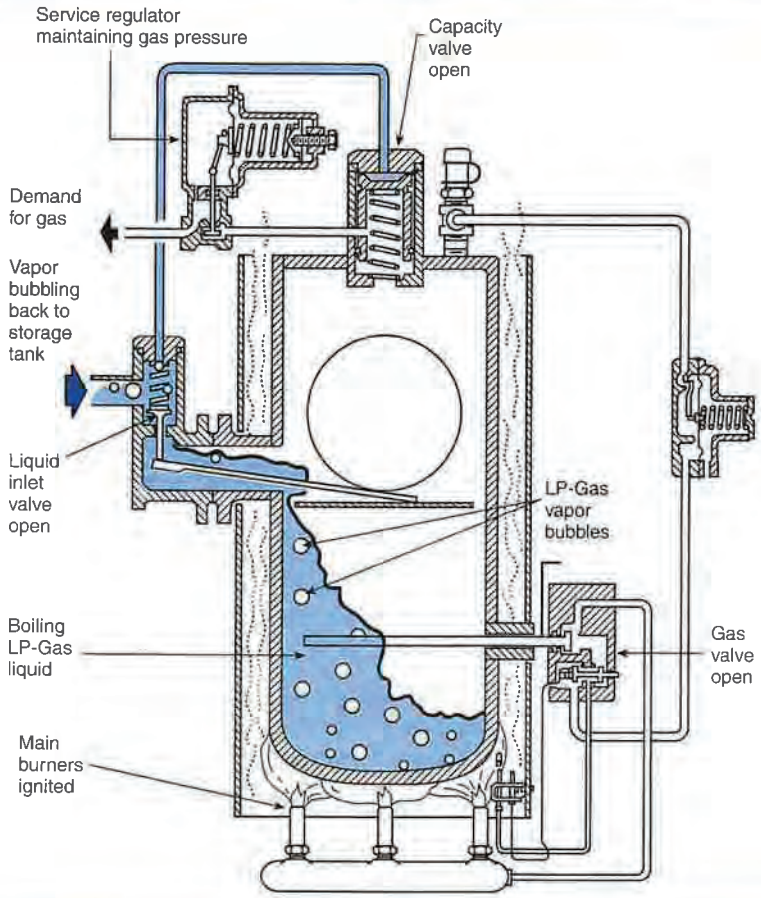


EXHIBIT 5.63 *Direct-Fired Vaporizer Operating on Demand. (Courtesy of National Propane Gas Association)*

with LP-Gas on the inside and the atmosphere on the outside, which could add to the vaporization rate of the vaporizer if subjected to fire outside the vaporizer. The outside surface includes the heat exchange surface plus the top of the vessel.

5.21.3.2 Direct-fired vaporizers shall be equipped with a spring-loaded pressure relief valve that provides a relieving capacity in accordance with 5.21.9.

5.21.3.3 The relief valve shall be located so as not to be subject to temperatures in excess of 140°F (60°C). Fusible plug devices shall not be used.

The relief valve must be located or protected in such a manner that it will not be subjected to a temperature above 140°F (60°C). This requirement is included because a direct-fired unit contains a burner that can create high temperatures from the products of combustion, and excessive temperature near a relief valve could destroy the seats and damage the mechanism inside of the relief valve.

The prohibition against fusible plugs and rupture discs addresses the same concerns as the similar provisions for indirect vaporizers. [See the commentary on 5.21.2.4.]

5.21.3.4 Direct-fired vaporizers shall be provided with automatic means to prevent the passage of liquid from the vaporizer to its vapor discharge piping.

5.21.3.5 A means for manually turning off the gas to the main burner and pilot shall be provided.

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

5.21.3.6 Direct-fired vaporizers shall be equipped with an automatic safety device to shut off the flow of gas to the main burner if the pilot light is extinguished.

5.21.3.7 If the pilot flow exceeds 2000 Btu/hr (2 MJ/hr), the safety device shall also shut off the flow of gas to the pilot.

5.21.3.8 Direct-fired vaporizers shall be equipped with a limit control to prevent the heater from raising the product pressure above the design pressure of the vaporizer equipment, and to prevent raising the pressure within the storage container above the pressure specified in the first column of Table 5.2.4.2 that corresponds with the design pressure of the container (or its ASME Code equivalent). *(See notes to Table 5.2.4.2.)*

Paragraph 5.21.3.6 reiterates the requirement for a 100 percent shutoff for the gas burner. This requirement is not unique to a direct-fired vaporizer burner.

Although 5.21.3.8 implies that the limit control should be a pressure-operated device, temperature-sensing devices are also commonly used for this purpose. Controlling the temperature of the vapor output of the vaporizer is a practical method of preventing the burner from overheating the vapor. The vaporizer cannot produce a vapor pressure higher than that provided to the liquid inlet of the vaporizer. If the pressure in the vaporizer were to exceed the inlet pressure, the flow of liquid into the vaporizer would stop and would be reversed into the supply container.

This provision to limit the pressure within the storage container was intended to protect a type of system seldom used today, one in which liquid is fed by gravity from a storage container into a vaporizer and vapor is returned from the vaporizer back into the top of the tank. Vapor is removed from the tank through a pressure regulator into the distribution system. With this type of system, it is theoretically possible, in extremely hot weather, for a vaporizer connected in this manner to raise the pressure in the container. A severe increase in pressure, of course, would cause the container pressure relief valves to operate, discharging vapor that, because of the presence of the direct-fired vaporizer, would almost certainly become ignited. Again, temperature controls in the vaporizer prevent this type of malfunction from taking place. Accordingly, a temperature control is the only practical type of control to satisfy this requirement.

5.21.4 Direct Gas-Fired Tank Heaters.

5.21.4.1 Direct gas-fired tank heaters shall be designed exclusively for outdoor aboveground use and so that there is no direct flame impingement upon the container.

5.21.4.2 Tank heaters shall be approved and shall be permanently and legibly marked with the following:

(1) The rated input to the burner in British thermal units per hour
(2) The maximum vaporizing capacity in gallons per hour
(3) The name or symbol of the manufacturer

5.21.4.3 The tank heater shall be designed so that it can be removed for inspection of the entire container.

5.21.4.4 The fuel gas supply connection to the tank heater shall originate in the vapor space of the container being heated and shall be provided with a manually operated shutoff valve at the heater.

5.21.4.5 The heater control system shall be equipped with an automatic safety shutoff valve of the manual-reset type arranged to shut off the flow of gas to both the main and pilot burners if the pilot flame is extinguished.

5.21.4.6 Where installed on a container exceeding 1000 gal (3.8 m^3) water capacity, the heater control system shall include a valve to automatically shut off the flow of gas to both the main and pilot burners if the container becomes empty of liquid.

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

5.21.4.7 Direct gas-fired tank heaters shall be equipped with a limit control to prevent the heater from raising the pressure in the storage container to more than 75 percent of the pressure shown in the first column of Table 5.2.4.2 that corresponds with the MAWP of the container (or its ASME *Boiler and Pressure Vessel Code* equivalent).

Direct gas-fired tank heaters are no longer widely used, but there is no reason to prohibit them. These heaters attach to the bottom of the container to heat the container shell at the point of contact, thereby heating the liquid product inside. In order to avoid the loss of container strength, however, no flame impingement on the container itself can occur. Most of these units were constructed so that they can be easily removed to inspect for possible corrosion of the container at the point of installation. Direct gas-fired tank heaters must be engineered so that there will be automatic means to prevent overheating the product in the container, to shut off the heater in case the container empties, and to shut off the gas flow to the heater in case the pilot light goes out. The need for direct-fired tank heaters exists only in very cold climates, where temperatures can go below about – 40°F (– 40°C). Below this temperature, container pressure will be negative and no gas will flow from the container.

5.21.5 Vaporizing Burners.

Vaporizing burners are a form of direct-fired vaporizers where the vaporizing burner is actually part of the appliance. The vapor is produced by heating liquid propane in a heat exchanger in the burner. Only a small portion of the heat is used to vaporize the liquid, and the appliance delivers the remainder as useful heat energy. Vaporizing burners are used where large quantities of vapor are required — for example, for crop dryers and for smaller applications such as for roofing equipment and portable weed burners. The need for a separate vaporizer and pressure controls is eliminated by the use of a vaporizing burner, with corresponding cost savings. The minimum design pressure must be 250 psig (1.7 MPag), which is the same as that of the container. The coils and jackets must be made of ferrous metals or high-temperature alloys because of the high temperature created by the flame.

The vaporizing burner shown in Exhibit 5.64 operates by delivering liquid through a tube (shown in the cutaway), which is encased in a shell with a concentric space between them. The liquid then reverses direction and proceeds back between the tube and the shell in a spiral flow pattern induced by the wire. This spiral flow pattern creates turbulence and enhances heat transfer from the flame impinging on the outside of the shell to the vaporizing liquid. The vapor created is then consumed in the burner that encloses the area outside of the concentric shell and tube.

EXHIBIT 5.64 *Vaporizing Burner. (Courtesy of Flame Engineering)*

5.21.5.1 Vaporizing burners shall be constructed with a pressure rating of 250 psig (1.7 MPag) with a safety factor of 5 to 1.

5.21.5.2 The vaporizing burner or the appliance in which it is installed shall be permanently and legibly marked with the following:

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

(1) The maximum burner input in British thermal units per hour
(2) The name or symbol of the manufacturer

5.21.5.3 Vaporizing coils or jackets shall be made of ferrous metals or high-temperature alloys.

5.21.5.4 The vaporizing section shall be protected by a relief valve, located where it will not be subject to temperatures in excess of 140°F (60°C), and with a pressure setting sufficient to protect the components involved but not lower than 250 psig (1.7 MPag).

5.21.5.5 The relief valve discharge shall be directed upward and away from the component parts of the vaporizing burner. Fusible plug devices shall not be used.

5.21.5.6 A valve shall be provided to turn off the gas supply to the main burner and the pilot.

5.21.5.7 Vaporizing burners shall be provided with an automatic safety device to shut off the flow of gas to the main burner and pilot in the event the pilot is extinguished.

5.21.5.8* Dehydrators and dryers utilizing vaporizing burners shall be equipped with automatic devices both upstream and downstream of the vaporizing section. These devices shall be installed and connected to shut off in the event of excessive temperature, flame failure, and, if applicable, insufficient air-flow.

A.5.21.5.8 See NFPA 61, *Standard for the Prevention of Fires and Dust Explosions in Agricultural and Food Processing Facilities*, for ignition and combustion controls applicable to vaporizing burners associated with grain dryers.

The intent of 5.21.5.8 is to provide safety devices installed at the specified locations that will automatically shut down the dehydrator or dryer (used to dry grain in agricultural applications) in order to avoid unsafe situations that could lead to overheating of the equipment.

5.21.5.9 Pressure-regulating and control equipment shall be so located or so protected to prevent its exposure to temperatures above 140°F (60°C), unless designed and recommended for use at a higher temperature by the manufacturer.

5.21.5.10 Pressure-regulating and control equipment located downstream of the vaporizing section shall be designed to withstand the maximum discharge temperature of hot vapor.

Because liquid is fed to the vaporizing burner, a hydrostatic relief valve in the burner is required to protect the piping when the burner is shut off and the liquid is trapped in the burner and piping. Without a hydrostatic relief valve, an increase in the temperature of the liquid would create a pressure that could burst the heater or the attached piping. Vaporizing burners are often used for temporary heating during construction or emergencies and are left unattended. As a result, the careful use of automatic equipment is extremely important. The units are also used as agricultural product dehydrators and dryers and should be properly equipped with automatic devices on both the inlet and the outlet of the vaporizer section of the burner. Because these units are generally portable, extreme care must be taken in their placement and to ensure that fuel connections are not subjected to mechanical damage.

5.21.6 Waterbath Vaporizers.

The waterbath vaporizer differs from a direct-fired vaporizer because there is no flame impingement on the vaporizer chamber itself. The flame is directed into the water under pressure, creating a boiling, swirling effect. This turbulence results in excellent heat transfer to the water. The liquid propane is circulated in pipes in the water chamber and is heated by the turbulent hot water.

Waterbath vaporizers are used where a very high vaporization requirement exists. The use of waterbath vaporizers in LP-Gas systems under the scope of NFPA 58 is not common.

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

Waterbath vaporizers are more commonly found in larger systems under the scope of NFPA 59, *Utility LP-Gas Plant Code* [28].

5.21.6.1 The vaporizing chamber, tubing, pipe coils, or other heat exchange surface containing the LP-Gas to be vaporized, hereinafter referred to as heat exchanger, shall be constructed in accordance with the applicable provisions of the ASME Code for a MAWP of 250 psig (1.7 MPag) and shall be permanently and legibly marked with the following:

(1) The marking required by the ASME Code
(2) The MAWP and temperature for which the heat exchanger is designed
(3) The name or symbol of the manufacturer

A waterbath vaporizer is a cross between a direct-fired vaporizer and an indirect-fired vaporizer. The portion of such a unit that contains and vaporizes the LP-Gas must be built in accordance with the provisions of the ASME Code for a minimum pressure of 250 psig (1.7 MPag) and be marked as required in 5.21.6.1. Again, vaporizers less than 6 in. (152 mm) in diameter are exempt from the ASME Code but must be constructed to a minimum MAWP of 250 psig (1.7 MPag). (See also the commentary following Section 5.21.) The same automatic safety controls used with indirect-fired and direct-fired vaporizers to prevent liquid passing into the vapor discharge piping must be provided. The immersion heater that provides heat to the waterbath must not be in contact with the LP-Gas heat exchanger surface in order to avoid overheating it. It also must be equipped with an automatic shutoff device to prevent overheating of the liquid waterbath, should the level of the waterbath liquid fall below the top of the heat exchanger.

5.21.6.2 Heat exchangers for waterbath vaporizers that have an inside diameter of 6 in. (150 mm) or less are exempt from the ASME Code and shall not be required to be marked.

5.21.6.3 Heat exchangers for waterbath vaporizers shall be provided with automatic control to prevent the passage of liquid through the heat exchanger to the vapor discharge piping. This control shall be integral with the vaporizer.

5.21.6.4 Heat exchangers for waterbath vaporizers shall be equipped with a spring-loaded pressure relief valve that provides a relieving capacity in accordance with 5.21.9. Fusible plug devices shall not be used.

5.21.6.5 Waterbath sections of waterbath vaporizers shall be designed to prevent a pressure from exceeding the design pressure.

5.21.6.6 The immersion heater that provides heat to the waterbath shall be installed so as not to contact the heat exchanger and shall be permitted to be electric or gas-fired.

Paragraph 5.21.6.6 states that the immersion heater that heats the waterbath is permitted to be electric or gas-fired. The intent is not to prevent any other form of heat source; however, the only two that seem practical are electric or gas-fired immersion heaters.

5.21.6.7 A control to limit the temperature of the waterbath shall be provided.

5.21.6.8 Gas-fired immersion heaters shall be equipped with an automatic safety device to shut off the flow of gas to the main burner and pilot in the event of flame failure.

5.21.6.9 Gas-fired immersion heaters with an input of 400,000 Btu/hr (422 MJ/hr) or more shall be equipped with an electronic flame safeguard and with programming to provide for prepurge prior to ignition, proof of pilot before the main burner valve opens, and full shutdown of the main gas valve and pilot upon flame failure.

5.21.6.10 The heat source shall be shut off if the level of the heat transfer medium falls below the top of the heat exchanger.

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

5.21.7 Reserved.

5.21.8 Gas–Air Mixers.

Gas–air mixers are devices used to "pre-mix" air into LP-Gas so that it can be used as a direct replacement for natural gas. Mixers are used most often in "stand-by" systems, which provide an alternate source of fuel to a facility when the primary source (natural gas) is not available. The concept of this system is to mix air with LP-Gas such that the concentration of the propane–air mix is still greater than the higher limit of flammability. The mixture is then distributed through the piping system to the fuel-burning equipment. As the mixture enters the appliance, it is mixed further with air to bring it within the flammability range.

The entire subsection on gas–air mixtures (5.21.8) contains requirements that are intended to prevent both flammable gas–air mixtures from entering the system and air from entering the gas distribution line.

5.21.8.1 Gas–air mixers shall be designed for the air, vapor, and mixture pressures to which they are subjected.

5.21.8.2 Gas–air mixers that are capable of producing combustible mixtures shall be equipped with safety interlocks on both the LP-Gas and air supply lines to shut down the system if combustible limits are approached.

5.21.8.3 In addition to the interlocks required in 5.21.8.2, a method shall be provided to prevent air from accidentally entering gas distribution lines without LP-Gas being present. Gas mixing control valves installed in the air and LP-Gas supply lines that fail closed when actuated by safety trip devices shall meet this requirement.

5.21.8.4 Check valves shall be installed in the air and LP-Gas supply lines close to the mixer to minimize the possibility of backflow of gas into the air supply lines or of air into the LP-Gas system. Gas-mixing control valves installed in the air and LP-Gas supply lines that fail closed when actuated by safety trip devices shall meet this requirement.

5.21.8.5 Gas–air mixers that utilize the kinetic energy of the LP-Gas vapor to entrain air from the atmosphere and are so designed that maximum air entrained is less than 85 percent of the mixture shall comply with the following:

(1) Be exempt from the interlock provisions in 5.21.8.2 through 5.21.8.4
(2) Be equipped with a check valve at the air intake to prevent the escape of gas to atmosphere when shut down

5.21.8.6 Gas–air mixers of this type receiving air from a blower, compressor, or any source of air other than directly from the atmosphere shall prevent air without LP-Gas, or mixtures of air and LP-Gas within the flammable range, from entering the gas distribution system accidentally.

The flammable limits for propane in air are approximately 2.15 percent to 9.6 percent. A venturi-type blender or mixer uses the kinetic energy of the LP-Gas vapor to entrain air from the atmosphere. Venturi mixers should be designed so that the maximum air entrained is less than 85 percent of the mixed gas formed. The mixture of 85 percent or less air with the remainder of 15 percent or more LP-Gas is not flammable (a flammable mixture is between 90.4 percent and 97.85 percent air), and the interlock provisions of 5.21.8.2 are specifically excluded, as are 5.21.8.3 and 5.21.8.4. A check valve at each air inlet venturi prevents any LP-Gas from escaping into the atmosphere when the system is not operating.

To prevent malfunction, most venturi mixers have high and low vapor pressure interlocks, high and low mixed LP-Gas–air pressure interlocks, and a low incoming vapor temperature interlock. The latter interlock prevents any LP-Gas liquid from entering the gas–air mixer. To prevent any possible vapor condensation problems, the mixer should be located as close as possible to the vaporizer, and the mixer vapor inlet connection should be sloped back

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

toward the vaporizer vapor outlet connection. If this is not practical, a drip leg with heater should be installed or the piping can be heated to prevent low temperatures by wrapping electric tracer heater cable around such piping. Unless ambient temperatures are very low, insulating the piping may be sufficient to prevent too low a temperature of the gas vapor.

Usually venturi mixers employing atmospheric air have an output mixture pressure of less than 3 psig (21 kPag) in order to produce a viable mixed gas. For mixer pressures greater than 3 psig (21 kPag), air under pressure must be supplied to the venturi mixer from an external source, such as a plant air system or an air compressor. For this external air supply system, a method must be provided on the venturi mixer to prevent 100 percent air or a flammable LP-Gas–air mixture from being supplied to the user's gas distribution piping. This prevention is usually accomplished through special controls and low air pressure interlocks that will shut down the mixer in the event of a malfunction.

Consideration also should be given to the method of installation of the downstream piping for the LP-Gas–air mixture from the mixer to the plant utilization point, relative to possible recondensation of the LP-Gas–air mixture. For most cases, when commercial propane is the LP-Gas–air feedstock and the LP-Gas–air mixture is at or below 100 psig (690 kPag), there would be no recondensation of propane in the mix until the mixed gas temperature is lowered to 20°F (–7°C) or colder. But if commercial butane is the LP-Gas–air feedstock, considerable care must be taken in the mixed gas piping design. At a mixed gas pressure of 10 psig (69 kPag), butane will start to condense at about 20°F (–7°C).

Thus, for higher mixed gas send-out pressures, condensation of butane will occur at higher temperatures; for example, at 50 psig (345 kPag), the condensation temperature is about 60°F (15.6°C). Heat for the butane–air mix gas line must thus be provided in the form of heat tracing or insulation to guard against possible butane condensation.

The venturi-type gas–air mixer uses the kinetic energy of LP-Gas vapor to entrain air from the atmosphere to provide a desired LP-Gas–air mixture. Each venturi includes a solenoid valve on the gas inlet side of the venturi. A controller monitors the outlet manifold pressure of the mixer and energizes each individual solenoid valve to provide a constant flow to the process at the required pressure. The air inlet of the venturi includes a backflow check valve to prevent the escape of LP-Gas to the atmosphere. In addition, the controller is interlocked with a low-vapor inlet temperature switch and high- and low-pressure switches on the gas inlet at gas–air outlet manifolds.

Exhibit 5.65 shows a high-pressure [greater than 3 psig (21 kPag)] variable-orifice type of gas–air mixer with inlet air and gas control trains located in a room complying with Chapter 10. Both the air and gas control trains include pressure regulators, check valves, shutoff

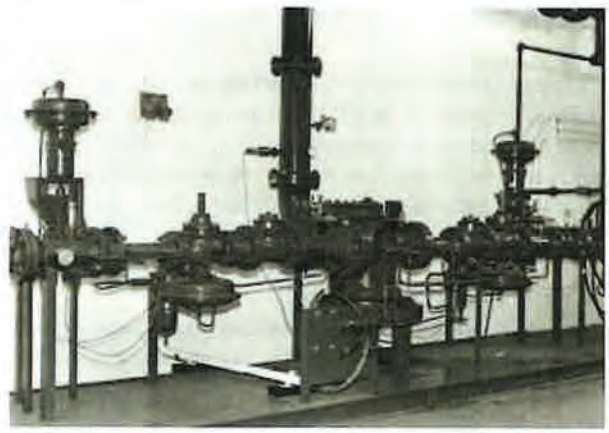


EXHIBIT 5.65 *High-Pressure Orifice Gas–Air Mixer. (Courtesy of Al-Gas SDI)*

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

valves, safety shutoff valves, temperature and pressure indicators, and high-low pressure switches. Process air for the mixer may be furnished from an air compressor in a separate room or from the plant air system. Air and gas pressures are both regulated to equal pressures on the inlet to the mixer. The variable orifice in the mixing valve will open and close, depending on flow, to provide a constant Btu value. The propane–air mixture is then distributed within the plant process piping.

5.21.9 Vaporizer Pressure Relief Valve.

The minimum rate of discharge in cubic feet of air per minute for pressure relief valves for LP-Gas vaporizers, either of the indirect type or direct-fired, shall comply with 5.21.9(A) through 5.21.9(C).

(A) Based on conservative heat transfer calculations (assuming that the vaporizing chamber is liquid full), the maximum vapor generating capacity (rate) shall be determined when maximum heat is available. That vapor rate shall be converted to an equivalent air rate.

The phrase "conservative heat transfer calculations" is explained by the statement in parenthesis. This calculation is considered conservative because the maximum vapor rate occurs when propane is in contact with the entire surface of the vaporizer and maximum heat is available.

Pressure relief valves and all other safety devices are designed for the worst-case condition, which is fire exposure over the entire surface of the vessel. In the event of fire exposure to a vaporizer, the pressure relief valve must be sized to handle vapor produced as a result of the liquid heating by both the normal heat source and the fire exposure.

Subsection 5.21.9 provides three separate criteria for sizing pressure relief valves for use on vaporizers. The size of the pressure relief valve must comply with each criterion that is applicable to the specific vaporizer.

(B) If the vaporizer is direct fired or if a substantial exterior surface is in contact with the LP-Gas, the sum of the vaporizer surface and the LP-Gas wetted exterior surface shall be used in conjunction with Table 5.7.2.5 to determine the required relief valve capacity.

(C) The minimum rate of discharge in cubic feet of air per minute for pressure relief valves for LP-Gas vaporizers, of either the indirect type or direct fire type, shall be at least 150 percent of the rated vaporizing capacity.

REFERENCES CITED IN COMMENTARY

1. ASME, *Boiler and Pressure Vessel Code*, 2007 edition, American Society of Mechanical Engineers, New York, NY.
2. UL 132, *Standard on Safety Relief Valves for Anhydrous Ammonia and LP-Gas*, 1997 edition, Underwriters Laboratories Inc., Northbrook, IL.
3. Title 49, Code of Federal Regulations, Part 178.50, U.S. Government Printing Office, Washington, DC.
4. Title 49, Code of Federal Regulations, Part 178.68, U.S. Government Printing Office, Washington, DC.
5. *National Board Inspection Code*, 2004 edition, National Board of Boiler and Pressure Vessel Inspectors, Columbus, OH.
6. CGA C-6, *Standard for Visual Inspection of Steel Compressed Gas Cylinders*, 2007 edition, Compressed Gas Association, Chantilly, VA.
7. CGA C-6.3, *Guidelines for Visual Inspection and Requalification of Low Pressure Aluminum Compressed Gas Cylinders*, 1999 edition, Compressed Gas Association, Chantilly, VA.
8. Title 49, Code of Federal Regulations, Part 180.213, U.S. Government Printing Office, Washington, DC.

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

9. NFPA 1192, *Standard on Recreational Vehicles*, 2005 edition, National Fire Protection Association, Quincy, MA.
10. ASME E-119, *Standard Test Methods for Fire Tests of Building Construction and Materials*, 2007 edition, American Society for Testing and Materials, West Conshohocken, PA.
11. CGA S-1.1, *Pressure Relief Device Standards, Part I — Cylinders for Compressed Gases,* 2005 edition, Compressed Gas Association, Chantilly, VA.
12. CGA C-14, *Methods for Hydrostatic Testing of Compressed Gas Cylinders*, 2005 edition, Compressed Gas Association, Chantilly, VA.
13. Title 49, Code of Federal Regulations, Part 173.304(d)(3)(ii), U.S. Government Printing Office, Washington, DC.
14. UL 2227, *Overfilling Prevention Devices*, 2007 edition, Underwriters Laboratories Inc., Northbrook, IL.
15. CGA V-1, *Standard for Compressed Gas Cylinder Valve Outlet and Inlet Connections,* 2005 edition, Compressed Gas Association, Chantilly, VA.
16. ANSI/UL 125, *Standard for Valves for Anhydrous Ammonia and LP-Gas (Other than Safety Relief),* 2007 edition, Underwriters Laboratories Inc., Northbrook, IL.
17. UL 1769, *Cylinder Valves*, 2006 edition, Underwriters Laboratories Inc., Northbrook, IL.
18. API 607, *Fire Test for Soft-Seated Quarter Turn Ball Valves,* 2005 edition, American Petroleum Institute, Washington, DC.
19. NFPA 54, *National Fuel Gas Code*, 2006 edition, National Fire Protection Association, Quincy, MA.
20. UL 144, *Standard for LP-Gas Regulators*, 1999 edition, Underwriters Laboratories Inc., Northbrook, IL.
21. UL 651, *Schedule 40 or 80 Rigid PVC Conduit*, 1995 edition, Underwriters Laboratories Inc., Northbrook, IL.
22. ASTM D 2513, *Standard Specification for Thermoplastic Gas Pressure Pipe, Tubing, and Fittings*, 2007 edition, American Society for Testing and Materials, West Conshohocken, PA.
23. ASTM B 86, *Standard Specification for Zinc-Alloy Die Casting,* 2006 edition, American Society for Testing and Materials, West Conshohocken, PA.
24. NIST Handbook 44, *Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices,* 2006 edition, National Institute of Standards and Technology,
25. Isner, M. S., "Propane Tank Truck Incident, Eight People Killed, Memphis, TN, December 23, 1988," Fire Investigation Report, February 6, 1990, National Fire Protection Association, Quincy, MA.
26. ANSI Z21 and Z83 series standards, CSA-America, Cleveland, Ohio
    a. ANSI Z21.1, *Household Cooking Gas Appliances*, 2005 edition.
    b. ANSI Z21.5.1, *Gas Clothes Dryers, Volume I, Type 1, Clothes Dryers,* 2006 edition.
    c. ANSI Z21.5.2, *Gas Clothes Dryers, Volume II, Type 2, Clothes Dryers,* 2005 edition.
    d. ANSI Z21.10.1/CSA 4.1, *Gas Water Heaters, Volume I, Water Heaters with Input Ratings of 75,000 Btu per Hour or Less,* 2006 edition.
    e. ANSI Z21.10.3, *Gas Water Heaters, Volume III, Storage Water Heaters with Input Ratings Above 75,000 Btu per Hour, Circulating and Instantaneous Water Heaters,* 2004 edition.
    f. ANSI Z21.11.1, *Gas-Fired Room Heaters, Volume I, Vented Room Heaters*, 1991 edition.
    g. ANSI Z21.11.2b, *Gas-Fired Room Heaters, Volume II, Unvented Room Heaters*, 1998 edition.
    h. ANSI Z21.11.3, *Propane Fired Portable Heater Systems* (draft).
    i. ANSI Z21.13/CSA 4.9, *Gas-Fired Low Pressure Steam and Hot Water Boilers*, 2005 edition.

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

j. ANSI Z21.19, *Refrigerators Using Gas Fuel*, 2002 edition.
k. ANSI Z21.40.1/CSA 2.91A-M97, and Addenda, Z21.40.1A and B, *Gas-Fired Heat-Activated Air Conditioning and Heat Pump Appliances*, 1997 edition (Revised 2002).
l. ANSI Z21.42, *Gas-Fired Illuminating Appliances*, 2004 edition.
m. ANSI Z21.47/CSA 2.3, *Gas-Fired Central Furnaces*, 2006 edition.
n. ANSI Z21.50, *Vented Decorative Gas Appliances*, 2007 edition.
o. ANSI Z21.56, *Gas-Fired Pool Heaters*, 2006 edition.
p. ANSI Z21.57, *Recreational Vehicle Cooking Gas Appliances*, 2005 edition.
q. ANSI Z21.58, *Outdoor Cooking Gas Appliances*, 2007 edition.
r. ANSI Z21.60, *Decorative Gas Appliances for Installation in Solid-Fuel Burning Fireplaces*, 2004 edition.
s. ANSI Z21.61, *Toilets, Gas-Fired*, 1983 (Reaffirmed, 2004) edition.
t. ANSI Z21.86, *Vented Gas-Fired Space Heating Appliances*, 2004 edition.
u. ANSI Z83.4, *Non-Circulating Direct Gas-Fired Industrial Air Heaters*, 2004 edition.
v. ANSI Z83.7, *Gas-Fired Construction Heaters*, 2000 (Reaffirmed 2005) edition.
w. ANSI Z83.8, *Gas Unit Heaters and Gas-Fired Duct Furnaces*, 2006 edition.
x ANSI Z83.11, *Gas Food Service Equipment*, 2006 edition.
y. ANSI Z83.19, *Gas-Fired High-Intensity Infrared Heaters*, 2001 edition.
z. ANSI Z83.20, *Gas-Fired Low-Intensity Infrared Heaters*, 2001 edition.

27. NFPA 501, *Standard on Manufactured Housing*, 2005 edition, National Fire Protection Association, Quincy, MA.
28. NFPA 59, *Utility LP-Gas Plant Code*, 2004 edition, National Fire Protection Association, Quincy, MA.

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

NFPA 58 Index

A

Acceptance of equipment and systems, 4.1
Actuated liquid withdrawal excess-flow valve, 5.7.4.1, 5.7.8.1
  Definition, 3.3.1
Adoption of code, Annex J
American Society of Mechanical Engineers *see* ASME
Ammonia contamination, 4.5, A.4.5
Anodeless risers, 5.9.5(E), 6.9.4.3
  Definition, 3.3.2
ANSI (definition), 3.3.3
API-ASME codes
  Compliance with, 5.2.1.1, 11.3.1.1, A.5.2.1.1
  Development of, D.1.2
API-ASME containers (or tanks), Annex D
  Definition, 3.3.5
  Design of, D.2.2 to D.2.4, D.3
  Filling, 7.4.3.1(4)
  Requalification for service, 5.2.1.2(B), 11.3.1.4
API (definition), 3.3.4; *see also* API-ASME codes; API-ASME containers (or tanks)
Appliances, LP-Gas, 5.20, A.5.20.6, A.5.20.7
  Approval, 5.20.1
  Conversion to LP-Gas, 5.20.2
  Installation of, 6.20
    Buildings, 6.19.2, 6.19.8, A.6.19.2.5, A.6.19.2.7
    Non-engine fuel systems, 6.23.7, A.6.23.7.6
    Patio heaters, 6.20.2
    Portable appliances, hose for, 6.20.3
    Vehicles, 6.23.7, A.6.23.7.6
  Pipe sizing between second-stage regulator and appliance, Table 15.1(c), Table 15.1(e), Table 15.1(g), Table 15.1(j), Table 15.1(l)
Application of code, 1.3, A.1.3.1(4) to A.1.3.2(8)
Approved (definition), 3.2.1, A.3.2.1
Appurtenances, container *see* Container appurtenances
ASME (definition), 3.3.6; *see also* API-ASME codes; ASME code; ASME containers
ASME code
  Compliance with, 5.2.1.1, 11.3.1.1, 11.3.1.2, A.5.2.1.1
  Definition, 3.3.7
  Development of, D.1.2
ASME containers, Annex D; *see also* API-ASME containers (or tanks)
  Appurtenances and connections, Table 5.7.4.1, 5.7.4.1(A), 5.7.4.2, 5.7.8.1, 5.7.8.4 to 5.7.8.6, 6.8.3.3, 6.26.3
  Definition, 3.3.8
  Design, D.2.1, D.2.3, D.2.4, D.3
  Engine fuel systems, 11.3.1.4(B), 11.3.2, 11.3.4, 11.4.1.7, 11.4.1.8
  Filling, 7.4.3.1(4), 7.4.3.2(C)
  Gauges, 5.7.5.4, 5.7.5.7
  Inlet and outlet connections, 5.7.8.5
  Installation, 6.6.3, 6.6.4, 6.6.6, 6.6.7.2(3), 6.23.3.2, 6.26, A.6.6.6.1
  Marking, 5.2.8.3, 5.2.8.3(C), 5.2.8.5, A.5.2.8.3
  Maximum allowable working pressure *see* Maximum allowable working pressure (MAWP)
  Non-engine fuel systems, 6.23.3.1
  Openings, 5.2.5, A.5.2.5.3 to A.5.2.5.7
  Pressure relief devices/valves, 5.7.2.1, 5.7.2.5 to 5.7.2.7, 5.7.4.1(A), 6.23.4.1, E.2
  Protection, 6.25.3, A.6.25.3
  Requalification for service, 5.2.1.2(B), 5.2.1.3, 11.3.1.4(B)
  Separation distances, 6.3.2 to 6.3.4, Table 6.3.9, 6.3.12
  Service pressure, 5.2.4.2
  Spacing, Fig. I.1(b), Fig. I.1(c)
  Specifications, Table 4.1.1
  Supports, 5.2.7.1
  Tank heaters, 6.21.4.1, 6.21.4.2
  Transfer into, 6.26.5.1, 6.26.5.2
  Transportation of, 9.3.4, 9.6.2.1
  Vehicles, on, 6.23.3.2, 6.26.5.1
ASTM (definition), 3.3.9
Attached structures, LP-gas distribution facilities, 10.3, A.10.3.2.6
Authority having jurisdiction (definition), 3.2.2, A.3.2.2

B

Backflow check valves, Table 5.7.4.1, 5.7.4.2(H), 5.7.4.5, 5.7.7.1, 5.7.7.2, 5.7.8.1, 5.12.3, 5.17.7, 6.12.3 to 6.12.5, 6.12.8, 6.12.9, 6.26.3.5, 6.26.4.1, 7.3.2.2(C), A.6.12.8
  Cargo tank vehicles, 9.4.2.4, 9.4.3.4
  Engine fuel systems, 11.4.1.4, 11.4.1.14, 11.9.1.8
  Railroad tank car end of hose, 7.2.3.7(2)
  Refrigerated containers, 12.1.1.5
Backflow prevention device, 6.21.2.9
Balconies, LP-Gas systems on, 6.19.11.2
Bleeder valves *see* Valves
Bonding, 6.22.1.3, 13.3.5, 13.3.6
Breakaway devices, 6.24.4.2, 7.2.3.8(8), 11.7.5.2
Buildings/structures
  Bulk plants *see* Bulk plants
  Containers in, 6.19, A.6.19.2.7 to A.6.19.10.3
    Gas discharge from, 6.8.1.5
    Location, 6.2.2
    Storage of portable containers, 8.2.1.3 to 8.2.1.5, 8.3
    Venting of cylinders, 7.3.2.2
  Educational and institutional occupancies in, 6.19.7, Table 8.3.1(a)
  Flame effects before a proximate audience in, 6.19.10, 6.19.10.3
  Gas distribution facilities *see* Bulk plants
  Heating *see* Heaters and heating systems
  Industrial occupancies in *see* Industrial occupancies (plants)
  LP-Gas systems in, 6.19, A.6.19.2.7 to A.6.19.10.3
  Piping systems in, 6.9.1.1(4), 6.9.1.2, 6.9.1.3, 6.19.1.2(E), 6.19.2, 6.19.12, A.6.9.1.1(4), A.6.9.1.2, A.6.19.2.5, A.6.19.2.7
  Public, frequented by, Table 8.3.1(a), Table 8.3.1(b), 8.3.2, 9.7.3.1, 9.7.3.2, 9.7.3.5, 11.12.4.3(2), 11.13.2.3(B)
  Separation distances, 6.3
  Transfer operations, 6.5.1, 6.5.4.1, 6.5.4.3, 6.19.1.5, A.6.5.1
  Under construction or renovation, 6.19.4, 6.19.5, 8.4.3

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

Vaporizers in, 6.21.2, 6.21.3, 6.21.8.2 to 6.21.8.4
Vehicles used in, 11.12.4.2, 11.12.4.3; *see also* Parking and garaging of vehicles
Bulk plants
Buildings or structures housing, Chap. 10
Attached, 10.3.1
Construction of, 10.2.1
Rooms within, 10.3.2, A.10.3.2.6
Separate, 10.2
Container connections and appurtenances, 5.7.4.1, Table 5.7.4.2, 5.7.4.3
Definition, 3.3.10, A.3.3.10
Fire protection, 6.25.4.2
Lighting at, 6.18.5
LP-Gas system installation, 6.18, A.6.18.2.5
Liquid transfer facilities, 6.18.2, A.6.18.2.5
Operations and maintenance, Chap. 14
Stationary containers, transportation of, 9.6.2.2
Burning vaporizing *see* Vaporizers

C

Cabinet heaters, 5.20.8, 5.20.9
Canadian Transport Commission, A.5.2.1.1
Carburetion equipment, 11.5
Cargo tanks, 9.3.3.8, 9.4.2, D.2.4.1, D.2.4.4; *see also* Cargo tank vehicles
Appurtenances
Installation, 6.8.3.3
Protection, 5.2.6.2
Attachment to trailer or semitrailer, 5.2.7.2(B)
Definition, 3.3.11
Filling, 7.4.3.1(3)
Liquid level gauging devices, 5.7.5.7
Valves, 9.4.2.3, 9.4.2.4, 9.4.3, A.9.4.3.5
Cargo tank vehicles, 6.18.2.3, 6.19.1.5, Table 6.22.2.2, 6.26.4.1, 9.1.1(2), 9.4, A.9.4.3.5, A.9.4.7; *see also* Cargo tanks
Electrical equipment on, 6.22.2.6, 9.2
Filling, 7.2.3.8
Servicing and repair, 9.7.3.7
Unloading, 7.2.3.3
Carts, farm *see* Movable fuel storage tenders
CGA (definition), 3.3.12
Charging *see* Filling
Code
Definition, 3.2.3, A.3.2.3
Sample ordinance, Annex J
Coils, heating or cooling, 5.2.1.9
Components *see* Equipment
Compressors, 5.17.3, 5.17.6
Installation, 6.17.3
Mounted on vehicle, 9.4.1.2, 9.4.4.1
Operating controls or disconnect switches, 6.18.2.4
Portable, 5.17.3.4, 6.17.3.3, 6.17.3.5, 11.14.1.5
Vapor, Table 6.22.2.2
Connections
Bleed, 13.3.2
Engine fuel systems, 11.3.6, 11.7.5.2(I)
Hose, 5.9.6
LP-Gas system piping, 6.18.2.7
Pipeaway system, 11.7.5.2(I)
Connectors
Flexible *see* Flexible connectors
Quick, 5.9.6
Container appurtenances, 5.2.1.2(C), 5.7, A.5.7.1.2 to A.5.7.5.3
ASME containers, 6.26.3
Bulk plants, 5.7.4.1, Table 5.7.4.2, 5.7.4.3
Definition, 3.3.14
Engine fuel systems *see* Engine fuel systems
Fabrication, 5.7.1, A.5.7.1.2
Installation, 5.7.8, 6.7
Leaks, 5.2.3.3, 9.3.2.6, 9.3.3.5
Non-engine fuel systems, 6.23.3.1(F)
Protection
Physical damage, against, 5.2.6, 6.9.3.14, 9.3.3.4, 9.4.5, 9.6.2.2, 9.6.2.4, 9.6.2.5
Weather exposure, against, 6.8.1.4, 6.9.3.4, 6.9.3.5
Requirements for, 5.7.4, Table 5.7.4.1
Service pressure, 5.7.1.3
Container assembly (definition), 3.3.15
Containers, 5.2, A.5.2.1.1 to A.5.2.8.3; *see also* Cylinders
API-ASME *see* API-ASME containers (or tanks)
ASME *see* ASME containers
With attached supports, 5.2.7
Buildings, containers in *see* Buildings/structures
Capacity, 7.4.2, 11.3.5, A.7.4.2.2, A.7.4.2.4, Annex F; *see also* Water capacity, of containers
Corrosion and corrosion protection, 5.2.1.4, 5.2.3.3, 6.6.1(I), 6.6.6.1(H), 6.6.6.3(4), 6.16, A.6.16
Definition, 3.3.13
Demonstration use, 6.19.9, A.6.19.9.3
Design, 5.2.1.1, 11.3.1, A.5.2.1.1, A.11.3.1, D.2
Design pressure *see* Design pressure
DOT *see* DOT containers
Engine fuel systems *see* Engine fuel systems
Evacuating, 7.2.2, A.7.2.2.5
Fabrication, 5.2.1.1, 5.2.4 to 5.2.7, A.5.2.1.1, A.5.2.5.3 to A.5.2.5.7
Filling *see* Filling
Flotation due to flooding, anchoring to prevent, 6.6.1.6
Heater-cylinder units, 6.19.4.5 to 6.19.4.10
Horizontal *see* Horizontal containers
Impoundment, 6.4.5.3, 6.4.5.4, A.6.4.5.3
Industrial trucks *see* Industrial trucks
Installation, 6.6, 6.19.2, 6.19.11, 11.7, A.6.6.1.4 to A.6.6.6.3(4)
Insulation system *see* Insulation system
Leaks, 5.2.3.3, 9.3.2.6, 9.3.3.5
Liquid level gauges, 5.7.5, A.5.7.5.3
Location, 6.2, 6.3, 6.4.4.5, 6.4.5.4 to 6.4.5.10, 6.4.5.12, 11.7.3, A.6.4.5.8, Annex I
Marking *see* Marking
Mounded *see* Mounded containers
Nonrefillable, 7.2.2.8, 8.3.2.4
Openings, 5.2.5, 5.7.7.1, A.5.2.5.3 to A.5.2.5.7
Overfilling, 7.4.4, A.7.4.4; *see also* Overfilling prevention devices (OPD)
Painting, 6.6.1.4, A.6.6.1.4
Portable *see* Portable containers
Portable storage *see* Portable storage containers
Protection, 6.6.1.2, 6.25.3, 8.4.2, 8.4.3, 8.5, 9.3.2.6 to 9.3.2.9, 9.3.3.5, 9.3.3.6, 9.6.2.2, 11.7.1.2, A.6.25.3, A.8.4.2.1, A.8.4.2.2, A.8.5
Refrigerated *see* Refrigerated containers
Reinstallation or reuse, 5.2.1.2, 5.2.1.3, 11.3.1.4, 11.3.1.6
Removal from service *see* Removal from service
Repairs, 5.2.1.5, 5.2.3.1, 11.3.3
Roofs, on *see* Roofs
Service pressure *see* Service pressure
Small, 6.19.9, A.6.19.9.3
Storage containers, 6.4.1; *see also* Portable storage containers
Storage of containers *see* Cylinders, Storage of
Testing, 5.2.1.1, A.5.2.1.1, Annex H
DOT cylinder requalification, C.3.2
Refrigerated containers, 12.6
Training use, 6.19.9, A.6.19.9.3
Transfer operations *see* Transfer, LP-Gas liquid
Transportation of *see* Transportation of LP-Gas
Underground *see* Underground containers
Vehicles, on *see* Vehicles, containers on/in
Vertical, 5.2.4.3, 5.2.7.1, 6.6.4
Water capacity *see* Water capacity, of containers
Welding, 5.2.1.6
Cooling, of portable containers, 5.2.1.9

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

Corrosion and corrosion protection, 5.2.1.4, 5.2.3.3, 5.2.8.3(A), 6.16, A.6.16
Engine fuel systems, 11.3.3.1, 11.3.7, 11.9.1.9, A.11.3.7
Piping systems, 6.9.3.11
Underground and mounded containers, 6.6.6.1(H), 6.6.6.1(I), 6.6.6.3(4), 6.16.1, Annex K
CSST, maximum capacity of, Table 15.1(m), Table 15.1(n)
Cutting *see* Welding
Cylinders, 5.2.2, A.5.2.2.1; *see also* Containers
Appurtenances and connections
Installation, 6.9.3.2
Physical damage protection, 5.2.6.1
Requirements, Table 5.7.4.1
Composite, 5.2.1.1(C), 5.2.1.2(D), 5.7.2.3, 5.7.3.5, A.5.7.3.5
Buildings, on roofs, or on balconies, systems in, 6.19.1.1(3), 6.19.1.2(C)
Engine fuel systems, 11.3.1.4(D)
Definition, 3.3.16
Design, construction, and requalification of, Annex C
Filling, 7.4.3.1
Flame effects before a proximate audience, use for, 6.19.10.3, A.6.19.10
Industrial trucks, 11.12.2, 11.12.4.2 to 11.12.4.4
Installation, 6.6.2, 6.19.1.1, 6.19.3
Liquid level gauging devices, 5.7.5.6
Location, 6.2.2, 6.3.7, 6.3.8, Table 6.3.9, 8.2.1, 8.3.3.2, 8.3.4.2, 8.4.1.1 to 8.4.1.3, Fig. I.1(a)
Marking, 5.2.8.1, 5.2.8.2, 5.2.8.4, 5.7.5.5, 5.7.5.6, 6.4.5.11, A.5.2.8.2
Non-engine fuel systems, 6.23.3.1
Nonrefillable, 7.2.2.8
Overfilling, 7.4.4, A.7.4.4; *see also* Overfilling prevention devices (OPD)
Pressure relief devices, 5.7.2.2, E.1
Regulators, 6.8.1.2
Removal from service *see* Removal from service
Requalification for service, 5.2.1.2(A), 5.2.2.2, 5.2.3
Service pressure, 5.2.4.1, 5.2.4.5, 7.2.2.9(1)
Specifications, Table 4.1.1, Annex C
Storage of, Chap. 8
Within buildings, 6.19.1.3, 8.2.1.3 to 8.2.1.5, 8.3
Empty containers, 8.1.1, 8.2.1.4
Fire protection, 8.5, A.8.5
Outside buildings, 8.4, A.8.4.1 to A.8.4.2.2
Protection of containers, 8.2.1
Outside buildings, 8.4.2, 8.4.3, A.8.4.2.1, A.8.4.2.2
Valves, 8.2.1.2, 8.2.2
Transportation of, 6.19.1.4, 6.19.3.6, 9.3.1, 9.3.2
Use in buildings or on roofs or balconies, 6.19.1.2, 6.19.2, 6.19.4 to 6.19.11, A.6.19.2.5, A.6.19.2.7
Venting, 7.3.2.2

D

Definitions, Chap.3
Demonstrations, containers used in, 6.19.9, A.6.19.9.3
Department of Transportation *see* DOT
Design certification (definition), 3.3.17
Design pressure, 7.2.2.9
Refrigerated containers, 12.1.2.1
Vaporizers, 11.5.2.4, 11.5.2.7
Design temperature *see* Temperature, design
Detector, LP-Gas, 13.2.3.2
Devices *see* specific type, such as Dispensers
Diameter (definition), 3.3.18
Dikes *see* Impoundment
Direct gas-fired tank heaters, 5.21.4, 6.21.4.5
Definition, 3.3.19
Dispensers, vehicle fuel *see* Vehicle fuel dispensers
Dispensing stations, 5.2.1.8, 6.24, 8.4.1.2(5)
Container storage at, 8.1.1
Definition, 3.3.20
Protection
Physical damage, against, 6.24.3.12
Tampering, against, 6.24.3.7
Distributing plants *see* Bulk plants
Docks *see* Marine shipping and receiving
DOT
Cargo tank vehicle specifications, 9.4.3.1, 9.4.3.4
Compliance with regulations, 5.2.1.1, 9.3.2.10, 9.3.3.7, A.5.2.1.1, D.2.4
Containers *see* DOT containers
Definition, 3.3.21
DOT containers, 5.2.7.3, 9.3.1, 11.3.1.1, 11.3.1.4; *see also* Cylinders
Connection and appurtenance requirements, Table 5.7.4.1
Portable containers of more than 1000 lb (454 kg) water capacity, 9.3.3.2
Pressure relief valves, 5.7.2.2, 5.7.2.4
Requalification for service, 5.2.2.2, 5.2.3, 11.3.1.4(A)

E

Educational occupancies, 6.19.7, Table 8.3.1(a)
Electrical equipment
Cargo tank vehicles, 9.4.4.4
Ignition source control, 6.22.2, Table 6.22.2.2, A.6.22.2.2, A.6.22.2.3
Installation, 6.18.3
Marine terminals, 13.2.1.9, 13.2.1.10, 13.2.2, 13.2.3.3
Emergency shutoff valves *see* Valves
Enforcement of code, 1.7
Engine fuel systems, 6.19.1.5, 9.1.2(4), Chap. 11, A.9.1.2(4)
Carburetion equipment, 11.5
Container appurtenances, 5.7.4.1(E), 11.4, 11.7, 11.8.1.2, 11.8.1.3, A.11.8.1.2
Containers, 5.2.4.4, 6.2.2, 11.3, 11.7, A.11.3.1, A.11.3.7
Conversion to LP-Gas, 11.7.3.7
Floor maintenance machines, 11.13
As ignition sources, 7.2.3.2(A)
Not mounted on vehicles, 11.14
Portable engines, 6.2.2, 11.14.1.1
Trucks powered by LP-Gas, 11.12
Valves, 11.4.1.3 to 11.4.1.10
Engines, pump/compressor, 5.17.6
Equipment
Agricultural, 7.2.3.5, A.7.2.35(A)
Carburetion *see* Carburetion equipment
Electrical *see* Electrical equipment
Industrial, 7.2.3.5, A.7.2.35(A)
LP-Gas *see* LP-Gas equipment
Equivalency to code, 1.5
Evacuation *see* Filling
Excess-flow valves *see* Valves
Exhaust systems, cargo vehicle, 9.4.9
Extinguishers, portable fire, 6.23.8, 6.25.4.2, 7.2.3.8(4), 8.5, 9.3.5, 9.4.7, 13.2.1.13, 14.3.3.4, A.8.5, A.9.4.7

F

Facilities
Bulk/gas distribution *see* Bulk plants
Liquid transfer, installation of, 6.18.2, A.6.18.2.5
Fail-safe product control, redundant, 6.26.4
Farm carts *see* Movable fuel storage tenders
Fences, 6.4.7, 6.18.4.2, A.6.4.7
Filling, Table 6.22.2.2, 7.2.2, 7.4.2.2, 7.4.2.3, 8.4.1.4, 14.2.2.3, A.7.2.2.5; *see also* Transfer, LP-Gas liquid
Alternate method, F.5.2
Ignition sources, 6.22.3.1, 6.22.3.2
Nonstationary installations, 6.5.4
Quantity of LP-Gas, 7.4, A.7.4.2.2 to A.7.4.4
Stationary installations, 6.3.10, 6.5.2
Volumetric *see* Volumetric method filling
Weight *see* Weight method filling
Fire blankets, 13.2.3.5
Fire protection, 6.23.8, 6.25, A.6.25.2 to A.6.25.5.1
Containers, 6.19.11.1, 8.5, A.8.5

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

Definition, 3.3.23, A.3.3.23
Maintenance of fire protection equipment, 14.3.3
Roofs, on, 6.19.11.1
Special, 6.25.5, A.6.25.5.1
Storage within buildings, 8.3.2.1
Fire walls, 6.4.7, A.6.4.7
Fittings, 5.9, A.5.9.5
Cargo tank vehicles, 9.4.3, A.9.4.3.5
Engine fuel systems, 11.6.2
Installation, 6.9.3, 6.9.4, A.6.9.3.1, A.6.9.4.5
Materials, 5.9.4
Polyethylene and polyamide pipe and tubing, 5.9.5, A.5.9.5
Protection of, 9.6.2.2
Fixed piping system (definition), 3.3.24; *see also* Piping and piping systems
Flame effects before a proximate audience, 6.19.10, 6.19.10.3
Flames, open *see* Open flames
Flexible connectors, 5.9.6, 6.19.2.6
Cargo tank vehicles, 9.4.3, A.9.4.3.5
Definition, 3.3.25
Flexible hose connectors, 6.8.1.2, 6.9.6.2
Flexible metallic connectors, 6.8.1.1, 6.8.1.2, 6.9.6.2
Definition, 3.3.25.2
Installation, 6.9.6.1
Non-engine fuel systems, 6.23.5.1
Regulator installation, 6.8.1.1
Floor maintenance machines, 11.13
Flow indicators, 5.17.1.3(B), 5.17.7
Food service appliances, 6.19.9.4
Emergency use in buildings, 6.19.8
Storage of butane nonrefillable containers, 8.3.2.3
Forklift trucks *see* Industrial trucks
Fuel systems, engine *see* Engine fuel systems
Fusible plug devices, 5.7.2.13, 5.21.2.4, 5.21.3.3, 5.21.5.5, 5.21.6.4, 11.4.1.7(A), 11.5.2.5

G

Gallon. U.S. Standard (definition), 3.3.26
Garaging of vehicles *see* Parking and garaging of vehicles
Gas
Definition, 3.3.27
Liquefied petroleum *see* LP-Gas
Gas–air mixers, 5.21.8, Table 6.22.2.2
Definition, 3.3.28, A.3.3.28
Installation, 6.21.8
Gas distribution facilities *see* Bulk plants
Gaskets, 5.7.1.4, 6.9.3.5, 12.3.3.4 to 12.3.3.6
Gas tank heaters *see* Direct gas-fired tank heaters
Gas vaporization *see* Vaporizers
Gauges, 9.7.3.5, 11.3.6.4
Bleeding of product, 5.7.5.10
Fixed liquid level, 5.7.5.10, 7.3.1(1)
Definition, 3.3.29.1
Fixed maximum liquid level, 5.2.5.7, 5.7.3.1 to 5.7.3.3, Table 5.7.4.1, 5.7.4.4, 5.7.5.2 to 5.7.5.4, 5.7.5.6, 5.7.5.7, 6.26.5.1, 6.26.5.2, A.5.2.5.7, A.5.7.3.2, A.5.7.5.3, F.5.3
Definition, 3.3.29.2
Engine fuel systems, 11.4.1.5, 11.4.1.6, 11.12.2.3
Liquid transfer from containers, 7.4.3.2
Vent location, 6.3.10
Float (magnetic), Table 5.7.4.1, 5.7.4.4, 5.7.5.2, 5.7.5.8, 6.26.5.2, 11.4.1.11
Definition, 3.3.29.3
Liquid level, 5.7.5, 5.7.8.1, 5.7.8.5(B), 12.4.1, A.5.7.5.3
Pressure *see* Pressure gauges
Protection of, 5.7.8.2
Rotary, 5.7.4.4, 5.7.5.2, 5.7.5.8, 5.7.5.10, 7.3.1(1)
Definition, 3.3.20.5
Slip tube, 5.7.4.4, 5.7.5.2, 5.7.5.10, 7.3.1(1)
Definition, 3.3.29.6, A.3.3.29.6
Temperature, 5.7.4.4
Variable liquid level, 5.7.1.2, 5.7.5.2, 5.7.5.8, 5.7.5.9, 7.4.3.2, 7.4.3.3, A.5.7.1.2
General requirements, Chap. 4
GPA (definition), 3.3.30
Grounding, 6.9.3.15, 6.22.1.3

H

Heater-cylinder units, 6.19.4.5 to 6.19.4.10
Heaters and heating systems
Buildings or structures, 10.2.3, 10.3.1.5, 10.3.2.8
Portable, 6.19.2.7, 6.19.2.8, A.6.19.2.7
Temporary/emergency, 6.19.2.7, 6.19.2.8, 6.19.6.2, 6.19.6.3, 6.19.8, A.6.19.2.7
Patio heaters, 6.20.2
In storage containers, 5.2.1.9
Tank heaters, 5.21.4, 6.21.4
Unattended, 5.20.3
On vehicles, 5.20.7, 6.23.7.3 to 6.23.7.6, A.5.20.7, A.6.23.7.6
Water, 5.20.7, A.5.20.7
High-liquid-level alarm/cutoff devices, 12.4.1.3 to 12.4.1.8
Horizontal containers, 5.7.3.6, 6.6.3
Horizontal filling, 5.7.5.6(B)
Hose, 5.9.6
Buildings, use in, 6.19.2.6, 6.19.12.2(H)
Cargo tank vehicles, 9.4.2.3, 9.4.3, 9.4.4.5, A.9.4.3.5
Delivery, 9.7.3.3, 9.7.3.4, 9.7.3.6
Dispensing, 6.24.3.5, 6.24.3.6, 6.24.3.13, 6.24.4.1
Engine fuel systems, 11.6.3, 11.12.3
Hydrostatic relief valve installation, 6.13
Inspection, 7.2.4
Installation, 6.20.3, 11.9
Low emission transfer, 6.26.5.2
Physical damage, protection against, 6.20.3.8
Protection, 6.18.2.6
Transfer, 6.5.1.4, 6.18.2.6, 6.18.2.7, 7.2.2.12, 7.2.3.7, 7.2.4
Trucks, 11.12.3
Vehicle engines, 11.7.5.2
Hose connections, 5.9.6, 6.19.2.6
Hydrostatic relief valves, 5.13, 6.13, 6.19.12.2(I), 6.23.5.1(L), 6.24.3.6, 11.9.2

I

ICC, 5.2.1.1(B), 11.3.1.3, A.5.2.1.1, Annex C, D.2.4
Definition, 3.3.31
Ignition sources *see* Sources of ignition
Impoundment, 6.4.5.3, 6.4.5.4, 6.4.6, 12.5, A.6.4.6
Refrigerated containers, 12.7.3
Incident reports, Small LP-Gas systems (SLGS), 14.4.3, A.14.4.3.1
Industrial occupancies (plants)
Buildings housing, 6.19.6
Container connections and appurtenances, 5.7.4.1, Table 5.7.4.2, 5.7.4.3, 6.8.1.4(B)
Definition, 3.3.33
Fire protection, 6.25.4.2
Indirect-fired vaporizers, 6.21.2.8
LP-Gas system installations, 6.18, A.6.18.2.5
Operations and maintenance, Chap. 14
Storage of LP-gas in, Table 8.3.1(b)
Industrial trucks, 5.7.3.6, 6.2.2, 11.3.2.2, 11.12, 11.13.2.1
Overfilling prevention devices (OPD), use of, 5.7.4.1(E)
Pressure relief valves, 5.7.2.13
Inspections
Corrosion protection, underground tanks, K.3
Hose, 7.2.4
Marine shipping and receiving, prior to transfer at, 13.4, A.13.4.1
Refrigerated containers, 12.6
Installation, LP-Gas systems, Chap. 6
Appliances, 6.19.2, 6.20, 6.23.7
Balconies, exterior, 6.19.11.2
Buildings, 6.19, A.6.19.2.7 to A.6.19.10.3
Bulk plants, 6.18, A.6.18.2.5
Container appurtenances, 6.7

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

Containers *see* Containers
Dispensers and dispensing stations, vehicle fuel, 6.24
Engine fuel systems, Chap. 11
Equipment, 6.17, 6.22.2, 6.23.6, A.6.22.2.2, A.6.22.2.3
Fire protection, 6.25, A.6.25.2 to A.6.25.5.1
Ignition source control, 6.22, A.6.22.1.2 to A.6.22.2.3
Industrial plants, 6.18, A.6.18.2.5
Multicontainer, 6.3.6, 6.3.11, 6.4.2, 6.4.3
Nonstationary, 6.5.4
Notification of, 4.3
Piping systems *see* Piping and piping systems
Plans, submission of, 4.3.1
Regulators, 6.8.1, 6.8.2, A.6.8.2(H)
Roofs, 6.19.11.1
Stationary *see* Stationary (fixed or permanent) installations
Temporary, 4.3.2, 6.6.5, 6.19.8
Transfer facilities, 6.18.2, A.6.18.2.5
Underground containers *see* Underground containers
Vaporizers, 6.21, 6.22.3.2
Vehicles, 6.23, Chap. 11, A.6.23.1, A.6.23.7.6
Institutional occupancies, 6.19.7
Insulation system, 5.2.8.3(B), 6.25.5.1, A.6.25.5.1, Annex H
Internal valves *see* Valves
Isolation valves, 13.3.2

J

Joints, 5.9.5, 6.9.3.5, 9.4.3.2, A.5.9.5

K

Kettles, portable tar, 6.19.2.8, 6.23.3.5
kPa (definition), 3.3.34
kPag (definition), 3.3.35

L

Labeled (definition), 3.2.4
Labeling *see* Marking
Life safety, 6.25.2.2
Marine shipping and receiving facilities, 13.2.1.6, 13.2.1.7, 13.2.1.13, 13.2.3.5
Small LP-Gas systems (SLGS), 14.4.2 to 14.4.9, 14.4.12, 14.4.13, A.14.4.3.1, A.14.4.7
Lighting
Bulk/industrial plant, 6.18.5
Marine terminals, 13.2.1.9, 13.2.1.10
Transfer operations, 7.2.3.2(B)
Vehicles, 9.2
Lightning protection, 6.22.1.2
Liquefied petroleum gases *see* LP-Gas
Liquid meters, 6.17.5, 9.4.4.5(A)
Liquid transfer *see* Transfer, LP-Gas liquid
Liquid volume tables, computations, and graphs, Annex F; *see also* Volumetric method filling (loading)
Listed (definition), 3.2.5, A.3.2.5
Loading *see* Filling
Low emission transfer, 6.5.4.4, 6.24.4.3, 6.26.5, 11.4.1.6
Definition, 3.3.37, A.3.3.37
LP-Gas
Definition, 3.3.36
Odorization, 4.2, 5.2.8.5, A.4.2.1, A.4.2.3
Properties of, Annex B
Refrigerated *see* Refrigerated containers
LP-Gas equipment, 5.17, Chap. 5
Acceptance of, 4.1
Building installations, 6.19.3
Fabrication, 5.17.1.3
Installation, 6.17, 6.22.2, 6.23.6, A.6.22.2.2, A.6.22.2.3
Protection of, 9.4.5
Vehicle installations, 6.23.6, 9.4.4, 11.10, 11.13.1.1
LP-Gas systems
Acceptance of, 4.1, Table 4.1.1
Definition, 3.3.38
Installation *see* Installation, LP-Gas systems
Location, Chap. 6
Protection against tampering, 6.18.4
Small LP-Gas systems (SLGS), 14.4, A.14.4

M

Maintenance, Chap. 14
Manholes, 5.7.8.4
Manufactured home installations, 6.8.2(A)
Marine shipping and receiving, Table 6.22.2.2, Chap. 13
Design and construction, 13.2.1, A.13.2.1.1
General cargo, 13.2.1.2
Inspections prior to transfer, 13.4, A.13.4.1
Operations and maintenance, Chap. 14
Pipelines, 13.3, A.13.3.1
Transfer procedures, 13.2.3, 14.2.1, A.14.2.1
Valving and connections, 13.3.2
Marking
Bleeder valves, 11.4.1.6
Container, 5.2.1.1, 5.2.8, 11.3.1.1, 11.3.4, 11.7.1.4, A.5.2.1.1, A.5.2.8.2, A.5.2.8.3
Container connections, 5.7.8.5
Cylinders, 6.4.5.11
Direct gas-fired tank heaters, 5.21.4.2
Fixed liquid level gauges, 5.7.5.4
Floor maintenance machinery, 11.13.2.3(A)
Pressure relief valves, 5.7.2.9, 11.3.6.3, 11.3.6.4, 11.4.1.9
Refrigerated containers, 12.2
Vaporizers, 5.21.2.1, 5.21.3.1, 5.21.6.1
Vaporizing burners, 5.21.5.2
Variable liquid level gauges, 5.7.5.7, 5.7.5.8
Vehicles, 9.4.6, 11.11, A.11.11.2.2; *see also* Placards
Maximum allowable working pressure (MAWP)
ASME containers, 5.2.4.2, 5.2.4.3(B), 5.2.4.4, 6.23.3.1
Engine fuel and mobile containers, 11.3.2
Filling and evacuating containers, 7.2.2.9(2)
Carburetion equipment, 11.5.1
Definition, 3.3.39
Vaporizers, 11.5.2.3
Mercantile occupancies, Table 8.3.1(b)
Metal parts, pressure-containing, 5.17
Meters, 5.17.1.3(C)
Liquid, 6.17.5.1, 6.17.5.2, 9.4.4.5(A)
Small LP-Gas systems (SLGS), 14.4.1.2
Minimum design metal temperature (definition), 3.3.40; *see also* Temperature, design
Minimum requirements, 4.6, A.4.6
Mixers, gas–air *see* Gas–air mixers
Mobile containers, 5.2.4.4, 6.23.3; *see also* Vehicles, containers on/in
Definition, 3.3.41
Maximum allowable working pressure (MAWP), 11.3.2
Mobile homes, appliances in, 5.20.6, 6.8.2(A), A.5.20.6
Mobile units
Portable units, general provisions for, 11.13
Safety precautions for, 6.23.8
Monitor nozzles, 6.25.6.3
Mounded containers, 6.6.6.3, 6.25.5.3, Annex K
Corrosion and corrosion protection, 6.6.6.3(4), 6.16.1, Annex K
Definition, 3.3.42
Flotation due to flooding, anchoring to prevent, 6.6.1.6
Location, 6.4.4
Marking, 5.2.8.3(B)
Pressure relief devices/valves, 5.7.2.8
Separation distances, Table 6.3.1, 6.3.4, 6.26.2
Movable fuel storage tenders, 9.3.4, 9.5
Definition, 3.3.43, A.3.3.43
Supports, 5.2.7.2, 5.2.7.2(D)
MPa (definition), 3.3.45

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7,'2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

MPag (definition), 3.3.45
Multipurpose passenger vehicles (definition), 3.3.46

N

NFPA (definition), 3.3.47
Nozzles, monitor, 6.25.6.3
NPGA (definition), 3.3.48

O

Odorization of LP-Gas, 4.2, 5.2.8.5, 14.4.5, A.4.2.1, A.4.2.3
One call notification center, 14.4.2.1, 14.4.2.2
Open flames, 6.9.3.6, 6.22.2.5, 6.22.3.1, 6.22.3.3, 6.22.3.4, 7.2.3.2(B), 7.2.3.5(B), 11.15
Operating pressure *see* Working pressure
Operations, Chap. 14; *see also* Transfer, LP-Gas liquid
  Small LP-Gas systems (SLGS), 14.4.10
Overfilling, 7.4.4, A.7.4.4
Overfilling prevention devices (OPD), 5.7.3, Table 5.7.4.1, 5.7.4.1(E), 5.7.4.1(G), 6.26.5.2(F), 7.4.4.1, 11.4.1.13 to 11.4.1.15, A.5.7.3.2
Overpressure shutoff devices/valves, 5.8.1.1, 5.8.1.2, 5.8.1.11, 6.8.2(E), 6.8.2(F)
  Definition, 3.3.50

P

Painting
  Cargo tank vehicles, 9.4.6
  Containers, 5.2.3.3, 6.6.1.4, A.6.6.1.4
  Engine fuel containers, 11.3.7
Parking and garaging of vehicles, 6.23.9, 7.2.3.4, 8.3.3.4, 9.7, 11.15, 13.2.1.4
Passenger-carrying vehicles, 6.23.3.1, 6.23.3.4(I), 6.23.7, 11.3.2.2, A.6.23.7.6
  Multipurpose passenger vehicles (definition), 3.3.46
Patio heaters, 6.20.2
Permanent installation *see* Stationary (fixed or permanent) installations
Permitted (definition), 3.3.52
Personnel
  LP-Gas liquid transfer, 7.2.1, 7.2.2.1, 7.2.3.8(5)
  Marine facilities, 13.2.1.6, 13.2.1.7, 13.2.1.13, 13.2.3.5
  Qualifications, 4.4, 14.4.10, A.4.4
  Safety, planning for, 6.25.2.2; *see also* Life safety
Piers *see* Marine shipping and receiving
Pipeaway system, 11.7.5.2
Pipelines, marine terminal, 13.3, A.13.3.1
Piping and piping systems, 5.9, 6.9, Table 6.22.2.2, A.5.9.5, A.6.9.1.1(4) to A.6.9.6.2
  Aboveground, 6.9.3.10, 6.9.3.11
  Buildings, liquid into *see* Buildings/structures
  Cargo tank vehicles, 9.1.1, 9.4.3, 9.4.5, A.9.1.1(3), A.9.4.3.5
  Definition, 3.3.53
  Discharge, 6.7.4, 6.8.1.5, 6.8.3.7, 6.8.3.11 to 6.8.3.15, 6.9.3.4
  Dispensers, 6.24.3.5, 6.24.3.6
  Fittings *see* Fittings
  Hydrostatic relief valve installation *see* Hydrostatic relief valves
  Installation, 6.9.3 to 6.9.5, 6.19.2, 6.21.8.1, A.6.9.3.1, A.6.9.4.5
  Joints *see* Joints
  Materials, 5.9.1.1, 5.9.3
  Non-engine fuel systems, 6.23.5
  Polyethylene and polyamide, 5.8.3.2, 5.9.5, 5.12.6, 6.9.1.1(3), 6.9.4, 6.9.5, 14.4.11.2, A.5.9.5, A.6.9.4.5
    Tables for sizing, Table 15.1(o) to Table 15.1(q)
  Protection of, 6.9.3.10, 6.9.3.11, 6.9.3.14, 9.4.5
  Refrigerated containers, 12.3.3
  Regulator venting, 5.8.3, A.5.8.3
  Service limitations, 6.9.1, A.6.9.1.1(4), A.6.9.1.2
  Sizing
    Tables for sizing, Chap. 15
    Vapor piping systems, 6.9.2
  Small LP-Gas systems (SLGS), 14.4.2, 14.4.4, 14.4.11
  Testing, 6.14, 11.9.1.10
  Underground *see* Underground piping
  Valves *see* Valves
  Vehicle engines, 11.6, 11.9
Placards, 9.3.2.10, 9.3.3.7, 9.4.6.2
Plants
  Bulk/distributing *see* Bulk plants
  Industrial *see* Industrial occupancies (plants)
Plugs, 5.7.7.1, 11.4.1.12, 11.5.2.6; *see also* Fusible plug devices
Point of transfer, 6.5.3, 6.5.4, 6.18.2.1, 6.18.2.2, 7.2.3.2, 7.2.3.5(A), 7.2.3.8(7), A.7.2.3.5(A)
  Cargo tank vehicles/railroad tank car, 6.18.2.3, 6.26.4.1, 9.4.10(2)
  Definition, 3.3.54
  Pier or dock, 13.2.1.2
  Tank heater location and, 6.21.4.5
Portable appliances
  Hose for, 6.20.3
  Regulators for, 6.8.1.7, 6.8.2(C)
Portable containers; *see also* Cylinders; Portable storage containers
  Appurtenances, protection against physical damage of, 5.2.6
  Definition, 3.3.55, A.3.3.55
  Indoors, 6.19, A.6.19.2.7 to A.6.19.10.3
  Installation, 6.6.5
  Location, 6.2, 6.19, A.6.19.2.7 to A.6.19.10.3
  Non-engine fuel systems, 6.23.3.1
  Outlet seals, 7.2.2.5, 7.2.2.6, A.7.2.2.5
  Regulators on, 6.8.1.2, 6.8.1.4(B), 6.8.1.7
  On roofs, 6.19.11.1
  Separation distances, 6.3.1
  Transportation of LP-Gas in, 9.3
Portable engines *see* Engine fuel systems
Portable multicontainer systems, 5.7.8.3
Portable (skid) tanks, 5.2.7.2, 5.2.7.3, D.2.4.1, D.2.4.4
  Container appurtenances, 6.9.3.3
  Definition, 3.3.57
  Filling, 7.4.3.1(3)
Portable storage containers
  Container appurtenances, 6.9.3.3
  Definition, 3.3.56, A.3.3.56
  Installation, 6.6.5
  Supports, 5.2.7.2
Powder coating, engine fuel containers, 11.3.7
Pressure-containing metal parts, 5.17
Pressure gauges, 5.2.5.5, 5.7.4.4, 5.7.6, 5.7.8.5(B), 5.7.8.6, A.5.2.5.5
Pressure relief devices/valves, 5.7.2, 5.7.8.1, 6.8.1.1, 6.8.1.2, 6.9.3.4, Annex E
  Connections, 5.2.5.6, 11.3.6
  Definitions, 3.3.58, 3.3.74.5, A.3.3.74.5.1 to A.3.3.74.5.4
  External, 5.7.4.1(A), Table 5.7.4.1, 5.7.4.4
    Definition, 3.3.74.5.1
  Fire exposure sizing, 12.8.4
  Flush-type full internal, Table 5.7.4.1, 5.7.4.4, 11.4.1.7, 11.4.1.10
    Definition, 3.3.74.5.2, A.3.3.74.5.2
  Full internal, Table 5.7.4.1
    Definition, 3.3.74.5.3, A.3.3.74.5.3
  Installation, 6.8.3
  Internal spring-type, Table 5.7.4.1, 5.7.4.1(A), 5.7.4.4, 5.21.2.4, 5.21.3.2, 5.21.3.3, 5.21.6.4
    Definition, 3.3.74.5.4, A.3.3.74.5.4
  Marking, 5.7.2.9
  Position of, 6.3.7, 6.3.9, 6.3.10, 6.6.1.1, 6.9.3.3, 8.2.1.2, 9.6.2.5

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

Vaporizers, 6.21.3.3
Vehicular transportation, for, 9.3.3.6
Protection, 11.7.5.2(J)
Refrigerated containers, 12.8
Regulator, 5.8.1.1, 5.8.1.2, 5.8.1.5 to 5.8.1.8, 5.8.1.11
Testing, E.2.3
Vaporizer, 5.21.9, 6.21.2.3
Vaporizing burners, 5.21.5.4, 5.21.5.5
Vehicles, 6.23.4.1, 9.5.2.5, 9.6.2.5, 11.4.1.7, 11.4.1.9, 11.7.5, 11.12.2.4, 11.12.2.6, 11.12.4.4
Psia (definition), 3.3.60
Psi (definition), 3.3.59
Psig (definition), 3.3.61
Pumps, 5.17.2, 5.17.6, 6.17.2, 6.18.2.4, Table 6.22.2.2, 6.24.3.4, 7.3.1(5), 9.4.1.2, 9.4.4, 11.14.1.5, 12.5.8.1
Purging, 7.3.1(6), 7.3.2, 9.7.3.7, 12.3.3.3, 13.4.6

Q

Quick connectors, 5.9.6
Definition, 3.3.62

R

Railroad tank cars *see* Tank cars
Recreational vehicles, 6.23.3.1
Appliances in, 5.20.6, 6.8.2(A), A.5.20.6
Engine fuel containers, 11.3.2.2
Redundant fail-safe product control, 6.26.4
References, Chap. 2, Annex L
Refrigerated containers, 6.4.6, Table 6.22.2.2, Chap. 12, 14.2.1.4, A.6.4.6
Construction and design, 12.1
Foundations, 12.3.4, A.12.3.4.2
Impoundment, 12.5
Inspections and tests, 12.6
Instruments and controls, 12.4
Marking, 12.2
Pressure and vacuum control, 12.4.2
Relief devices, 12.8
Siting, 12.7
Transfer of refrigerated product, 7.2.2.10
Refrigerated LP-Gas (definition), 3.3.63
Regulators, 5.8, 6.8, 6.19.2.2, A.5.8.3, A.6.8.2(H)
Automatic changeover (definition), 3.3.64.1, A.3.3.64.1
Carburetion equipment, 11.5.3.2
Engines not on vehicles, 11.14.1.4
Fabrication, 5.17.1.3
First-stage, 5.8.1.6, 5.8.1.7, 5.8.1.9, 6.8.1.1, 6.8.1.3, 6.8.2(D), 6.9.2.1
Definition, 3.3.64.2
Pipe sizing between first- and second-stage regulators, Table 15.1(a), Table 15.1(d), Table 15.1(f), Table 15.1(h), Table 15.1(k), Table 15.1(o), Table 15.1(p)
High-pressure, 5.8.1.3, 5.8.1.5, 5.8.1.8, 6.8.1.1, 6.8.1.3, 6.8.2, A.6.8.2(H)
Definition, 3.3.64.3
Hose use with, 6.20.3.1
Installation, 6.8.1, 6.8.1.1, 6.8.1.2, 6.8.2, A.6.8.2(H)
Integral 2-psi service (definition), 3.3.64.4
Integral two-stage, 5.8.1.2 to 5.8.1.5, 6.8.2, A.6.8.2(H)
Definition, 3.3.64.5
Line pressure, 6.8.1.8, 6.8.2(H), A.6.8.2(H)
Definition, 3.3.64.6
Pipe sizing between 2-psi service and line pressure regulator, Table 15.1(b), Table 15.1(i)
Non-engine fuel systems, 6.23.4.2
Protection, 5.7.8.2, 6.8.1.4
Second-stage, 5.8.1.2, 6.8.1.1, 6.8.1.2, 6.8.2(D)
Definition, 3.3.64.7
Pipe sizing between first- and second-stage regulators, Table 15.1(a), Table 15.1(d), Table 15.1(f), Table 15.1(h), Table 15.1(j), Table 15.1(k), Table 15.1(o), Table 15.1(p)
Pipe sizing between second-stage regulator and appliance, Table 15.1(c), Table 15.1(e), Table 15.1(g), Table 15.1(l)
Pipe sizing between second-stage regulator and building, Table 15.1(q)
Selection of, 6.8.2, A.6.8.2(H)
Single-stage, 5.8.1.1, 6.8.1.7, 6.8.2, A.6.8.2(H)
Definition, 3.3.64.8
Pipe sizing between first- and second-stage regulators, Table 15.1(j)
Small LP-Gas systems (SLGS), 14.4.1.2
2 psi regulator system, 6.8.2, A.6.8.2(H)
Definition, 3.3.64.9
2 psi service, 5.8.1.11, 6.8.2(H), A.6.8.2(H)
Definition, 3.3.64.10
Pipe sizing between 2 psi service and line pressure regulator, Table 15.1(b), Table 15.1(i)
Two-stage regulator system, 5.8.1.8, 6.8.2, A.6.8.2(H)
Definition, 3.3.64.11
Vaporizing burners, 5.21.5.9, 5.21.5.10
Vehicles, 9.4.4.5, 11.10.1.2
Venting, pipe for, 5.8.3, A.5.8.3
Remote shutoff controls, 5.7.4.2, 5.12.4, 6.10, 6.11.4, 6.11.5, 6.18.2.4(C), 6.24.3.8 to 6.24.3.11, 6.26.3.3, 6.26.4.3, 7.3.1(8), 9.4.3.4, A.6.10(3)
Removal from service, 5.2.1.4, 11.3.3.1
Residential buildings, storage within, Table 8.3.1(a), 8.3.2, 8.3.5
Retroactivity of code, 1.4
Roofs
Containers on, 4.3.1, 6.6.7, 6.19.11, 8.2.1.5
Fire protection for containers on, 6.25.3.1
LP-Gas systems on, 6.19.11
Rooms, within structures, 8.3.4, 10.3.2, A.10.3.2.6

S

Safety, operational, 7.2, A.4.6, A.6.1.3, A.7.2.2.5, A.7.2.3.5(A)
Safety, personnel *see* Life safety
SCFM, 5.7.2.6, 5.7.2.9
Definition, 3.3.70
Scope of code, 1.1, A.1.1
Security provision, 6.18.4
Seismic loading
ASME containers, 5.2.4.3(D)
Refrigerated containers, 12.3.2
Semitrailers, 5.2.7.2(B), 9.5
Separation
Container pressure relief valve and building openings, 6.3.7, 6.3.9, Table 6.3.9, 6.3.10
Containers, 6.3, 6.4.4.5, 6.4.5.4 to 6.4.5.10, 6.4.5.12, 6.26.2, A.6.4.5.8
Cylinders in storage, 8.3.3.2, 8.3.4.2, 8.4.1.1 to 8.4.1.3
Refrigerated containers, 12.7
Tank heaters, 6.21.4.1, Table 6.21.4.1
Transfer points, 6.5.3, Table 6.5.3
Vaporizers, 6.21.2.11, 6.21.3.6, Table 6.21.3.6
Vaporizing burners and containers, 6.21.5.2, Table 6.21.5.2
Service head adapter (definition), 3.3.65
Service pressure, 5.2.4, 7.2.2.9, A.5.2.4.4
Container appurtenances, 5.7.1.3
Fittings, 11.6.2.2, 11.6.2.3
Pipe, tubing fittings, and valves, 5.9.1.4, 5.9.4.1, Table 5.9.4.1, 5.12.2
Pressure-containing metal parts, 5.17.1.2
Recreational vehicles, cylinders on, 6.23.3.1(B)
Small LP-Gas systems (SLGS), 14.4.11.3
Shutoff valves *see* Valves
Sight flow glasses, 5.17.7
Skid (portable) tanks *see* Portable (skid) tanks
Small LP-Gas systems (SLGS), 14.4, A.14.4
Application, 14.4.1

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

Construction records, maps and operating history, 14.4.6
Consumer education, 14.4.13
Damage prevention, 14.4.2
Incident reporting, 14.4.3, A.14.4.3.1
Interruption of service, 14.4.9
Key valve maintenance, 14.4.7, A.14.4.7
Leaks
Response to reports of, 14.4.9
Survey, 14.4.12
Testing, 14.4.8
Odorization, 14.4.5
Operator qualification and covered tasks, 14.4.10
Piping system service limitations, 14.4.4, 14.4.11
Smoking, 7.2.3.2(B), 9.4.10
Snowfall, heavy, 6.15
Sources of ignition, 6.3.10
Control, 6.18.6, 6.22, 7.2.3.2, 7.2.3.8, A.6.22.1.2 to A.6.22.2.3
Definition, 3.3.67
Garaging of vehicles, 11.15
Piers, 13.2.1.9 to 13.2.1.12
Point of discharge, distance from, 6.8.1.6
Special buildings, storage within, 8.3.4
Special protection, 6.25.5, A.6.25.5.1
Definition, 3.3.68, A.3.3.68
Sprinkler systems, 6.19.11.1, 8.3.2.1
Standard cubic foot (SCF) (definition), 3.3.69
Stationary engines, 11.14
Stationary (fixed or permanent) installations, 4.3.1
Containers in, 6.5.2
Definition, 3.3.71
Regulator installation, 6.8.1.1
Tank supports, 5.2.7.1
Storage, refrigerated *see* Refrigerated containers
Storage occupancies, Table 8.3.1(b)
Storage of cylinders *see* Cylinders
Strainers, 5.17.1.3(B), 6.17.4
Structures *see* Buildings/structures
Swivel-type piping, 6.12.2 to 6.12.6, 6.18.2.6, 7.2.3.7

T

Tank cars, 6.12.11, 6.18.2.3, 6.18.2.6, Table 6.22.2.2, 6.26.4.1, 7.2.3.6 to 7.2.3.8
Tank heaters, 5.21.4, 6.21.4
Tanks *see* API-ASME containers (or tanks); ASME containers; Cargo tanks; Containers; Portable (skid) tanks
Tar kettles, 6.19.2.8, 6.23.3.5
Temperature, design
Minimum design metal temperature (definition), 3.3.40
Refrigerated containers, 12.1.2
Temperature gauge, 5.7.4.4, 12.4.1.9
Temporary container installations, 4.3.2, 6.6.5, 6.19.8; *see also* Portable containers
Tenders, movable fuel storage *see* Movable fuel storage tenders
Tests
Containers *see* Containers
Hose assembly pressure test, 5.9.6.5
Hose stream resistance, H.4
Insulation, container, Annex H
Piping and piping systems, 6.14, 11.9.1.10
Pressure relief devices/valves, E.2.3
Thermal insulation, H.3
Tractors, 6.23.5.2, 11.9.1.11
Trailers, 5.2.7.2(D), 9.1.1(2), 9.5
Attachment of tank to, 5.2.7.2(B)
Fuel connection to tractor, 6.23.5.2, 11.9.1.11
Training, 4.4, 6.19.9, 11.2, A.4.4, A.6.19.9.3
Transfer, LP-Gas liquid, 6.19.1.5, Chap. 7
Arrangement of systems, 7.2.3, A.7.2.3.5(A)
Cargo tank vehicles, 7.2.3.3 to 7.2.3.5, 7.2.3.8, 9.1.1(3), 9.4, A.7.2.3.5(A), A.9.1.1(3), A.9.4.3.5, A.9.4.7
Containers, 7.2.2, 7.4, A.7.2.2.5, A.7.4.2.2 to A.7.4.4
Nonstationary installations, 6.5.4
Stationary installations, 6.5.2
Facilities, installation of, 6.18.2, A.6.18.2.5
Ignition source control, 7.2.3.2
Location, 6.5, A.6.5.1
Low emission transfer *see* Low emission transfer
Marine terminals, Chap. 13
Notification of intent for transfer, 4.3.3
Operations, 7.2.3, 14.2.1, A.7.2.3.5(A), A.14.2.1
Personnel, 4.4, 7.2.1, 7.2.2.1, 7.2.3.8(5), A.4.4
Safety, 7.2, A.7.2.2.5, A.7.2.3.5(A)
Venting, 7.3
Transfer personnel, 7.2.3.8(5)
Transfer point *see* Point of transfer
Transportation of LP-Gas, 6.19.1.5, Chap. 9
Cylinders, 6.19.1.4, 6.19.3.6, 9.3.1, 9.3.2
Extinguishers, portable fire, 9.3.5, 9.4.7, A.9.4.7
Movable fuel storage tenders *see* Movable fuel storage tenders
Parking and garaging of vehicles, 9.7
Portable containers, 9.3
Qualification of personnel, 4.4, A.4.4
Stationary containers, 9.6
Trailers and semitrailers, 9.5
Trucks, A.9.1.1(3)
Industrial (forklift) *see* Industrial trucks
Piers or docks, on, 13.2.1.3
Tubing, 5.9.1, 5.9.3.2
Cargo tank vehicles, 9.4.3.1 to 9.4.3.3
Copper, 5.9.3.2
Engine fuel systems, 11.6.1.1
Pipe sizing, Table 15.1(f) to Table 15.1(j)
Use in buildings of, 6.19.12.2(B)
Wall thickness of, Annex G
Engine fuel systems, 11.6.1, 11.6.2
Fittings, 5.9.4, 5.9.5, A.5.9.5
Installation, 6.9.3 to 6.9.5, A.6.9.3.1, A.6.9.4.5
Non-engine fuel systems, 6.23.5.1(A)
Regulator venting, 5.8.3, A.5.8.3
Sizing tables, Chap. 15
Two-stage regulator system *see* Regulators

U

UL (definition), 3.3.72
Underground containers, 6.25.5.4, D.3, Fig. I.1(c)
Access, 6.3.11
Connections, 5.7.8.4
Corrosion and corrosion protection, 6.6.1(I), 6.6.6.1(H), 6.16.1, Annex K
Filling, 7.4.3.2(A)
Flotation due to high water table, anchoring to prevent, see 6.6.1.6
Installation, 5.7.8.4, 6.6.6.1, 6.6.6.2, A.6.6.6.1, Annex K
Container appurtenances, 6.7
Location, 6.4.4
Manholes, domes, or housings, 5.7.8.4
Marking, 5.2.8.3(B)
Pressure relief devices/valves, 5.7.2.8, 5.7.4.1(A)
Separation distances, Table 6.3.1, 6.3.4, 6.4.5.7, 6.26.2
Underground piping, 6.9.1.1(3)(b), 6.9.3.12 to 6.9.3.14
Small LP-Gas systems (SLGS), 14.4.2
Universal cylinders (definition), 3.3.73
Unloading *see* Filling

V

Vacuum controls, 12.4.2
Vacuum relief devices, 12.8
Valves, 5.9, A.5.9.5

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

Backflow check *see* Backflow check valves
Bleeder valves, 7.3.1(3), 11.4.1.5, 11.4.1.6
Bypass, 9.4.4.3
Cargo tank vehicles, 9.4.2.3, 9.4.2.4, 9.4.3, 9.4.4.3, 9.7.3.4 to 9.7.3.6, A.9.4.3.5
Check, 5.21.8.4, 5.21.8.5, 13.3.3
Container, 5.7.4, Table 5.7.4.1
Emergency shutoff, 5.7.4.2, 5.12.3, 5.12.4, 6.12, 6.18.2.6, 6.26.4.1, 6.26.4.2, 7.3.1(8), 12.1.1.5, A.4.6, A.6.1.3, A.6.12.8
  Appliances, 5.20.7, 6.23.7.4, A.5.20.7
  Definition, 3.3.74.1
  Railroad tank car end of hose, 7.2.3.7
  Remote shutoff actuation, 6.10, 6.24.3.8 to 6.24.3.10, A.6.10(3)
Engine fuel systems, 11.4.1.3 to 11.4.1.10, 11.4.1.14, 11.7.2.1, 11.7.2.2, 11.7.4.3
Excess-flow, 5.7.4.1, Table 5.7.4.1, 5.7.4.2, 5.7.4.5, 5.7.7.1, 5.7.7.2, 5.7.8.1, 5.12.3, 6.23.7.3, 11.4.1.3
  Actuated liquid withdrawal, 5.7.8.1
    Definition, 3.3.1
  Buildings, piping systems in, 6.19.12.2
  Cargo tank vehicles, 9.4.3.4, 9.4.4.5(B)
  Definition, 3.3.74.2
  Dispensers, 6.24.3.5, 6.24.3.8, 6.24.3.11
  Internal (definition), 3.3.74.3
Hydrostatic relief, 5.13, 6.13, 6.19.12.2(I)
Internal, 5.7.4.2, 5.7.4.5, 5.7.7.1, 5.7.7.2, 5.7.8.1, 6.11, 6.26.3.1 to 6.26.3.4, 6.26.4.2, 7.3.1(8), 9.4.2.3, 9.4.2.4, 9.4.4.3, 11.4.1.3, 11.4.1.7, 11.4.1.10, 12.1.1.5
  Definition, 3.3.74.4, A.3.3.74.4
  Excess-flow (definition), 3.3.74.3
  Flush-type full internal pressure relief *see* Pressure relief devices/valves
  Remote shutoff actuation, 6.10, 6.24.3.8 to 6.24.3.10, A.6.10(3)
  Spring-type pressure relief *see* Pressure relief devices/valves
Isolation, 13.3.2
Liquid, 5.7.4.1
Materials, 5.12
Outlet, 7.2.2.5, 7.2.2.6, 8.2.2.2, 8.2.2.3, A.7.2.2.5
In polyamide and polyethylene piping systems, 6.9.5
Power operated, 13.3.2.1, 13.3.2.2
Pressure relief *see* Pressure relief devices/valves
Protection of, 5.7.8.2, 5.7.8.3, 6.23.3.4(E), 8.2.1.2, 8.2.2, 9.3.2.4, 9.3.3.4, 9.6.2.2, 9.6.2.4
Shutoff, 5.7.2.9, 5.7.4.1, 5.7.4.2, 5.7.8.1, 5.21.5.6, 5.21.5.8, 6.10, 6.11.5, 6.12, 6.13, 11.15(3), Table 5.7.4.2
Small LP-Gas systems (SLGS) key valve maintenance, 14.4.7, A.14.4.7
Vapor, Table 5.7.4.1, 6.8.1.1, 13.3.2.1
Vaporizers, 5.21, Table 6.22.2.2, 6.22.2.5, A.5.21.5.8
  Burner *see* Vaporizing burners
  Definition, 3.3.75
  Direct-fired, 5.21.3, 5.21.9, 6.21.6.2
    Definition, 3.3.75.1
    Gas-air mixers used with, 6.21.8.4
    Installation, 6.21.3, 6.22.3.2
  Electric
    Definition, 3.3.75.2
    Direct immersion, 6.21.7
      Definition, 3.3.75.2.1
    Indirect, 6.21.7
      Definition, 3.3.75.2.2
    Installation, 6.21.7
  Indirect (indirect-fired), 5.21.2, 5.21.9, 6.21.6.1, 6.21.7
    Definition, 3.3.75.3
    Gas-air mixers used with, 6.21.8.3
    Installation, 6.21.2, 6.22.3.2
  Installation, 6.21, 6.22.3.2
  Operating procedures, 14.2.1.3
  Piping systems feeding, 6.9.1.1(4), 6.9.1.3
  Regulator installation, 6.8.1, 6.8.2
  Vehicle engines, 11.5.2
  Waterbath (immersion-type), 5.21.6
    Definition, 3.3.75.4
    Installation, 6.21.6
Vaporizing burners, 5.20.5, 5.21.5, A.5.21.5.8
  Definition, 3.3.76
  Installation, 6.21.5
Vapor meters, 6.17.5.1, 6.17.5.3
Vapor piping systems *see* Piping and piping systems
Vapor service valves, 6.8.1.1
Vehicle dispensing stations *see* Dispensing stations
Vehicle fuel dispensers, Table 6.22.2.2, 6.24
  Definition, 3.3.77
Vehicles
  Appliance installation, 6.23.7, A.6.23.7.6
  Containers on/in *see* Vehicles, containers on/in
  Engine fuel systems *see* Engine fuel systems
  Equipment installation, 6.23.6
  Garaging of *see* Parking and garaging of vehicles
  Industrial trucks *see* Industrial trucks
  Interiors, 11.8, A.11.8.1.2
  Marking/placarding, 9.3.2.10, 9.3.3.7, 9.4.6.2, 11.11, A.11.11.2.2
  Movable fuel storage tenders or farm carts *see* Movable fuel storage tenders
  Multipurpose passenger (definition), 3.3.46
  Non-engine fuel system installation, 6.23, A.6.23.1, A.6.23.7.6
  Parking, 6.23.9, 9.7
  Passenger-carrying *see* Passenger-carrying vehicles
  Piers or docks, vehicles on, 13.2.1.3
  Precautions, general, 6.23.8
  Safety provisions, 9.4.10
  Servicing and repair, 6.23.9, 9.7.3.6, 9.7.3.7
  Trailers and semitrailers, 9.5
  Transportation LP-Gas, Chap. 9
Vehicles, containers on/in, 11.8, A.11.8.1.2
  Cargo tank vehicles, 9.3.3.8, 9.4.2
  Fuel dispensers *see* Vehicle fuel dispensers
  Leakage, 9.7.3.5, 9.7.3.6
  Location, 6.2.2
  Non-engine fuel systems, 6.23.3
  Parking of, 11.12.4.3
  Transfer of liquid into, 6.5.1, A.6.5.1
Ventilation, building, 9.7.3.5, 10.2.2, 10.3.1.5, 10.3.2.8
Venting, regulator, pipe for, 5.8.3, A.5.8.3
Venting gas to atmosphere, 6.5.4.2, 6.6.6.1(G), 6.9.3.3, 6.9.3.7, 6.23.3.3, 7.3, 8.3.4.3
Vents, fixed maximum liquid level gauge, 6.3.10
Vertical filling, 5.7.5.6(B)
Volume, liquid, Annex F
Volumetric method filling (loading), 5.2.5.7, 5.7.5.3, 7.4.2.1, 7.4.2.3, Table 7.4.2.3(a) to Table 7.4.2.3(c), 7.4.3, A.5.2.5.7, A.5.7.5.3, A.7.4.2.3

W

Walls, fire, 6.4.7, A.6.4.7
Warning signs/labels
  Appliances, 6.23.7.10
  ASME containers, 5.2.8.5
  Cylinders, 5.2.8.4
  Emergency remote shutdown stations, 6.11.5
  Marine shipping and receiving, prior to transfer at, 13.2.1.5, 13.2.3.1
  Tank cars, filling of, 7.2.3.6(1)

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

Water capacity, of containers, 5.2.1.7, 5.2.1.8, Table 7.4.2.2
Definition, 3.3.79
Portable containers of more than 1000 lb (454 kg) water capacity, 9.3.3
Stationary installations, 4.3.1
Storage of containers, 8.3.2.3, 8.3.3.1
Vehicles, containers installed on, 11.3.5
Water heaters, 5.20.7, A.5.20.7
Water spray fixed systems, 6.25.6
Weight method filling, 7.4.2.1, 7.4.2.2, Table 7.4.2.2, 7.4.2.3, A.7.4.2.2
Definition, 3.3.22.2
Welding, 5.2.1.6, 5.7.3.6, 6.6.1.3, 6.9.3.2, 6.22.3.3, 7.2.3.2(C), 11.3.3.3, 11.7.4.2, 13.2.1.11
Wharves *see* Marine shipping and receiving
Wheel chocks, 7.2.3.6(2), 9.4.8
Wind loading
ASME containers, 5.2.4.3(C)
Refrigerated containers, 12.3.1
Wiring, electrical, 6.22.2, 9.2, 13.2.2, A.6.22.2.2, A.6.22.2.3
Working pressure; *see also* Maximum allowable working pressure (MAWP)
Hose, 5.9.6.5, 11.6.3

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

Commentary Index

A

Absolute pressure, 3.3.61

Absolute vapor pressure
Refrigerated containers, 12.1.2.1

Active cathodic protection systems, A.6.6.6.1(H), 6.16.2

Actuated liquid withdrawal excess-flow valves, A.5.2.5.4, 5.7.4.1(D), 9.6.2.2, Exhibit 5.9, Exhibit 5.10
Defined, 3.3.1
New-style, 5.7.4.1(D)
Old-style, 5.7.4.1(D)

Aerosol filling plants, 1.3.2(4)

Aerosol-packaging industry, 10.1.1

Aerosol product manufacturing facilities, 1.3.2(4)

Aggregate storage, 6.25.3.1

Agricultural installations
Hose, 5.9.6.4(D)
Hose pressure, 6.19.2.6
Piping, 5.9.1.2
Portable containers in stationary installations, 6.6.3.7
Safety precautions, 7.2.3.5(B)

Air-gas valve carburetors, Exhibit 11.5

Air intakes
Separating cylinders from, 6.19.11.1(B)

Alloys
Brazing, 5.9.4.1
Melting points for, Commentary Table 6.4

Alternate vehicle fuels, 6.24

Aluminum components, 5.17.1.3(C), 5.17.1.3(E)

Aluminum construction cylinders (DOT 4E), A.5.2.1.1, 5.2.1.2(D)

Aluminum cylinders, 11.3.1.4(D)

American Gas Association, A.4.2.3, 6.22.3.4

American National Standard, 12.3.1.2

American National Standards Institute (ANSI), 3.3.3

American Petroleum Institute (API), 1.3.1(3), 3.3.4, A.5.2.1.1, 6.22.3.4

American Society for Testing and Materials (ASTM), 3.3.9

American Society of Civil Engineers, 12.3.1.2

American Society of Mechanical Engineer (ASME)
Defined, 3.3.6

American Welding Society, 6.22.3.4

Ammonia, A.4.5, 4.5.2

Anchorage, 6.19.3.5
Of ASME containers, 6.6.1.6
Of cylinders, 6.6.1.6
Of dispensing units, 6.24.3.12
In plant transport unloading areas, 6.12

Anhydrous ammonia, 4.2.5, A.4.5

Annex K, Burial and Corrosion Protection for Underground and Mounded ASME Containers, A.6.6.6.1

Anodeless risers, 6.9.4.3(B)
Defined, 3.3.2
Permitted use of, A.5.9.5(E)

Anodes
Sacrificial, A.5.9.5(E), 6.16.2

ANSI/CSA Z21, ***Outdoor Cooking Gas Appliances,*** 7.2.2.6

ANSI/UL 125, ***Standard for Valves for Anhydrous Ammonia and LP-Gas (Other than Safety Relief),*** 5.7.4.1, 5.12.1(C)

ANSI/UL 913, ***Standard for Safety, Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, and III Division 1, Hazardous (Classified) Locations,*** 13.2.3.3

ANSI Z21/83 Committee on Performance and Installation of Gas-Burning Appliances and Related Accessories, 5.20.1

ANSI Z21.80/CSA 6.22, ***Standard for Line Pressure Regulators,*** 6.8.1.8

API 607, ***Fire Test for Soft-Seated Quarter Turn Ball Valves,*** 5.7.4.2(I)(2)

API 620, ***Design and Construction of Large Welded, Low-Pressure Storage Tanks,*** 12.1.1.1, 12.1.1.3, 12.1.1.4, 12.2.2.2, 12.4.2.2, Chapter 12

API 2510, ***Design and Construction of Liquefied Petroleum Gas (LPG) Installations,*** 1.3.1(3), 1.3.2(2), Chapter 12

API 2510A, ***Fire Protection Considerations for the Design and Operation of Liquefied Petroleum Gas (LPG) Storage Facilities,*** 1.3.2(2)

API-ASME Code, A.5.2.1.1, 5.2.1.1(B)

API-ASME containers (tanks)
Defined, 3.3.5
Judging suitability of, 5.2.1.1(B)

API RP 520, ***Sizing, Selection, and Installation of Pressure-Relieving Devices in Refineries,*** 6.7.2.15

API RP 521, ***Guide for Pressure-Relieving and Depressuring Systems,*** 6.3.10

Appliances. *See also* portable appliances
Coverage, 5.20
Fuel type conversion, 5.20.2
Gas input for, Commentary Table 15.1
Manufacturing approvals, 5.20.1
Multi-fuel, 5.20.2

Approved
Defined, A.3.2.1

Appurtenances. *See* container appurtenances; engine fuel container appurtenances

ASCE 7, ***Minimum Design Loads for Buildings and Other Structures,*** 12.3.1.2, 12.3.2.2

ASME B 31.3, *Process Piping Code,* A.6.9.3.1, 6.19.2.5, 12.3.3.1

ASME B31.8, ***Gas Transportation and Distribution Piping Systems,*** A.1.3.1(4)

ASME ***Boiler and Pressure Vessel Code,*** A.5.2.1.1, 5.2.1.1(A), 5.2.1.1(B), 5.2.1.2(B), 5.2.1.6, 5.2.4.2, 5.2.4.3(E), 5.2.7.2(D), A.5.2.8.3, 5.21.2.1, 5.21.2.2, 5.21.3.1, 6.9.3.2, 9.4.4, 11.1.3, 11.4.1.9, 12.1.1.1, 12.1.2.1
ASME container pressure relief valves, 5.7.2.6
Container nameplates, A.5.2.8.3
Design margin (safety factors), A.5.2.1.1

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

Pressure relief valves, 5.7.2.4(A)
U-68 specifications, A.5.2.1.1, 5.2.1.3, 5.2.4.2
U-69 specifications, A.5.2.1.1, 5.2.1.3, 5.2.4.2
U-200 specifications, A.5.2.1.1
U-201 specifications, A.5.2.1.1
ASME bulk tanks, 6.19.2.1
ASME containers, 3.3.57, 3.3.58, Chapter 5. *See also* containers; vertical ASME containers
Actuated liquid withdrawal excess-flow valves, A.5.2.5.4, 9.6.2.2
Alternate installation provisions, 6.26
Anchoring, 6.6.1.6
Approval of systems using, 4.1.1
Appurtenance requirements, 5.7.4.1
On building roofs, 6.5.1.3, 6.6.7, 6.6.7.2
Capacities, A.5.2.1.1
Corrosion protection painting, A.6.6.1.4
Defined, 8.1
Dented, bulging, gouged, or corroded, 5.2.1.4
Determining suitability of, 5.2.1.1(B), 7.2.2.2, 7.2.2.7
Filling into the vapor space, A.5.2.5.3
Fire protection, 6.25, 6.25.3.1
Fusible plugs, 5.7.2.12
Horizontal installation of, 6.6.3.1
Hydrostatic pressure testing, 5.2.1.2(B)
Installation exceptions, 6.6.3.4
Installation on noncombustible foundations, 6.6.3.1, Exhibit 6.12
LP-Gas capacity of, 7.4.2.1
Marking for underground use, 6.6.6.1
Maximum allowable working pressure (MAWP) for, 5.2.4.2, 5.13.1
Nondestructive test methods, 5.2.1.2(B)
NOT ODORIZED marking, 5.2.8.5, Exhibit 5.18
Openings, 5.2.5.1
Overfilling, 6.6.3.2, 6.6.3.3, 6.6.7.2
Performance regulatory approach, A.5.2.1.1
Performance requirements, 6.6.3.3
Portable, 9.3.2.1
Prescriptive regulatory approach, A.5.2.1.1
Pressure relief valve manifolds, 5.7.2.5, Exhibit 5.27
Pressure relief valves, 5.7.2.1, 5.7.2.4(A), 5.7.2.6, 6.3.11, 6.7.2.3, Exhibit 5.21, Exhibit 5.22
Propane capacity, 3.3.79
Removing from service, 5.2.1.4
Requirements, A.5.2.1.1
Saddles, 6.6.3.1, Exhibit 6.13
Seismic considerations, 6.6.7.2
Served by single pressure regulator, Exhibit 6.23
Special transportation permits, 9.6.1.2
Temporary installations, 5.2.7.2
U-68 containers, A.5.2.1.1, 5.2.1.3, 5.2.4.2
U-69 containers, A.5.2.1.1, 5.2.1.3, 5.2.4.2
Underground installations, 6.6.6.1, Exhibit 6.16, Exhibit 6.17, Exhibit 6.18
Verification of fitness, A.5.2.1.1
Vertical installations, 5.2.4.3(E), 5.2.7.1(C), 6.6.4.1, 6.6.4.3, 6.6.4.5, Exhibit 6.15
Water capacity, 3.3.79
ASME engine fuel containers
Criterion for, 11.3.1.4(D)
Damaged, 11.3.3.1
Design pressure, 11.3.2.2
Double backflow check valves, 11.4.1.14
Engine fuel, 11.3.2.2
Labeling requirements, 11.3.4(B)
Nameplates, 11.3.4(B)
Overfilling, 11.4.1.13
Overfilling prevention devices (OPD), 11.4.1.13, 11.4.1.15
Pressure relief valves, 11.4.1.7(B)
Shutoff valves, 11.4.1.8
Solenoid-actuated valves, 11.4.1.8
Welding, 11.3.3.3
ASME pressure vessels, 7.2.2.9
ASME refrigerated containers, 12.1.1.1
ASME tanks
Volumetric filling method, 7.4.1
Assembly occupancies
Defined, 6.20.2.3
Patio heaters in, 6.20.2.3
ASTM B 86, *Standard Specifications for Zinc-Alloy Die Casting*, 5.17.1.3(E)
ASTM D-1835, *Standard Specifications for Liquefied Petroleum Gases*, 3.3.36
ASTM D-2513, *Standard Specification for Thermoplastic Gas Pressure Pipe, Tubing, and Fittings*, A.5.9.5, 6.9.4
ASTM E-119, *Standard Test Methods for Fire Tests of Building Construction and Materials*, 5.2.7.1(C)
Atmospheric heat source indirect vaporizers, 6.21.2.11, 6.21.2.12
Atmospheric-type regulators, 11.13.2.1
Austenitic stainless steels, 12.1.1.4
Authority having jurisdiction (AHJ)
Code enforcement and, Chapter 1
Container installations and, 6.3.11
Defined, A.3.2.2
Fire safety analysis and, 6.25.3.3
Pressure vessels, A.5.2.1.1
Stationary installation plans submitted to, 4.3.1
Automatic changeover regulators, 6.8.1.4, Exhbit 3.12, Exhibit 6.24
Automatic pump bypass, 6.16.2.3(D), Exhibit 6.34
AWS Z49.1, *Safety in Welding, Cutting and Allied Processes*, A.1.3.2(5)

B

Backflow check valves, 5.7.8.1(A), 6.26.3.5
Flammable mixtures and, 7.3.2.2(C)
Operation of, 5.7.4.5(4), Exhibit 5.36
In plant transport unloading areas, 6.12
In tank cars, 6.12.1
In tank car unloading stations, 6.12
Back pressure relief valves, 12.8.1.2
Balconies
Cylinders on, 6.19.1.2(B), Exhibit 6.43
Permanent cylinder installations, 6.19.11
Bartlesville Energy Research Center, A.4.2.3
Battelle Memorial Institute, A.4.5, 6.3.10
"Bill stuffers," 14.4.13.1
BLEVEs (Boiling Liquid Expanding Vapor Explosions), A.3.3.68, 6.3.1
Enclosures and, A.6.4.7
Pressure relief devices and, 6.7.2.2
Special protection and, 6.25.5
Training on, 6.25.2.2
Water spray systems and, 6.25.5.2
"BLEVE Update," 6.25.2.2
Blower-type heaters, 6.19.4.6
Bobtail drivers
Determining suitability of ASME containers, 7.2.2.2
Training, A.4.4
Bobtails, 3.3.11, 3.3.54, Exhibit 9.2
Excess-flow valves and, 5.7.8.1(H)
Internal valves, 9.4.2.4
Liquid outlets, 9.4.2.4
Piping systems, 9.4, Exhibit 9.7, Exhibit 9.8
Propane use by, A.9.1.2(4)
Rooftop containers filled from, 6.6.7
Boilers
As heat source for vaporizers, 6.21.2.9
Preventing explosions in, 6.21.2.6
Boiling Liquid Expanding Vapor Explosions (BLEVEs). *See* BLEVEs (Boiling Liquid Expanding Vapor Explosions)
Boiling point, A.6.4.5.3
Bottom connections
For mounded containers, A.6.6.6.3(1)
Branch lines, 5.7.8.1(H)
Brass fittings, A.4.5
Brass valves, 9.4.3.9
Brazing, 5.9.4.1, 6.9.3.5
Brush fires, 6.4.5.2

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

Building extensions
Separation distance, 6.3.11
Building openings
Cylinder installations and, 6.3.7
Defined, 6.3.7
Distance from pressure relief valves to, 6.3.9
Building renovation
Equivalency requirements for, 6.19.4.10
During hours when public is present, 6.19.5.2
Buildings
Air intakes, separating cylinders from, 6.19.11.1(B)
Atmospheric heat source indirect vaporizers used in, 6.21.2.11
Container installations inside, 6.19
Cylinder installations inside, 6.19, 6.19.1.2(B), 6.19.2.1
Cylinder installations underneath, 6.3.8
Cylinder storage within, 8.3
Cylinder use for food preparation, 6.19.9.1
Cylinder use for temporary exhibitions and demonstrations, 6.19.9.1
Gas manufacturing, 6.3.5
Important, 6.3.1
Manifold cylinders adjacent to, 6.3.6, Exhibit 6.3
Piping liquid LP-Gas into, 6.19.12.1, 6.19.12.2(J)
Point of transfer in, 6.5.4.1, 6.5.4.3
Polyamide and polyethylene piping prohibited in, 6.9.1.1
Rooftop ASME containers, 6.5.1.3, 6.6.7, 6.6.7.2
Routing delivery hoses through, 6.5.1.4
Separation distances from, 6.3.3, 8.4.1.1
Venting of gas within, 6.5.4.2
Bulk containers, A.5.2.1.1. *See also* ASME containers
Appurtenance requirements, 5.7.4.1
History of, A.5.2.1.1
Water capacity of, 5.7.4.2
Bulkheads
Dispensing stations, 7.2.3.4
Bulk plants, Exhibit 3.2, Exhibit 3.3, Exhibit 6.37
Container and piping details, Exhibit 6.38
Cylinder filling buildings at, 6.3.5
Defined, A.3.3.10
Fire safety analysis, 6.25.3.2
General use containers, 5.2.1.6
Liquid transfer operations, 6.17.5.3
Maintenance procedures, A.14.3
Operating procedures, 14.2.1
Points of transfer at, 3.3.54, Exhbit 3.9
Public refilling points, 7.2.3.1
Remote shutdown, A.6.10(3)
Burst disks, 5.7.2.4(A)
Butane
Diking, 6.4.5.12
Flash point and, A.6.4.5.3
Warning labels, 5.2.8.4
Butane containers
Propane or propane/butane mixture in, 7.2.1.3
Butane cylinders
Nonrefillable, inside use of, 6.19.9.1
Pressure relief devices, 5.7.2.3
Restaurant storage of, 8.3, 8.3.2.3
Butane-fueled portable cooking appliances, A.6.19.9.3, 6.19.9.4, Exhibit 6.40
Bypass
Automatic pump bypass valve, Exhibit 6.34
For positive displacement pumps, 6.17.2.3(D)

C
Cabin heaters, A.1.3.2(8)
Calibration
Of meters, 6.17.5.3
Carbon monoxide, A.5.20.7
Carbon monoxide alarms, A.5.20.7
Carbon steel wire braid, 5.9.6.2
Carburetion equipment, 11.5
Shutoff valves, 11.5
Two-stage pressure regulation converter, 11.5, Exhibit 11.4
Vacuum fuel locks, 11.5, Exhibit 11.6
Cargo containers
Flush-type internal pressure relief valves for, 5.7.2.4(A), Exhibit 5.23
Cargoes of particular hazard, 13.3.1
Cargo tank heaters, 6.23.7.3
Cargo tanks, 3.3.11
Internal valves, 9.4.2.4, Exhibit 9.10
Portable containers used as, 9.3.3.8
Transferring LP-Gas directly from railcars to, 4.3.3
Cargo tank vehicles, 3.3.11, 6.23.2, Exhibit 9.9. *See also* bobtails
Accidents involving, 6.12
Bobtails, 9.4
Brass valves prohibited on, 9.4.3.9
Construction specifications, A.9.1.1(3)
DOT safety features, 9.4.2.4
Electrical lighting requirements, 9.2
Electric pumps, 9.4.4.4
Excess-flow valves and, 5.7.8.1(H)
Filling at pipeline terminals, 7.1.2, Exhibit 7.1
Hazardous materials and, 9.4
Liquid transfer from railcars, 6.18.2.3(C)
Maximum container capacity, 11.3.5.1, Commentary Table 11.1
MC-331, A.9.1.1(3), 9.4.4, Exhibit 9.1
Parking regulations, 9.7, 9.7.2.4, 9.7.3.5, Exhibit 9.15
Passive transport shutdown systems, 7.2.3.9, Exhibit 7.13
Pull away protection, 7.2.3.9
Regulation of, Chapter 9
Retail delivery (*See* bobtails)
Safety requirements, 7.2.3.9
Servicing, 9.7.3.6, Exhibit 9.16
Tractor-trailers (transports), 9.4
Unloading, 7.2.3.4
Valves, 9.4.3.4
Carousel filling installations, 7.4.2.1, Exhibit 7.17
Cast iron, 5.17.1.3(E)
Catalytic heaters, 6.19.2.8
Cathodic protection systems, 6.6.6.1(H), A.6.6.6.1(H)
Active, A.6.6.6.1(H), 6.16.2
Failure of, 6.16.2
Passive, 6.16.2
Cavitation, 6.16.2.3(D)
Centrifugal pumps, 5.17.2
CGA A-1.1, ***Pressure Relief Device Standards, Part I—Cylinders for Compressed Gases,*** 5.7.2.2, 5.7.2.3
CGA C-6, ***Standard for Visual Inspection of Steel Compressed Gas Cylinders,*** 5.2.2.2, 5.2.3
CGA C-6.3. ***Guidelines for Visual Inspection and Requalification of Low Pressure Aluminum Compressed Gas Cylinders,*** 5.2.2.2
CGA C-14, ***Methods for Hydrostatic Testing of Compressed Gas Cylinders,*** 5.7.2.3
CGA 791 connections, 6.19.3.6(C), 7.2.2.5
CGA 810 connections, 6.19.3.6(C), 7.2.2.5
CGA S-1.3, 11.4.1.9
CGA V-1, ***Standard Compressed Gas Cylinder Valve Outlet and Inlet Connections,*** 5.7.3.4
Check-Lok, 3.3.1
Check-Mate, 3.3.1
Checkmate valves, A.5.2.5.4
Check valves, 5.7.4.2(F)(2), 5.7.4.2(H)(4)
Chemical plants, 1.3.2(4)
Chemical Transportation Emergency Center (CHEMTREC), 7.3.1
Chock blocks, A.9.1.1(3)
Class A fires, 8.5.2
Class B fires, 8.5.2
Class C fires, 8.5.2
Class I, Division 1 locations, A.6.22.2.2, 13.2.3.3
Class I, Division 2 locations, A.6.22.2.2
Class I, Group D locations, 6.21.6.1
Class I flammable liquids, A.6.4.5.3
Class II flammable liquids, A.6.4.5.3
Class I locations, A.6.22.2.2

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

Click-Lok valves, A.5.2.5.4
Closed-bodied vehicles
Cylinder transport in, 9.3.2.5
Coatings. *See also* corrosion coatings
Containers, 6.25.5.1
Underground piping, 6.16.2
Code
Defined, 2.1
Color-coded stakes
For snow removal operations, 6.6.3.6
Combustible liquids
Horizontal separation from containers, 6.4.5.5
In underground tanks, 6.4.5.7
Combustible materials
Loose or piled, 6.4.5.2
Vegetation, 12.7.7
Combustion explosion hazards, 10.1.1
Commerce
Transportation in, A.1.1
Commercial customers
Cylinder warning labels, Exhibit 5.17
Common grounding
Defined, A.6.22.1.2
Composite cylinders, 5.2.1.1, 11.3.1.4(D)
Compressed air or gas
Prohibited for liquid transfer, 6.18.2
Compressed Gas Association (CGA), 3.3.12, 3.3.48, 6.6.2.2
Compressed Gas Manufacturers' Association, 3.3.12, 3.3.48
Compressed natural gas (CNG), A.1.3.2(11)
As vehicle fuel, 6.24
Compression-type fittings, A.5.9.5(D)(3)
Compressor liquid transfer method, 7.2.3, Exhibit 7.6
Compressors
Liquid traps, 5.17.3.3, Exhibit 5.57
Operation of, 6.18.2.4(A)
Portable, 5.17.3.4, 6.17.3.5, Exhibit 6.36
With protection devices, 5.17.3.2, Exhibit 5.56
Selection of, 5.17.3.1
Condensation
Dew point and, 14.4.11.3
Second-stage pressure regulators and, 6.9.3.8
Temperature and, 6.9.1.1, 6.9.3.8, 14.4.11.3
Connecting pipe, 6.6.2.2
Construction
Equivalency requirements for, 6.19.4.10
Fire resistance ratings, 6.6.7.2, Commentary Table 6.3
Separation distance from, 8.4.1.3
Construction Safety Standards (State of Michigan, Dept. of Labor & Economic Growth), 6.23.3.5
Consumer education, 14.4.13.1
Consumer Product Safety Commission (CPSC), A.4.2.3
Container appurtenances, Chapter 5
Accessibility of, 6.6.1.5
Container type and, 5.7.4.1
Criteria for, 5.7
Defined, 6.7
Engine fuel containers, 11.4.1.3
For engine fuel containers, 11.4
Gaskets, 5.7.1.3(D)
Materials, 5.7.1(2), A.5.7.1.2(4)
Protection, 5.7.8.2
Protection of, on motor vehicles, 6.23.3.4(I)
Requirements, 6.19.2.1
Safety system operation, 5.7.8.4(C)
Container assembly
Defined, 7.2.2.11
Container installations, 6.6
Authority having jurisdiction and, 6.3.11
On building roof, 6.6.7
Distances between groups of containers, 6.4.2
Domestic, 6.6.3.1, Exhibit 6.11
Exceptions, 6.6.3.4
Flammable liquid storage containers and, A.6.4.5.3
Location, 6.2.2
Loose or piled combustible material and, 6.4.5.2
Multiple, Exhibit 6.2
Number of containers in groups, 6.4.2
Overhead electric power lines and, 6.4.5.12
Positioning, 6.6.1.1
Protection during snowfall, 6.6.3.6, Exhibit 6.14
Saddles for, 6.6.3.1
Separation distances, 6.3.1, 6.3.4, 6.3.9
Separation of combustible liquids from, 6.4.5.5
Separation of flammable liquids from, 6.4.5.3, 6.4.5.5
Smaller containers, 6.4.5.6
Stacked, 6.4.5.1
Container markings. *See* markings
Container nameplates. *See* nameplates
Container ownership, A.5.2.1.1
Containers, Chapter 5. *See also* ASME containers; ASME engine fuel containers; bulk containers; engine fuel containers; industrial containers; LP-Gas containers; mounded containers; portable containers; propane containers; refrigerated containers; underground containers
Accurate filling of, 7.1.2
Ammonia contamination of, A.4.5
Appurtenance requirements, 5.7.4.1
Coatings, 6.25.5.1
Defined, 3.3.13
Determining code-compliance of, 7.2.2.7
Determining suitability for filling, 7.2.2.2
Enclosures for, A.6.4.7
Failure of, 6.25.5.1
Filling, 7.2.2.2, 7.2.2.7, Exhibit 7.2
Filling by weight, 3.3.22, 7.4.1
Filling methods, 7.4.1
Fire fighters and, A.3.3.68
Fire protection, 6.25
Five percent water capacity provision, 9.6.2.2, Exhibit 9.14
General use, 5.2.1.6
Inspection of internal components, 5.2.1.9
Installed on vehicles, maximum capacity, 11.3.5
Insulation of, 6.25.5.1
Leased, A.5.2.1.1
Lightning protection, A.6.22.1.2
Liquid withdrawal from, 6.6.1.1
LP-Gas capacity of, 7.4.2.1
Maximum filling densities, 7.4.2.2
Maximum filling limit, 3.3.22
Maximum surface temperatures, 6.3.1, 6.25.5.1, Commentary Table 6.1
On motor vehicles with LP-Gas systems, 6.23.3.4(I)
Noncomplying, notification of owner, 7.2.2.1
Older, 5.2.1.2(B)
Owned by industrial customers, A.5.2.1.1
Owned by residential customers, A.5.2.1.1
Pressure of, A.4.2.3
Propane capacity of, 3.3.79
Protection of, 6.25.5.1
Radiant heat effects on, 6.3.1
Requalification, 5.2.2.2
Retroactive requirements, 1.4.2
Rooftop, 6.19
Separation distances, 6.3.1
Separation of pressure relief valves from, 6.7.2.7
Size classification, 5.7.4.1
Special protection of, 6.25.5, Exhibit 6.52
Special transportation permits, 9.6.1.2
Stationary installations of, 4.3.1
Transferring LP-Gas into, A.3.3.37
Transportation of, 9.6.2.2
Type of service classification, 5.7.4.1
Underground, installed above ground, 5.7.2.7
Vertical installation of, 5.2.4.3(E)
Water capacity of, 3.3.79, 5.2.1.9
Water spray fixed protection of, 6.25.5, Exhibit 6.53
Continuing education programs, 14.4.13.1
Cooking appliances. *See* portable cooking appliances
Cooking demonstrations
Cylinders used in, 6.19.9.1

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

Copper
For POL connectors, 6.6.2.2
Corrosion
Cathodic protection systems, 6.6.6.1(H)
Caused by water trapped under insulation, 6.25.5.1, Exhibit 6.54
Container nameplates and, A.5.2.8.3
Holes, Exhibit 6.19
Pinholes, 6.6.6.1(H)
Rate of, 6.6.6.1(H)
Visual inspection and, 5.2.3.3
Corrosion coatings
Damage repair, A.6.6.6.1(J)
Epoxy coal tar, 6.6.6.3
Powder, A.11.3.7
Underground containers, 6.6.6.1(H), A.6.6.6.1(H), 6.6.6.2
Corrosion protection
Engine fuel containers, 11.3.7
Mounded containers, A.6.6.6.3(4), 6.16.2
Underground containers, 6.16.2
Underground piping, 6.9.3.14
Corrosion protection painting
ASME containers, A.6.6.1.4
Container burial depth, A.6.6.6.1(B)
Mounded containers, 6.6.6.3
Paint color, A.6.6.1.4
Steel cylinders, A.6.6.1.4
Corrugated stainless steel tubing (CSST) systems, A.6.8.2(H)
Characteristics of, A.6.9.1.1(4), Exhibit 6.27
CSA American Inc., 5.20.1
Cutting
Cylinders for, 5.7.3.5(1)
Purging requirements, 6.22.3.4
Cylinder cabinets, 8.4.1.1, 8.4.2.1, Exhibit 8.2
Cylinder collars, 5.2.6.1, 6.7.2.2, 6.19.2.1, 6.19.3.5, 8.2.2.2, Exhibit 5.11
Cylinder connections, 4.1.1
Cylinder filling rooms, 10.1.1
Cylinder installations
Building openings and, 6.3.7
Fifty percent open perimeter of space below decks, 6.3.8, Exhibit 6.5
Firm foundation for, 6.6.2.1
Location, Exhibit 6.4
Manifold, next to buildings, Exhibit 6.3
Next to buildings, 6.3.6, 6.3.7
Separation distances, 6.3.9
Tiling, 6.6.1.1
Underneath buildings, 6.3.8
Weather protection, 6.3.8
Cylinder refilling facilities, 3.3.20, 7.2.2.7, Exhibit 7.3
Cylinders, Chapter 5. *See also* butane cylinders; DOT cylinders; DOT/TC cylinders; gas grill cylinders; industrial truck cylinders; portable cylinders; propane cylinders; rooftop cylinders; universal cylinders
Aluminum, A.5.2.1.1, 5.2.1.2(D), 11.3.1.4(D)
Anchoring, 6.6.1.6
Approval of systems using, 4.1.1
On balconies, 6.19.11, Exhibit 6.43
Capacity of, Commentary Table 5.1
Checking, before filling, 7.2.2.7
Composite, 5.2.1.1, 11.3.1.4(D)
Connection of, 6.19.9.4
Damage protection, 8.2.1.1
Defined, 3.3.16, 8.1
Designed weakness points in, 5.7.2.3
Determining code-compliance of, 7.2.2.7
Disposable, 7.2.2.6, 7.2.2.8
DOT 4BA-240 (steel construction) cylinders, A.5.2.1.1
DOT 4E (aluminum construction) cylinders, A.5.2.1.1, 5.2.1.2(D)
DOT regulation of, A.5.2.1.1
"Empty," 8.2.1.4
Exchange, 6.3.9
Filling, 7.2.2.2, 7.2.2.7
Filling at bulk plants, 6.3.5
Filling methods, 7.4.1
Filling on site, 5.2.3
Filling time, 8.4.1.4
Fire-damaged, 5.2.1.2(D)
Firm foundation for, 5.2.3.3
Horizontal, 5.7.3.5(2), 5.7.3.6, 5.7.5.6(B)(2)
Inside buildings, 6.19, 6.19.1.2(B), 6.19.3.4
Inside buildings, for food preparation, 6.19.9.1
Inside buildings, for temporary exhibitions and demonstrations, 6.19.9.1
Liquid withdrawal from, 6.6.1.1
Location of, 8.2.1.1
Manifold, 6.3.6, Exhibit 6.3
Maximum size for educational buildings, 6.19.7.2
In mobile and engine fuel service, 5.7.8.1(D)
In multifamily buildings, 6.19.11.2, Exhibit 6.42
National requirements for, A.5.2.1.1
Nonrefillable, 7.2.2.6, 7.2.2.8, 8.3
Non-U.S., 8.1
One-pound, A.6.19.9.3
Orientation of, 6.19.2.1
Out-of-date, 7.2.2.7
Overfilling, 5.7.3
Overfilling prevention devices for, 5.7.3, 7.2.2.7
Overheating, 6.19.4.6
"Permanently" installed, A.5.2.1.1
Physical protection of, 6.19.3.4
For portable cooking appliances, A.6.19.9.3, 6.19.9.4
Portable tar kettles, 6.23.3.5
Pressure relief devices for, 6.7.2.2
Pressure relief valves for, 5.7.2.2, 6.19.3.4, 8.2.1.2
Propane capacity of, 3.3.79
Purging, 7.3.2.2(C)
Redundant seals, 7.2.2.5
Replacing, 5.7.8.3
Requalification markings, 5.2.2.2
Requalification of, 5.2.2.2, 11.3.1.4(D), 11.3.1.5
Restaurant use of, 6.19.9.1, 6.19.9.4
"Rocketing," 5.7.2.3
Room temperature and, 6.19.3.4
Securing, 6.19.3.5
Separating from air intakes, 6.19.11.1(B)
Steel, A.5.2.1.1, A.6.6.1.4
For temporary heating equipment, 6.19.8.1
Transportation within buildings, 6.19.3.6(C)
Transportation within buildings undergoing major renovation, 6.19.4.2
Transport Canada (TC) regulations for, A.5.2.1.1
Types of, A.5.2.1.1, 6.19.2.1, Commentary Table 5.1
Universal, 3.3.74
Vapor service, 6.19.2.1
Wallpaper steamers, 8.3.2.2
Warning labels, 5.2.8.4
Wood foundations for, 6.6.2.1
Cylinder storage, 6.19.1.3, 8.2, Chapter 8. *See also* outside cylinder storage
Cabinets, 8.4.1.1, 8.4.2.1
Cylinders awaiting use, 6.19.1.3
Fire extinguishers, 8.5.2
Fire protection, 8.5
Non-publicly accessible buildings, 8.3.3.3
Outdoor, 8.4
Protection, 8.4.2.1
Publicly accessible buildings, 8.3
Residential buildings, 8.3, 8.3.5
Rooftop, 8.2.1.5
Separation from gas or diesel fuel dispensers at gas stations, 8.4.1.1
Special buildings or rooms, 8.3
Sprinkler density and, 8.3.1(B)
Storage racks, 8.4.1.4, Exhibit 8.3
Vehicular damage protection, A.8.4.2.2
Cylinder valve plugs, 9.3.2.4
Cylinder valves
Approval of, 4.1.1
Protection of, 8.2.2.2, 9.3.2.4

D

Decks
Fifty percent open perimeter of space below, 6.3.8, Exhibit 6.5
Definitions, Chapter 3
Deflagration, Chapter 10

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

Delivery hoses
Routing through buildings, 6.5.1.4
Demonstrations
Temporary use of cylinders inside buildings for, see6.19.9.1
Designed points of weakness, 5.7.2.3
Design margin (safety factors), A.5.2.1.1
Design pressure
ASME engine fuel containers, 11.3.2.2
Engine fuel containers, 11.3.1
Flexible connectors, 9.4.3.4
Hydrostatic pressure relief valves, 5.13.2
Mobile containers, 6.23.3.1(F)
Pressure vessels, 7.2.2.9
Refrigerated containers, 12.7
Detonation, Chapter 10
Dew point, 14.4.11.3
Diesel engines, 3.3.67
Differential back pressure valves, 5.17.5.1, 6.24.3.5, Exhibit 6.51
Digging
Around underground propane containers, A.6.6.6.1(E)
Dikes
For butane, 6.4.5.12
For refrigerated and nonrefrigerated propane, 6.4.5.12
Refrigerated containers, 12.5, 12.5.4, 12.5.5, 12.5.8.1, 12.5.9.3
Dip tubes, 5.7.5.7
Direct-currant voltage, A.6.6.6.1(H)
Direct-fired vaporizers, 3.3.75.1, 5.21.3.1, 6.21.3.6, Exhibt 5.62
Defined, 6.21.3
Indirect vaporizers *vs.*, 6.21.2.4
Liquid provided to heat-exchanger, 6.21.3.4
Location of, 6.21.3.1, 6.21.3.6
Markings, 5.21.3.1
Multiple installations, 6.21.3, Exhibit 6.46
Operating on demand, Exhibit 5.63
Outside surface, 5.21.3.1
100 percent shutoff requirements, 5.21.3.8
Relief valves for, 5.21.3.3
Shutoff valves for, 6.21.3.5
Source of ignition, 6.21.3
Temperature-sensing devices for, 5.21.3.8
Vaporizing burners, 5.21.5
Direct gas-fired tank heaters, 5.21.4.7
Defined, 6.21.4
Hazards of, 6.21.4.4
Safety instructions, 6.21.4.5
Direct spring-loaded pressure relief valves, 5.7.2.4(A), 5.7.2.4(B)
Discharge piping, 6.7.2.5, 6.9.3.4
Materials for, 6.7.2.15
Protection against physical damage, 6.7.2.15
Rate of flow, 6.7.2.15
Requirements for, 6.7.2.15
Discharge stacks, 6.7.2.7
Dispenser tanks, 3.3.54
Dispensing stations
Anchorage of units, 6.24.3.12
Defined, 3.3.20
Installation instructions, 6.24.3.1
Quick-acting shutoff valves, 6.24.3.13
Remotely operated shutoff valves with thermal actuation, 6.24.3.8, 6.24.3.10
Security, 6.24.3.7
Separation distance from, 8.4.1.3, 8.4.1.4
Shutoff valve distance to dispenser, 6.24.3.14
Underground containers serving, 6.7.2.13
Vehicular traffic and, 7.2.3.4
Disposable cylinders
Filling, 7.2.2.8
Valve outlet seals and, 7.2.2.6
"Distinct hazard to life and property," 1.4.3
DOT 4BA-240 (steel construction) cylinders, A.5.2.1.1
DOT cylinders
Aluminum construction (4E), A.5.2.1.1, 5.2.1.2(D)
Defined, 8.1
Determining suitability for filling, 7.2.2.2
Fire-damaged, 5.2.1.2(D)
Installation of, 6.3.5
Marking requirements, A.5.2.1.1, 5.2.8(B), Exhibit 5.4, Exhibit 5.14
Pressure relief valves for, 5.7.2.2
Requalification of, 5.2.2.2, 11.3.1.4(D), 11.3.1.5
Requirements for, A.5.2.1.1, 5.2.4.1
Steel construction (4BA-240), A.5.2.1.1
Volumetric filling method, 7.4.3.1
Water capacity markings, 9.3.2.1
DOT nonrefillable metal containers
Pressure relief valves, 5.7.2.3
2P containers, 5.7.2.3
2Q containers, 5.7.2.3
DOT 51 portable containers, 9.3.3, Exhibit 9.6
DOT shipping containers, 3.3.57
DOT-SP 11209 exemption, 9.3.4
DOT/TC cylinders
Capacities of, Exhibit 5.3
Dimensions of, Exhibit 5.3
Pressure relief valves, Exhibit 5.19
Requirements for, A.5.2.1.1
Types of, Exhibit 5.1, Exhibit 5.2
Double backflow check valves, 11.4.1.14
Double-check filler valves, 9.6.2.2
Downcomers, 12.5.3
Dowtherm, 6.21.2.5
Drainage channels, 12.5.3
Drill size orifice
Venting and, 6.5.4.2, 7.3.1
"Dry" hose, 9.4.4.5(B)

E
Educational occupancies
Maximum cylinder size for, 6.19.7.2
Elastomeric gaskets, 6.9.3.5
Electrical equipment
Classified areas, A.6.22.2.2, Exhibit 6.49
Prohibited areas for, A.6.22.2.2
Electrical wiring
In same trench with gas piping, 6.9.4.6(B)
Electric power lines, 6.4.5.12
Electric vaporizers, 3.3.75.2
Electronic LP-Gas cylinder filling carousel, 7.4.2.1, Exhibit 7.17
Emergency fuel supply
Rooftop cylinders for, 6.19.1.2(C)
Emergency heating equipment
Cylinders for, 6.19.8.1
Emergency responders
Coordination with, 6.25.2.1
Fire safety analysis and, 6.25.3.3
Training of, 6.25.2.2
Venting and, 7.3.1
Emergency response procedures
"Readily available" manuals, 13.4.3
Training in, 7.2.2.1
Emergency shutoff valves (ESVs), 5.12.4, 6.12, 7.2.3.6, A.9.1.1(3), Exhibit 5.50
Automatic activation of, 6.12.6
Fire safety analysis and, 6.25.3.5
Installation of, 6.12, Exhibit 6.28
Manual control of, 6.12
Plant transport unloading areas, 6.12
Pull away protection, A.6.12.8
Remote control of, 6.12, 6.12.9
Retroactivity of requirements, 6.12.9
Separation distance and, 6.4.3
Tank cars, 6.12.1
Tank car unloading stations, 6.12
Testing, 6.12.9
Two-directional flow and, 6.12.5
"Empty" cylinders, 8.2.1.4
Enclosures
Aboveground propane containers, A.6.4.7
Regulators, 6.8.1.5
Use of term, 6.8.1.6
Enforcement, 1.7, Chapter 1
Engine fuel container appurtenances, 11.4
Excess flow check valves, 11.4.1.3
Installation, 11.7
Internal excess-flow valves, 11.4.1.3
Engine fuel containers
Corrosion protection, 11.3.7
Design pressure, 11.3.1
Exchangeable, 11.3.1.8
External pressure relief valves, Exhibit see11.3
Fastener strength, 11.7.4.1

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

Gastight boxes around, 11.8.1.5, Exhibit 11.10, Exhibit 11.11
Ignition sources and, 11.3.6.4
Installation, 11.7, 11.7.4.1
Interior installation, 11.8.1.5
Location of, 11.7
Maximum capacities, 11.3.5.1, 11.3.5.2, Commentary Table 11.1
Permanently installed, 11.3.1.8
Remote filling, Exhibit 11.3, Exhibit 11.12
Road clearances, 11.7.3.1
Storage rack for, 8.4.1.4, Exhibit 8.3
Trunk mounted, 11.8.1.5, Exhibit 11.9
Typical, 11.3.5.2, Exhibit 11.2
Engine fuel systems, Chapter 11
General purpose vehicles, 11.1
Industrial trucks, 11.1
Low emission transfer, 11.4.1.6
Piping and hose, 11.6
Pressure relief discharge location and, 11.7.4.3
Propane, 11.1, Chapter 11
Spring-loaded check valves, 11.9.1.8
Truck locations, 11.7.5.1, Exhibit 11.7, Exhibit 11.8
Vehicle exhaust systems and, 11.7.1.3
Engines, 5.17.6. *See also* internal combustion engines
"Explosion-proof," 5.17.6
Portable, 5.17.6, Exhibit 5.59
Epoxy coal tar coatings, 6.6.6.3
Equipment, 5.17
Aluminum components, 5.17.1.3(C), 5.17.1.3(E)
Materials, 5.17.1.3(E)
Minimum requirements, A.4.6
Propane, 5.17
Equivalency requirements, 1.5, 6.19.4.10
Ethyl mercaptan, A.4.2.1, A.4.2.3
Excess-flow valves, A.5.2.5.4, 5.7.4.1(C), 5.7.4.2(A)(2), 5.7.4.2(H)(4), 5.7.8.1(A). *See also* actuated liquid withdrawal excess-flow valves
Cargo tanks, 9.4.2.4
Characteristics, 5.7.4.5(4)
Engine fuel container appurtenances, 11.4.1.3
Internal, 11.4.1.3
Liquid LP-Gas transfer and, 7.2.3
LP-Gas meters, 6.24.3.5
Operation, 5.7.4.5(4), Exhibit 5.35
Pressure regulators and, 5.7.4.1(F)
Sizing, 5.7.8.1(H)
System maximum design flow capacity, 5.7.8.1(H)
Vapor service cylinders, 6.19.2.1
Vehicles, 6.23.7.3
Exchange cylinders, 6.3.9
Exhibitions
Temporary use of cylinders inside buildings for, 6.19.9.1
Exit access
Cylinder storage not permitted in, 8.2.1.3
Expansion loops, 6.9.3.7
"Explosion-proof" engines, 5.17.6
Explosion venting, 10.1.1, 10.2.1.2
Exterior bearing walls
Fire resistance ratings, Commentary Table 6.3

F

Facilities of particular hazard, 13.3.1
Factory-assembled risers, A.5.9.5(E), 6.9.4.4(B)
Farm carts, 3.3.43, 9.3.4, 9.5.2.6
Farm equipment, A.1.3.2(6)
Federal Aviation Administration (FAA), 1.3.2(7), 11.1
Fencing
Security, 6.18.4.2(C)
Field-assembled risers, A.5.9.5(E)
Design-certified, 6.9.4.4(A)
Materials, 6.9.4.4(B)
Pressure testing, 6.9.4.4(A)
Field welding, 5.2.1.6, 6.6.1.3
Fifty (50) percent of perimeter, 6.3.8
Filling methods
Volumetric method filling, 3.3.22.1, 5.7.3.1, 7.4.1, 7.4.3.1
Weight method filling, 3.3.22.2
Film (surface), 6.19.2.1
Final Rule HM-220D, U.S. DOT, 5.2.2.2
Fire Analysis Department, NFPA, 6.25.3.2
Fire damaged DOT cylinders, 5.2.1.2(D)
Fire department response, 6.25
Fire detection, A.3.3.23
Fire extinguishers, 6.25.4.2, A.9.1.1(3)
Class A rating, 8.5.2
Class B rating, 8.5.2
Class C rating, 8.5.2
For cylinder storage locations, 8.5.2
Fire fighters
LP-Gas containers and, A.3.3.68
Fire protection
Defined, A.3.3.23, 6.25.3.1
Emergency responders and, 6.25.2.1, 6.25.2.2
Incident response plans, 6.25.2.2
LP-Gas storage containers, 6.25
Planning, 6.25.2, 6.25.2.1
Fire resistance ratings, 6.6.7.2, Commentary Table 6.3
Point of transfer within buildings, 6.5.4.3
Fire safety analysis, 6.25
Authority having jurisdiction and, 6.25.3.3
Bulk plants, 6.25.3.2
Emergency responders and, 6.25.3.3
Emergency shutoff valves, 6.25.3.5
High value occupancies and, 6.25.3.6
Internal valves, 6.25.3.5
Shutoff valves, 6.25.3.5
Special protection and, 6.25.3.6
For stationary installations, 4.3.1
Total product control, 6.25.3.5
Updating, 6.25.3.4
"Fires at LP-Gas Bulk Plants" (NFPA, Fire Analysis Department), 6.25.3.2
Fire suppression, A.3.3.23
Fire Test Committee, 6.25.5.1
Firm foundation
For cylinders, 6.6.2.1
First-stage pressure regulators, A.1.3.2(6), Exhbit 3.11
Functions of, 6.8.1.4
High-pressure regulators and, 6.8.2 (D)
Installation of, 6.8.1.3, 6.8.1.4
LP-Gas vapor condensation and, 6.9.3.8
Role of, 6.8.2 (B)
Fittings
Brazing, 5.9.4.1
Compression type, A.5.9.5(D)(3)
Flared, 5.9.4.2
Fusion joints, A.5.9.5
Mechanical, A.5.9.5(D)(1), Exhibit 5.48
Metallic piping and tubing, 5.9.4
Polyethylene and polyamide piping and tubing, A.5.9.5(D)
Safety requirements, 9.4.3.2
Fixed fill lines
For rooftop propane tanks, 6.6.7.2, Exhibit 6.22
Fixed maximum liquid level gauges, A.5.2.5.7, 5.7.5.7, Exhibit 5.40
Cylinder size and, 5.7.4.1(H)
Locations for, 5.7.5.7, Exhibit 5.42
Flame effects displays, 6.19.10.5
Flame failure protection
For portable heaters, 6.19.2.8
Flammable gases
Backflow check valves and, 7.3.2.2(C)
Dispersion of, 6.3.10, Exhibit 6.6
Labels, 5.2.8(B), Exhibit 5.13
LP-Gas liquid transfer and, 7.2.2.3
Flammable liquids
Class I, A.6.4.5.3
Class II, A.6.4.5.3
Horizontal separation from containers, 6.4.5.5
In underground tanks, 6.4.5.7
Flammable liquid storage containers
Proximity of LP-Gas containers to, A.6.4.5.3
Flammable vapor-air mixtures
Ignition of, 10.1.1
Flanged piping systems
Gaskets for, 6.9.3.5
Flared fittings, 5.9.4.2
Flashover
Of lightning currents, A.6.22.1.3

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

Flash points, A.6.4.5.3
Flexible connectors, 3.3.25, 5.9.6.4(A), 5.17.5.3, 6.9.6.2, A.9.1.1(3)
Defined, 3.3.25
Metallic, 6.8.1.3, 6.9.6.2
defined, 3.3.25
Minimum design pressure, 9.4.3.4
Replacement of, 9.4.3.7
Floor buffing machines, 5.7.3.5(1), 11.13.1, 11.13.2.3(B), Exhibit 11.14
Flotation devices, 13.2.3.5
Flow capacity
Of pressure relief valves, 5.7.2.7
Flow-check mechanisms, 6.19.3.6(C)
FM Global, 6.25.5.1
Food-warming delivery vehicles, A.6.23.1
Forge-welded containers, A.5.2.1.1
Forklift trucks
LP-Gas fueled, 11.12, Exhibit 11.13
Overfilling prevention devices and, 5.7.4.1(E)
Universal cylinders, 5.7.5.6(B)(2)
Formal Interpretation 58-1, 11.7.4.3
Formal Interpretation 58-01-3, 5.12.4
Formal Interpretation 58-04-01, 6.13
Formal Interpretation 58-04-4, 6.25.3.1
Formal Interpretation 79.1, 6.12.2
Formal Interpretation 79.2, 6.12.2
Formal Interpretation 89-3, 6.19.9.1
Formal Interpretation 95-1, 6.5.3
Form RSPA F7100, A.14.4.3.1
Foundations
For cylinders, 5.2.3.3, 6.6.2.1
Materials for, 6.6.2.1
Noncombustible, 6.6.3.1, Exhibit 6.12
Refrigerated containers, A.12.3.4.2, 12.3.4.6
FPN No. 1, A.6.22.2.2
FPN No. 2, A.6.22.2.2
Frozen ground containers, 1.3.2(1)
Fuel dispensers. *See* vehicle fuel dispensers
Fusible plugs, 5.21.2.4, 11.4.1.7(B)
ASME containers, 5.7.2.12
Fusion joints, A.5.9.5

G

Galley stoves, A.1.3.2(8)
Gas-air mixers, A.3.3.28, 5.21.8
Defined, 5.21.8, 6.21.8
High-pressure orifice, 5.21.8.6, Exhibit 5.65
Installation methods, 5.21.8.6
Process air for, 5.21.8.6
Ratio of gas to air, 6.21.8.4
Venturi, 5.21.8.6
Gas chromatographic analysis, A.4.2.3
Gaseous hydrogen storage, A.6.4.5.8, 6.4.5.9
Gas grill cylinders
Excess-flow valves, 6.19.2.1
Overfilling prevention devices, 5.7.3
Storage, 8.3.5
Tampering protection, 8.2.1.1
Transport of, 9.3.2.5
Valves and connections, 7.2.2.6
Verification of fitness of, A.5.2.1.1
Warning labels, 5.2.8.4, Exhibit 5.16
Gas grill fires, 5.7.3
Gaskets, 5.7.1.3(D), 6.9.3.5
Gas plants
Application of NFPA 58 to, 1.3.1(3)
Exclusion of, 1.3.2(2)
Gas Processors Association (NPA), A.4.2.3
Gas safety, A.5.20.7
Gas stations
Separation of cylinders from gas or diesel fuel at, 8.4.1.1
Gauge pressure, 3.3.61
Gear pumps, Exhibit 5.54
Operation of, Exhibit 5.55
General-purpose vehicles
Defined, 11.1
Engine fuel systems on, 11.1, 11.12
Marking, 11.1
Maximum container capacity, 11.3.5.1, Commentary Table 11.1
General requirements, Chapter 4
General use containers, 5.2.1.6
Glass-forming operations, A.1.3.2(5)
Grass fires, 6.4.5.2
Groundwater
Undertank insulation and, 12.3.4.7
***Guidance Manual for Operators of Small LP-Gas Systems, The* (PHMSA),** 14.4.2.2

H

Half-buried containers, 6.6.6.2
Half-cell meters, 6.16.2
Handling, A.1.1
Hazardous materials
Cargo tank vehicles and, 9.4
DOT container marking requirements, 5.2.8(B)
Marine terminals and, 13.3.1
Placard requirements, 9.3.2.10
Heaters
Cylinder overheating and, 6.19.4.6
Safety, 5.20.4
Heat transfer fluids, 6.21.2.5
Heavy construction requirements, 10.2.1.2, Exhibit 10.1
High-high-liquid level flow cutoff devices, 12.4.1.7
High-liquid level alarms, 12.4.1.3, 12.4.1.6
High-pressure orifice gas-air mixers, 5.21.8.6, Exhibit see5.65
High-pressure regulators, 6.8.2 (D), 6.8.2 (E)
Functions, 6.8.1.4
Installation, 6.8.1.4
High value occupancies
Fire safety analysis and, 6.25.3.6
Holidays
Corrosion and, 6.6.6.1(H)
Horizontal ASME containers, 6.6.3.1
Interconnected, overfilling, 6.6.3.2
Horizontal cylinders
Filling, 5.7.5.6(B)(2)
Overfilling prevention devices and, 5.7.3.5(2), 5.7.3.6
Required markings, 5.7.3.6
Hose, 5.9.6.1
Agricultural applications, 5.9.6.4(D)
Delivery, routing through buildings, 6.5.1.4
Design capacity, 5.9.6.4(B)
"Dry," 9.4.4.5(B)
Failure, 9.4.3.7
Inspection, 7.2.4.5
Kinking, 7.2.4.5
Length, 6.19.2.6
Portable appliances, 6.20.3.3
Pressure testing, 5.9.6.4(C), 7.2.4.5
Protection against physical damage, 6.20.3.8
Replacement frequency, 9.4.3.7
Restrictions, 6.9.3.9
Stainless steel wire braid, 3.3.25.2, 9.4.3.7
Swivel end fittings, 7.2.4.5, Exhibit 7.14
Vehicular non-fuel LP-Gas systems, 6.23.5.1(E)
Wet, 9.4.4.5(B)
Working pressure and, 5.9.6.4(A)
Working pressure requirements, 6.19.2.6
Hose connections, 5.9.6.4(A)
Hose stream resistance, 6.25.5.1
Hot air balloons, 1.3.2(7), 11.1
Hydrocarbon vapors
Low emission transfer, A.3.3.37
Vapor pressure, 3.3.36
Hydrogen containers
Separation distance, A.6.4.5.8
Hydrogen fuel
For vehicles, 1.3.2(11)
Hydrostatic pressure relief valves, 5.13.1, Exhibit 5.51
For liquid LP-Gas piping, 5.9.1.4
Operation of, 6.13
Piping system design pressure and, 5.13.2
Set point of, 5.13.1
For vaporizing burners, 5.21.5.10
Hydrostatic pressure testing
ASME containers, 5.2.1.2(B)

I

Ignition
Prevention of, A.6.22.2.2

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

Ignition sources, 3.3.67, 6.22.2.5
Controlling, 6.22
Engine fuel containers and, 11.3.6.4
LP-Gas transfer operations and, 7.2.3.2(B), 7.2.3.2(C), 7.2.3.2(D)
Recreational vehicles (RVs), 7.2.3.2(E)
Immersion heaters, 5.21.6.6
Immersion suits, 13.2.3.5
Important buildings, 6.3.1
Impractical, 1.4.4
"In attendance"
During LP-Gas liquid transfer, 7.2.1.2
Incident response plans, 6.25.2.2
Incubators (farm equipment), A.1.3.2(6)
Indirect-fired electric waterbath vaporizers, 6.21.2, Exhibit 6.45
Indirect-fired vaporizers, 5.21.2.1, 5.21.2.2
Atmospheric heat, 6.21.2.11
Boilers as heat source for, 6.21.2.9, 6.21.2.10
Defined, 6.21.2
Direct vaporizers *vs.*, 6.21.2.4
Ignition source and, 6.21.2
Installation of, 6.21.2.9
Phase separators and, 6.21.2.10
Remote heat sources, 6.21.2
Vapor discharge piping, 5.21.2.3
Indoor trade shows
Cylinder use for, 6.19.9.1
Industrial containers
Appurtenance requirements, 5.7.4.1, 5.7.4.4
Safety precautions, 7.2.3.5(B)
Water capacity of, 5.7.4.2
Industrial LP-Gas systems
Liquid transfer, 6.17.5.3
Industrial occupancies (plants)
Atmospheric vaporizers, 6.21.2.12
Containers owned by, A.5.2.1.1
Cylinder storage, 8.3
Cylinder warning labels, Exhibit 5.17
LP-Gas storage facilities, 3.3.33
Maintenance procedures, A.14.3
Operating procedures, 14.2.1
Operations and maintenance manuals, A.14.1.2
Industrial truck containers
Storage rack for, 8.4.1.4, Exhibit 8.3
Industrial truck cylinders
Overfilling prevention devices and, 5.7.3.5(1), 5.7.4.1(E)
Pressure relief valves, 5.7.2.13, 11.12.2.5
Requirements for, 11.12.2
Industrial trucks
Atmospheric-type regulators, 11.13.2.1
LP-Gas fueled, 11.12
Propane fueled, 11.1
Infrared heaters
Cylinder overheating and, 6.19.4.6
Inlet openings
Internal valves, 6.26.3.5
In-line hygrometers, 7.4.1, Exhibit 7.16
Inspections
Container internal components, 5.2.1.9
Corrosion, 5.2.3.3
Cylinders, 5.2.3.3
Cylinders filled on site, 5.2.3
Documentation of, 5.2.3.2, 5.2.3.3
Hose, 7.2.4.5
Pressure relief valves, 5.7.2.13
Inspectors
Third-party, 12.6.2
Training and qualification of, 5.2.3.2
Installation. *See also* container installations; cylinder installations
LP-Gas systems, Chapter 6
Safety-enhancing equipment not required, A.6.1.3
Institutional occupancies
Maximum cylinder size, 6.19.7.2
Insulation
Containers, 6.25.5.1
Corrosion caused by water trapped under, 6.25.5.1, Exhibit 6.54
Railroad tank cars, 6.25.5.1
Integral full-capacity relief valves, 5.8.1.2
Integral two-stage regulators, Exhibit 3.12
Operation of, 5.8.1.3
Interchangeable aboveground-underground container assemblies, 6.6.6.1
Specifications for, A.6.6.6.1(D)
Interconnected ASME containers
Overfilling, 6.6.3.2
Interior bearing walls
Fire resistance ratings, Commentary Table 6.3
Intermodal containers, Exhibit 5.6
Defined, A.5.2.1.1
Internal combustion engines, 5.17.6. *See also* engines
At points of transfer, 7.2.3.2(A)
Portable, 5.17.6, Exhibit 5.59
Separation distance, 9.4.10, Exhibit 9.11
Internal excess-flow valves, 11.4.1.3
Internal pressure relief valves, A.3.3.74.4, Exhibit 3.15. *See also* pressure relief valves
Bulk plant containers, 5.7.4.2
Container size and, 5.7.4.3
Design, 5.7.4.1(A)
Industrial containers, 5.7.4.2
Industrial sizes, 5.7.4.2(I)(2)
Lever-operated, for flanged installation, Exhibit 5.31
Lever-operated, for threaded installation, Exhibit 5.30
Liquid inlet openings, 5.7.4.2(F)(2), 5.7.4.5(6)
Pneumatically operated, Exhibit 5.32
As positive shutoff valves, 5.7.4.5(6)
Pump pressure-operated, Exhibit 5.33
Remote operating point, 5.7.4.2(G)
Retrofit installations, 5.7.4.2(C), 5.7.4.2(D)(2)
Types, 5.7.4.2, Exhibit 5.30, Exhibit 5.31, Exhibit 5.32, Exhibit 5.33
Internal valves
Automatic shutoff capability, 6.4.3
Cargo tanks, 9.4.2.4, Exhibit 9.10
Fire safety analysis and, 6.25.3.5
Remote shutoff capability, 6.4.3, 6.11.5
For withdrawal and inlet openings, 6.26.3.5
Interstate Commerce Commission (ICC), A.5.2.1.1
Intrinsically safe equipment
Marine terminals, 13.2.3.3
Isolating spark gaps, A.6.22.1.2

J

Jewelry operations, A.1.3.2(5)
Joint efficiency
Of refrigerated containers, 12.1.1.1
Joint Industry Task Force on Propane Odorization, A.4.2.3

K

Key valves, A.14.4.7
Kilo-pascals, 3.3.61

L

Labeled, 3.2.4
Labels
DOT requirements, 5.2.8(B), Exhibit 5.13
Latent heat of vaporization, 5.21
Leakage
Corrosion holes and, 6.6.6.1(H)
Piping system service limitations and, 6.9.1
Safety considerations, 6.8.1.4
Testing, 6.14.1, 14.4.8.2
Underground containers, A.6.6.6.1(F)(2)
Leak reports, 14.4.9.1
Leak surveys, 14.4.12.4
Leased containers, A.5.2.1.1
"Length-of-stain" tube tests, A.4.2.3
Lever operated internal valves
For flanged installation, Exhibit 5.31
For threaded installation, Exhibit 5.30
Life Safety Code Committee, 8.4.1.1
Lifting lugs, 5.2.4.3(E), 9.6.2.2
Lightning conductors, A.6.22.1.2
Lightning protection, A.6.22.1.2
Lightweight construction requirements, 10.2.1.2, Exhibit 10.1
Line of adjoining property, 6.3.1, Exhibit 6.1
Line pressure regulators, 6.8.1.10

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

"Liquid full," 3.3.58, 7.4.2.2
Liquid inlet openings
Internal pressure relief valves in, 5.7.4.2(F)(2), 5.7.4.5(6)
Options for, 5.7.4.2(H)(4)
Liquid level gauging devices
Fixed maximum, 5.7.5.7
Float type, variable, Exhibit 5.39
Identifying, 5.7.8.5(B)
Rotary type, variable, Exhibit 5.38
Variable, 5.7.5.7, 5.7.5.8
Liquid LP-Gas
Devices preventing return of, 6.21
Gas release during liquid transfer, 7.1.2, Chapter 7
Piping into buildings, 6.19.12.1, 6.19.12.2(J)
Pressure limitations, 6.19.1.2(D)
Liquid LP-Gas piping, 5.9.1.4
Hydrostatic pressure relief valves for, 5.9.1.4
Material requirements, 6.9.1.3
Requirements, 6.19.2.5
Restrictions of use of, 6.9.1
Liquid meters, 5.17.5.1
Liquid propane
Pressurized, 6.4.5.12
Liquid transfer, Chapter 7
ASME container filling, 7.2.2.2
Bulk plants, A.3.3.10, 6.17.5.3
Compressed air or gas prohibited for, 6.18.2
Compressor method, 7.2.3, Exhibit 7.6
Container filling, 7.2.2.2, 7.2.2.7, Exhibit 7.2
Cylinder filling, 7.2.2.2
Determining container code-compliance, 7.2.2.7
Excess-flow check valves and, 7.2.3
Flammable gas mixtures and, 7.2.2.3
Gas release during, 7.1.2, 7.2.1.2, Chapter 7
Hose inspection, 7.2.4.5
Ignition sources and, 7.2.3.2(B), 7.2.3.2(C), 7.2.3.2(D)
Industrial systems, 6.17.5.3
Internal combustion engines and, 7.2.3.2(A)
LP-Gas capacity and, 7.4
Mobile railcar unloading systems, 6.18.2.3(C), Exhibit 6.39
New unused cylinders, 7.2.2.6
Nonrefillable (disposable) cylinders, 7.2.2.6, 7.2.2.8
Operating procedures, 14.2.1.1
Portable compressors, 6.17.3.5, Exhibit 6.36
Pressure differential gravity method, 7.2.3, Exhibit 7.4
Pump method, 7.2.3, Exhibit 7.5
Purging, 7.3.2.2(C)
Qualified persons in attendance during, 7.2.1.2
From railcars to cargo tank trucks, 6.18.2.3(C)
Redundant seals and, 7.2.2.5
Remote shutoff, 6.18.2.4(C)
Transfer system operations, 7.2.3
Venting LP-Gas to atmosphere, 7.3.1
Liquid traps
Compressors, 5.17.3.3, Exhibit 5.57
Liquid withdrawal fittings, 6.6.1.1
Liquid withdrawal lines, 5.7.4.2(B), 5.7.4.2(C)
Liquid withdrawal valves, 6.6.1.1
Listed, A.3.2.1, A.3.2.5
Locking devices, 6.18.4.2(C)
Lock out/tag out procedures, 6.17.2.3(D)
Louvers
Motor vehicles with LP-Gas systems, 6.23.4.2(E)
Low emission transfer, A.3.3.37
Engine fuel systems, 11.4.1.6
Nozzle, Exhibit 6.55
Overfilling prevention, 6.26.5.2(F), 11.4.1.15
Requirements, 6.26.5.1(D)
Separation distance and, 6.26.5
LP-Gas
Anhydrous ammonia contamination and, A.4.5
Burning with oxygen, A.1.3.2(5)
Cloud ignition, 6.25.4.2
High-pressure piping for industrial applications, A.6.9.1.2
Ignition source control, 6.22
As material of trade, A.1.1
Odorization, A.4.2.1, 4.2.2, 5.2.8.5, 14.4.5
Portable cooking appliances, 6.19.8.3
Preventing ignition of, A.6.22.2.2
Refrigerant, 1.3.2(9)
Technical Committee on Liquefied Petroleum Gases, 8.3.1
Transferring directly from railcars to cargo tanks, 4.3.3
Transferring into containers, A.3.3.37
Transport of, A.1.1
Vapor pressure, 3.3.36
Venting to atmosphere, 7.3.1
Warning labels, 5.2.8.4
"LP-Gas: Emergency Planning and Response," 6.25.2.2
LP-Gas Committee, 8.4.1.1
LP-Gas committee, 6.6.6.1(H)
LP-Gas containers. *See* containers
LP-Gas detectors
Portable, 13.2.3.1, Exhibit 13.3
LP-Gas distribution facilities, Chapter 10
Attached structures, 10.3.1
Buildings constructed before 1972, 10.1.2
Common walks, 10.3.1
Construction of rooms within structures, 10.3.2
Heavy construction, 10.2.1.2, Exhibit 10.2
Lightweight construction, 10.2.1.2, Exhibit 10.1
Locations for, 10.2
LP-Gas industry, A.1.1
LP-Gas installations, Chapter 6
Container locations, 6.2
Rural and urban areas, 6.4.1
Separation distances, 6.3
LP-Gas liquid transfer. *See* liquid transfer
LP-Gas-powered vehicles, 6.4.1
Point of transfer, 6.5.4.1
LP-Gas propellants, 10.1.1
LP-Gas railroad tank cars
BLEVEs from, A.3.3.68
LP-Gas storage facilities
Accidents, 6.12
LP-Gas systems
Mounted on motor vehicles, A.6.23.1, 6.23.2, 6.23.3.3
LP-Gas transportation, Chapter 9
History of, Chapter 9
LP-Gas vapor
Accumulation of, 10.2.1.4
Activating remote shutdown with, A.6.10(3)
Burning off, 7.3.2.2(C), Exhibit 7.15
Condensation of, 6.9.1.1
Condensation temperature, 6.9.3.8
Maximum pressure, 6.9.1.1
Pits, sumps and sewers and, 6.21.3.2
Recondensation, 6.8.1.3
LP-Gas vapor piping, Exhibit 15.1
Discharge piping, 6.9.3.4
Sizing, 6.9.2.2
Working pressure design, 6.9.3.3

M

Magnetic gauges, 3.3.29.4
Maintenance. *See* operations and maintenance
Maintenance contractors, 14.3.1.3
Maintenance manuals, 14.3.2.5
Maintenance procedures, A.14.3, 14.3.1.4
Maintenance records, 14.3.2.5
Major renovation, 6.19.4.2
Mandatory references, 2.1
Mandatory requirements, 2.1
Manifold containers
First-stage regulators, 6.8.1.3
Overfilling, 6.6.3.2
Manifold cylinders
Adjacent to buildings, 6.3.6, Exhibit 6.3
Manifolded LP-Gas systems
Installed on different floors from heaters, 6.19.4.9

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

Maximum pressure, 6.19.4.8
Separation of, 6.19.4.8
Manual shutoff valves, A.5.2.5.4, 11.4.1.3
Manufactured homes, A.5.20.6, 6.23.2
Point of transfer hazards, 6.5.3
Marine terminals, 1.3.1(3), 13.2.1, Chapter 13, Exhibit 1.1, Exhibit 13.1
Cargoes of particular hazard, 13.3.1
Electrical equipment, 13.2.2
Emergency procedures manuals, 13.4.3
Facilities of particular hazard, 13.3.1
Flammable liquids handling, 13.2.3, Exhibit 13.2
Flotation devices, 13.2.3.5
Immersion suits, 13.2.3.5
Intrinsically safe equipment, 13.2.3.3
Lighting, 13.2.1.9(5)
Location, 13.2.3
Medical first aid equipment, 13.2.1.13
Mooring equipment, 13.2.1.8
Pipeline protection, 13.3.1
Portable LP-Gas detectors, 13.2.3.1, Exhibit 13.3
Refrigerated facilities, 14.2.1.4
Security, 13.2.1.7
U.S. DOT regulations, 1.3.1(3)
Markings
Direct-fired vaporizers, 5.21.3.1
DOT requirements, 5.2.8(B), Exhibit 5.14
Horizontal cylinders, 5.7.3.6
Underground containers, 6.6.6.1
For variable liquid level gauges, 5.7.5.8
Water capacity, 9.3.2.1
Mass meters, 5.17.5.1
Material of trade, A.1.1
"Maximum allowable quantities," 8.3.1
Maximum allowable working pressure (MAWP), 5.21.2.1
For ASME containers, 5.2.4.2
Metallic piping, 6.9.3.3
For mobile fuel containers, A.5.2.4.4
Waterbath vaporizers, 5.21.6.1
MC-331 cargo tank vehicles, A.9.1.1(3), 9.4.4, Exhibit 9.1
Means of egress, 8.4.1.1
Mechanical fittings, A.5.9.5(D)(1), Exhibit 5.48
Mechanical ventilation systems
As building openings, 6.3.7
Inlet blockage, 10.2.2
Reliability of, 10.2.2
Medical first aid equipment
Marine terminals, 13.2.1.13
Mega-pascals, 3.3.61
Melting points
For metals and alloys, 6.7.2.15, Commentary Table 6.4
Mercantile occupancies
Cylinder storage, 8.3
Merriam-Webster's Collegiate Dictionary, 3.1
Metal alloys
Brazing, 5.9.4.1
Melting points for, Commentary Table 6.4
Metallic connectors, 3.3.25, 6.8.1.3, 6.9.6.2, 6.17.2.2
Metallic fittings, 6.9.3.7
Metallic piping
Burial depth, 6.9.3.12
Expansion loops for, 6.9.3.7
Lightning protection, A.6.22.1.2
Maximum allowable working pressure (MAWP), 6.9.3.3
Protection of, 6.9.3.12
Rules of, A.6.9.3.1
Metallic tubing, 6.9.3.12
Meters
Calibration, 6.17.5.3
Differential back pressure valves, 6.24.3.5, Exhibit 6.51
Excess-flow valves, 6.24.3.5
Field calibration, 5.17.5.1
Half-cell, 6.16.2
In-line hygrometers, 7.4.1, Exhibit 7.16
Liquid, 5.17.5.1
Mass, 5.17.5.1
Positive displacement, 5.17.5.1
Positive displacement liquid, 5.17.5.1, Exhibit 5.58
Turbine, 5.17.5.1
Type approval, 5.17.5.1
Ultrasonic, 5.17.5.1
Vapor, 5.17.5.1
Vehicle-mounted systems, 5.17.5.1
Metric units of measurement, 3.3.61
Mexico
Container installations, 6.4.1
Propane pump discharge pressures, 5.17.2
Michigan Dept. of Labor & Economic Growth, 6.23.3.5
Milford, CT, cylinder valve fire, 7.2.2.5
Minor renovations, 6.19.4.2, 6.19.5.2
Mobile containers
Defined, 3.3.41, 6.23.3.1(F)
Design pressure, 6.23.3.1(F)
Maximum allowable working pressure (MAWP) for, A.5.2.4.4
Mobile homes. *See* manufactured homes
Mobile railcar unloading systems, 6.18.2.3(C), Exhibit 6.39
Modified hydrostatic test method, 5.2.2.2
Monitor nozzles, 6.25.5.3
Mooring equipment, 13.2.1.8
Motor carrier safety regulations, 9.4
Motor vessels, A.1.3.2(8)
Mounded containers
Bottom connections, A.6.6.6.3(1)
Corrosion protection, 6.6.6.1, 6.6.6.3, A.6.6.6.3(4), 6.16.2
Defined, 3.3.42
Installation of, 6.6.6.3
Nameplates for, A.5.2.8.3
Partially buried, 6.6.6.2, A.6.6.6.3(1)
Separation distances, 6.3.4, 6.3.4.1, 6.4.4.5, 6.26.2.3
Special protection, 6.6.6.3, A.6.6.6.3(1), Exhibit 6.20
Mounding materials, A.6.6.6.3(1)
Movable fuel storage tenders, 9.5.2.6
Multifamily buildings
Cylinders in, 6.19.11.2, Exhibit 6.42
Multi-fuel appliances, 5.20.2
Multipurpose passenger vehicles, 3.3.46

N

Nameplates, A.5.2.8.3, Exhibit 5.15
ASME engine fuel containers, 11.3.4(B)
For buried or mounded tanks, A.5.2.8.3
Containers, A.5.2.8.3, Exhibit 5.15
Corrosion and, A.5.2.8.3
Missing, A.5.2.8.3
Refrigerated containers, 12.2.2
National Board Inspection Code (NBIC), 5.2.1.6
National Board of Boiler and Pressure Vessel Inspectors, 6.6.1.3
National Board of Fire Underwriters, Chapter 9
National Board "R" Stamp, 5.2.1.6, Exhibit 5.8
National Bottled Gas Association, 3.3.48
National Conference on Weights and Measures (NCWM), 5.17.5.1
National Fire Protection Association
Official Definitions, Chapter 3
Standards Council, 7.2.2.2, 8.4.1.1
National Fire Protection Association (NFPA)
Fire Analysis Department, 6.25.3.2
As standards-developing organization, 3.3.3
National Geographic, A.4.2.3
National Institute of Standards (NIST)
Handbook 44, 5.17.5.1
National LP-Gas Association, 3.3.48
National Pipe Thread (MNPT), 5.13.1
National Propane Gas Association (NPGA), 3.3.12, 6.25
Defined, 3.3.48
Membership, 3.3.48
Technology and Standards Committee, 3.3.48, A.3.3.68
National Type Evaluation Program (NTEP), 5.17.5.1
NBFU 59, *Regulations for the Design, Construction, and Operation of Automobile Tank Trucks and Tank Trailers for the Transportation of Liquefied Petroleum Gases*, Chapter 9
NEMA 7 liquid-level switches, 5.17.3.3

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

NFPA 10, *Standard for Portable Fire Extinguishers*, 2.1, 6.25.4.2, 8.5.2, 14.3.3.4
NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*, 6.25.5.2
NFPA 30, *Flammable and Combustible Liquids Code*, A.6.4.5.3, 6.4.5.7, 6.26.5, 12.5.4, Chapter 13
NFPA 30-2003, *Flammable and Combustible Liquids Code*, A.6.22.2.2
NFPA 30A, *Code for Motor Fuel Dispensing Facilities and Repair Garages*, 1.3.2(11), 3.3.20, 6.5.3, 6.24, 6.24.4.1
NFPA 30B, *Code for the Manufacture and Storage of Aerosol Products*, 1.3.2(4), 10.1.1
NFPA 37, *Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines*, 6.6.7
NFPA 45, *Standard on Fire Protection for Laboratories Using Chemicals*, 6.19.7.2
NFPA 50, *Standard for Bulk Oxygen Systems at Consumer Sites*, A.6.4.5.8
NFPA 50A, *Standard for Gaseous Hydrogen Systems at Consumer Sites*, A.6.4.5.8
NFPA 51, *Standard for the Design and Installation of Oxygen-Fuel Gas Systems for Welding, Cutting, and Allied Processes*, A.1.3.2(5)
NFPA 51B, *Standard for Fire Prevention During Welding, Cutting, and Other Hot Work*, 6.22.3.4, 7.2.3.2(C)
NFPA 52, *Liquefied Petroleum Gas Piping and Appliance Installations in Buildings*, A.1.3.2(6)
NFPA 54, *National Fuel Gas Code*, A.1.3.2(6), 5.7.8.3, 5.8.1.2(3), 5.9.1.2, 6.8.1.10, A.6.9.1.1(4), 6.9.2.2, 6.14.1, 6.14.2, 6.19.8.1, 6.23.7.5, Chapter 15, Exhibit 1.2
NFPA 55, *Standard for Storage, Use, and Handling of Compressed Gases and Cryogenic Fluids in Portable and Stationary Containers, Cylinders, and Tanks*, A.6.4.5.8, 6.4.5.9
NFPA 58, *Liquefied Petroleum Gas Code*, A.1.3.2(6), Chapter 1
  Application, 1.3, 1.3.1(2)
  Enforcement, 1.7, Chapter 1
  Equivalency, 1.5
  Retroactivity, 1.4
  Scope, A.1.1, Exhibit 1.2
  U.S. Dot regulations and, A.1.1, 1.3.1(2)
NFPA 58-2004, *Liquefied Petroleum Gas Code*, A.6.22.2.2
NFPA 59, *Utility LP-Gas Plant Code*, 1.3.2(3), 5.21.6, Chapter 12, Chapter 13
NFPA 59A, *Standard for the Production, Storage, and Handling of Liquefied Natural Gas (LNG)*, Chapter 13
NFPA 68, *Standard on Explosion Protection by Deflagration Venting*, 10.1.1, 10.2.1.2, Chapter 10
NFPA 70, *National Electrical Code*, 6.9.3.15, 6.21.6.1, 6.22, A.6.22.2.2, 13.2.3.3
NFPA 77, *Recommended Practice on Static Electricity*, A.6.22.1.3, 7.3.2.2(C)
NFPA 85, *Boiler and Combustion Systems Hazards Code*, 6.21.2.6
NFPA *101*, *Life Safety Code*, 3.3.33, 6.19.7.2, 8.2.1.3, 8.3, 8.4.1.1
NFPA 160, *Standard for the Use of Flame Effects Before an Audience*, 6.19.10.5
NFPA 220, *Standard on Types of Building Construction*, 6.6.7
NFPA 290, *Standard for Fire Testing of Passive Protection Materials for Use on LP-Gas Containers*, 6.25.5.1
NFPA 302, *Fire Protection Standard for Pleasure and Commercial Motor Craft*, A.1.3.2(8), 11.1
NFPA 407, *Standard for Aircraft Fuel Servicing*, 6.6.7
NFPA 501, *Standard on Manufactured Housing*, A.5.20.6
NFPA 501B, *Standard for Mobile Homes*, 6.23.2
NFPA 505, *Fire Safety Standard for Powered Industrial Trucks Including Type Designations, Areas of Use, Conversions, Maintenance, and Operations*, 11.12
NFPA 780, *Standard for the Installation of Lightning Protection Systems*, A.6.22.1.2, A.6.22.1.3
NFPA 1192, *Standard on Recreational Vehicles*, 1.3.2(10), A.5.2.4.4, A.5.20.6, 6.23.2, 6.23.9.2, 11.7.1.3
***NFPA 5000, Building Construction and Safety Code*,** 3.3.33, 8.3.1, Chapter 10
Noncombustible foundations
  Installation of ASME containers on, 6.6.3.1, Exhibit 6.12
Noncomplying containers
  Notification of owners, 7.2.2.1
Nondestructive test methods
  ASME containers, 5.2.1.2(B)
Nonferrous materials, 12.1.1.4
Nonrefillable cylinders
  Filling, 7.2.2.8
  Storage in restaurants, 8.3
  Valve outlet seals and, 7.2.2.6
Nonventing liquid level devices, 6.26.5.2(F)
Normal fluids, A.6.9.3.1
NOT ODORIZED marking, 5.2.8.5, Exhibit 5.18
Nylon piping. *See* polyamide (PA) piping

O

Occupiable structures, 6.8.1.6
Odorator, A.4.2.3
Odor fade, A.4.2.3
Odorization, A.4.2.1, 4.2.2, 14.4.5
  NOT ODORIZED marking, 5.2.8.5, Exhibit 5.18
  Restrictions on use of, 5.2.8.5
  Unodorized propane, 5.2.8.5
Office of Pipeline Safety (OPS), A.14.4, A.14.4.3.1
One-call notification system, 14.4.2.2
One-pound cylinders, A.6.19.9.3
One-stage pressure regulation systems, 5.8.1.1
Open-bodied vehicles
  Cylinder transport, 9.3.2.5
Open delivery trucks
  Portable container transport, 9.3.2.1, Exhibit 9.4
Operating procedures, 14.2.1
  Content, 14.2.2.2
  Location, 14.2.1.5
Operations and maintenance, Chapter 14
  Consumer education, 14.4.13.1
  Dew point, 14.4.11.3
  Gas leak reports, 14.4.9.1
  Key valves, A.14.4.7
  Leak surveys, 14.4.12.4
  Leak testing, 14.4.8.2
  LP-Gas liquid transfer, 14.2.1.1
  Maintenance contractors, 14.3.1.3
  Maintenance manuals, 14.3.2.5
  Maintenance procedures, A.14.3, 14.3.1.4
  Maintenance records, 14.3.2.5
  Manuals, A.14.1.2
  Odorization, 14.4.5
  Operating procedures, 14.2.1, 14.2.1.5, 14.2.2.2
  Operator qualification, 14.4.10.1
  Refrigerated LP-Gas storage systems, 14.2.1.4
  Retroactivity, A.14.1
  Vaporizers, 14.2.1.3
Operations & Maintenance Handbook
  CD-ROM, Chapter 14
Operator qualification, 14.4.10.1
Outage gauges, 3.3.29.2
Outdoor appliances
  Overfilling prevention devices for, 5.7.3

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

Outside cylinder storage
Cabinets, 8.4.1.1, Exhibit 8.2
Distance to doorways or openings, 8.4.1.1
Separation distances to building openings, 8.4.1.1
Separation distance to construction work, 8.4.1.3
Separation distance to dispensing stations, 8.4.1.3, 8.4.1.4
Outside surface
Direct-fired vaporizers, 5.21.3.1
Overfilling
ASME containers, 6.6.3.2, 6.6.3.3, 6.6.7.2
ASME engine fuel containers, 11.4.1.13
Cylinders, 5.7.3
Interconnected horizontal ASME containers, 6.6.3.2
Low emission transfer, 6.26.5.2(F), 11.4.1.15
Manifold containers, 6.6.3.2
Portable cylinders, A.7.4.4
Purging and, 7.3.2.2(C)
Refrigerated containers, 12.4
When permitted, 7.4.1
Overfilling prevention devices (OPD), 5.7.3, 6.26.5.2(F), Exhibit 3.8, Exhibit 5.29
ASME engine fuel containers, 11.4.1.13, 11.4.1.15
Checking, before filling cylinders, 7.2.2.7
Cylinders, 5.7.3, 7.2.2.7
Cylinder size and, 5.7.4.1(G)
Cylinder valve restrictions, 5.7.3.4
Defined, 3.3.49
Forklift trucks, 5.7.4.1(E)
Gas grill cylinders, 5.7.3
Horizontal cylinders and, 5.7.3.5(2), 5.7.3.6
Industrial truck service cylinders and, 5.7.3.5(1), 5.7.4.1(E)
Outdoor appliances, 5.7.3
Portable propane cylinders, 5.7.3.1
Propane cylinders, 5.7.3, 5.7.3.1
Purging and, 7.3.2.2(C)
Retrofit provisions, 5.7.3.2
UL listing, 5.7.3.1
Welding cutting gas service and, 5.7.3.5(1)
Overpressure, 5.8.1.2
Overpressure protection
Methods, 5.8.1.2
2 psi regulator systems, 5.8.1.11
Two-stage pressure regulation systems, 6.8.1.8, 6.8.2 (G)
Overpressure shutoff devices, 3.3.50, 5.8.1.2
Owners
Notifying of noncomplying containers, 7.2.2.1
Oxygen containers, A.6.4.5.8
Oxygen-fueled gas systems, A.1.3.2(5)
Oxy-propane torches, A.1.3.2(5), A.6.4.5.8

P

Parking regulations, 9.7, 9.7.2.4, 9.7.3.5, Exhibit 9.15
Pascals (Pa), 3.3.61
Passenger vehicles. *See also* vehicles
Cylinder valve fire, 7.2.2.5
Engine fuel container installation in, 11.8.1.5
Grill cylinder transport in, 9.3.2.5
Maximum container capacity, 11.3.5.1, Commentary Table 11.1
Multipurpose, 3.3.46
Propane systems, 11.1, Exhibit 11.1
Passive cathodic protection systems, 6.16.2
Passive transport shutdown systems, 5.7.8.1(H), 7.2.3.9, Exhibit 7.13
Patio heaters, 6.20.2.2, 6.20.2.3
"Peak shaving" installations, A.3.3.28
Performance requirements
Vehicle impact protection, 6.6.1.2
"Permanently" installed cylinders, A.5.2.1.1
Permitted, 3.3.52
Personnel qualifications, A.4.4, Commentary Table 4.1
Field welding, 6.6.1.3
Training, A.4.4
Welding, 6.9.3.2
Petrochemical plants
Application of NFPA 58 to, 1.3.1(3)
Exclusion of, 1.3.2(2)
Phase separators, 6.21.2.10
"Piggyback" regulators, 5.8.1.3. *See also* integral two-stage regulators
Pigtail, 6.6.2.2, 6.8.1.3
Pilot-operated pressure relief valves, 5.7.2.4(A), 5.7.2.4(B), Exhibit 5.24
Closed position, 5.7.2.4(B), Exhibit 5.25
Open position, 5.7.2.4(B), Exhibit 5.26
Pilot plant, 1.3.2(4)
Pinhole corrosion, 6.6.6.1(H)
Pipeline and Hazardous Materials Safety Administration (PHMSA), A.14.4, 14.4.2.2
Pipeline systems
One-call notification systems, 14.4.2.2
Regulation of, A.1.3.1(4)
Pipeline terminals
Filling cargo tank vehicles at, 7.1.2, Exhibit 7.1
Piping. *See also* discharge piping; liquid LP-Gas piping; LP-Gas vapor piping; metallic piping; polyamide (PA) piping; polyethylene (PE) piping; PVC piping; underground piping
Aboveground, 6.9.3.10
Agricultural applications, 5.9.1.2
Brazing, 5.9.4.1
Connecting, 6.6.2.2
Between container and second-stage regulator, 5.9.1.2
Corrosion protection, 6.9.3.14
Defined, 5.9
Electrical wiring in same trench with, 6.9.4.6(B)
Fittings for metallic piping and tubing, see5.9.4
Flashover of lightning currents on, A.6.22.1.3
Leakage, 6.9.1
Leak testing, 6.14.1
Lightning protection, A.6.22.1.2
Liquid LP-Gas, 5.9.1.4
Material limitations, 6.9.1.1
Operating pressure requirements, 9.4.3.3
Plastic, 5.9.3.2
Pressure limitations, 5.9.4
Pressure testing, 6.14.2
Prohibited as grounding electrode, 6.9.3.15
Redundant fail-safe product control measures (RFPCM), 6.26.4.3(C)
Refrigerated storage systems, 12.1.1.5
Safety requirements, 9.4.3.2
Service limitations, 6.9.1
Sizing methods, Chapter 15
Sizing tables, Chapter 15, Commentary Table 15.2, Commentary Table 15.3, Commentary Table 15.4
Snowfall and, 6.15
Vehicular damage protection, 6.9.3.10
Vehicular liquid LP-Gas installments, 6.23.5.1
Placards, 9.3.2.10, Exhibit 9.5
Plant transport unloading areas
Safety devices, 6.12
Plastic pipe and tubing, 5.9.3.2
Pneumatic valves, 5.12.4
Emergency shutoff, 6.12, 6.12.5, Exhibit 6.29, Exhibit 6.31
Internal pressure relief, Exhibit 5.32
Points of transfer, Exhbit 3.9
In buildings, 6.5.4.1, 6.5.4.3
Defined, 3.3.54
Distance requirements, 6.5.3, Exhibit 6.10
Fire resistance rating and, 6.5.4.3
Hazards, 6.5.3
Internal combustion engines, 7.2.3.2(A)
LP-Gas-powered vehicles, 6.5.4.1
Portable containers, 6.5, Commentary Table 6.2
Separation distances, 6.5.4.2
Stationary containers, 6.5, Commentary Table 6.2
Vehicle fuel dispensers, 6.24

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

POL connectors, 6.6.2.2
POL valves, 6.19.3.6(C)
Polyamide (PA) piping, 3.3.2, 5.9.3.2, A.5.9.5.5
Burial depth, 6.9.4.2
Expansion and contraction of, A.6.9.4.5
Installation, 6.9.4
Mechanical fittings for, A.5.9.5(D)(3)
Protecting with steel pipe, 6.9.4.9
Repairing, 6.9.4.13
Restrictions on use of, A.5.9.5(D)(3), 6.9.1.1, 6.9.4.1
Risers and, A.5.9.5(E)
Tracer wire or pipe for locating, 6.9.4.6(B)
Valve boxes for, 6.9.5.1
Vault installation, 6.9.4.7
Polyethylene (PE) piping, 3.3.2, 5.9.3.2
Burial depth, 6.9.4.2
Expansion and contraction of, A.6.9.4.5
Installation, 6.9.4
Mechanical fittings for, A.5.9.5(D)(3)
Prohibited from indoor use, 6.9.4.1
Protecting with steel pipe, 6.9.4.9
Repairing, 6.9.4.13
Restrictions on use of, A.5.9.5(D)(3), 6.9.1.1
Risers and, A.5.9.5(E)
Tracer wire or pipe for locating, 6.9.4.6(B)
Valve boxes for, 6.9.5.1
Vault installation, 6.9.4.7
Portable appliances
Butane, A.6.19.9.3
Cylinders for, 8.2.1.2, Exhibit 8.1
Hose length for, 6.20.3.3
Propane, A.6.19.9.3
Two-stage regulation and, 6.8.2 (C)
Portable compressors, 5.17.3.4
Liquid transfer, 6.17.3.5, Exhibit 6.36
Vapor recovery, 6.17.3.5, Exhibit 6.36
Portable container appurtenances
Physical damage protection, 5.2.6.2(C)
Portable containers
ASME, 9.3.2.1
As cargo tanks, 9.3.3.8
Container location, A.6.5.1
DOT 51, 9.3.3, Exhibit 9.6
Farm carts, 9.3.4
Filling, 6.5
"Full framework," 5.2.7.3
Integrity of, 6.6.5.4
Maximum size, 9.3.2.1
Open delivery truck transport of, 9.3.2.1, Exhibit 9.4
Point of transfer, 6.5, 6.5.3, Commentary Table 6.2
Stationary installations, 6.6.3.7
Temporary installations, 6.6.5.4
Transportation of, 9.3.3, Chapter 9
Portable cooking appliances
Butane, 6.19.9.4, Exhibit 6.40
Designed weakness points in cylinders for, 5.7.2.3
Listed butane cylinders for, 6.19.9.4, Exhibit 6.41
LP-Gas for, 6.19.8.3
Prohibition of, A.6.19.9.3
Removal after use, 6.19.8.3
Restaurant use of, 8.3
Portable cylinders
CGA 791 and 810 connections, 7.2.2.6
DOT/TC cylinders, A.5.2.1.1
Maximum size, 9.3.2.1
Overfilling, A.7.4.4
Propane capacity, 5.2.8.4
Tampering protection, 8.2.1.1
Warning labels, 5.2.8.4
Portable heaters
Electronic ignition, 6.19.2.8
Flame failure protection, 6.19.2.8
Pilot lights, 6.19.2.8
Safety of, 5.20.4
Structural support restrictions, 6.19.2.8
Portable internal combustion engines, 5.17.6, Exhibit 5.59
Portable LP-Gas detectors, 13.2.3.1, Exhibit 13.3
Portable tanks
Defined, 3.3.57
DOT design specifications, 6.6.3.8
Positive closure, 5.7.4.5(1)
Positive displacement liquid meters, 5.17.5.1, Exhibit 5.58
Positive displacement meters, 5.17.5.1
Positive displacement pumps, 5.17.2, Exhibit 5.52
Bypass for, 6.17.2.3(D), Exhibit 6.34
Positive shutoff valves, 5.7.4.1(C), 5.7.4.2(F)(2), 5.7.4.2(H)(4), 5.7.4.5(6)
Pump bypass return, 9.4.4.3
Positive suction head, 6.17.2.3(D)
Pounds per square inch (psi), 3.3.61
Powder coatings
For corrosion protection, A.11.3.7
Power takeoff, 9.4.4.4
Pressure differential gravity liquid transfer method, 7.2.3, Exhibit 7.4
Pressure gauges, 5.7.6.2
Installing, A.5.2.5.5
Pressure measurements, 3.3.61
Pressure regulation systems
One-stage, 5.8.1.1
Operation of, 5.8.1, Exhibit 5.45, Exhibit 5.46
Overpressure protection, 6.8.1.8
Three-stage, 5.8.1.11
Two-stage, 5.8.1, 5.8.1.2, 6.8.1.8, 6.8.2 (B), 6.8.2 (C), 6.8.2 (G), 6.23.4.2(E), Exhibit 5.47
Pressure regulators. *See* regulators
Pressure relief devices, 3.3.58
Burning gas discharged from, 6.7.2.2
Butane cylinders, 5.7.2.3
Corrosion protection paint color and, A.6.6.1.4
Cylinder orientation and, 6.19.2.1
Defined, 3.3.58
Fire protection requirements, 6.8.1.7
Installation of, 6.7.2.1
Maintenance on, 6.7.2.10
Propane cylinders, 5.7.2.3
Protection of, 6.7.2.5
For water vapor relief, 5.7.2
Pressure relief discharge
Direction of, 6.19.2.1, 11.7.4.3
Engine fuel systems, 11.7.4.3
Truck locations, 11.7.4.3, Exhibit 11.7, Exhibit 11.8
Pressure relief stacks, 6.7.2.7, 6.7.2.12
Pressure relief valve manifolds, 6.7.2.10
For ASME containers, 5.7.2.5, Exhibit 5.27
Pressure relief valves, A.5.2.1.1, 6.7. *See also* internal pressure relief valves
ASME containers, 5.7.2.1, 5.7.2.6, 6.3.9, 6.3.11, 6.7.2.3
ASME engine fuel containers, 11.4.1.7(B)
Blockage, 12.8.1.10
Container position and, 6.6.1.1
Cylinders, 6.3.9
Cylinders in industrial truck service, 5.7.2.13
Direct-fired vaporizers, 5.21.3.3
Direct spring-loaded, 5.7.2.4(A), 5.7.2.4(B)
Discharge from, 6.8.1.8
Discharging liquid, 5.2.5.6(C)
Discharging vapor, 5.2.5.6(C)
Discharging vertically upward, 6.21.2.3
Dispersion of flammable gases from, 6.3.10, Exhibit 6.6
Distance to building opening, 6.3.9
DOT cylinders, 5.7.2.2
DOT nonrefillable metal containers, 5.7.2.3
DOT/TC cylinders, Exhibit 5.19
Engine fuel containers, 11.3.1
Excess-flow, 5.7.4.1(C)
External type, for large ASME containers, 5.7.2.4(A), Exhibit 5.21
External type, for small ASME containers, 5.7.2.4(A), Exhibit 5.22
Fire exposure and, 5.2.5.6(C), 12.8.4.1
5 to 1 safety factor, A.5.2.1.1
Flow capacity of, 5.7.2.7
Flush-type internal, for cargo containers, 5.7.2.4(A), Exhibit 5.23
4 to 1 safety factor, A.5.2.1.1
High temperature and, 6.19.3.4

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

Industrial truck cylinders, 11.12.2.5
Inspection, 5.7.2.13
Installation, 6.23.4.1
Internal, 5.7.4.1(A)
Location, 5.2.5.6(C), 6.23.4.1
Pilot-operated, 5.7.2.4(A), 5.7.2.4(B)
Positioning, 8.2.1.2
Positive shutoff, 5.7.4.1(C)
Pressure settings, 5.7.2.6
Propane cylinders, 5.7.2.2
Rain caps and, 6.7.2.5
Rating calculations, 5.7.2.5
Refrigerated containers, 12.4.2.1, 12.8, 12.8.1.1, 12.8.1.4, 12.8.1.10, 12.8.1.11, 12.8.2, 12.8.4.1, 12.8.4.4
Release of gases through, 6.3.11
Replacement of, 5.7.2.13
Required distance to, 6.3.9
Separation from containers, 6.7.2.7
Sizing, 12.8.1.1, 12.8.1.3, 12.8.2
Start-to-discharge settings for, 6.3.9
Tamperproof nonadjustable internal springs, 5.7.2.10
Testing, 12.8.1.4, 12.8.1.11
Underground containers, 5.7.4.1(A), 6.4.5.1, 6.7.2.11
Vacuum condition protection, 12.8.1.2
Vaporizer, 5.21.9, 6.21.2.2
Venting upwards, 6.7.2.3
Pressure testing
Hose, 5.9.6.4(C)
Piping, 6.14.2
Pressure vessels, A.4.2.3
Authority having jurisdiction and, A.5.2.1.1
Construction requirements, A.5.2.1.1
Design margin, A.5.2.1.1
Design pressure, 7.2.2.9
Welding operations on, 6.6.1.3
Pressurized LP-Gas containers, A.5.2.1.1
Primary storage, A.1.1
Propane
Boiling point, 12.4.2.1, Chapter 12
Condensation temperature of, 6.9.1.1
Engine fuel systems, 6.24, A.9.1.2(4), 11.1, Chapter 11
Flash point and, A.6.4.5.3
Ignition temperature, 7.2.3.2(D)
Not odorized, 5.2.8.5
Pressurized liquid, 6.4.5.12
Refrigerated containers for, Chapter 12
Vaporization of, paint color and, A.6.6.1.4
Vapor pressure of, 6.9.1.1, Commentary Table 6.5
Warning labels, 5.2.8.4
Propane-air mixtures
Gas-air mixers, 6.21.8
Vehicle fuel dispensers, 6.24.3.3
Propane capacity
ASME containers, 3.3.79
Containers, 3.3.79
Cylinders, 3.3.79
Portable cylinders, 5.2.8.4
Warning labels and, 5.2.8.4
Propane containers
Diking, 6.4.5.12
Enclosures for, A.6.4.7
Installation of, A.1.3.2(6)
Location of, 6.2.2
In Mexico, 6.4.1
Proximity to buildings, 6.3.1
Proximity to property lines, 6.3.1
Regulators for, 5.8.1
Separation distances, 6.3.1
Underground, digging around, A.6.6.6.1(E)
Underground service, 5.7.2.7
Propane cylinders
Hot air ballooning, 1.3.2(7)
Indoor storage of, 6.2.2
Maximum size for educational occupancies, 6.19.7.2
Overfilling prevention devices for, 5.7.3, 5.7.3.1
Pressure relief valves, 5.7.2.2, 5.7.2.3
Service pressure, 5.7.2.2
Shopping malls, A.1.3.2(5)
Sprinkler density and, 8.3.1(B)
Storage in non-publicly accessible buildings, 8.3.3.3
Test pressure, 5.7.2.2
Propane dispensers, 1.3.2(11)
Propane Education and Research Council (PERC), 6.25, 6.25.2.2, Chapter 14
"Propane Emergencies, Facilitator's Guide," 6.25.2.2
Propane equipment, 5.17
Propane facilities
Fueling stations, 6.24
Latent heat of vaporization, 5.21
Security requirements, 6.18.4.1
Propane-fueled portable cooking appliances, A.6.19.9.3
Propane-fueled vehicle fueling stations, 6.24, Exhibit 6.50
Low emission nozzles, Exhibit 6.55
Propane-fueled vehicles
General-purpose, 11.1
Industrial trucks, 11.1
Types of, 11.1
Propane-fueled vessels, 11.1
Propane industry regulation, A.3.2.2
Propane-powered floor buffing machines, 11.13.1, 11.13.2.3(B), Exhibit 11.14
Propane pumps
Discharge pressure of, 5.17.2
Operation of, 6.17.2.3(D)
Selection of, 6.17.2.3(D)
Propane tanks
Rooftop, 6.6.7.1, Exhibit 6.21
Propane vapor
Open drains, sewers or sump pits and, 6.21.2.2
Protective housing
For regulator vents, 6.8.1.5
Public access
Refilling points at LP-Gas storage areas, 7.2.3.1
Pull away protection, A.6.12.8, Exhibit 6.33
Cargo tank vehicles, 7.2.3.9
Fuel dispensers, 6.24.4.2
Pull away valves, A.6.12.8, Exhibit 6.32
Pump bypass return
Positive shutoff valves, 9.4.4.3
Pump discharge pressures, 6.17.2.3(D)
Pump liquid transfer method, 7.2.3, Exhibit 7.5
Pump pressure-operated internal valves, Exhibit 5.33
Pumps
Bypass piping, 6.17.2.3(D)
Cargo tank vehicles, 9.4.4.4
Centrifugal, 5.17.2
Discharge pressure of, 5.17.2
Gear, Exhibit 5.54
Lock-out procedures, 6.17.2.3(D)
Operation of, 6.17.2.3(D)
Positive displacement, 5.17.2, Exhibit 5.52
Requirements for, 5.17.2
Selection of, 6.17.2.3(D)
Sliding vane, Exhibit 5.53
Strainers, 6.17.4
Suction inlet pressure, 6.17.2.3(D)
Temperature-operated automatic shutoff, 12.5.9.3
Temperature-sensitive valves, 12.5.9.3
Typical installation, 6.17.2.3(D), Exhibit 6.35
Vibration stresses, 6.17.2.2
Purging, 7.3.2.2(C)
PVC piping, 6.7.2.7
Discharge piping and, 6.7.2.15
For venting regulators, 5.8.3.1

Q

Quick-closing coupling (QCC), 6.19.12.2(J)
Quick connectors, 3.3.62

R

Radiant-type heaters, 6.19.4.6
Railroad sidings, 6.18.2.3(C)
Railroad tank cars
Compressors and, 5.17.3.1
Dome, Exhibit 7.11
Insulation of, 6.25.5.1
Liquid transfer to cargo tank trucks, 6.18.2.3(C)

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

Pull away protection, A.6.12.8, Exhibit 6.33
Transferring LP-Gas directly to cargo tanks from, 4.3.3
Transfer station accidents, 7.2.3.6
Unloading facilities, 7.2.3.6, 7.2.3.7, 7.2.3.8, Exhibit 7.10, Exhibit 7.12
Unloading with compressors, 7.2.3
Warning sign, 7.2.3.6, Exhibit 7.8
Rain caps, 6.7.2.5
"Readily accessible," 11.7.4.3
"Readily available," 13.4.3
Recommendations, 2.1
Recreational vehicles (RVs), 1.3.2(10)
Cylinder storage for, 8.3.5
Ignition sources, 7.2.3.2(E)
With LP-Gas systems, 6.23.2
Point of transfer hazards, 6.5.3
Propane tanks, 3.3.41, Exhibit 3.7
Universal cylinders, 5.7.5.6(B)(2)
Red litmus paper test, A.4.5
Redundant fail-safe product control measures (RFPCM), 6.26, 6.26.4.3(C)
Redundant pressure seals, 7.2.2.5
Referenced publications, Chapter 2
Refineries
Application of NFPA 58 to, 1.3.1(3)
Exclusion of, 1.3.2(2)
Refresher training, A.4.4
Refrigerated containers, Chapter 12
Absolute vapor pressure, 12.1.2.1
Air prohibited in, 12.4.2.2
API 620 code, 12.1.1.1
ASME code, 12.1.1.1
Back pressure relief valves, 12.8.1.2
Design and construction, 12.1
Design pressure, 12.7
Design temperature and pressure, 12.1.2.1
Diking, 12.5, 12.5.4, 12.5.5, 12.5.8.1, 12.5.9.3
Downcomers, 12.5.3
Enclosed drainage channels prohibited, 12.5.3
Foundations, A.12.3.4.2, 12.3.4.6
Frozen ground containers, 1.3.2(1)
High-high-liquid level flow cutoff devices, 12.4.1.7
High-liquid level alarms, 12.4.1.3, 12.4.1.6
Impoundments, 12.5.4
Joint efficiency, 12.1.1.1
Marking requirements, 12.2.2
Nameplates, 12.2.2
Overfilling, 12.4
Pressure relief valve blockage, 12.8.1.10
Pressure relief valves, 12.4.2.1, 12.8
Pressure relief valve sizing, 12.8.1.1, 12.8.1.3, 12.8.1.11, 12.8.4.1, 12.8.4.4
Pressure relief valve testing, 12.8.1.4, 12.8.1.11
Separation from vegetation, 12.7.7
Siting, 12.7
Soil heave and, 12.3.4.6
Spills in diked areas, 12.5.5
Temperature allowances, 12.1.2.2
Temperature sensors, 12.4.1.8
Third-party inspectors, 12.6.2
Types, Chapter 12
Undertank insulation, 12.3.4.7
Uses, Chapter 12
Vacuum relief devices, 12.8.1.2, 12.8.3.1
Welded, 12.1.1.1, 12.1.1.3
Wind loading, 12.3.1.2
Refrigerated LP-Gas, 1.3.2(9), 3.3.63
Refrigerated LP-Gas storage systems, Chapter 12
Design and construction, 12.1.1.1
Monitoring, 14.2.1.4
Piping requirements, 12.3.3.1
Piping system failure, 12.1.1.5
Seismic analysis, 12.3.2.2
Size of, Chapter 12
Refrigeration cycle equipment, 1.3.2(9)
Regulators, 6.7. *See also* first-stage pressure regulators; second-stage pressure regulators; 2 psi regulator systems
Automatic changeover, 6.8.1.4, Exhbit 3.12, Exhibit 6.24
Excess-flow valves and, 5.7.4.1(F)
Failure, 5.8.1.2
Functions, 5.8.1, 6.8.1.4
High-capacity, 5.8.1.2(3), 5.8.1.8
High-pressure, 6.8.2 (D), 6.8.2 (E)
Line pressure, 6.8.1.10
Outdoor installation, 5.8.1.2
Propane safety and, 5.8.1
Single-stage, 6.8.1.9, 6.8.2 (B)
Types, 3.3.64, Commentary Table 3.1, Exhibit 3.11, Exhibit 3.12, Exhibit 3.13
Weather protection, 6.8.1.5
Regulator venting pipe, 5.8.3.1
Regulator vents
Discharging, 6.6.6.1(G)
Protective housing for, 6.8.1.5
Remote bulkheads, 6.5.3, Exhibit 6.10
Remote control
Bulk plants shutdown, A.6.10(3)
Emergency shutoff valves (ESVs), 6.12, 6.12.9
Filling engine fuel containers, Exhibit 11.3, Exhibit 11.12
Internal valve shutoff, 6.4.3, 6.11.5
Liquid transfer shutoff, 6.18.2.4(C)
LP-Gas vapor shutdown, A.6.10(3)
Shutoff valves with thermal actuation, 6.24.3.8, 6.24.3.10
Renovation sites equivalency requirements, 6.19.4.10
"Repair" templates, 5.2.1.6, Exhibit 5.8
Requalification
Containers, 5.2.2.2
Cylinder markings, 5.2.2.2
Cylinders, 5.2.2.2, 11.3.1.4(D), 11.3.1.5
DOT cylinders, 5.2.2.2, 11.3.1.4(D), 11.3.1.5
Requalifier identification number (RIN), 5.2.2.2, 5.2.3.3
Residential buildings
Cylinder storage within, 8.3, 8.3.5
Residential customers
Containers owned by, A.5.2.1.1
Restaurants
Cylinder storage within, 8.3, 8.3.2.3
Cylinder use in, 6.19.9.1, 6.19.9.4
Patio heaters, 6.20.2.2
Retail delivery cargo tank vehicles. *See* bobtails
Retail marketing
Bulk plant, A.3.2.2
Residential installations, A.3.2.2
Vehicle, A.3.2.2
Retail stores
Cylinder storage, 8.4.1.2, Exhibit 8.2
Retroactivity, 1.4
Retrofitting
Internal pressure relief valves, 5.7.4.2(D)(2)
Liquid withdrawal lines, 5.7.4.2(C)
Retroactive requirements, 1.4.2
Rim relief, 6.19.9.4
RIN (requalifier identification number), 5.2.2.2, 5.2.3.3
Risers
Anodeless, 3.3.2, A.5.9.5(E), 6.9.4.3(B)
Factory-assembled, 6.9.4.4(B)
Field-assembled, A.5.9.5(E), 6.9.4.4(A), 6.9.4.4(B)
Integrity of, 6.9.4.3(C)
Rocketing, 5.7.2.3, 6.19.9.4
Roofing industry, 6.23.3.5
Rooftop containers
Allowed uses, 6.19
ASME containers, 6.5.1.3, 6.6.7, 6.6.7.2
Requirements for, 6.6.7
Rooftop cylinders
Allowed uses, 6.19, 6.19.1.2(B)
For emergency fuel supply, 6.19.1.2(C)
Permanent installations, 6.19.11
Prohibited storage, 8.2.1.5
Rooftop propane tanks, 6.6.7.1, Exhibit 6.21
Fixed fill lines for, 6.6.7.2, Exhibit 6.22
Rotary gauges, 3.3.29.4
"R" stamp certification, 6.6.1.3
Rubber gaskets, 6.9.3.5
Rural container installations, 6.4.1

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

S
Sacrificial anodes, A.5.9.5(E), 6.16.2
Saddles, 6.6.3.1, Exhibit 6.13
Saddle trailers, Exhibit 9.13
Safety factors, A.5.2.1.1
SafEvac valves, A.5.2.5.4
Sandford, North Carolina, emergency shutoff valve incident, 6.12.9
SCFM, 5.7.2.8
Secondary storage, A.1.1
Second-stage pressure regulators, A.1.3.2(6), Exhibit 3.13
Discharge pressure limits, 5.8.1.2
High-pressure regulators and, 6.8.2 (D)
LP-Gas vapor condensation and, 6.9.3.8
Overpressure protection, 6.8.1.8
Piping downstream of, 5.9.1.2
Role of, 6.8.2 (B)
Security requirements
Dispensing stations, 6.24.3.7
Fencing, 6.18.4.2(C)
Fire safety analysis and, 6.25
Locking devices, 6.18.4.2(C)
Marine terminals, 13.2.1.7
Propane facilities, 6.18.4.1
Seismic considerations
ASME containers, 6.6.7.2
Self-extinguishing materials, 6.6.3.3
Self-vaporizing liquid burners, 6.21.5. *See also* vaporizing burners
Semi-refrigerated LP-Gas storage systems, Chapter 12
Semitrailer cargo tank vehicles, 9.4, Exhibit 9.9
As temporary storage, 9.5.2.1
Separation distances
Between aboveground containers, 6.3.4
Building extensions and, 6.3.11
Building openings, 8.4.1.1
Buildings, 6.3.1, 6.3.3
Buildings used for gas manufacturing, 6.3.5
Emergency shutoff valves (ESVs), 6.4.3
Exchange cylinders, 6.3.9
Flammable and combustible liquids, 6.4.5.5
Flammable and combustible liquids in underground tanks, 6.4.5.7
Important buildings, 6.3.1
Internal combustion engines, 9.4.10, Exhibit 9.11
Line of adjoining property, 6.3.1, Exhibit b.1
Low emission transfer and, 6.26.5
Mounded containers, 6.3.4, 6.4.4.5, 6.26.2.3
Oxygen and gaseous hydrogen containers, A.6.4.5.8
Point of transfer, 6.5.4.2
Rural and areas, 6.4.1
Smaller containers, 6.4.5.6
Smoking, 7.2.3.2(B)
Two-hour fire resistance ratings and, 6.4.5.9
Underground containers, 6.3.4, 6.4.4.5, 6.26.2.3
Vaporizing burners, 6.21.5
Vehicle fuel dispensers, 6.24
Service head adapters, 3.3.65
Service interruptions
Cylinder replacement following, 5.7.8.3
Shutoff valves
ASME engine fuel containers, 11.4.1.8
Carburetion equipment, 11.5
Direct-fired vaporizers, 6.21.3.5
Engine fuel systems, 11.13.2.1
Fire safety analysis and, 6.25.3.5
First-stage regulators, 6.8.1.3
Installation of, 6.7.2.10
Location, 6.20.3.6
Manually operated, A.5.2.5.4
Quick-acting, 6.24.3.13
Readily accessible, 11.7.4.3
Remotely operated, with thermal actuation, 6.24.3.8, 6.24.3.10
Sierra Nevada mountains
Snowfall model law, 6.15
Sight flow indicators, 5.17.7, Exhibit 5.60, Exhibit 5.61
Single-stage pressure regulators, 6.8.1.9, 6.8.2 (B)
Sliding vane pumps, Exhibit 5.53
Slugging, 7.2.3
Smoking
Prohibition, 9.4.10
Separation distance, 7.2.3.2(B)
Sniff testing, A.4.2.3, 14.4.5
Snowfall
Container installation protection, 6.6.3.6, Exhibit 6.14
Model law, 6.15
Piping installations and, 6.15
Snow stakes, 6.6.3.6, Exhibit 6.14
Soil heave
Refrigerated containers and, 12.3.4.6
Solder, 6.9.3.5
Solenoid-actuated valves
ASME engine fuel containers, 11.4.1.8
Sources of ignition, 3.3.67
Spark-ignition internal combustion engines, 3.3.67
Special buildings or rooms
Cylinder storage within, 8.3
Defined, 8.3.4.3
Special Permit 11209, 9.5.2.6
Special Permit 13341, 9.6.1.2, Exhibit 9.14
Special protection, Exhibit 6.52
Defined, 6.25.5
Fire safety analysis and, 6.25.3.6
Modes of, 6.25.5
Mounded containers, 6.6.6.3, A.6.6.6.3(1), Exhibit 6.20
Splash guards
Motor vehicles with LP-Gas systems, 6.23.3.4(I)
Spring-loaded pressure relief valves, 5.21.2.4
Sprinkler systems
Cylinder storage and, 8.3.1(B)
Stainless steel containers, A.11.3.7
Stainless steel reinforced tub, 3.3.25.2
Stainless steel wire braid hose, 3.3.25.2, 9.4.3.7
Stain tube test, A.4.2.3
Standard cubic foot, 5.7.2.8
Stand-by systems
Gas-air mixers, 5.21.8
State boiler agencies, A.5.2.1.1
Stationary containers
Transportation of, 9.6.1.2, Exhibit 9.13
Stationary installations
Filling, 6.5, 6.5.2
Fire safety analysis for, 4.3.1
Plans submitted to AHJ, 4.3.1
Point of transfer, 6.5, 6.5.3, Commentary Table 6.1
Portable containers in, 6.6.3.7
Steel container failure, 6.25.5.1
Steel cylinders
Corrosion protection painting, A.6.6.1.4
DOT 4BA-240, A.5.2.1.1
Steel tubing, 6.23.5.1
"Stop, Tank Car Connected" warning sign, 7.2.3.6, Exhibit 7.8
Storage. *See also* cylinder storage; outside cylinder storage; refrigerated LP-Gas storage systems
Accidents, 6.12
Cylinders, Chapter 8
Gaseous hydrogen, A.6.4.5.8, 6.4.5.9
Indoor, 6.2.2
Industrial occupancies, 3.3.33
Lightning protection, A.6.22.1.2
Primary, A.1.1
Propane cylinders, 6.2.2
Propane cylinders for hot air ballooning, 1.3.2(7)
Secondary, A.1.1
Separation distances, 6.3.1
Tertiary, A.1.1
Utility gas plants, 1.3.2(3)
Storage and transfer facilities, 1.3.1(3), Exhibit 1.1
Public access, 7.2.3.1
Strainers, 6.17.4
Strapping systems, 5.2.4.3(E)
"Study of Cleaning Methods for LP-Gas Transports, A" (Battelle Memorial Institute), A.4.4.5
Submerged-combustion vaporizers, 6.21.3

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

Suction inlet pressure, 6.17.2.3(D)
Sulfur, 4.2.2
Sump pumps, 12.5.8.1
Supplement I, Guidelines for Conducting a Fire Safety Analysis, 6.25.3.2

T

Tamperproof nonadjustable internal springs, 5.7.2.10
Tank cars. *See also* railroad tank cars
Transfer from, 6.12.1, Exhibit 6.30
Unloading station safety devices, 6.12
Tank heaters, 5.21
Defined, 6.21.4
Direct gas-fired, 5.21.4.7
Spacing requirements, 6.21.4.1
Tar kettles, A.6.23.1, 6.23.3.5
Technical Committee on Liquefied Petroleum Gases, 1.3.2(1), 1.3.2(3), 2.1, 3.3.12, 3.3.48, A.3.3.68, A.5.2.1.1, 5.2.1.1(A), 5.7.2.2, 5.7.4.2, 5.7.4.2(I)(2), A.6.9.3.1, A.6.10(3), 6.21.3.6, 6.25.3.1, 8.3.1
Technical Committee on Liquefied Petroleum Gases at Utility Plants, Chapter 12
Technical Committee on LP-Gas at Utility Gas Plants, 1.3.2(3)
Technical Committee on Special Effects, 6.19.10.5
Technical Committee on Water Spray Fixed Systems, 6.25.5.2
Technical documentation, 1.5.2
Temperature
Cylinders inside buildings and, 6.19.3.4
Temperature sensors
Refrigerated containers, 12.4.1.8
Temporary heating equipment
Cylinders for, 6.19.8.1
Temporary installations, 4.3.2
Portable containers, 6.6.5.4
10-percent gauge, 3.3.29.2
Tentative Interim Agreement (TIA), 8.4.1.1
Tertiary storage, A.1.1
Test and Specification Committee, Compressed Gas Association, 3.3.12
Test flares, 6.21.8, Exhibit 6.47
Thermal actuation
Remotely operated shutoff valves, 6.24.3.8, 6.24.3.10
"Thermal inertia," 7.4.2.2
Therminol, 6.21.2.5
Thiophane (tetrahydrothiophene, THT), A.4.2.3
Three-stage pressure regulation systems, 5.8.1.11
TIA (01-1), 5.2.3
Tiling
Cylinders, 6.6.1.1
Title 24, Code of Federal Regulations
24 CFR 3280 "Mobile Home Construction and Safety Standard," 6.23.2
Title 49, Code of Federal Regulations (CFR), A.1.1, 3.3.57, 5.2.7.3
49 CFR, Parts 190-192, A.14.4
49 CFR 100-185, 9.4
49 CFR 173.301, 5.7.2.3
49 CFR 173.304, 5.7.2.3
49 CFR 173.315, 9.5.2.6
49 CFR 177.834, Subpart B, *Hazardous Materials Regulations,* 6.23.3.3
49 CFR 180, Continuing Qualification and Maintenance of Packagings, 5.2.2.2
49 CFR 192, A.1.3.1(4)
49 CFR 195, 13.3.1
49 CFR 393, "Motor Carrier Safety Regulations," 6.23.3.3
49 CFR 397.13, 9.4.10
49 CFR 712.502, 9.3.2.10
49 CFR 712.532[6], 9.3.2.10
Cylinder marking under, 5.2.8(B)
Total product control, 6.25.3.5
Tracer wires or tapes
For locating underground piping, 6.9.4.6(B)
Tractor-trailers (transports), 9.5.2.1, Exhibit 9.9
Training, A.4.4
Transfer systems
LP-Gas liquid transfer, 7.2.3
Transportation regulations, Chapter 9. *See also* Title 49, Code of Federal Regulations (CFR)
Commerce, A.1.1
U.S. Department of Transportation, A.1.1, 1.3.1
Transport Canada (TC)
Cylinder regulations, A.5.2.1.1
Transportation regulations, Chapter 9
Transport trucks, 3.3.11
Unloading stations, 7.2.3.4, Exhibit 7.7
Unloading with compressors, 7.2.3
Tubing
Fittings for metallic piping and tubing, see 5.9.4
Plastic, 5.9.3.2
Polyamide (PA, or nylon), 5.9.3.2,
Polyethylene (PE), 5.9.3.2
Sizing tables, Chapter 15
Turbine meters, 5.17.5.1
20-percent gauge, 3.3.29.2
Two-hour fire resistance ratings
Separation distance and, 6.4.5.9
2P nonrefillable metal containers, 5.7.2.3, 8.3.2.1
2 psi regulator systems, A.1.3.2(6), Exhibit 1.2
CSST systems and, A.6.8.2(H)
Overpressure protection, 5.8.1.11
2Q nonrefillable metal containers, 5.7.2.3, 8.3.2.3
Two-stage pressure regulation systems, 5.8.1, 5.8.1.3, 11.5, Exhibit 3.12, Exhibit 5.47, Exhibit 11.4
Components of, 6.8.2 (B)
Fixed piping systems, 6.8.2 (B)
Motor vehicles with LP-Gas systems, 6.23.4.2(E)
Overpressure protection, 6.8.1.8, 6.8.2 (G)
Portable appliances and, 6.8.2 (C)
Preventing overpressure with, 5.8.1.2
Type approval
Meters, 5.17.5.1

U

U. S. Environmental Protection Agency (EPA), 6.6.6.1(F)(2)
U-200 ASME specifications, A.5.2.1.1
U-201 ASME specifications, A.5.2.1.1
U-68 containers, 5.2.1.1, A.5.2.1.1, 5.2.4.2
U-69 containers, A.5.2.1.1, 5.2.1.3, 5.2.4.2
UL 132, *Standard on Safety Relief Valves for Anhydrous Ammonia and LP-Gas,* A.5.2.1.1, 5.7.2.4(A)
UL 144, *Standard for LP-Gas Regulation,* 5.8.1.2, 6.8.1.5
UL 644, *Container Assemblies for LP-Gas,* A.6.6.6.1(D)
UL 651, *Schedule 40 and 80 Rigid PVC Conduit,* 5.8.3.1, 6.7.2.7
UL 147A, *Nonrefillable (Disposable) Type Fuel Gas Cylinder Assemblies,* A.6.19.9.3, 8.3.2.3
UL 147B, *Nonrefillable (Disposable) Type Metal Container Assemblies for Butane,* 6.19.9.4, 8.3.2.3
UL-listed materials, 3.3.72
Ultrasonic meters, 5.17.5.1
Underground containers
Abandonment, A.6.6.6.1(F)(2)
Aboveground containers over, 6.4.5.1
Aboveground installations, 5.7.2.7
Access, 6.3.11
Cathodic protection systems, A.6.6.6.1(H)
Collapse, A.6.6.6.1(F)(2)
Corrosion protection, 6.6.6.1, 6.6.6.1(H), A.6.6.6.1(H), 6.6.6.2, 6.16.2
Digging around, A.6.6.6.1(E)
External pressure relief valves, 5.7.4.1(A)
Filling methods, 7.4.1
Installation, 6.6.6.1, Exhibit 6.16, Exhibit 6.17, Exhibit 6.18
Leaking, A.6.6.6.1(F)(2)
Marking, 6.6.6.1

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

Nameplates, A.5.2.8.3
Partially underground, 6.6.6.2
Pressure relief valves, 6.4.5.1, 6.7.2.11
Preventing shifting of, A.6.6.6.1(J)
Propane, 5.7.2.7
Relief stack requirements, 6.7.2.12
Separation distances, 6.3.4, 6.3.4.1, 6.4.4.5, 6.26.2.3
Serving dispersing stations, 6.7.2.13
Vehicular traffic protection, A.6.6.6.1(B), A.6.6.6.1(C)
Underground gasoline tanks
Leaking, A.6.6.6.1(F)(2)
Underground heating oil tanks
Leaking, A.6.6.6.1(F)(2)
Underground piping
Burial depth, 6.9.3.12
Coating, 6.16.2
Corrosion protection, 6.9.3.14, 6.16.2
Damage prevention, 14.4.2.2
Protection, 6.9.3.12
Tracer wire or tape for, 6.9.4.6(B)
Undertank heating systems, 12.3.4.6
Undertank insulation, 12.3.4.7
Underwriters Laboratories, Inc. (UL), 3.3.72, 6.8.1.5
Universal cylinders, 3.3.74, 5.7.3.5(1), 8.4.1.4, 8.4.2.1
Filling in horizontal position, 5.7.5.6(B)(2)
Position of, 11.12.2.5
Requirements for, 11.12.2
Urban area container installations, 6.4.1
U.S. Bureau of Weights and Measures, 6.24.4.1
U.S. Coast Guard, 1.3.1(3), 13.2.3.5, 13.3.1
U.S. Department of Housing and Urban Development (HUD), A.5.20.6
U.S. Department of Transportation (DOT), 3.3.57
Cargo tank vehicle safety requirements, 7.2.3.9
Composite cylinders, 5.2.1.1
Container marking requirements, 5.2.8(B)
Cylinder requirements, A.5.2.1.1
Design specifications for portable tanks, 6.6.3.8
Final Rule HM-220D, 5.2.2.2
Jurisdiction, 1.3.2(7)
Marine terminal regulations, 1.3.1(3)
Office of Motor Carrier Safety, 9.1.2
Pressure relief valves, 5.7.2.2
Transportation regulations, A.1.1, 1.3.1(2), A.5.2.5.4, Chapter 9
U.S. Environmental Protection Agency (EPA), Chapter 14
U.S. Occupational Safety and Health Administration (OSHA), A.3.2.2, 6.17.2.3(D)
Utility companies
One-call notification systems, 14.4.2.2
Utility gas plants
LP-Gas storage, 1.3.2(3)

V

Vacuum fuel locks, 11.5, Exhibit 11.6
Vacuum relief devices
Refrigerated containers, 12.8.1.2, 12.8.3.1
Valve boxes, 6.9.5.1
Valve outlet seals
Nonrefillable (disposable) cylinders, 7.2.2.6
Redundant, 7.2.2.5
Valves. *See also* actuated liquid withdrawal excess-flow valves; backflow check valves; emergency shutoff valves (ESVs); excess-flow valves; hydrostatic pressure relief valves; internal pressure relief valves; internal valves; pressure relief valves; shutoff valves
Brass, 9.4.3.9
Internal, A.3.3.74.4, Exhibit 3.15
Performance criteria for materials, 5.12.1(C)
Redundant pressure seals for, 7.2.2.5
Safety requirements, 9.4.3.2, 9.4.3.4
Vapor discharge piping, 5.21.2.3
Vapor eliminators, 5.17.5.1
Vaporization
Latent heat of, 5.21
Process, 6.21
Volumetric method filling and, 3.3.22.1
Vaporizer pressure relief valves, 5.21.9
Vaporizers, 5.21. *See also* direct-fired vaporizers; indirect-fired vaporizers
Boilers as heat source for, 6.21.2.9, 6.21.2.10
Defined, 3.3.75
Devices preventing return of liquid LP-Gas and, 6.21
Electric, 3.3.75.2
First-stage regulators, 6.8.1.3
Indirect-fired electric waterbath, 6.21.2, Exhibit 6.45
Internal capacity, 5.21.2.5
Maintenance, 6.21
Operating procedures, 14.2.1.3
Operator training, 6.21
Pressure relief valves, 6.21.2.3
Submerged-combustion, 6.21.3
Testing, 6.21
Types, 6.21
Uses, 6.21
Waterbath, 3.3.75.4, 5.21.2, 5.21.6, 5.21.6.1, Exhibit 6.45
Vaporizing burners, 5.21.5, 6.21, Exhibit 5.64
Automatic shutdown devices, A.5.21.5.8
Defined, 6.21.5
Hydrostatic relief valves, 5.21.5.10
Installation, 6.21.5
Separation distances, 6.21.5
Temporary use, 5.21.5.10
Uses, 6.21.5
Vapor meters, 5.17.5.1
Vapor piping, 6.19.2.5
Vapor pressure, 3.3.36, 12.1.2.1
Vapor service cylinders, 6.19.2.1
Vapor withdrawal lines, 5.7.4.2(A)(2), 5.7.8.5(B)
Vapor withdrawal openings, 5.7.4.2(E)(2)
Vapor withdrawal valves, 9.6.2.2
Variable liquid level gauges, Exhibit 5.43
Float type, Exhibit 5.39
Gauge scale, 5.7.5.8
Markings, 5.7.5.8
No. 54 drill size opening, 5.7.5.10
Reliability, A.5.2.5.7
Rotary type, Exhibit 5.38
Variable liquid level gauging devices, 5.7.5.7
Vegetation
Refrigerated containers and, 12.7.7
Vehicle exhaust systems, 11.7.1.3
Vehicle fuel dispensers, 6.24
Anchorage, 6.24.3.12, 6.24.4.2
Defined, 3.3.20
Differential back pressure valves, 6.24.3.5
Hose length limits, 6.24.4.2
Installation instructions, 6.24.3.1
Propane-air mixtures, 6.24.3.3
Pull away protection, 6.24.4.2
Security, 6.24.3.7
Separation distances from points of transfer, 6.24
Separation of propane and gasoline dispensers, 6.24.4.3
Shutoff valves, 6.24.3.8, 6.24.3.10, 6.24.3.13, 6.24.3.14
Vehicle fuel types, 6.24
Vehicle non-fuel LP-Gas systems
Container installation limitations, 6.23.3.1
Container mounting arrangements, 6.23.3.4(I)
Storage quantity, 8.3.3.4
Vehicle refueling stations, 1.3.2(11), 6.4.1, 6.24
Vehicles. *See also* cargo tank vehicles; general-purpose vehicles; passenger vehicles; recreational vehicles
Alternate vehicle, 6.24
Closed-bodied, 9.3.2.5
Dispensing stations and, 7.2.3.4
Food-warming delivery, A.6.23.1
Impact protection, 6.6.1.2
Internal combustion engines, 7.2.3.2(A)
LP-Gas-powered, 6.4.1, 6.24

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

Maximum container capacity, 11.3.5.1, Commentary Table 11.1
Open-bodied, 9.3.2.5
Placard display, 9.3.2.10, Exhibit 9.5
Semitrailer cargo tank, 9.4, 9.5.2.1, Exhibit 9.9
Service equipment containers, 8.3, 8.3.3.4
Vehicular damage protection, 8.2.1.1
Aboveground piping, 6.9.3.10
Cylinder storage and, A.8.4.2.2
Performance requirements, 6.6.1.2
Underground containers, A.6.6.6.1(B), A.6.6.6.1(C)
Vehicular non-fuel LP-Gas systems, 6.23.3
Appliance installation, 6.23.7.3
Container appurtenances, 6.23.3.4(I), 6.23.4.1
Container installation, 6.23.3.1, 6.23.3.1(F)
Container location, 6.23.3.3
Container mounting arrangements, 6.23.3.4(I)
Excess-flow valves, 6.23.7.3
Hose length, 6.23.5.1(E)
Parking, servicing, and repair of vehicles, 6.23.9.2
Piping, 6.23.5.1
Separation of LP-Gas systems from combustion systems, 6.23.7.5
Steel tubing, 6.23.5.1(A)
Tar kettle cylinders, 6.23.3.5
Two-stage pressure regulation, 6.23.4.2(E)
Types, A.6.23.1
Vent blockage tests, 5.8.1.2
Vent discharge elevation, 6.8.1.8, Exhibit 6.26
Vent extensions, 6.8.1.5, Exhibit 6.25
Ventilated caps, 5.2.6.1, 6.19.2.1
Ventilated collars, 5.2.6.1
Venting gas to atmosphere, 7.3.1, 7.3.2.2(C)
Venting gas within buildings, 6.5.4.2
Venturi gas-air mixers, 6.21.8, Exhibit 6.47
Venturi mixers, 5.21.8.6
Vertical ASME containers, Exhibit 5.12, Exhibit 6.15
Applications, 6.6.4.1
Attached supports, 5.2.7.1(C)
Continuous steel skins, 5.2.7.1(C)
Lifting lugs, 5.2.4.3(E)
Manifolded, 6.6.4.5
Structural base, fire protection, 6.6.4.3
Vessels
Propane-fueled, 11.1
Visual cylinder inspection, 5.2.3.3
Visual requalification method, 5.2.2.2
Volumetric method filling, 5.7.3.1, 7.4.1, 7.4.3.1
Defined, 3.3.22.1

W

Wallpaper steamers, 8.3.2.2
Warning labels
Cylinders, 5.2.8.4
Gas grill cylinders, 5.2.8.4, Exhibit 5.16
Industrial cylinders, Exhibit 5.17
Portable cylinders, 5.2.8.4
Waterbath vaporizers, 3.3.75.4, 5.21.6
Class I, Group D locations, 6.21.6.1
Immersion heaters, 5.21.6.6
Maximum allowable working pressure (MAWP), 5.21.6.1
Safety controls, 5.21.6.1
Venturi gas-air mixers, 6.21.8, Exhibit 6.47
Water capacity markings, 9.3.2.1
Water-jacket hydrostatic test method, 5.2.2.2
Water levels
Discharging regulator vents above, 6.6.6.1(G)
Water spray fixed protection, Exhibit 6.53
Automatic activation, 6.25.5.2
Criteria for, 6.25.5.2
Monitor nozzles, 6.25.5.3
Performance problems, 6.25.5.2
Weather shelters, 6.5.1.1
Weep holes, 6.7.2.5
Weight method filling, 3.3.22, 7.4.1
Welded refrigerated containers
Acceptable defects, 12.1.1.1
Construction standards, 12.1.1.3
Piping system failure, 12.1.1.5
Welder qualifications, 6.9.3.2
Welding
ASME engine fuel containers, 11.3.3.3
Cylinders used in, 5.7.3.5(1)
Field welding, 5.2.1.6, 6.6.1.3
LP-Gas transfer operations and, 7.2.3.2(C)
Pressure vessels, 6.6.1.3
Purging requirements, 6.22.3.4
Wet hose, 9.4.4.5(B)
Wheel chocks, 7.2.3.6, Exhibit 7.9
Wind loading, 12.3.1.2
Wire braid
Carbon steel, 5.9.6.2
Stainless steel, 3.3.25.2, 9.4.3.7
Withdrawal openings, 6.26.3.5
Wood cylinder foundations, 6.6.2.1
Wood enclosures, A.6.4.7

Z

Zero governors, 11.13.2.1
Zinc, 5.17.1.3(E)

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

IMPORTANT NOTICES AND DISCLAIMERS CONCERNING NFPA® DOCUMENTS

NOTICE AND DISCLAIMERS OF LIABILITY CONCERNING THE USE OF NFPA DOCUMENTS

NFPA codes, standards, recommended practices, and guides, including the documents contained herein, are developed through a consensus standards development process approved by the American National Standards Institute. This process brings together volunteers representing varied viewpoints and interests to achieve consensus on fire and other safety issues. While the NFPA administers the process and establishes rules to promote fairness in the development of consensus, it does not independently test, evaluate, or verify the accuracy of any information or the soundness of any judgments contained in its codes and standards.

The NFPA disclaims liability for any personal injury, property or other damages of any nature whatsoever, whether special, indirect, consequential or compensatory, directly or indirectly resulting from the publication, use of, or reliance on these documents. The NFPA also makes no guaranty or warranty as to the accuracy or completeness of any information published herein.

In issuing and making these documents available, the NFPA is not undertaking to render professional or other services for or on behalf of any person or entity. Nor is the NFPA undertaking to perform any duty owed by any person or entity to someone else. Anyone using these documents should rely on his or her own independent judgment or, as appropriate, seek the advice of a competent professional in determining the exercise of reasonable care in any given circumstances.

The NFPA has no power, nor does it undertake, to police or enforce compliance with the contents of these documents. Nor does the NFPA list, certify, test or inspect products, designs, or installations for compliance with these documents. Any certification or other statement of compliance with the requirements of these documents shall not be attributable to the NFPA and is solely the responsibility of the certifier or maker of the statement.

ADDITIONAL NOTICES AND DISCLAIMERS

Updating of NFPA Documents

Users of NFPA codes, standards, recommended practices, and guides should be aware that these documents may be superseded at any time by the issuance of new editions or may be amended from time to time through the issuance of Tentative Interim Amendments. An official NFPA document at any point in time consists of the current edition of the document together with any Tentative Interim Amendments and any Errata then in effect. In order to determine whether a given document is the current edition and whether it has been amended through the issuance of Tentative Interim Amendments or corrected through the issuance of Errata, consult appropriate NFPA publications such as the National Fire Codes® Subscription Service, visit the NFPA website at www.nfpa.org, or contact the NFPA at the address listed below.

Interpretations of NFPA Documents

A statement, written or oral, that is not processed in accordance with Section 6 of the Regulations Governing Committee Projects shall not be considered the official position of NFPA or any of its Committees and shall not be considered to be, nor be relied upon as, a Formal Interpretation.

Patents

The NFPA does not take any position with respect to the validity of any patent rights asserted in connection with any items which are mentioned in or are the subject of NFPA codes, standards, recommended practices, and guides, and the NFPA disclaims liability for the infringement of any patent resulting from the use of or reliance on these documents. Users of these documents are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, is entirely their own responsibility.

NFPA adheres to applicable policies of the American National Standards Institute with respect to patents. For further information, contact the NFPA at the address listed below.

Law and Regulations

Users of these documents should consult applicable federal, state, and local laws and regulations. NFPA does not, by the publication of its codes, standards, recommended practices, and guides, intend to urge action that is not in compliance with applicable laws, and these documents may not be construed as doing so.

Copyrights

The documents contained in this volume are copyrighted by the NFPA. They are made available for a wide variety of both public and private uses. These include both use, by reference, in laws and regulations, and use in private self-regulation, standardization, and the promotion of safe practices and methods. By making these documents available for use and adoption by public authorities and private users, NFPA does not waive any rights in copyright to these documents.

Use of NFPA documents for regulatory purposes should be accomplished through adoption by reference. The term "adoption by reference" means the citing of title, edition, and publishing information only. Any deletions, additions, and changes desired by the adopting authority should be noted separately in the adopting instrument. In order to assist NFPA in following the uses made of its documents, adopting authorities are requested to notify the NFPA (Attention: Secretary, Standards Council) in writing of such use. For technical assistance and questions concerning adoption of NFPA documents, contact NFPA at the address below.

For Further Information

All questions or other communications relating to NFPA codes, standards, recommended practices, and guides and all requests for information on NFPA procedures governing its codes and standards development process, including information on the procedures for requesting Formal Interpretations, for proposing Tentative Interim Amendments, and for proposing revisions to NFPA documents during regular revision cycles, should be sent to NFPA headquarters, addressed to the attention of the Secretary, Standards Council, NFPA, 1 Batterymarch Park, Quincy, MA 02169-9101.

For more information about NFPA, visit the NFPA website at www.nfpa.org.

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

Tentative Interim Amendment
NFPA 58
Liquefied Petroleum Gas Code
2008 Edition

Reference: 11.6.3
TIA 08-3
(SC 07-10-5/TIA Log #890)

Pursuant to Section 5 of the NFPA Regulations Governing Committee Projects, the National Fire Protection Association has issued the following Tentative Interim Amendment to NFPA 58, *Liquefied Petroleum Gas Code,* 2008 edition. The TIA was processed by the Technical Committee on Liquefied Petroleum Gases, and was issued by the Standards Council on October 4, 2007, with an effective date of October 24, 2007.

A Tentative Interim Amendment is tentative because it has not been processed through the entire standards-making procedures. It is interim because it is effective only between editions of the standard. A TIA automatically becomes a proposal of the proponent for the next edition of the standard; as such, it then is subject to all of the procedures of the standards-making process.

1. Make the following changes to Section 11.6.3:

~~**11.6.3** Hose that is utilized at lower than container pressure shall be designed and marked for its maximum anticipated operating pressure.~~

11.6.3 Hose, Hose Connections, and Flexible Connectors.

11.6.3.1 Hose, hose connections, and flexible hose connectors (see 3.3.26) used for conveying LP-Gas liquid or vapor at pressures in excess of 5 psig (34.5 kPag) shall be fabricated of materials resistant to the action of LP-Gas both as liquid and vapor and the hose and flexible hose connector and shall be reinforced with stainless steel wire braid.

11.6.3.2 Hose that can be exposed to container pressure shall be designed for a pressure rating of 350 psig (2.4 MPag) with a safety factor of 5 to 1, and the reinforcement shall be of corrosion-resistant material.

11.6.3.3 Hose shall be continuously marked with LP-GAS, PROPANE, 350 PSI WORKING PRESSURE and the manufacturer's name or trademark. Each installed piece of hose shall contain at least one such marking.

11.6.3.4 After the application of couplings, hose assemblies shall be capable of withstanding a pressure of not less than 700 psig (4.8 Mpag). If a pressure test is performed, such assemblies shall be pressure tested at 120 percent of the pressure rating [350 psig (2.4 Mpag) minimum] of the hose.

11.6.3.5 Hose used for vapor service at 5 psig (34.5 kPag) or less shall be constructed of material resistant to the action of LP-Gas.

11.6.3.6 Hose in excess of 5 psig (34.5 kPag) service pressure and quick connectors shall be approved.

11.6.3.7 Hose that is utilized at lower than container pressure shall be designed and marked for its maximum anticipated operating pressure.

Issue Date: October 4, 2007

Effective Date: October 24, 2007

Copyright © 2007 All Rights Reserved
NATIONAL FIRE PROTECTION ASSOCIATION

Copyright 2014 National Fire Protection Association (NFPA). Licensed, by agreement, for individual use and download on October 7, 2014 to UNIVERSITY OF MARYLAND. No other reproduction or transmission in any form permitted without written permission of NFPA. For inquires or to report unauthorized use, contact licensing@nfpa.org.

Tentative Interim Amendment
NFPA 58
Liquefied Petroleum Gas Code
2008 Edition

Reference: 5.2.1.5 (New)
TIA 08-2
(SC 07-10-4/TIA Log #884)

Pursuant to Section 5 of the NFPA Regulations Governing Committee Projects, the National Fire Protection Association has issued the following Tentative Interim Amendment to NFPA 58, *Liquefied Petroleum Gas Code,* 2008 edition. The TIA was processed by the Technical Committee on Liquefied Petroleum Gases, and was issued by the Standards Council on October 4, 2007, with an effective date of October 24, 2007.

A Tentative Interim Amendment is tentative because it has not been processed through the entire standards-making procedures. It is interim because it is effective only between editions of the standard. A TIA automatically becomes a proposal of the proponent for the next edition of the standard; as such, it then is subject to all of the procedures of the standards-making process.

1. Add the following text to NFPA 58:

5.2.1.5 Except for containers used in cargo tank vehicle service, ASME containers of 3,000 gallons water capacity or less used to store anhydrous ammonia shall not be converted to LP-gas fuel service.

2. Renumber current 5.2.1.5 through 5.2.1.9 as 5.2.1.6 through 5.2.1.10.

Issue Date: October 4, 2007

Effective Date: October 24, 2007

Copyright © 2007 All Rights Reserved
NATIONAL FIRE PROTECTION ASSOCIATION